Online ISSN : 2249-4626
Print ISSN : 0975-5896
DOI : 10.17406/GJSFR

Global Journal

of Science Frontier Research: D

Agriculture & Veterinary

Associated Non Paddy Soils

Environmental Impact of Agrochemical

Highlights

Evaluation of Irrigation Regime

Defense Responses of Wheat Seedling

Discovering Thoughts, Inventing Future

VOLUME 20 ISSUE 3 VERSION 1.0

© 2001-2020 by Global Journal of Science Frontier Research, USA

Global Journal of Science Frontier Research: D
Agriculture & Veterinary

Global Journal of Science Frontier Research: D
Agriculture & Veterinary

Volume 20 Issue 3 (Ver. 1.0)

Open Association of Research Society

© Global Journal of Science Frontier Research. 2020.

All rights reserved.

This is a special issue published in version 1.0 of "Global Journal of Science Frontier Research." By Global Journals Inc.

All articles are open access articles distributed under "Global Journal of Science Frontier Research"

Reading License, which permits restricted use. Entire contents are copyright by of "Global Journal of Science Frontier Research" unless otherwise noted on specific articles.

No part of this publication may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopy, recording, or any information storage and retrieval system, without written permission.

The opinions and statements made in this book are those of the authors concerned. Ultraculture has not verified and neither confirms nor denies any of the foregoing and no warranty or fitness is implied.

Engage with the contents herein at your own risk.

The use of this journal, and the terms and conditions for our providing information, is governed by our Disclaimer, Terms and Conditions and Privacy Policy given on our website http://globaljournals.us/terms-and-condition/menu-id-1463/

By referring / using / reading / any type of association / referencing this journal, this signifies and you acknowledge that you have read them and that you accept and will be bound by the terms thereof.

All information, journals, this journal, activities undertaken, materials, services and our website, terms and conditions, privacy policy, and this journal is subject to change anytime without any prior notice.

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

Global Journals Inc.

*(A Delaware USA Incorporation with "Good Standing"; **Reg. Number: 0423089**)*
Sponsors: Open Association of Research Society
Open Scientific Standards

Publisher's Headquarters office

Global Journals® Headquarters
945th Concord Streets,
Framingham Massachusetts Pin: 01701,
United States of America
USA Toll Free: +001-888-839-7392
USA Toll Free Fax: +001-888-839-7392

Offset Typesetting

Global Journals Incorporated
2nd, Lansdowne, Lansdowne Rd., Croydon-Surrey,
Pin: CR9 2ER, United Kingdom

Packaging & Continental Dispatching

Global Journals Pvt Ltd
E-3130 Sudama Nagar, Near Gopur Square,
Indore, M.P., Pin:452009, India

Find a correspondence nodal officer near you

To find nodal officer of your country, please email us at *local@globaljournals.org*

eContacts

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investors@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

Pricing (Excluding Air Parcel Charges):

Yearly Subscription (Personal & Institutional)
250 USD (B/W) & 350 USD (Color)

Editorial Board

Global Journal of Science Frontier Research

Dr. John Korstad

Ph.D., M.S. at Michigan University, Professor of Biology, Department of Biology Oral Roberts University, United States

Dr. Alicia Esther Ares

Ph.D. in Science and Technology, University of General San Martin, Argentina State University of Misiones, United States

Dr. Sahraoui Chaieb

Ph.D. Physics and Chemical Physics, M.S. Theoretical Physics, B.S. Physics, cole Normale Suprieure, Paris, Associate Professor, Bioscience, King Abdullah University of Science and Technology United States

Tuncel M. Yegulalp

Professor of Mining, Emeritus, Earth & Environmental Engineering, Henry Krumb School of Mines, Columbia University Director, New York Mining and Mineral, Resources Research Institute, United States

Andreas Maletzky

Zoologist University of Salzburg, Department of Ecology and Evolution Hellbrunnerstraße Salzburg Austria, Universitat Salzburg, Austria

Dr. Gerard G. Dumancas

Postdoctoral Research Fellow, Arthritis and Clinical Immunology Research Program, Oklahoma Medical Research Foundation Oklahoma City, OK United States

Dr. Mazeyar Parvinzadeh Gashti

Ph.D., M.Sc., B.Sc. Science and Research Branch of Islamic Azad University, Tehran, Iran Department of Chemistry & Biochemistry, University of Bern, Bern, Switzerland

Dr. Indranil Sen Gupta

Ph.D., Mathematics, Texas A & M University, Department of Mathematics, North Dakota State University, North Dakota, United States

Dr. Richard B Coffin

Ph.D., in Chemical Oceanography, Department of Physical and Environmental, Texas A&M University United States

Dr. A. Heidari

Ph.D., D.Sc, Faculty of Chemistry, California South University (CSU), United States

Dr. Xianghong Qi

University of Tennessee, Oak Ridge National Laboratory, Center for Molecular Biophysics, Oak Ridge National Laboratory, Knoxville, TN 37922, United States

Dr. Vladimir Burtman

Research Scientist, The University of Utah, Geophysics Frederick Albert Sutton Building 115 S 1460 E Room 383, Salt Lake City, UT 84112, United States

Dr. Shyny Koshy

Ph.D. in Cell and Molecular Biology, Kent State University, United States

Dr. Gayle Calverley

Ph.D. in Applied Physics, University of Loughborough, United Kingdom

Dr. Bingyun Li

Ph.D. Fellow, IAES, Guest Researcher, NIOSH, CDC, Morgantown, WV Institute of Nano and Biotechnologies West Virginia University, United States

Dr. Baziotis Ioannis

Ph.D. in Petrology-Geochemistry-Mineralogy Lipson, Athens, Greece

Dr. Matheos Santamouris

Prof. Department of Physics, Ph.D., on Energy Physics, Physics Department, University of Patras, Greece

Dr. Vyacheslav Abramov

Ph.D in Mathematics, BA, M.Sc, Monash University, Australia

Dr. Fedor F. Mende

Ph.D. in Applied Physics, B. Verkin Institute for Low Temperature Physics and Engineering of the National Academy of Sciences of Ukraine

Dr. Moustafa Mohamed Saleh Abbassy

Ph.D., B.Sc, M.Sc in Pesticides Chemistry, Department of Environmental Studies, Institute of Graduate Studies & Research (IGSR), Alexandria University, Egypt

Dr. Yaping Ren

School of Statistics and Mathematics, Yunnan University of Finance and Economics, Kunming 650221, China

Dr. Yilun Shang

Ph.d in Applied Mathematics, Shanghai Jiao Tong University, China

Dr. T. David A. Forbes

Associate Professor and Range Nutritionist Ph.D. Edinburgh University - Animal Nutrition, M.S. Aberdeen University - Animal Nutrition B.A. University of Dublin-Zoology

Dr. Bing-Fang Hwang

Department of Occupational, Safety and Health, College of Public Health, China Medical University, Taiwan Ph.D., in Environmental and Occupational Epidemiology, Department of Epidemiology, Johns Hopkins University, USA Taiwan

Dr. Moaed Almeselmani

Ph.D in Plant Physiology, Molecular Biology, Biotechnology and Biochemistry, M. Sc. in Plant Physiology, Damascus University, Syria

Dr. Giuseppe A Provenzano

Irrigation and Water Management, Soil Science, Water Science Hydraulic Engineering , Dept. of Agricultural and Forest Sciences Universita di Palermo, Italy

Dr. Eman M. Gouda

Biochemistry Department, Faculty of Veterinary Medicine, Cairo University, Giza, Egypt

Dr. Claudio Cuevas

Department of Mathematics, Universidade Federal de Pernambuco, Recife PE, Brazil

Dr. Arshak Poghossian

Ph.D. Solid-State Physics, Leningrad Electrotechnical Institute, Russia Institute of Nano and Biotechnologies Aachen University of Applied Sciences, Germany

Dr. Qiang Wu

Ph.D. University of Technology, Sydney, Department of Mathematics, Physics and Electrical Engineering, Northumbria University

Dr. Lev V. Eppelbaum

Ph.D. Institute of Geophysics, Georgian Academy of Sciences, Tbilisi Assistant Professor Dept Geophys & Planetary Science, Tel Aviv University Israel

Prof. Jordi Sort

ICREA Researcher Professor, Faculty, School or Institute of Sciences, Ph.D., in Materials Science Autonomous, University of Barcelona Spain

Dr. Eugene A. Permyakov

Institute for Biological Instrumentation Russian Academy of Sciences, Director Pushchino State Institute of Natural Science, Department of Biomedical Engineering, Ph.D., in Biophysics Moscow Institute of Physics and Technology, Russia

Prof. Dr. Zhang Lifei

Dean, School of Earth and Space Sciences, Ph.D., Peking University, Beijing, China

Dr. Hai-Linh Tran

Ph.D. in Biological Engineering, Department of Biological Engineering, College of Engineering, Inha University, Incheon, Korea

Dr. Yap Yee Jiun

B.Sc.(Manchester), Ph.D.(Brunel), M.Inst.P.(UK) Institute of Mathematical Sciences, University of Malaya, Kuala Lumpur, Malaysia

Dr. Shengbing Deng

Departamento de Ingeniera Matemtica, Universidad de Chile. Facultad de Ciencias Fsicas y Matemticas. Blanco Encalada 2120, Piso 4., Chile

Dr. Linda Gao

Ph.D. in Analytical Chemistry, Texas Tech University, Lubbock, Associate Professor of Chemistry, University of Mary Hardin-Baylor, United States

Angelo Basile

Professor, Institute of Membrane Technology (ITM) Italian National Research Council (CNR) Italy

Dr. Bingsuo Zou

Ph.D. in Photochemistry and Photophysics of Condensed Matter, Department of Chemistry, Jilin University, Director of Micro- and Nano- technology Center, China

Dr. Bondage Devanand Dhondiram

Ph.D. No. 8, Alley 2, Lane 9, Hongdao station, Xizhi district, New Taipei city 221, Taiwan (ROC)

Dr. Latifa Oubedda

National School of Applied Sciences, University Ibn Zohr, Agadir, Morocco, Lotissement Elkhier N66, Bettana Sal Marocco

Dr. Lucian Baia

Ph.D. Julius-Maximilians, Associate professor, Department of Condensed Matter Physics and Advanced Technologies, Department of Condensed Matter Physics and Advanced Technologies, University Wrzburg, Germany

Dr. Maria Gullo

Ph.D., Food Science and Technology Department of Agricultural and Food Sciences, University of Modena and Reggio Emilia, Italy

Dr. Fabiana Barbi

B.Sc., M.Sc., Ph.D., Environment, and Society, State University of Campinas, Brazil Center for Environmental Studies and Research, State University of Campinas, Brazil

Dr. Yiping Li

Ph.D. in Molecular Genetics, Shanghai Institute of Biochemistry, The Academy of Sciences of China Senior Vice Director, UAB Center for Metabolic Bone Disease

Nora Fung-yee TAM

DPhil University of York, UK, Department of Biology and Chemistry, MPhil (Chinese University of Hong Kong)

Dr. Sarad Kumar Mishra

Ph.D in Biotechnology, M.Sc in Biotechnology, B.Sc in Botany, Zoology and Chemistry, Gorakhpur University, India

Dr. Ferit Gurbuz

Ph.D., M.SC, B.S. in Mathematics, Faculty of Education, Department of Mathematics Education, Hakkari 30000, Turkey

Prof. Ulrich A. Glasmacher

Institute of Earth Sciences, Director of the Steinbeis Transfer Center, TERRA-Explore, University Heidelberg, Germany

Prof. Philippe Dubois

Ph.D. in Sciences, Scientific director of NCC-L, Luxembourg, Full professor, University of Mons UMONS Belgium

Dr. Rafael Gutirrez Aguilar

Ph.D., M.Sc., B.Sc., Psychology (Physiological), National Autonomous, University of Mexico

Ashish Kumar Singh

Applied Science, Bharati Vidyapeeth's College of Engineering, New Delhi, India

Dr. Maria Kuman

Ph.D, Health and Happiness Books, Department of Physics and Space, United States

Contents of the Issue

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 20 Issue 3 Version 1.0 Year 2020
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Characterization and Classification of Paddy and Associated Non Paddy Soils of Upper Brahmaputra Valley of Assam

By Zenesia A. Phillips, Dr. R. M Karmakar & Dr. S. Dutta
Assam Agricultural University

Abstract- An investigation was done to characterize and classify paddy and associated nonpaddy soils of the Upper Brahmaputra Valley of Assam. In this study, three districts viz., Sivasagar, Jorhat, and Golaghat in the Brahmaputra valley of Assam were selected. These districts are located in the Upper Brahmaputra Valley Zone (UBV) of Assam. Combined, they cover an approximate area of 9021 sq. Km or about 55.7 per cent of UBV. Six soil profiles, three each from mono-cropped paddy and, associated nonpaddy areas were collected from the districts mentioned. These samples were collected Horizon wise from each soil profile. Each soil sample was dried and passed through a 2 mm sieve. The samples from each pedon were evaluated for morphological and Physicochemical characteristics, based on morphological and physicochemical properties. The soils were classified as Aquic Dystric Eutrudepts (P1), Dystric Eutrudepts (NP1, NP2, P3, NP3) and Dystric Fluventic Eutrudepts (P2).

Keywords: *mono-cropped, morphological, physic-chemical, horizon, pedon.*

GJSFR-D Classification: *FOR Code: 050399, 070199*

Strictly as per the compliance and regulations of:

© 2020. Zenesia A. Phillips, Dr. R. M Karmakar & Dr. S. Dutta. This is a research/review paper, distributed under the terms of the Creative Commons Attribution-Noncommercial 3.0 Unported License http://creativecommons.org/licenses/by-nc/3.0/), permitting all non commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Characterization and Classification of Paddy and Associated Non Paddy Soils of Upper Brahmaputra Valley of Assam

Zenesia A. Phillips [α], Dr. R. M Karmakar [σ] & Dr. S. Dutta [ρ]

Abstract- An investigation was done to characterize and classify paddy and associated nonpaddy soils of the Upper Brahmaputra Valley of Assam. In this study, three districts viz., Sivasagar, Jorhat, and Golaghat in the Brahmaputra valley of Assam were selected. These districts are located in the Upper Brahmaputra Valley Zone (UBV) of Assam. Combined, they cover an approximate area of 9021 sq. Km or about 55.7 per cent of UBV. Six soil profiles, three each from mono-cropped paddy and, associated nonpaddy areas were collected from the districts mentioned. These samples were collected Horizon wise from each soil profile. Each soil sample was dried and passed through a 2 mm sieve. The samples from each pedon were evaluated for morphological and Physicochemical characteristics, based on morphological and physicochemical properties. The soils were classified as Aquic Dystric Eutrudepts (P1), Dystric Eutrudepts (NP1, NP2, P3, NP3) and Dystric Fluventic Eutrudepts (P2).

Keywords: mono-cropped, morphological, physic-chemical, horizon, pedon.

I. Introduction

Soils show diverse behavior owing to differences in pedogenic pathways they have gone through in the course of pedogenesis. The pedogenic processes has been reflected in soil morphological, physicochemical, mineralogical, and other properties. Collecting soil information through a systematic soil survey is a prudent way of registering the holistic picture of the behavior of soils in a particular area. Information gathered tells about soil morphology, genesis, properties, and classification (M. Balthazar, *et al.*, 2016).

Morphology of the soils is an expression of the effect of soil-forming factors and processes. The formation of paddy soils has been induced by the practice of puddling, followed by flooding and drainage regime, which leads to the development of a plow-pan and specific redoximorphic features of the soil (Kogel-Knabner *et al*., 2010). Change in soil were caused by artificial hydromorphism, normally associated with rice cultivation, which is the change in dominant soil colour from brown to gray (with chroma <2) with the presence of mottles, higher in chroma (Kanno, 1956). The pattern of gray colour formation in paddy soils varied according to water management and ground water hydrology (Moormann and van Breeman, 1978). The colour of rice growing soils of Assam ranged from very pale brown to gray (Baruah *et al*., 1996; Dey 1987) with the occurrence of mottles of higher chroma (6-8) and low chroma (<2) which are indicative of hydromorphic characteristics (Das, 1990).

Typical paddy growing soils of Assam have characteristic plow-pans with high bulk densities (Das, 1990). Gangopadhyay *et al*. (1998) observed that the texture of rice growing soils of upper Assam varied from sandy loam in the surface to sandy loam and loam to sand in the subsurface horizons. Dutta (2001) reported that the texture of the paddy and non-paddy soils varied from sandy clay loam to clay and from sandy loam to clay loam respectively.

Puddling in paddy soils is the most common method of rice cultivation, which damages soil structure in plow-layer of these soils and decreases pores and voids in this layer (Hassannezhad *et al*., 2008). Puddling leads to deteriorated soil physical properties by breaking down soil aggregates and forming hardpans at shallow depths in paddy soils. This practice leads to induced changes in pore size distribution; and the increase in bulk density (BD) of the soil (Zhou *et al.,* 2014). The structure of rice growing soils of the Brahmaputra valley of Assam was massive in the surface and weak to moderately develop in the surface horizons (Das, 1990; Baruah *et al*., 1996). Plow-sole was reported to form in medium-textured and well drained Latosol (Grant, 1965) but absent in sandy young alluvial, calcareous soils (Moormann and Dudal, 1964) and in much fined textured soils (Stout, 1966). Fukushi and Iwama (1982) confirmed that plow-sole formation steadily deceases from well drained to poorly drained soils.

The paddy soils developed on recent alluvium was reported to have lower clay content in the surface (Kanno *et al*., 1964; Somasiri, 1985). In strongly acid soils, seasonal wetting, and drying causes breakdown of clay by a process called ferrolysis, resulting in lower clay content in the surface soils (Brinkman, 1970).

II. Physicochemical Characteristics

An understanding of the physical and chemical conditions of any soil is necessary for the proper

Author: Division of soil science, Assam Agricultural University – Jorhat 785013, India. e-mail: zenesia_phillips@yahoo.com

© 2020 Global Journals

implementation of soil management practices. Therefore, the study of soil physicochemical properties is necessary, since it affects soil productivity. Physicochemical study of soil were based on various parameters, which included; pH, bulk density, electrical conductivity, texture, moisture, temperature, soil organic matter, available nitrogen, phosphorus and, potassium (Tale and Indole, 2015).

There are several reports that paddy cultivation increases the bulk density of surface layer and leads to the formation of plow-sole of higher bulk density (Motomura *et al*., 1970; Meelu *et al.,* 1979). Studies by Kurniati *et al.* (2015) suggested that generally, paddy soils had a higher value than dry soil. Paddy profiles showed a plow- pan layer found below the top soil. This layer showed an increase in bulk density value as compared to that of top soil or layers below. This was mainly attributed to the puddling process during rice cultivation.

Motomura *et al.* (1970) and Mitsuchi (1974) observed a significant increase in organic matter content in the lowland paddy soils and yellow paddy soils, and the effect of cultivation was recognized only in the surface horizon. Similar observations had been made on the paddy soils of China (Okajima and Imai, 1981; Xi, 1981). On the contrary, several workers reported a decrease in organic matter content in surface layers of paddy soils (Van Veen *et al.,* 1984; Katou *et al.,* 1985). Dey and Sehgal (1997) reported that organic matter content was lower in paddy, than the associated non-paddy soils due to repeated cycles of wetting and drying. Zhang and Chen (2009) reported that surface soil organic carbon and $CaCO_3$ had notable changes within the initial stage (50 yrs) of paddy cultivation. Clay content and free iron oxides changed notably, when paddy cultivation history reached 700 years. The results of gains and losses of key elements indicate Ca, Mg, and Na are strongly lost in the initial stage (50 yrs) of paddy cultivation and gradually depleted with increasing paddy cultivation over time. The decomposition of organic matter is less efficient under anaerobic conditions during the anthropogenic submergence of paddy top soils, resulting in more accumulation of organic matter relative to the nonpaddy top soils (Kalbitz, *et al*., 2013).

It has been known that in paddy soils, the overall effect of submergence is to increase the pH of the acid soils and to decrease the pH of the alkaline soils. The increase in pH of acid soil is mainly due to the reduction of ferric oxides and oxyhydroxides (Ponnamperuma *et al.,* 1966). But after the harvest of rice, the pH of the paddy soils becomes acidic. Prasad and Jondhale (2006) observed that rice soils had lower pH and higher organic matter content than their non-growing counterparts, with minor amounts of Ca and Mg ions as compared to non-paddy soils. Further studies have shown that pH in paddy soil was higher than pH from dry land. Flooded soil causes increased bases solubility, so the concentration of H+ in the soil was reduced. Increasing the pH in acid soils as a result of flooding is controlled by system Fe2+ - Fe (OH) that consumes H+ (Kurniati *et al.,* 2015).

Paddy soils exhibited higher CEC than the associated nonpaddy profiles (Dutta, 2001). Baruah *et al*. (1996) also reported exchangeable H^+ as the dominant acid cation in surface soils of the rice- growing areas of the Brahmaputra valley of Assam. This finding has been corroborated by the findings of Dutta (2001). Traditional Paddy and nonpaddy soils of Brahmaputra and Barak valley of Assam have been studied for their physical and chemical characteristics and classification by Dey and Sehgal (1997). They reported that organic carbon and cation exchange capacity to clay ratio were lower in the surface horizon of paddy soils as compared to non-paddy associates. They also found that paddy soils were characterized by a lesser amount of mica in both fine sand and silt fractions and of olivines in silt fractions as compared to that of nonpaddy associates in their surface horizons. It has been reported that paddy soils contained relatively more amounts of total, dithionite, and oxalate extractable Al than the associated nonpaddy soils (Dutta, 2001). Paddy soils generally contained higher amount of silicate and amorphous inorganic forms of Fe and Al and a lower amount of crystalline formations of Fe and Al as compared to the nonpaddy soils (Dutta 2001).

III. Materials and Methods

The information about the study area as well as the methods utilized in the present investigation has been described below:

a) Location and extent

The three districts that were selected for this study were, Sivasagar, Jorhat and, Golaghat, which were all located in the Brahmaputra valley of Assam. These districts are situated in the Upper Brahmaputra Valley Zone (UBV) of Assam covering just about 55.7 percent of UBV with an area of about 9021 sq. Km. These districts together form a part of the southern bank of the Brahmaputra valley of Assam. The district of Sivasagar lies between 26°27' N and 27°9' N latitudes and 94°15' E and 95°15' E longitudes. It is bounded on the north by the Brahmaputra River, on the south by Naga Hills, on the east by Dibrugarh district, and on the west by Jorhat district. The total geographical area of the district is 2668 sq.km. The district of Jorhat is situated between 26°20' N to 27°10' N latitudes and 93°57' E to 94°37 E longitudes in the eastern part of Assam. It is bounded by North Lakhimpur district in the north, Nagaland in the south and south-east, Sivasagar district in the east and Golaghat district in the west. The total geographical area of the district is 2853.332 sq. Km. The district of Golaghat is situated between 26° N

© 2020 Global Journals

to 27° N latitudes and 93° E to 94°18' E longitudes. It is bounded by the river Brahmaputra in the north, Nagaland in the south, Jorhat district in the east and, Karbi Anglong district in the west. The total geographical area of the district is 3540.7 sq. Km.

b) Geology

The Brahmaputra valley is a part of the Indo-Gangetic Brahmaputra river system of North East India, covering an area of 56,570sq.Km. The study area takes up approximately 15.95 percent of the Brahmaputra Valley. This valley had been formed during the Pleistocene and in recent periods from the sediments brought down from the Assam Plateau in the south and Assam Himalayas in the north (Wadia, 1966). The geological nature of the deposits brought down by the river is quite different from that deposited by the tributaries flowing down from the foothills on both sides resulting in the formation of different types of alluvium. These districts consist mainly of substantial thickness of recent alluvium and tertiary rocks.

c) Climate

The climate of the study area is humid sub-tropical. This condition had been influenced mainly by the southwest monsoon from the Bay of Bengal and determined by the surrounding hills of Assam. Mean annual rainfall of Sivasagar, Jorhat, and Golaghat districts are 2119.8, 1919.3, and 1743.0 mm respectively. The mean annual temperatures in these districts are 23.4, 23.8 and 23.7 C, respectively. The mean maximum and minimum temperatures in these districts vary from 28.3 to 29.0 C and 18.0 to 19.3 C, respectively. The difference between mean summer and mean winter o temperatures in the study area is >5 C. The soil moisture and temperature regimes in these districts are udic and hyperthermic, respectively.

IV. Location of Sampling Sites

Six soil profiles were dug following the collection of soil samples, three samples each from mono-cropped paddy and associated non-paddy areas had been collected from Sivasagar, Jorhat and Golaghat districts of Assam. Samples had been collected Horizon-wise from each soil profile. Details of location and site information of the study has been given in Table 1.

Table 1: Location and site characteristics of studied profiles

Si. No.	Location	Lithology	Physiography	Land use	Slope
P1	Nimaigarh Habigaon	Alluvium	Alluvial plain	Paddy cultivation	0-3
P2	Nimaigarh Habigaon	Alluvium	Alluvial plain	Non-paddy, Fallow	0-3
P3	Silikha Sanaton	Alluvium	Alluvial plain	Paddy cultivation	0-3
P4	Silikha Sanatongaon	Alluvium	Alluvial plain	Non-paddy, Fallow	0-3
P5	Khumtai	Alluvium	Alluvial plain	Paddy cultivation	0-3
P6	Khumtai	Alluvium	Alluvial plain	Non-paddy, Fallow	0-3

a) Preparation of soil samples

The soil samples were firstly air-dried, and ground before being passed through a 2 mm sieve. The sieved soil samples were then stored in polythene bags and later utilized for various physicochemical analyses. Fresh soil samples had been stored a refrigerator for the purpose of carrying out microbiological analyses.

b) Physicochemical analysis

Morphological features of each pedon had been studied in the field following standard procedure (All India Soil and Land Use Survey Organization, 1971). Conventional methods had been adopted for physicochemical and microbiological analyses which has been presented in Table 2.

Table 2: Methods adopted for morphological and Physico- chemical analysis

Si. No.	Parameters	Methods	Reference
1	Mechanical analysis	International Pipette Method	Piper (1966)
2	Soil reaction (1:2.5)	Glass electrode pH meter	Jackson (1973)
3	Electrical conductivity (1:2.5)	Electrical conductivity meter	Jackson (1973)
4	Organic carbon	Walkley and Black's method	Jackson (1973)
5	Cation exchange capacity	Distillation method	Jackson (1973)
6	Percent base saturation		
7	Available nitrogen	Alkaline KMnO4 method (1956)	Subbiah and Asija (1956)
8	Available phosphorous	Extracted with 0.03N NH4F in 0.025 N HCl (Bray's-I method).	Bray and Kurtz (1945)
9	Available potassium	Flame photometric method	Jackson (1973)
10	Bulk density	Clod method	Black (1965)

© 2020 Global Journals

V. Results and Discussion

a) Morphological characteristics

The morphological characteristics of the soils have been given in Table 3. Soil color varied from light olive-brown to yellow. The hue of soil color ranged from 2.5Y to 10YR, with 10YR being most dominant. Dominant hue of 10YR in soils of Assam had been reported by Chakravarty *et al*. (2008), Karmakar and, Rao (1999a). The yellower color of soil, 2.5Y was observed only below 55 cm depth of P2 under paddy cultivation. The value ranged from 5 to 8 and chroma from 1 to 8. Chroma of 2 or less observed in subsurface horizons of P1, NP1 and, P3 indicate aquic conditions and the process of gleization operating in these soils. Few, fine, distinct to common, medium, prominent mottles with colors of 7.5YR 6/8 to 7.5YR 8/8 had been observed in some subsurface horizons of the studied soils. Mottles with higher chroma are said to be associated with rice cultivation (Kanno, 1956) and are indicative of hydromorphic conditions (Das, 1990).

The soil textural class varied from loamy sand to clay loam. Such types of textural variations in paddy and non-paddy soils of Assam have been reported earlier (Dey and Sehgal, 1997: Gangopadhyay *et al*., 1998). The soil structure varied from massive to sub-angular blocky. Surface horizons of paddy soils exhibited massive structure. This structure in the surface horizons of paddy soils was due to the destruction of soil structure during puddling. This practice damages soil structure in the plow-layer of paddy soils and decreases pores and voids in this layer. (Hassannezhad *et al.,* 2008). Medium, weak to strong sub angular structure, had been observed in the soils. The consistence noted in the studied soils ranged from being slightly hard to hard, very friable to firm, slightly sticky and, slightly plastic.

Table 3: Morphological characteristics of the soils

Horizon	Depth (cm)	Soil colour (moist)	Mottling	Texture	Structure	Consistence
P1 (Nimaigarh Habigaon – Paddy soil) : *Aquic Dystric Eutrudepts*						
Ap	0-15	10YR 6/8		Clay loam	massive	dsh, mfr, wss, wps
Bw1	15-40	10YR 6/2	7.5YR 7/6 f1d	Clay loam	m2sbk	dh, mfi, ws, wp
Bw2	40-100	10YR 7/3	7.5YR 7/6 c2d	Clay loam	m3sbk	dh, mfi, ws, wp
2Cg	100-120	10YR 7/2	7.5YR 7/6 c2d	Clay loam	m2sbk	dsh, mfr, wss, wps
NP1 (Nimaigarh Habigaon – Non-paddy soil): *Dystric Eutrudepts*						
Ap	0-33	10YR 6/4		Clay loam	m1sbk	dsh, mfr, wss, wps
Bw1	33-55	10YR 5/3		Clay loam	m2sbk	dsh, mfr, wss, wps
Bw2	55-80	10YR 7/2		Clay loam	m3sbk	dh, mfi, ws, wp
Bw3	80-100	10YR 6/3		Clay loam	m2sbk	dsh, mfr, wss, wps
2Cg1	100-190	10YR 7/2	7.5YR 7/8 f1d	Sandy Clay loam	m2sbk	dsh, mfr, wss, wps
2Cg2	190-220	10YR 7/1	7.5YR 7/8 c2d	Clay loam	m2sbk	dsh, mfr, wss, wps
P2 (Silikha Sanaton – Paddy soil): *Dystric Fluventic Eutrudepts*						
Ap	0-15	10YR 5/4		Sandy loam	massive	dsh, mfr, wss, wps
Bw	15-55	10YR 6/6		Sandy clay loam	m1sbk	dsh, mfr, wss, wps
Bg1	55-90	2.5Y 6/4	7.5YR 6/8 f1p	Clay loam	m2sbk	dh, mfi, ws, wp
Bg2	90-125	2.5Y 5/4	7.5YR 6/8 c2p	Clay loam	m2sbk	dsh, mfr, wss, wps
NP2 (Silikha Sanaton – Non-paddy soil): *Dystric Eutrudepts*						
A	0-10	10YR 6/4		Sandy clay loam	f2sbk	ds, mvfr, wss, wps
Bw1	10-35	10YR 6/4		Sandy clay loam	m2sbk	dsh, mfr, wss, wps
Bw2	35-90	10YR 6/6		Sandy clay loam	m2sbk	dsh, mfr, wss, wps
2C1	90-115	10YR 6/8	7.5YR 6/8 f1d	Loamy sand	massive	ds, mvfr, wss, wps
3C2	115-165	10YR 6/4		Sandy loam	massive	ds, mvfr, wss, wps

Horizon	Depth (cm)	Soil colour (moist)	Mottling	Texture	Structure	Consistence
P3 (Khumtai – Paddy soil): *Dystric Eutrudepts*						
Ap	0-15	10YR 6/3		Sandy clay loam	massive	dsh, mfr, wss, wps
Bw1	15-50	10YR 6/4		Sandy clay loam	m2sbk	dsh, mfr, wss, wps
Bw2	50-100	10YR 7/4	7.5YR 7/8 c1d	Clay loam	m3sbk	dh, mfi, ws, wp

© 2020 Global Journals

Bw3	100-165	10YR 8/4	7.5YR 7/8 c2d	Clay loam	m3sbk	dh, mfi, ws, wp
Bg	165-190	10YR 6/2	7.5YR 6/8 c3d	Clay loam	m2sbk	dsh, mfr, wss, wps
NP3 (Khumtai – Non-paddy soil): *Dystric Eutrudepts*						
Ap	0-20	10YR 6/6		Sandy Clay loam	m1sbk	dsh, mfr, wss, wps
AB	20-27	10YR 7/8		Sandy clay loam	m2sbk	dsh, mfr, wss, wps
Bw1	27-60	10YR 7/8	7.5YR 6/8 f1d	Clay loam	m2sbk	dh, mfi, ws, wp
Bw2	60-95	10YR 7/8	7.5YR 8/8 c2d	Clay loam	m3sbk	dh, mfi, ws, wp
Bw3	95-125	10YR 6/8	7.5YR 8/8 c2d	Clay loam	m2sbk	dsh, mfr, wss, wps

VI. Physico-Chemical Characteristics

a) Mechanical composition of soils

A perusal of particle size distribution data in Table 4 shows that the sand content of the soils varied from 29.5-60.9 percent in surface and 27.5-55.8 percent in the subsurface horizons of paddy profiles, and 31.8-56.4 percent in surface and 27.0-84.2 percent in the subsurface horizons of nonpaddy soils. The sand content seemed to increase with depth in P1 (paddy) and, NP1, NP2 (nonpaddy) soils decreased with depth in P2, P3, NP3.

The silt content of the soils varied from 20.0-35.0 percent in surface and 18.6-35.5 percent in the subsurface horizons of paddy soils, and 21.1-38.1 percent in the surface and 8.2-40.5 percent in the subsurface horizons of nonpaddy soils. The silt content increased with soil depth in both paddy and non-paddy soils of Khumtai (P3, NP3). In other soils depth distribution of silt content was irregular. Such type of sand and silt distribution in soil profiles is persistent in soils formed on alluvium.

The clay content of the soils varied from 18.7-35.5 percent in surface and 25.6-38.5 percent in the subsurface horizons of paddy soils, and 22.5-30.1 percent in the surface and 7.6-33.5 percent in the subsurface horizons of nonpaddy soils. The paddy soils developed on recent alluvium has been reported to have lower clay content on the surface (Kanno *et al*., 1964; Somasiri, 1985). In strongly acid soils, seasonal wetting and, drying cause breakdown of clay by a process called ferrolysis, resulting in lower clay content in the surface soils (Brinkman, 1970). Ferrolysis is a hydromorphic soil process where soil pores become water logged extensive periods of time. Excess moisture conditions slow down the process for clay formation as the anaerobic conditions are less favorable.

The amount of clay increased with soil depth, reached a maximum value, and decreased after that. Such type of distribution is indicative of moderate development of soils (Barshad, 1964). These observations indicated that silt and clay had been formed from transformation of sand fraction and or biosynthesis of clay. The profiles of Nimaigarh Habigaon (P1, NP1) contained a maximum amount of clay (27.0-37.0 percent) which was followed by the soils of Khumtai (22.5-32.5 percent), and Silikhasanaton (7.6-31.3 percent). This amount increased with soil depth, reached a maximum value and, then decreased. Sand/silt and silt/ (silt + clay) ratios changed abruptly at a dept below 100 cm of NP1 and below 90 cm of NP2, which suggested stratification or lithological discontinuity in these soils.

Table 4: Mechanical composition (%) of the soils (particle size in mm)

Horizon	Depth (cm)	Sand (2-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Sand / Silt	Silt / Silt+clay
P1 (Nimaigarh Habigaon – Paddy soil) : *Aquic Dystric Eutrudepts*						
Ap	0-15	29.5	35.0	35.5	0.84	0.50
Bw1	15-40	27.5	35.5	37.0	0.77	0.49
Bw2	40-100	29.5	32.0	38.5	0.92	0.45
2Cg	100-120	35.5	35.0	29.5	1.01	0.54
NP1 (Nimaigarh Habigaon – Non-paddy soil): *Dystric Eutrudepts*						
Ap	0-33	31.8	38.1	30.1	0.83	0.56
Bw1	33-55	27.0	40.5	32.4	0.67	0.54
Bw2	55-80	26.8	39.7	33.5	0.67	0.56
Bw3	80-100	34.1	36.4	29.5	0.94	0.55
2Cg1	100-190	47.1	24.6	28.3	1.91	0.47
2Cg2	190-220	36.5	36.5	27.0	1.00	0.57
P2 (Silikha Sanaton – Paddy soil): *Dystric Fluventic Eutrudepts*						
Ap	0-15	60.9	20.4	18.7	2.98	0.52
Bw	15-55	55.8	18.6	25.6	3.00	0.42
Bg1	55-90	44.3	24.3	31.3	1.82	0.44
Bg2	90-125	40.3	29.9	29.8	1.35	0.50

© 2020 Global Journals

NP2 (Silikha Sanaton – Non-paddy soil): *Dystric Eutrudepts*						
Ap	0-10	53.6	22.3	24.1	2.40	0.48
Bw1	10-35	49.5	22.3	28.2	2.22	0.44
Bw2	35-90	50.5	22.9	26.6	2.20	0.46
2C1	90-115	84.2	8.2	7.6	10.27	0.52
3C2	115-165	78.2	8.6	13.2	9.09	0.39
P3 (Khumtai – Paddy soil): *Dystric Eutrudepts*						
Ap	0-15	52.5	20.0	27.5	2.63	0.42
Bw1	15-50	46.5	25.0	28.5	1.60	0.42
Bw2	50-100	47.0	22.5	30.5	1.73	0.37
Bw3	100-165	40.0	27.5	32.5	1.45	0.46
Bg	165-190	40.0	30.0	30.0	1.33	0.50
NP3 (Khumtai – Non-paddy soil): *Dystric Eutrudepts*						
Ap	0-20	56.4	21.1	22.5	2.67	0.48
AB	20-27	55.0	20.0	25.0	2.75	0.44
Bw1	27-60	40.5	31.5	28.0	1.29	0.53
Bw2	60-95	39.5	28.0	32.5	1.41	0.46
Bw3	95-125	41.7	30.1	28.2	1.38	0.52

b) Organic C, bulk density, pH and, E.C.

The data on soil organic carbon content (Table 5.) show that the organic carbon content in soil varied from 5.40-7.90 g kg^{-1} in the surface and 0.90-6.30 g kg^{-1} in the subsurface horizons. The amount of organic carbon was lower (5.40-6.20 g kg^{-1}) in the surface horizons of paddy soils after comparisons were made to that of the surface horizons of nonpaddy soils (5.70-7.90 g kg^{-1}). These findings are in corroboration with those of Van Veen *et al*. (1984) and Katou *et al*. (1985), who reported a decrease in organic matter content in surface layers of paddy soils. Dey and Sehgal (1997) also published lower organic matter content in paddy soils than the associated non-paddy soils of Assam due to repeated cycles of wetting and drying, which mineralize the organic matter in the soil. The amount of organic carbon was higher in the surface horizon of all studied profiles, and it decreased with soil depth. The surface horizon of NP1 contained the highest amount of organic carbon (7.90 g kg^{-1}) as compared to other soils.

Bulk density of soils ranged from about 1.12-1.42 g/cc in the surface and 1.17-1.70 g/cc in the subsurface horizons. The bulk density was lower in the surface horizon of all studied profiles, and it increased with soil depth. This condition may have been due to more aggregation on soil surface horizons as well as the presence of more clay. Puddling on paddy soils breaks down aggregates and increases porosity, thereby decreasing bulk density. The pH of the profiles (1:2.5 soil: water ratio) was in the acidic range, and varied from 4.6-5.7 in the surface, and 4.7-6.0 in the subsurface horizons. The surface horizons of paddy soils did not show higher pH than that of nonpaddy profiles. Though submergence increases the pH of acid soil during rice cultivation due to the reduction of ferric oxides and oxyhydroxides (Ponnamperuma *et al.* 1966),the samples collected for the study were after the harvest of rice (oxidative condition) during which pH of the soils becomes acidic. Prasad and Jondhale (2006) also observed similar results in their study. The reduction of pH values of the paddy soil also suggests that the decreased organic matter content observed in the surface horizons contributed to an acidic soil pH. The electrical conductivity of the soils was low varying from 0.09 to 0.33 dSm^{-1} ,as reflected in tables 5. This suggests the presents of soluble salts in all soil profiles were generally low.

Table 5: Organic carbon, bulk density, pH, EC and available nitrogen, phosphorus and potash of the soils

Horizon	Depth (cm)	O.C. (g kg^{-1})	Bulk density g/cc	pH (1:2.5 H_2O)	E.C. (1:2.5 H_2O) (dSm^{-1})	Available (kg ha^{-1})		
						N	P_2O_5	K_2O
P1 (Nimaigarh Habigaon – Paddy soil) : *Aquic Dystric Eutrudepts*								
Ap	0-15	7.30	1.34	4.6	0.23	279.1	28.2	257.6
Bw1	15-40	4.70	1.38	5.4	0.23	272.8	23.1	241.8
Bw2	40-100	1.50	1.57	5.9	0.16	269.7	20.5	197.2
2Cg	100-120	1.20	1.59	6.0	0.22	266.6	17.9	101.5
NP1 (Nimaigarh Habigaon – Non-paddy soil): *Dystric Eutrudepts*								
Ap	0-33	7.90	1.35	5.2	0.12	272.8	38.5	389.5
Bw1	33-55	6.30	1.37	5.1	0.13	266.6	33.2	332.8
Bw2	55-80	5.50	1.57	4.7	0.29	266.6	20.5	201.6
Bw3	80-100	4.40	1.58	5.1	0.27	263.4	21.5	206.4

© 2020 Global Journals

2Cg1	100-190	1.50	1.53	5.0	0.18	250.9	10.8	110.5
2Cg2	190-220	0.90	1.63	5.6	0.31	250.9	7.7	111.8
P2 (Silikha Sanaton – Paddy soil): *Dystric Fluventic Eutrudepts*								
Ap	0-15	5.40	1.12	5.2	0.12	297.1	23.1	289.8
Bw	15-55	4.20	1.36	5.1	0.33	272.8	20.5	288.5
Bg1	55-90	3.90	1.39	5.5	0.17	269.7	7.7	203.5
Bg2	90-125	3.50	1.46	5.6	0.26	269.7	7.7	197.5
NP2 (Silikha Sanaton – Non-paddy soil): *Dystric Eutrudepts*								
Ap	0-10	5.70	1.42	5.2	0.19	279.1	12.5	417.5
Bw1	10-35	4.80	1.48	5.0	0.10	272.8	14.5	332.5
Bw2	35-90	3.50	1.59	5.2	0.09	266.6	10.5	335.5
2C1	90-115	2.70	1.59	5.2	0.11	269.7	10.5	389.1
3C2	115-165	1.20	1.58	6.0	0.25	269.6	5.5	220.6
P3 (Khumtai – Paddy soil): *Dystric Eutrudepts*								
Ap	0-15	5.40	1.42	5.1	0.10	283.2	25.6	432.5
Bw1	15-50	4.20	1.52	5.5	0.14	272.8	20.5	389.5
Bw2	50-100	2.70	1.70	5.5	0.13	279.1	12.8	201.1
Bw3	100-165	1.60	1.52	5.5	0.25	269.7	10.3	334.5
Bg	165-190	1.00	1.53	5.5	0.17	263.4	7.7	201.1
NP3 (Khumtai – Non-paddy soil): *Dystric Eutrudepts*								
Ap	0-20	6.30	1.39	5.7	0.15	282.2	23.1	160.7
AB	20-27	5.40	1.17	5.7	0.22	254.0	12.8	357.8
Bw1	27-60	2.70	1.44	4.9	0.14	266.6	10.1	331.5
Bw2	60-95	1.70	1.46	5.2	0.33	235.2	10.1	257.6
Bw3	95-125	1.50	1.70	5.2	0.28	272.8	7.7	349.5

c) Available N, P_2O_5, K_2O

The data on available N, P_2O_5, K_2O of the soils are presented in Table 5. The available nitrogen content of the soil varied from 263.4 to 297.1 kg ha^{-1} in paddy soils and, 235.2 to 282.2 kg ha^{-1} in non-paddy soils. The amount of available nitrogen was lower in surface horizons and it increased in the subsurface horizons except in NP3 soils. The surface horizons of paddy soils contained a higher (279.1-297.1 kg ha^{-1}) amount of available nitrogen as compared to surface horizons of non-paddy soils (272.8-282.2 kg ha^{-1}). Nitrogen availability might have been as a result of more mineralization of soil organic carbon in the surface horizons of paddy soils during puddling and alternating oxidation-reduction conditions during rice cultivation, as suggested by Singh and Timsina (2005). However, more recent research proposed that soils under intensified wetland rice production systems showed mineralization to be insufficient and insignificant under these anaerobic conditions (Sahrawat, 2010). This was as a result of differences in activity of microorganisms functioning under aerobic and anaerobic conditions. The mineralization process is slower under anaerobic conditions due to less efficient and incomplete decomposition of organic matter (White and Reddy 2001).

Available P_2O_5 content of the soil varied from 7.7 to 28.2 kg ha^{-1} in paddy soils and 5.5 to 38.5 kg ha^{-1} in non-paddy soils. The surface horizons of paddy soils contained lesser amount of available P_2O_5 as compared to the surface horizons of nonpaddy soils except in soils of Nimaigarh Habigaon (P1, NP1). In general, the amount of available P_2O_5 was higher in the surface horizons, and it tended to decrease with soil depth. Higher amounts of available P_2O_5 in the surface horizon might be as a result of an acidic pH on the surface horizons of these soils. In acid soils, P is bound due to Ca, Al, and Fe ions, which make it readily adsorbed on clay surfaces.

Available K_2O in soil varied from 101.5 to 432.5 kg ha^{-1} in paddy soils and 110.5 to 389.5 kg ha^{-1} in nonpaddy soils. The amount of available K_2O was higher in surface horizons, and it decreased in subsurface horizons except in the NP3 profile. This increase in K_2O in surface soils was indicative of soil organic carbon being responsible for available K_2O.

d) Exchangeable cations, cation exchange capacity (CEC) and base saturation

The data on exchangeable cations, cation exchange capacity (CEC), and percent base saturation are presented in Table 6.

The exchangeable Ca^{++} was the dominant cation usually followed by exchangeable Mg^{++}, K^+,and Na^+ in the soils. The dominance of exchangeable Ca^{2+} in these soils is in general agreement with the findings of earlier workers on soils of Assam (Chakravarty *et al.*, 1978; Dey and Sehgal, 1997; Karmakar and Rao, 1999a). Low amounts of exchangeable Na+ and K+ in these soils may be due to preferential losses of monovalent cations over divalent cations in leaching under high rainfall conditions. The amount of exchangeable Ca^{++} ranged from 1.50-2.50 centimoles (p^+) kg^{-1}. The surface horizons of paddy soils contained lower amount of exchangeable Ca^{++} (1.50-2.25 centimoles (p^+) kg^{-1}) as compared to the surface horizons of nonpaddy soils (1.75-2.50 centimoles (p^+) kg^{-1}). Zang and Chen (2009) reported Ca, Mg, and Na losses in the initial stage (50 yrs) of paddy cultivation

© 2020 Global Journals

with more gradual depletion with increasing paddy cultivation over time.

The amount of exch. Mg^{++} ranged from 1.25 to 2.00 centimoles (p^+) kg^{-1} in paddy soils and from 1.00 to 1.75 centimoles (p^+) kg^{-1} in nonpaddy soils. The amount of exchangeable Na^+ ranged from 0.59 to 0.96 centimoles (p^+) kg^{-1} in paddy soils and from 0.22 to 1.05 centimoles (p^+) kg^{-1} in non-paddy soils. The amount of exchangeable K^+ ranged from 0.47 to 1.33 centimoles (p^+) kg^{-1} in paddy soils and from 0.52 to 1.66 centimoles (p^+) kg^{-1} in non-paddy soils.

The results concerning cation exchange capacity (CEC) of the soil profiles (Table 6) showed variations from 6.8 to 10.8 centimoles (p^+) kg^{-1}. Earlier studies revealed that the CEC of the alluvium-derived soils of Assam is low, and it is related to the dominance of low activity clay-like Kaolinite (Chakravarty and Barua, 1983; Karmakar and Rao, 1998; Dutta and Shanwal, 2006). These findings, therefore, suggested that silt and organic carbon contributed more CEC to these soils. Several researchers also reported that silt fractions contain sufficient negative charge and positively impacted CEC of soils (Leinweber *et al*., 1993; Caravaca *et al.,* 1999; Karmakar, 2014). The base saturation of the soil varied from 52.0 to 68.2 percent (Table 6). Acidic soil conditions allowed for low base saturation levels in these soils; this was also a result of low CEC.

Table 6: Exchangeable cations, cation exchange Table capacity (CEC) and base saturation of the soils

Horizon	Depth (cm)	Exchangeable bases				CEC	Base Saturation (%)	Exch. Ca^{++} / Exch. Mg^{++}
		Ca^{++}	Mg^{++}	Na^+	K^+			
		< ---------- cmol (p^+) kg^{-1} ---------- >						
P1 (Nimaigarh Habigaon – Paddy soil): *Aquic Dystric Eutrudepts*								
Ap	0-15	2.00	1.75	0.88	1.20	9.2	63.4	1.14
Bw1	15-40	2.00	1.75	0.83	1.25	8.8	66.2	1.14
Bw2	40-100	2.25	2.00	0.87	0.69	8.6	67.5	1.13
2Cg	100-120	2.00	1.75	0.91	0.55	8.6	60.6	1.14
NP1 (Nimaigarh Habigaon – Non-paddy soil): *Dystric Eutrudepts*								
Ap	0-33	2.50	1.75	0.34	0.94	10.8	51.2	1.43
Bw1	33-55	2.25	1.75	0.22	1.65	9.6	61.1	1.29
Bw2	55-80	2.25	1.75	0.23	0.52	8.8	54.0	1.29
Bw3	80-100	1.75	1.50	0.80	1.60	8.8	64.2	1.17
2Cg1	100-190	1.75	1.50	1.00	0.58	8.6	56.2	1.17
2Cg2	190-220	1.50	1.25	1.05	1.77	8.6	64.8	1.20
P2 (Silikha Sanaton – Paddy soil): *Dystric Fluventic Eutrudepts*								
Ap	0-15	1.50	1.25	0.95	1.10	7.8	61.6	1.20
Bw	15-55	1.75	1.40	0.96	1.03	7.6	67.6	1.25
Bg1	55-90	1.75	1.50	0.90	0.48	7.6	60.9	1.17
Bg2	90-125	2.00	1.50	0.81	0.47	7.4	64.6	1.33
NP2 (Silikha Sanaton – Non-paddy soil): *Dystric Eutrudepts*								
Ap	0-10	1.75	1.25	0.96	1.25	8.2	63.5	1.40
Bw1	10-35	2.25	1.50	0.95	1.05	8.8	65.3	1.50
Bw2	35-90	1.75	1.60	0.94	1.03	8.4	63.3	1.09
2C1	90-115	2.00	1.25	0.35	1.33	8.2	60.1	1.60
3C2	115-165	1.25	1.00	0.48	1.31	6.8	59.5	1.25
P3 (Khumtai – Paddy soil): *Dystric Eutrudepts*								
Ap	0-15	2.25	1.25	0.92	1.50	9.0	65.8	1.80
Bw1	15-50	2.25	2.00	0.75	1.14	9.0	68.2	1.13
Bw2	50-100	2.00	1.75	0.90	0.11	7.8	61.1	1.14
Bw3	100-165	1.50	1.25	0.59	1.33	7.8	59.9	1.20
Bg	165-190	1.50	1.25	0.59	1.13	7.4	60.4	1.20
NP3 (Khumtai – Non-paddy soil): *Dystric Eutrudepts*								
Ap	0-20	2.50	1.75	0.60	0.63	8.8	62.3	1.43
AB	20-27	2.50	1.25	0.81	1.07	8.5	66.2	2.00
Bw1	27-60	2.25	1.50	0.93	0.91	8.4	66.6	1.50
Bw2	*60-95*	*1.50*	*1.00*	*0.75*	*1.33*	*8.8*	*52.0*	*1.50*
Bw3	95-125	1.50	1.00	0.70	1.66	8.6	56.5	1.50

e) Soil classification

Based on morphological and physicochemical properties, the paddy and associated non-paddy soils were classified according to Table 7. These classifications were found to be Aquic Dystric Eutrudepts (P1), Dystric Eutrudepts (NP1, NP2, P3, NP3), and Dystric Fluventic Eutrudepts (P2).

All the studied soils have Ochric diagnostic epipedons (horizon that forms near soil surface) and cambic diagnostic subsurface horizons. In these profiles

© 2020 Global Journals

clay content increased with soil depth, reached a maximum, and decreased after that. The subsurface horizons of P2, NP2 and, NP3 contained more than 1.2 times clay as compared to the respective surface horizons. However, clay cutans were absent in these soils. Therefore, the subsurface horizons of P2, NP2 and NP3 did not qualify as being argillic. The studied profiles belong to the order *Inceptisols*. Since the base saturation (by 1N NH4 OAc) is 60 percent or more in one or more horizons at a depth between 25 and 75 cm from the mineral soil surface, then It can be said that all soils studied qualify for the great group *Eutrudepts*. All the soils do not have free carbonates throughout any horizon within 100cm of mineral soil surface and therefore qualify for dystric characteristics at the subgroup level. In addition to dystric features, the soils of P1 have in one horizon within 60cm of the mineral soil surface, redox depletions with chroma, and also aquic conditions for some time in typical years as indicated by presence of reddish-yellow mottles. The soils of P1 qualify for *Aquic Dystric Eutrudepts* at the subgroup level. The soils of P2, in addition to dystric characteristic, have more than 0.2 percent organic carbon at a depth of 125cm below the mineral soil surface and also have a slope of less than 25 percent. The soils of P2 qualify for *Dystric Fluventic Eutrudepts* at the subgroup level. The profiles of NP1, NP2, P3, and NP3 qualify for *Dystric Eutrudepts* at the subgroup level.

Table 7: Classification of studied soils

Pedons	Order	Suborder	Great group	Subgroup
P1 (Nimaigarh Habigaon – Paddy soil)	Inceptisols	Udepts	Eutrudepts	Aquic Dystric Eutrudepts
NP1 (Nimaigarh Habigaon – Non-paddy soil)	Inceptisols	Udepts	Eutrudepts	Dystric Eutrudepts
P2 (Silikha Sanaton – Paddy soil)	Inceptisols	Udepts	Eutrudepts	Dystric Fluventic Eutrudepts
NP2 (Silikha Sanaton – Non-paddy soil)	Inceptisols	Udepts	Eutrudepts	Dystric Eutrudepts
P3 (Khumtai – Paddy soil)	Inceptisols	Udepts	Eutrudepts	Dystric Eutrudepts
NP3 (Khumtai – Non-paddy soil)	Inceptisols	Udepts	Eutrudepts	Dystric Eutrudepts

VII. Summary and Conclusion

a) Morphological characteristics

1. Soil color varied from light olive-brown to yellow with a dominant hue of 10YR, a value ranging from 5 to 8 and chroma from 1 to 8.
2. Reddish-yellow mottles had been observed in the subsurface horizons of the soils, indicating oxidation-reduction cycles.
3. The texture of the soils ranged from loamy sand to clay loam.
4. The structure of the soils ranged from massive to sub-angular blocky. Surface horizons of paddy soils exhibited massive soil structure.

b) Mechanical composition

5. Sand content varied from 29.5-60.9 percent in the surface and 27.5-55.8 percent in the subsurface horizons of paddy soils, and 31.8-56.4 percent in the surface and 27.0-84.2 percent in the subsurface horizons of nonpaddy soils.
6. Silt content varied from 20.0-35.0 percent in the surface and 18.6-35.5 percent in the subsurface horizons of paddy soils, and 21.1-38.1 percent in the surface and 8.2-40.5 percent in the subsurface horizons of nonpaddy soils.
7. Clay content varied from 18.7-35.5 percent in the surface and 25.6-38.5 percent in the subsurface horizons of paddy soils, and 22.5-30.1 percent in the surface and 7.6-33.5 percent in the subsurface horizons of nonpaddy soils.
8. Sand content was negatively and significantly correlated with silt (r= - 0.958**) and clay (r= - 0.927**).

c) Physico-chemical properties

9. Organic carbon content in soil varied from 5.40-7.90 g kg^{-1} in the surface and 0.90-6.30 g kg^{-1} in the subsurface horizons. The amount of organic carbon was found to be lower (5.40-6.20 g kg^{-1}) in the surface horizons of paddy soils in comparison to that in the surface horizons of nonpaddy soils (5.70-7.90 g kg^{-1}). Organic carbon content decreased with soil depth.
10. The bulk density of soils varied from 1.12-1.42 g/cc in the surface and 1.17-1.70 g/cc in the subsurface horizons. Bulk density of soils increased with soil depth.
11. The pH of the soils (1:2.5 soil: water ratio) varied from 4.6-5.7 in the surface and 4.7-6.0 in the subsurface horizons. The pH of the soil manifested a negative correlation with organic carbon (r= - 0.459*).
12. The electrical conductivity of soil was low (0.09-0.33 dSm^{-1}) in the studied soils.
13. Available nitrogen content of the soil varied from 263.4 to 297.1 kg ha^{-1} in paddy soils, and 235.2 to 282.2 kg ha^{-1} nonpaddy soils. The amount of available nitrogen was lower in surface horizons and

© 2020 Global Journals

it increased in subsurface horizons except in NP3 profiles.

14. Available P_2O_5 content of the soil varied from 7.7 to 28.2 kg ha^{-1} in paddy soils, and 5.5 to 38.5 kg ha^{-1} in nonpaddy soils. The amount of available P_2O_5 was higher in the surface horizons and it tended to decrease with soil depth.
15. Available K_2O in soil varied from 101.5 to 432.5 kg ha^{-1} in paddy soils and 110.5 to 389.5 kg ha^{-1} in nonpaddy soils. The amount of available K_2O was higher in surface horizons and it decreased in subsurface horizons except NP3 soils.
16. The exchangeable Ca^{++} was the dominant cation (1.25-2.50 centimoles (p^+) kg^{-1}) followed by exchangeable Mg^{++} (1.00-2.00 centimoles (p^+) kg^{-1}), exchangeable K^+ (0.11-1.77 centimoles (p^+) kg^{-1}) and, exchangeable Na^+ (0.35-1.05 centimoles (p^+) kg^{-1}).
17. The surface horizons of paddy soils contained lower amount of exchangeable Ca^{++} (1.50-2.25 centimoles (p^+) kg^{-1}) as compared to the surface horizons of nonpaddy soils (1.75-2.50c mol (p^+) kg^{-1}).
18. The cation exchange capacity of soil varied from 7.4-10.8 centimoles (p^+) kg^{-1},and base saturation varied from 52.0-68.2 percent.

d) Soil classification

19. Generally, based on the morphological and physico-chemical properties, the soil profiles were classified as *Aquic Dystric Eutrudepts* (P1), *Dystric Eutrudepts* (NP1, NP2, P3, NP3) and *Dystric Fluventic Eutrudepts* (P2).

Bibliography

1. Balthazar. M.et.al. (2016). Morphology, Genesis, Physico-chemical Properties, Classification and Potential of Soils Derived from Volcanic Parent Materials in Selected Districts of Mbeya Region, Tanzania. *International journal of plant and soil science* 10(4): 1-19.
2. Barshad,I.(1964). Chemistry of soil development.In: *Chemistry of the soil.*Bear, F.E.(ed.).2nd Edition. Oxford and IBH publishing Co., New Delhi, pp. 1-70
3. Baruah, B.K., Chakravarty,D.N. and Karmakar,R.M. (1996). Variability of soils in two rice growing toposequences. *Journal of the Indian Society of Soil Science* 44(4): 690-694.
4. Brinkman, R. (1970). Ferrolysis, a hydromorphic soil forming process. *Geoderma* 3: 199-206.
5. Chakravarty , D.N., Sehgal, J.L and Dev, G. (1978). Influence of climate and topography on the pedogenesis of alluvium derived soils in Assam: Geographical settings, morphological and physico-chemical properties. *Indian journal of Agricultural Chemistry.*11:77-97.
6. Das, K.N. (1990). Characterisation and Classification of some typical paddy growing soils of Assam. M. Sc. (Agri.) Thesis, Assam Agricultural University Jorhat.
7. Dey, J.K. (1987). Pedogenesis and classification of some submerged soils of Assam and their sustainability for rice cultivation. Ph.D. Thesis, P.A.U.,Ludhiana.
8. Dey, J.K. and Sehgal, J.L. (1997). Characteristics and classification of some alluvial derived paddy and associated non-paddy soils of Assam. *Agropedology* 7:22-31.
9. Dutta, M. (2001) . Pedogenic evaluation of Fe, Al and Mn in soils under paddy and non-paddy land uses. M.Sc. (Agri) Thesis, Assam Agric. Univ., Jorhat.
10. Fukushi, S. and Iwama , H. (1982). On the distribution of paddy soils in Muda irrigation area- a detailed soil survey of ACRBD-4 Block. *JARQ* 16:64-71
11. Gangopadhyay, S.K.,Walia, C.S., Chamuah, G.S. and Baruah, U. (1998). Rice growing soils of Upper Brahmaputra Valley of Assam – their characteristics and suitability. Journal of Indian Society of soil science 46:103-109.
12. Grant, C.J. (1965). Soil characteristics associated with the wet cultivation of rice. In: The Mineral Nutrition of Rice Plant. John Hopkins, Baltimore. Pp 15-28.
13. Hassannezhad, H., Pashaee, A., Khormali, F. and Mohammadian, M. (2008). Morphology and micromorphology of paddy soils under different soil moisture regime and ground water table in Mazandaran province, Northern Iran, Amol. *International Journal of Soil Science* 3(3): 149 -156.
14. Kalbitz, K. *et al*. The carbon count of 2000 years of rice cultivation. *Global Change Biol.* 19, 1107–1113 (2013).
15. Kanno, I (1956). A scheme for soil classification of paddy fields in Japan with special reference to mineral paddy soil. *Soil plant food* 2:148-152.
16. Kanno, I., Honjo, Y., Arimura, S. and Tokudome, S. (1964). Genesis and characteristics of rice soils developed on polder lands of the Shiroshi area, Kyushu. *Soil Science and Plant Nutrition* 10:1-19.
17. Karmakar, R.M. and Rao, A.E.V. (1999a). Soils on different physiographic units in Lower Brahmaputra Valley zone of Assam. I. Characterization and classification. *Journal of the Indian Society of soil science* 47: 761-767.
18. Katou,H., Nakaya, N. and Maeda, K. (1985). Changes in sediment volume, liquid limit and plastic limit of Alluvial soils upon drying. *Soil Science and Plant Nutrition* 31: 215-226.
19. Kongel-Knabner, I., Amelung, W., Cao, Z., Fiedler, S. and Frenzel, P (2010). Biogeochemistry of paddy soils. *Geoderma* 157:1-14.

© 2020 Global Journals

20. Kurniati *et.al.*(2016). Characterization of Several Paddy Soil Types in Bogor, West Java, Indonesia. *Department of Soil Science and Land Resource, Bogor Agricultural University Bogor 16680, Indonesia* p. 05.
21. Mitsuchi,M. (1974). Characters of humus formed under rice cultivation. *Soil Science and Plant Nutrition* 20: 249-259.
22. Moormann, F.R.(1981). The classification of Paddy soils as related to soil taxonomy. In: paddy Soils. Institute of Soil Science, Academic Sinica, Nan Jing. China, pp. 139-150.
23. Moormann, F.R. and Dudal, R. (1964). Characteristics of soils on which paddy is grown in relation to their capability classification. International Rice Comm. *Working Party on Rice, soils, Water and Fertilizer practices, Manila Philippines*, p 18.
24. Moormann, F.R. and van Breeman, N. (1978). Rice: Soil, Water and Land. IRRI, Los Banos, Philippines, p 185.
25. Motomura, S., Lapid,F.M. and Yokoi,H. (1970). Soil structure development in Ariake Polder soils in relation to iron forms. *Soil Science and Plant Nutrition* 16:47-54.
26. Okajima, H. and Imai (1981). Some Chemical Properties of soils from the Taoyuan Prefecture, China, in soils. National Institute of soil science, Academia Sinica, Nanjing, China, p 444-448.
27. Ponnamperuma, F.N., Martinery, E. and Loy, T.N. (1966). Influence of redox poteniial and partial pressure of carbondioxide on pH values and the suspension effect of flooded soil. *Soil science* 101: 421-431.
28. Prasad, Jagdish and Jondhale, D.G. (2006). Characteristics of rainfed rice and associated non – rice shrink-well soils in Central India. *Clay Research* 25(1):55-67
29. Sahrawat. K.L. (2010) Nitrogen mineralization in lowland rice soils: The role of organic matter quantity and quality. *Archives of Agronomy and Soil Science* Vol. 56, No. 3,pg. 337–353.
30. Singh.Y., Timsina. J. (2005). Crop residue management for nutrient cycling and improving soil production in rice based cropping systems in the tropics. *Science Direct Journal and books, Advances in Agronomy*. pg 124-128.
31. Somasiri, S. (1985). Wet Alfisols with special reference to Sri Lanka. Proc. Symp. Wetland solis: Characterization, Classification and Utilization. IRRI, Los Banao, Philippines, pg. 421-438.
32. Stout, B.A. (1966). Equipment for rice production. *FAO Agricultural Development paper* 84,p 169.
33. Smita Tale and Sangita Ingole (2015). A Review on Role of Physico-Chemical Properties in Soil Quality. *Chemical science Review and Letter*s pg 57.
34. Van Veen, J.A., Ladd, J.N. and Frissel, M.J. (1984). Modelling C and N turnover through the microbial biomass soil. *Plant Soil* 76:257-274.
35. Wei Zhou, Teng-Fei Lv, Yong Chen, Anthony P. Westby (2014). Soil Physicochemical and Biological Properties of Paddy-Upland Rotation: A Review. *Scientific World Journal* Volume 2014, Article ID 856352.
36. White JR, Reddy KR. (2001). The effects of select electron acceptors on organic nitrogen mineralization in northern Everglades soils. *Soil Sci Soc Am J*. 65:941–948.
37. Xi,Z. (1981). On the tendancy of organic matter accumulation in paddy soil under triple cropping system in suburbs of Shanghai. Proc. Symp. Paddy soils, Institute of Soil Science, Nanjing, China, p 471-474.
38. Zang, Gan-Lin and Chen, Liu-Mei. (2009). Soil genesis along a paddy soil chronosequence in a millennium scale. 19th World Congress of Soil Science, soil solutions for a changing World, 1-6 August 2010, Brisbane Australia.

© 2020 Global Journals

This page is intentionally left blank

© 2020 Global Journals

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 20 Issue 3 Version 1.0 Year 2020
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Defense Responses of Wheat Seedling under Biotic Stress Mimicked by the Linear β-(1,3)-Glucan

By Abderrakib Zahid
Institut Agronomique et Vétérinaire Hassan II

Abstract- Reactive oxygen species (ROS) production causes damage, and to better deal with the toxic effects of ROS, the seeds have developed detoxification mechanisms, among which the enzymes of the antioxidant system (catalase, superoxide dismutase, ascorbate peroxidase). Another result supports the link between ROS and redox regulation catalyzed by redoxin family in the seed. Among which, thioredoxins (Trxs) and peroxiredoxins (Prxs), particularly 1-Cys-Prx, expressed during maturation and germination steps.

Keywords: biotic stress, laminarin, peroxyredoxins, pr proteins, thioredxoin, wheat seedling.

GJSFR-D Classification: FOR Code: 070399

Strictly as per the compliance and regulations of:

© 2020. Abderrakib Zahid. This is a research/review paper, distributed under the terms of the Creative Commons Attribution-Noncommercial 3.0 Unported License http://creativecommons.org/licenses/by-nc/3.0/), permitting all non commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Defense Responses of Wheat Seedling under Biotic Stress Mimicked by the Linear β-(1,3)-Glucan

Abderrakib Zahid

Abstract- Reactive oxygen species (ROS) production causes damage, and to better deal with the toxic effects of ROS, the seeds have developed detoxification mechanisms, among which the enzymes of the antioxidant system (catalase, superoxide dismutase, ascorbate peroxidase). Another result supports the link between ROS and redox regulation catalyzed by redoxin family in the seed. Among which, thioredoxins (Trxs) and peroxiredoxins (Prxs), particularly 1-Cys-Prx, expressed during maturation and germination steps.

This study aim to assess the effect of the laminarin (β-(1,3)-glucan) as an elicitor in the triggering of the natural defenses of the wheat seedling. Also, the fungus *Fusarium oxysporum*, known to attack wheat during maturation, exhibit a high chitin / glucan ratio. Thus, we have followed the expression of several markers known for their roles in the protection against oxidative stress, including 1-Cys-Prx, a protein-specific of cereals seed, as well as catalase and ascorbate peroxidase enzymes of the antioxidant system. The β-(1,3)-glucan induce the expression of pathogenesis related genes known for their antimicrobial activities. The triggering of defense mechanisms using exogenous elicitors, allowed to developed new strategies of phytosanitary protection more respectful of the environment.

Keywords: biotic stress, laminarin, peroxyredoxins, pr proteins, thioredoxin, wheat seedling.

I. Introduction

Wheat is the most important cereal crop worldwide in terms of production and utilization. It is the most widely grown cereals and is a one source of energy, protein, and dietary fiber in human nutrition. The gluten proteins constitute up to 80% to 85% of total flour protein, and confer properties of elasticity and extensibility that are essential for the functionality of wheat flours. The gliadins and glutenins constitute each around 50% of the gluten proteins. Consequently, the most exciting and most researched areas in cereal chemistry and technology are the composition of wheat storage proteins and finding the relation between composition and functional properties [1,2,3] to improve the technological and rheological qualities [4,5]. However, in addition to the composition and the structural organization of the storage compounds, wheat seed quality depends on a several parameters including the activation of the metabolism of seed cells upon imbibition and the protection of tissues against oxidative stress during seed germination and desiccation [6].

Germination is a very complex process and is affected by many factors [7]. Minimum accumulation of reactive oxygen species (ROS) and enhanced activity of enzymes affect seed quality; thus, germination potential [8]. Thus, redox control is a critical determinant of these processes. Redox control of enzyme activities by thiol/disulfide exchange provides a mechanism for equilibrating the oxidation state of proteins of the surrounding environment. Mainly related to the activity of many seed enzymes and storage proteins [9, 10]. The redoxin family characterized by the typical motif -CXXC- in which two cysteines are separated by two other residues are among the proteins involved in redox control [11,12]. This motif is found in proteins of the thioredoxin (Trxs) belonging to the redoxin family. Plant Trxs are classified into different types (*m*, *f*, *x*, *y*, *o*, and *h*), depending on their characteristic: primary structure and cellular location. Trx *h* proteins are abundant in cereal seeds both during development and in germinating seeds, which reduces storage and α-amylase inhibitors [13, 14, 15, 16]. Trxs *h* are involved in the mobilization of storage proteins at the early stages of germination [17]. This role is proved by the identification of a large number of proteins as Trxs targets in cereals grain [16, 18]. Down-regulation of wheat Trx*h* induced easily forming glutenin macropolymers and the resistance of storage proteins to degradation [19]. Trxs *h* are involved in a complex interplay with other redox regulators such as glutaredoxin (Grx), glutathione (GSH) or peroxiredoxins (Prxs), also implicated against the oxidative stress. The Prxs are thiol-dependent antioxidants, containing one (1-cysteine [1-Cys] or two (2-Cys) conserved Cys residues. In barley (*Hordeum Vulgare*), the 2-Cys BAS1 exhibit an antioxidant activity [20, 21]. The 1-Cys Prxs are involved in the protection of the aleurone and embryo cells under oxidative stress by using the NADPH-dependent thioredoxin reductase (*NTR*)/*Trx* system, which localized in the nucleus [22]. The expression of the 1-Cys-Prxs increase during the late seed development, the protein is detected in embryo of mature seeds and the level increase with development age [23]. Under normal

Author: Unité de Protection Intégrée des Cultures, Département de Production, Protection et Biotechnologie Végétale, Institut Agronomique et Vétérinaire Hassan II, B.P. 6202 Rabat Instituts, Madinat Al Irfan, C.P 10101 Morocco. e-mail: abderrakib.zahid@gmail.com

© 2020 Global Journals

growth conditions the 1-Cys-Prxs have been proposed in maintaining dormancy [23, 21]. Under unfavorable conditions, dormancy have a beneficial effect for the seed because this property improve the possibility of survival during germination process. However, 1-Cys-Prxs are involved in sensing environmental conditions by the inhibition of germination in oxidative stress [26]. Other results suggest that 1-Cys-Prxs function not only to relieve mild oxidative stress but also as molecular chaperones under severe conditions during seed germination and plant development [27].

Antioxidant systems which act as ROS scavenger in seed biology play a major role in the growth processes during seed development. Some protective mechanisms involving ROS scavenging enzymes, such as catalase (CAT) [28] and, Ascorbate peroxidase (APX) [29]. Antioxidant enzyme CAT, which allows the tolerance of plant under stress conditions, is also recognized to be involved in the physiology of germination [30,31,32,33]. CAT activity in seeds and seedlings is also involved in the preservation of viability during storage, and necessary for seed germination and early seedling growth [34,35]. This enzyme has been used for determining the viability of seeds and germination capacity [36]. There are several studies about changes in enzyme activity that are related to germination, development, and tolerance of plants [37,38, 39, 40].

The importance of the CAT enzyme was signaled during the germination, the activity of CAT increases most drastically under unfavorable conditions such as saline stress during the early steps of germination [41,42], indicate that CAT is one of enzymes detoxifying hydrogen peroxide.

In addition to abiotic stress, biotic stress poses threats to wheat growth and production by reducing the germination of the seedling. Since the pathogenic fungi represent a significant constraint to wheat production. Pathogenesis related (PR) proteins involved in the general defense response of plants include glucanases and chitinases [43]. Generally, these enzymes increase in early plant-pathogens interactions. There are two distinct signal pathways in plant disease resistance; salicylic-dependent and jasmonic-acid-dependent pathways [44]. These two pathways induce different sets of defense-related genes. PR proteins, such as glucanase and chitinase, are generally induced by the salicylic-dependent pathway and degrade cell walls of fungal pathogens that contain glucan and chitin [45, 46].

As yet, most studies showed the effect of abiotic conditions in the expression of enzymes, and their responses to oxidative stress during different phases. In the present study, we attempt to gain more understanding on seed physiology. For this, wheat seeds (cv Soissons) were germinated under biotic stress mimicked by the linear β-(1,3)-glucan elicitor [47]. The objective of this study was to measure the response of wheat seedling by monitoring the expressions of 1-Cys-Prx, Trx *h*1, CAT, APX, and molecular markers of biotic stress such as the PR proteins (PR.1.1) and β-(1,3)-glucanase (Glu3). The final goal is to identify the markers able to enhance the germination of the wheat seeds under biotic stress.

II. Materials and Methods

a) Biological material and growth conditions

Seeds of Wheat (*Triticum aestivum*, cv Soisson) were sterilized by soaking in a 10% sodium hypochlorite for 20 min. Seeds were washed several times in sterile water and incubated in HCl 10 mM buffer for 5 min, followed by several rinses with sterile distilled water. The wheat seeds were germinated in the dark under controlled conditions. Biotic stress was simulated with a 200 μg. mL^{-1} of laminarin (linear β-(1,3)-glucan) from *laminaria digitata* algae (Sigma), and samples were collected at 0h, 12h, 24h, 48h and 72h after imbibition. Control was allowed germinating in the same conditions of biotic stress.

b) RNA extraction and Real-time quantitative PCR

Total RNA for qRT-PCR was isolated from wheat seedling after treatment with 200 μg.mL^{-1} of laminarin solution at 0h, 12h, 24h, 48h, and 72h. Total RNA was extracted using the RNeasy plant mini kit (Qiagen) following the manufacturer's instructions. Before qRT-PCR, RNA was treated with RNase-free DNase I (Qiagen) to eliminate any contaminating genomic DNA. cDNA was synthesized from 1 μg of total RNA using high capacity cDNA reverse transcription kit (Applied Biosystems) following the manufacturer's instructions. The PCR mix included 1X SYBR Green Master Mix (Applied Biosystems), cDNA template, and each of the forward and reverse primers (Table 1). The PCR cycling parameters were 20 s at 95 °C, followed by 40 cycles at 95 °C for 30 s, 60 °C for 30 s and finally 15 s at 95 °C. After completion of the cycling parameters, dissociation melt curve analyses (60 °C for 1 min, followed by 15 s at 95 °C and 15 s at 60 °C) were conducted to eliminate the effects of primers dimer formation and contamination. The qRT-PCR was performed in triplicate, and the negative controls included water and mRNA before reverse transcription. The genes investigated were 1-Cys-Prxs, CAT, PR.1.1 and Glu3. For the CAT gene, a TaqMan Universal PCR Master Mix (Applied Biosystems), gene primers and probes were used. 18S rRNA and β-tubulin genes were used as internal controls for the levels of cDNA. The relative fold changes were calculated according to the $2^{-\Delta\Delta CT}$ method [48].

© 2020 Global Journals

Table1: Primers used in qRT-PCR

Name	Primer sequence 5'>3'
rRNA18S	AGTAAGCGCGAGTCATCAGCT
	CATTCAATCGGTAGGAAGCGAC
TUBβ	TCCCAACAACATCCAGACCG
	TCCATACCCTCGCCAGTGTA
1-Cys-Prx	CGACCAGCTAGCTTTGATTG
	AAGCGCGGAGCTAGC
PR1.1	ACTACGACTACGGGTCCAACA
	TCGTAGTTGCAGGTGATGAAG
TRXh1	AAGAAGCTGGTGGTCATTGACTT
	AAGTCAATGACCACCAGCTTCTT
GLU3	CCTTGCCTCTTTGTATGCCTGA
	TCATCTTTTGTGGGTTCTTGC
CAT	CTCGGCCAGAAGCTCGC
	GATTTGCGCACTCCATGGA
	FAM AGC-CGT-CTC-AGC-TCC-AAG-CCG-A TAMRA

c) *Immunoblot analysis*

Proteins were extracted from wheat seedlings treated with 200 μg.mL^{-1} of the linear β-(1,3)-glucan solution and harvested at 0h, 12h, 24h, 48h, and 72h. Extraction was performed from each sample using 50 mM Tris-HCL (pH 8), one mM EDTA, and 0.5 mM PMSF. Proteins were separated in 4-12 % Nu-PAGES Gel using X-Cell SureLock™ Electrophoresis Cell (Invitrogen), transferred onto polyvinylidene fluoride membranes (Bio-Rad). Immuno-detection of protein was performed using antibodies against 1-Cys Prx and Trx*h*1 coupled with rabbit anti-chicken Ig Y (Ig G) (Sigma) and detected with sigma Fast ™ BCIP/NBT Tablets (Sigma). Finally, the quantification of the 1-Cys Prx and Trx*h*1 proteins were performed with the QuantiScan Software.

d) *Catalase and ascorbate peroxidase activities*

Proteins were extracted from wheat seedlings treated with 200 μg.mL^{-1} of the linear β-1,3-glucan solution and harvested at 0h, 12h, 24h, 48h, and 72h. Sample (0.5g) was ground in liquid nitrogen and then homogenized at 4°C in 1 ml of 0.2 M phosphate buffer pH 7.3 containing 1 mM EDTA, 1 mM ASA (ascorbate) and 2 mM 2-mercaptoethanol. The homogenate was rapidly centrifuged at 14000g for 15 min. The supernatant was used for enzyme assays and protein determination. Catalase activity was assayed measuring the rate of decrease of the absorbance of hydrogen peroxide at 240nm (ε= 39.4 M^{-1} cm^{-1}) in 3 ml of 0.2 M phosphate buffer pH 7 containing an aliquot of supernatant and 4 mM hydrogen peroxide [49]. For APX, activity was determined by measuring the decrease in absorbance at 290 nm, according to Chen et Asada (1989). The 1 ml reaction mixture contained 100 mM KPO4 (pH 7.5), 0.5 mM ascorbate, 0.2 mM H_2O_2, and 20 μl of extraction solution. APX activity was expressed as μmol ascorbate oxidized min^{-1}g^{-1}FW.

III. Results

Laminarin-treated seeds showed a development of stressed seeds compared to control (Fig. 1). This development of wheat seeds could be related to the fact that laminarin acts as an elicitor, inducing a mechanism at the molecular level which accelerates metabolic processes.

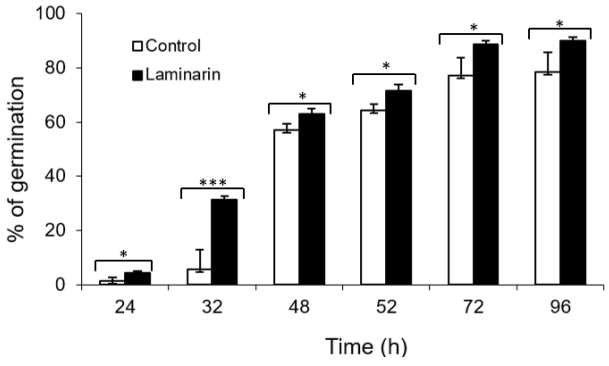

Figure 1: Monitoring germination of control and laminarin-treated wheat seeds.

a) *Study of Peroxyredoxine-1 (1-Cys-Prx)*

The expression and accumulation of 1-Cys-Prx transcripts and proteins during the maturation of wheat seed by qRT-PCR and western blot analysis, increases to reach its maximum at the end of this stage (35 DAA) (Fig. 2).

© 2020 Global Journals

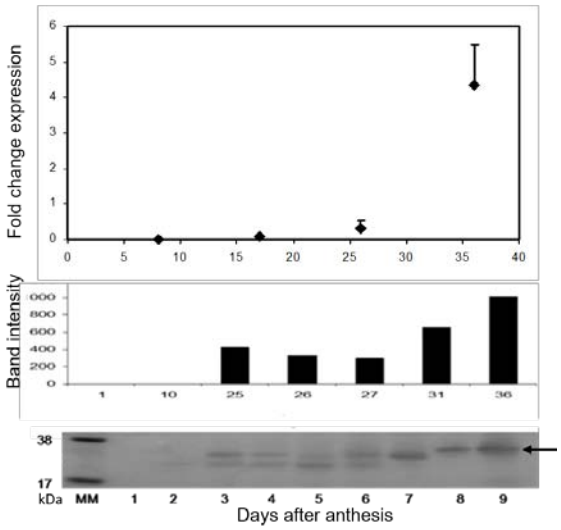

Figure 2: Expression pattern of soft wheat 1-Cys Prx transcript and protein in seed at the ripening stage.

b) 1-Cys-Prx transcript and protein expression

The *1-Cys Prx* gene expression is measured by qRT-PCR as described in experimental procedures, during seedling germination. Under laminarin treatment, the *1-Cys-Prxs* are highly expressed during the early steps of germination mainly at 24 and 48h (Fig. 3A), in comparison with the control whose expression decreases along with the germination (Fig.3A). To follow the accumulation of 1-Cys-Prxs proteins, a western blot analysis on extracts proteins from stressed and control seedling and quantification were performed on the band corresponding to 1-Cys-Prxs. The results show that 1-Cys-Prxs proteins increase gradually during the germination to reach a maximum at 48h and 72h (Fig. 3B, 3C), corresponding to the transduction phenomena. However; in the control, the proteins expression decreases throughout the germinating process. It is important to note that the gene expression of 1-Cys-Prxs decreases under normal conditions during germination.

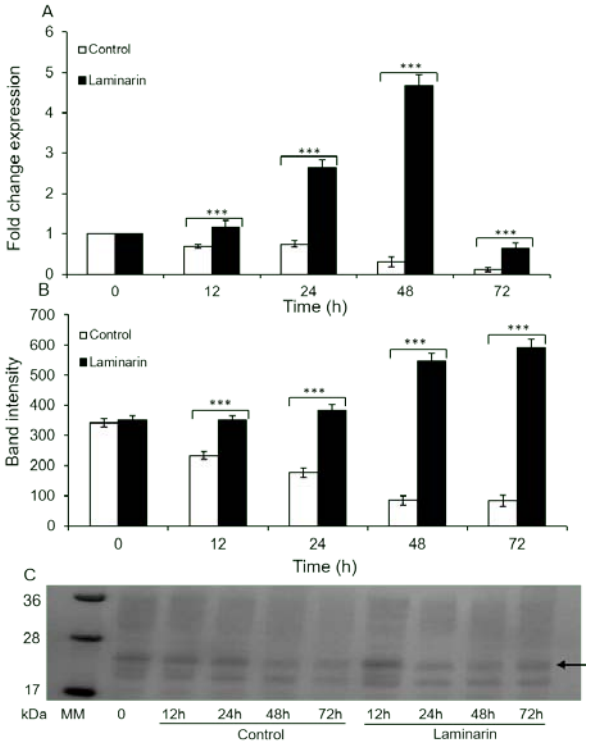

Figure 3: Wheat seeds were germinated in the presence of 200 $\mu g.mL^{-1}$ of laminarin solution, and samples were harvested at 0, 12h, 24h, 48h, and 72h after imbibition. A) Time course of 1-Cys Prxs gene expression using qRT-PCR in wheat seedling after treatment. B) Quantification of 1-Cys Prxs protein by QuantiScan software after western blot analysis. The values represent the mean from 3 biological replicates

© 2020 Global Journals

c) Trx h1 gene and protein expressions

The result obtained by qRT-PCR showed that laminarin treatment has a strong effect on Trx *h*1 gene expression during the earliest stages of germination (Fig. 4A). However, the western blot analysis using an antibody against Trx*h*1 showed the detection of two bands (a) and (b) corresponding to the Trx*h*1 proteins isoforms. The expressions were identical between control and biotic stress until 48h (Fig. 4B, 4C), however; the accumulation of Trx*h*1 proteins increase considerably at 72h under laminarin treatment compared with the control.

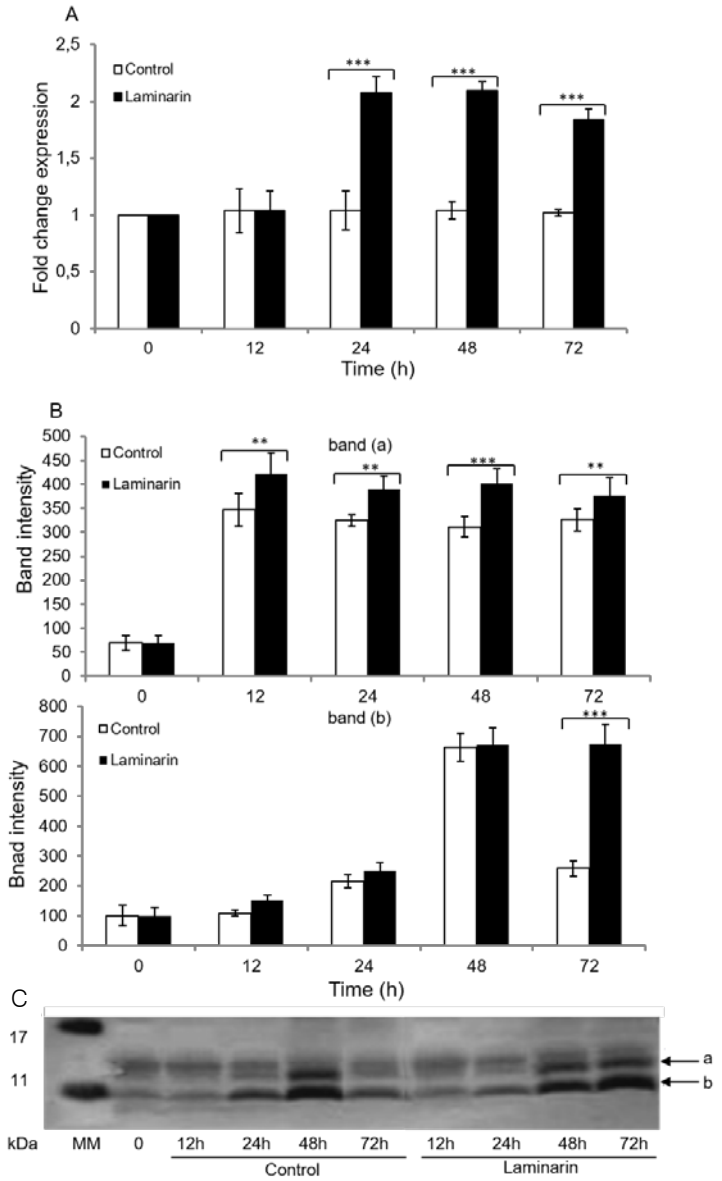

Figure 4: Wheat seeds (*Triticum aestivum*, cv Soisson) were allowed to germinate in the presence of 200 µg.mL-1 of laminarin solution, and samples were harvested at 0h, 12h, 24h, 48h, and 72h after imbibition. A) Time course of Trxh1 gene expression using qRT-PCR in wheat seedling after treatment and B) Western blot analysis of Trxh1 expression using the anti-Trxh1 antibody. a and b) Quantification of Trx *h*1 protein isoforms (a and b) by QuantiScan software after western blot analysis. The values represent the mean from 3 biological replicates

d) Catalase expression

The mRNA transcripts catalase increases during germination under laminarin treatment (Fig. 5A). The higher levels were observed at 24h and 48h (fig. 5A) before decrease afterward. However, in control, the expression remains almost unchanged along with the germination. The measure of CAT activity in the presence of hydrogen peroxide showed that under biotic stress, the activity increase throughout the germination to reach a maximum at 72h (fig. 5B).

© 2020 Global Journals

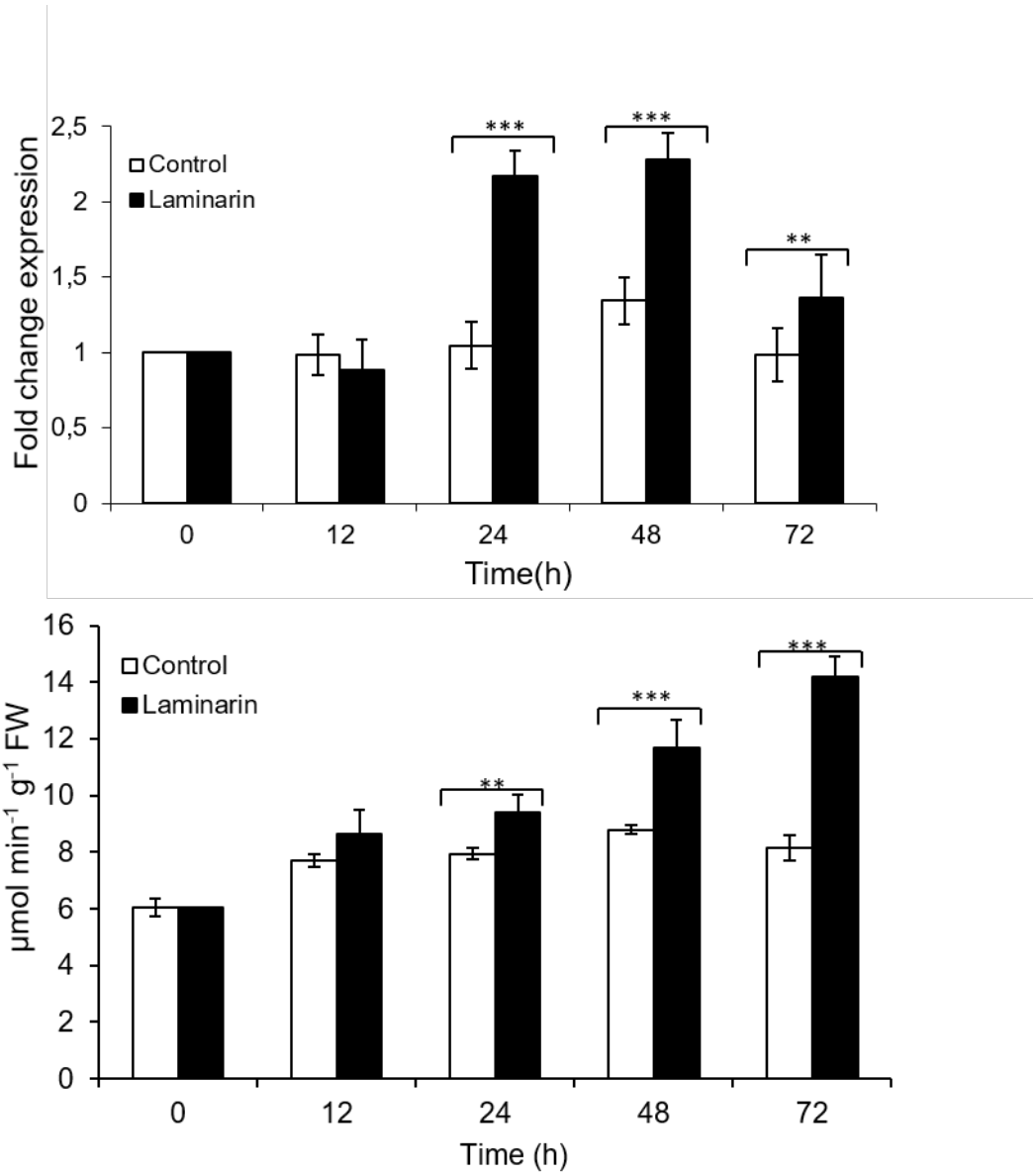

Figure 5: Wheat seed were germinated in the presence of 200 μg.mL^{-1} of laminarin solution, and samples were harvested at 0h, 12h, 24h, 48h, and 72h after imbibition. A) Time course of catalase genes expression using qRT-PCR in wheat seedling after treatment. B) Catalase activity measured the rate of decrease of the absorbance of hydrogen peroxide. The values represent the mean from 3 biological replicates

e) Ascorbate peroxidase

The enzymatic activity does not show any differences between the control and stressed samples up to 48 hours, after which the activity increase to reach a maximum at 72 hours in the presence of laminarin (Fig. 6).

© 2020 Global Journals

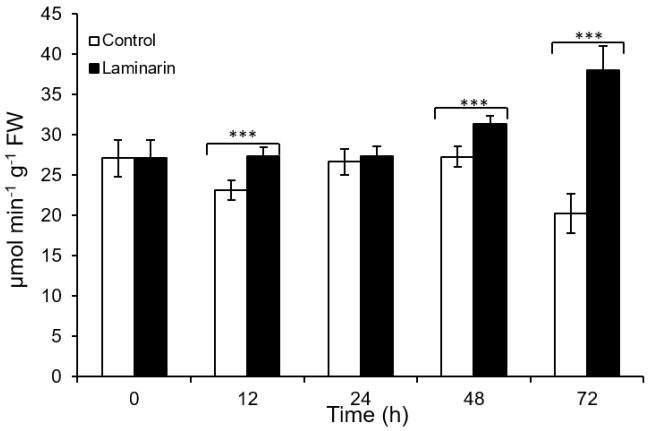

Figure 6: Wheat seeds were germinated in the presence of 200 μg.mL^{-1} of laminarin solution, and samples were harvested at 0h, 12h, 24h, 48h, and 72h after imbibition. APX activity measured the rate of decrease of the absorbance of hydrogen peroxide. The values represent the mean from 3 biological replicates

f) The molecular marker of biotic stress

To give proof that the germination process takes place in conditions of biotic stress simulated by the linear β-(1,3)-glucan. The measure of gene expression showed an increase of *PR.1.1* and *Glu3* expression at 72h, in comparison with the control characterized by an unchanged profile (Fig. 7A, 7B).

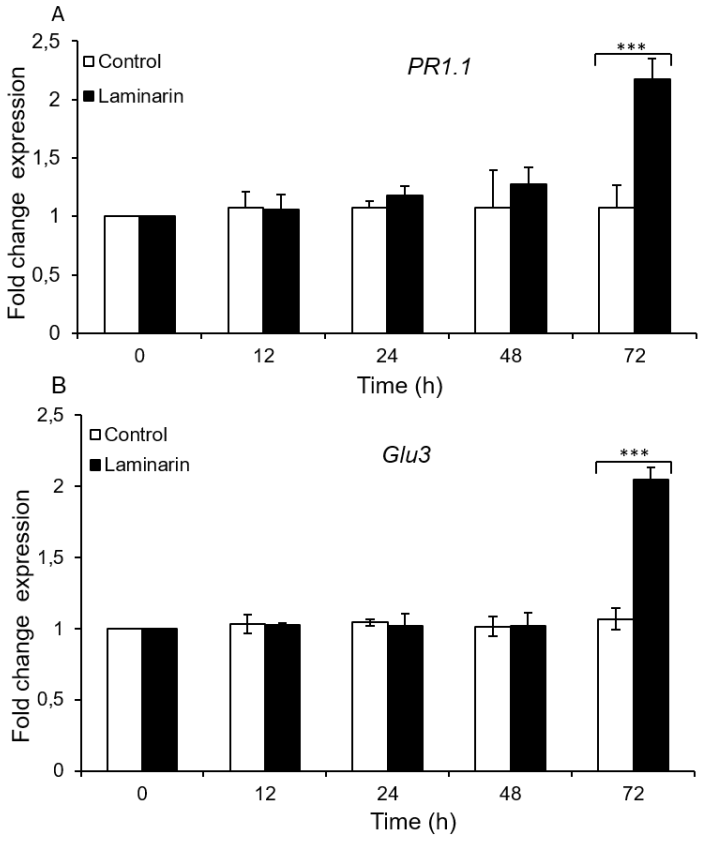

Figure 7: Wheat seeds were germinated in the presence of 200 μg.mL^{-1} of laminarin solution, and samples were harvested at 0h, 12h, 24h, 48h, and 72h after imbibition. Time course of A) *PR1.1* and B) *Glu3* genes expression using qRT-PCR in wheat seedling after treatment. The values represent the mean fold-changes from 3 biological replicates.

© 2020 Global Journals

IV. Discussion

Germination is a very complex process and is affected by many factors [7]. Minimum accumulation of ROS and enhanced activity of enzymes affect seed quality, thus germination potential [8].

In the present study, stress conditions induced by laminarin treatment caused an increase of enzyme activities during seedling germination however, each enzyme showed a various expression profile. The 1-Cys-Prxs known to be specific of wheat seeds, constituted the main enzyme against stress oxidative [22], due to those expressions during the earliest stage of germination [26]. Despite the expression of 1-Cys-Prx decrease during the germination, the utilization of laminarin allows maintaining 1-Cys-Prx at a higher level. Results already confirmed [50], the rice mRNA of 1-Cys-Prxs level became significantly diminished immediately after seeds germination under normal conditions. [23] showed that 1-Cys-Prxs are highly expressed during late seed development and desiccation stage, suggesting the implication of the 1-Cys-Prxs against oxidative stress in this stage caused by dehydration. The function of oxidative stress was confirmed in rice by the production of transgenic R1-Cys Prxs plants, exhibiting enhanced resistance against stress [50]. These results suggest that 1-Cys-Prxs used in the germination process were accumulated during the desiccation stage, and after imbibition, the transcript level becomes dramatically reduced and completely disappears once the germination process ends. Since the use of molecules as laminarin maintains a high expression of 1-Cys-Prxs involved against oxidative stress during unfavorable conditions.

At the early steps of germination, Trx *h* is involved in the mobilization of storage proteins and oxidative stress by the reduction of the 1-Cys-Prxs [22]. Our work exhibit the effect of laminarin on Trx*h*1 protein expression, suggesting an improvement of the mobilization of storage and the reduction of 1-Cys-Prxs. The acceleration of germination in transgenic barley lines overexpressing Trx *h* [51], as well as the retardation of germination in transgenic wheat lines with suppressed Trx *h* expression [52], confirms this function of the Trx system in cereals seeds. The Trx *h* controls the oxidative stress in the living tissues, specifically in the scutellum and the aleurone layer [22]. However, under abiotic stress, the analysis of the expression of Trx *h* in seedling shows a difference in the expression profile in the aleurone compared with other tissues. The aleurone of cells suffering oxidative stress is characterized by the presence of the NTR/Trx *h* system [53; 22], suggests that it is associated with antioxidant response. Moreover, in dry seeds, the NTR/Trx *h* and 1-Cys-Prxs are localized in the nucleus of the seed and the NTR-dependent activity of the 1-Cys-Prxs [22].

One of the factors that determine seed quality is the presence of CAT enzyme [37]. In addition to allow the tolerance of the plants under stress conditions, the antioxidant enzymes CAT is reported to be involved in the physiology of germination [30, 32, 33]. Our study showed the effect of laminarin in inducing CAT gene expression and activity during the early steps of germination. In this subject, many studies have demonstrated that enzymes CAT, are related to various stresses during the germination [54,55], the activities were increased significantly in roots and shoots. Among the antioxidant enzymes, CAT activity increase most drastically under abiotic and biotic stress due to its specificity to detoxifying the hydrogen peroxide (H_20_2), suggesting that the CAT enzyme is a major enzyme involved in oxidative stress. After anthesis and during maturation steps, the dehydration steps caused a stress for seeds, and the detoxification potential of seeds might be strongly altered if these enzymes were to undergo to some damage during seeds storage, leading to a reduction of seeds vigor. Under biotic or abiotic stresses, the activatation of antioxidant defense mechanisms, contribute in maintaining the structural integrity of the cell and decrease oxidative damage [56]. In rice plants, an important cereal model, increased expression levels of antioxidant enzymes and genes have been related to the response to stress factors [57, 58].

The genes *PR1.1* and *Glu-3* are generally considered as molecular markers of the JA and SA-dependent pathway. Our data show that transcriptional responses to the β-(1.3)-glucan induce the expression of *PR1.1* and *Glu3* related to biotic stress. The sulfated β-(1,3)-glucan induces the production of acidic isoforms of PR proteins *via* the salicylic acid (SA) and ET dependent signaling pathways in tobacco, Arabidopsis, and grapevine [59,60]. The biotic markers genes are expressed rather than the detoxifying enzymes, suggesting that laminarin causes stress conditions and the generation of reactive oxygens species. The induction of antioxidant enzymes in plants may protect themselves from the active oxygen damage due to pathogen invasion. However, PR proteins, such as β-1-3-glucanase and chitinase, degrade cell walls of fungal pathogens that contain glucan and chitin. Since the use of β-(1-3)-glucan elicit the full cascade of specific defense responses.

All these results suggest that the accumulation of 1-Cys-Prxs, Trx *h*1, and the antioxidant enzymes as CAT and APX during seed maturation allowed to protect seedlings against oxidative stress at the early stage of germination under biotic stress. Since laminarin use as an elicitor could improve seed germination quality and vigor and protect wheat seedling against pathogens attacks.

© 2020 Global Journals

V. Conclusion

The use of compounds like laminarin seems to promote the natural defenses mechanisms in wheat seeds. Thus, we have highlighted the importance of the proteins of 1-Cys-Prx and the PR proteins in the protection against possible stress linked to the presence of pathogens. In cereals, because 1-Cys-Prx is seed-specific, the use of external substances such as laminarin is a means for stimulating this protein and thus improving protection against the possible attacks by fungi, such as Fusarium wilt which attacks common wheat.

This study mainly allowed to discriminate the implication of markers of redoxins and those of the antioxidant system in the study of seeds physiology. 1-Cys-Prx seems to be well placed to address this physiology and oxidative stress in particular during germination in the presence of biotic stress in relation to the antioxidant system. The importance of Trxs *h* seems to be secondary, due to their involvement in the mobilization of storage proteins. Thus, 1-Cys-Prx can be used as a marker indicating the seeds redox state during the first stages of germination. The use of external treatments with oligosaccharide substances capable of stimulating the natural defenses constitutes a plant protection strategy.

This approach, which reconciles agriculture and environment constitute an alternative in plant protection. The strategy of stimulating plant defense mechanisms using natural compounds differs from the use of pesticides, by stimulating the plant defense and weakening against pathogens. The use of substances such as laminarin has the considerable advantage of not unnecessarily mobilizing the metabolism of the plant before defense.

References Références Referencias

1. Barro, F., Rooke, L., Bekes, F., Gras, P., Tatham, A.S., Fido, R.,Lazzeri, P., Shewry, P.R. and Barcelo, P. (1997) 'Transformation of Wheat with High Molecular Weight Subunit Genes Results in Improved Functional Properties. Nature Biotech.15, 1295–1299.
2. Shewry, PR ; Tatham AS ; NG and Halford. (2001) Nutritional control of storage protein synthesis in developing grain of wheat and barley. Plant Growth Regulation 34, 105–111.
3. Shewry, PR and Halford, NG (2001). Cereal seed storage proteins: structures, properties and role in grain utilization. *Journal of Experimental Botany*. 53, 370, 947–958.
4. Haros M, Rosell CM, Benedito C. 2002. Improvement of flour quality through carbohydrases treatment during wheat tempering. J Agric Food Chem.14:4126-30.
5. Zečević V., D. Knežević and D. Mičanović (2007): Variability of technological quality components in winter wheat. – Genetika. 39, 3, 365 - 374.
6. Zahid A, Afoulous S and Cazalis R. 2008. Thioredoxin h and wheat seed quality. Cereals chemistry 85: 799-807.
7. Shafii B., J. Price W.J, 2001. Estimation of cardinal temperatures in germination data analysis. Journal of Agricultural, Biological, and Environmental Statistics 6 (3), 356-366.
8. Rao R.G.S., Singh P.M., Mathura Rai M., 2006. Storability of onion seeds and effects of packaging and storage conditions on viability and vigour. Scientia Horticulturae, 110 (1), 1-6.
9. Wong J H, Jiao J-A, Kobrehel K, Buchanan BB (1995) Thioredoxin-dependent deinhibition of pullulanase of barley malt by inactivation of a specific inhibitor protein. Plant Physiol 108:67
10. Wong JH, Cai N, Tanaka CK, Vensel WH, Hurkman WJ, Buchanan BB (2004) Thioredoxin reduction alters the solubility of proteins of wheatstarchy endosperm: an early event in cereal germination. Plant CellPhysiol45:407–415
11. Holmgren, A., Söderberg, B. O., Eklund, H et Bränden, C. I. 1975. Three-dimensional structure of Escherichia coli thioredoxin-S2 to 2.8 Angström resolution. *Proceeding of the National Academy of Sciences. U S A.* 72: 2305-2309.
12. Martin, J. L. 1995. Thioredoxin: A fold for all reasons. Structure 3:245-250.
13. Jiao, J., Yee, B.C., Wong, J.H., Kobrehel, K et Buchanan, B.B. 1993. Thioredoxin-linked changes in regulatory properties of barley? -amylase/subtilisn inhibitor protein. *Plant physiology and Biochemistry*. 31: 799-804.
14. Kobrehel, K., Wong, J.H., Balogh, A., Kiss, F., Yee, B.C et Buchanan, B.B. 1992. Specific reduction of wheat storage proteins by thioredoxin h. *Plant Physiology*. 99: 919-924.
15. Lozano, R.M., Wong, J.H., Yee, B.C., Peters, A., Kobrehel, K et Buchanan, B.B. 1996. New evidence for a role for thioredoxin h in germination and seedling development. *Planta*. 200: 100-106.
16. Yano, H., Wong, J.H., Cho, M.J., and Buchanan, B.B. 2001a. Redox changes accompanying the degradation of seed storage proteins in germinating rice. *Plant Cell Physiology*. 42: 879-883.
17. Besse, I., Wong, J. H., Kobrehel, K., and Buchanan, B. B. 1996. Thiocalsin: A thioredoxin-linked; substrate-specific protease dependent on calcium. *Proceeding of The National. Academy of Science. USA*. 93:3169-3175.
18. Marx, C., Wong, J.H et Buchanan, B.B. 2003. Thioredoxin and germinating barley: targets and protein redox changes. *Planta*. 216: 454-460.
19. Guo H, Wang S, Xu F, Li Y, Ren J, Wang X, Niu H, Yin J. 2013. The role of thioredoxin h in protein

© 2020 Global Journals

metabolism during wheat (Triticum aestivum L.) seed germination. Plant Physiol Biochem. 67:137-43.
20. Baier M et Dietz K.J. 1997. The plant 2-Cys peroxiredoxin BAS1 is a nuclear-encoded chloroplast protein: its expressional regulation, phylogenetic origin, and implications for its specific physiological function in plants. *Plant Journal*. 12:179-190.
21. Stacy, R.A., Munthe, E., Steinum, T., Sharma, B et Aalen, R.B. 1996. A peroxiredoxin antioxidant is encoded by a dormancy-related gene, per1, expressed during late development in the aleurone and embryo of barley grains. *Plant of Molecular Biology*. 31: 1205-1216.
22. Pulido, P., Cazalis, R et Francisco, J.C. 2009. An antioxydant redox system in the nucleus of wheat seed cells suffering oxidative stress. *The plant journal*. 57: 132-145.
23. Stacy, R.A., Nordeng, T.W., Culianez-Macia, F.A et Aalen, R.B. 1999. The dormancy-related peroxiredoxin anti-oxydant, PER1, is localized to the nucleuss of barely embryo and aleurone cells. *The Plant Journal*. 216: 454-460.
24. Gold-mark, P.J., Curry, J., Morris, C.F et Walker-Simmons, M.K. 1992. Cloning and expression of an embryo-specific mRNA up-regulated in hydrated dormant seeds. *Plant Moleculare Biology*. 19: 433-441.
25. Haslekas, C., Stacy, R.A., Nygaad, V., Culianez,-Macia, F. A et Aelen R.B. 1998. The expression of a peroxiredoxin antioxidant gene, AtPer1, in Arabidopsis thaliana is seed-specific and related to dormancy. *Plant Molecular Biology*. 36: 833-845.
26. Haslekas, C., Viken, M.K., Grini, P.E., Nygaad, S.H., Meza, T.J et Aelen, R.B. 2003. Seed 1-cysteine peroxiredoxin antioxidants are not involved in dormancy, but contribute to inhibition of germination during stress. *Plant physiology*. 133: 1148-1157.
27. Kim SY, Paeng SK, Nawkar GM, Maibam P, Lee ES, Kim KS, Lee DH, Park DJ, Kang SB, Kim MR, Lee JH, Kim YH, Kim WY, Kang CH. 2011.The 1-Cys peroxiredoxin, a regulator of seed dormancy, functions as a molecular chaperone under oxidative stress conditions. Plant Sci. 181:119-24.
28. Sofo, A Scopa, A Nuzzaci, M and Vitti, A. 2016. Ascorbate Peroxidase and Catalase Activities and Their Genetic Regulation in Plants Subjected to Drought and Salinity Stresses. Int J Mol Sci. 16, 6 : 13561–13578.
29. Bonifacio A, Martins MO, Ribeiro CW, Fontenele AV, Carvalho FE, Margis-Pinheiro M, Silveira JA. Role of peroxidases in the compensation of cytosolic ascorbate peroxidase knockdown in rice plants under abiotic stress. Plant Cell Environ. 2011;34:1705–1722.
30. Scandalios, J.G Oxygen stress and superoxide dismutases (1993) *Plant Physiology*. 101, 1, 7–12.
31. Reuzeau, T and Cavalie G. 1995 Activities of free radical processingenzymes in dry sunflower seeds. New Phytol. (1995), 130, 59-66
32. Bailly, C. 2004. Active oxygen species and antioxidants in seed biology. *Seed Science Research*. 14: 93-107.
33. Kibinza S., Bazin J., Bailly C., Farrant J.M., Corbineau F., El-Maarouf-Bouteau H., 2011. Catalase is a key enzyme in seed recovery from ageing during priming. Plant Science 181 (3), 309–315.
34. Bernal-Lugo I., Camacho A., Carballo A., 2000. Effects of Seed Ageing on the Enzymic Antioxidant System of Maize Cultivars. Chapter 14 (Edited by Black M., Bradford K.J., Vazquez-Ramos J., Seed biology Advances and Applications) CABI publishing, 151-160 Cambridge, USA.
35. Miloševic M., M. Vujakovic, D. Karagic 2010. Vigour tests as indicators of seed viability- Genetika, 42 (1), 103 -118.
36. Prodanović O., Prodanović R., Bogdanović J., Mitrović A., Milosavić N, and Radotić K. 2007. Antioxidative enzymes during germination of two lines of Serbian Spruce [*Picea omorika* (PANČ.) PURKYNĚ] Arch. Biol. Sci., Belgrade, 59 (3), 209.
37. Bailly C., Audigier C., Ladonne F., Wagner M.H., Coste F., Corbineau F., Côme D., 2001. Changes in oligosaccharide content and antioxidant enzyme activities in developing bean seeds as related to acquisition of drying tolerance and seed quality. J. Exp. Bot. 52 (357): 701-708.
38. Cai F., Mei L-J., An X-L., Gao S., Tang L., Chen F. 2011. Lipid Peroxidation and Antioxidant Responses during Seed Germination of *Jatropha curcas* International Journal of Agriculture and Biology 13, 25–30.
39. Jihong Q.; Qing L. 2009. Impact of seasonally frozen soil on germinability and antioxidant enzyme activity of *Picea asperata* seeds. Canadian Journal of Forest Research, 39 (4)723-730.
40. Demirkaya M., Dietz K.J., Sivritepe H.Ö. 2010. Changes in Antioxidant Enzymes during Ageing of Onion Seeds. Not. Bot. Hort. Agrobot. Cluj 38 (1), 49-52.
41. Heidari, M and Mesri, F. 2008. Salinity effects on compatible solutes, antioxidants enzymes and ion content in three wheat cultivars. Pak J Biol Sci. 2008 May 15;11(10):1385-9.
42. Haiyan Li, Xiaoshuang Li, Daoyuan Zhang, Huiliang Liu and Kaiyun Guan Effects of drought stress on the seed germination and early seedling growth of the endemic desert plant Eremosparton songoricum (Fabaceae). Excli J. 12 : 89–101.
43. Collinge, D. B., P. L. Gregersen, and H. Thordal-Christensen. 1994. The induction of gene

© 2020 Global Journals

expression in response to pathogenic microbes, pp. 391-433. In A. S. Besra (ed.), Mechanisms of Plant Growth and Improved Productivity, Modern Approaches and Perspectives. Marcel Dekker, New York, U.S.A.
44. Agrios, G. N. 1997. Plant Pathology, 4th Ed. Academic Press, San Diego, U.S.A.
45. Kim, Y. J. and B. K. Hwang. 1994. Differential accumulation of β-1-3-glucanase and chitinase isoforms in pepper stems infected by compatible and incompatible isolates of Phytophthora capsici. Physiol. Mol. Plant Pathol. 45: 195209.
46. Kim, Y. J. and B. K. Hwang. 1997. Isolation of a basic 34 kilodalton β-1-3-glucanase with inhibitory activity against Phytophthora capsici from pepper stems. Physiol. Mol. Plant Pathol. 50: 103-115.
47. Klarzynski, O., Plesse, B., Joubert, J., Yvin, J., Kopp, M., Kloareg, B et Fritig, B. 2000. Linear beta-1,3 glucans are elicitors of defenses in tobacco. *Plant Physiology*. 124: 1027-1038.
48. Livak, K.J et Schmittgen, T.D. 2001. Analysis of relative gene expression data using real-time quantitative and the 2T- C method. *Methods*. 25: 402-408.
49. Beaumont F., Jouve H.M., Gagnon J., Gaillard J., Pelmont J. (1990) Purification and properties of a catalase from potato tubers *(Solanum tuberosum)*. Plant Sci., 72, 19-26.
50. Chen GX, Asada K (1989) Ascorbate peroxidase in tea leaves: Occurrence of two isoenzymes and the differences in their enzymatic and molecular properties. Plant Cell Physiol 30: 987–998.
51. Lee, K.O., Jang, H.H., Jung, B.G., Chi, Y.H., Lee, J.Y., Choi, Y.O., Lee, J.R., Lim, C.O., Cho, M.J et Lee, S.Y. 2000. Rice 1Cys-peroxiredoxin over-expressed in transgenic tobacco does not maintain dormancy but enchances antioxydant activity. *FEBS Letters*. 486: 103-106.
52. Wong, J.H., Kim, Y.B., Ren, P.S., Cai, N., Cho, M.J., Heden, P., Lemaux, P.G et Buchanan, B.B. 2002. Transgenic barley grain overexpressing thioredoxin shows evidence of communication between the endosperm and the embryo and aleurone. *Proceeding of the National Academy of Sciences. USA*. 99: 16325-16330.
53. Guo, H.X., Yin, J., Ren, J.P., Wang, Z.Y et Chen, H.L. 2007. Changes in proteins within germinating seeds of transgenic wheat with an antisense construct directed against the thioredoxin. *Journal of Plant Physiology and Molecular Biology*. 33: 18-24.
54. Serrato, A.J et Cejudo, F.J. 2003. Type-h thioredoxins accumulate in the nucleus of developing wheat seed tissues suffering oxidative stress. *Planta*. 217: 392-399.
55. Kim, S.Y., Lim, J.H., Park, M. R., Kim, Y.J., Park, T.I., Seo, Y.W., Choi, K.G et Yun, S.J. 2005. Enhanced antioxidant enzymes are associated with reduced hydrogen peroxide in barley roots under saline stress. *Journal of Biochemistry and Molecular Biology*. 38: 218-224.
56. Oracz, K., El-Maarouf Bouteau, Y., Farrant, J.M., Cooper, K., Belghazi, M., Job, C., Job, D., Corbineau., F et Bailly, C. 2007. ROS production and protein oxidation as a novel mechanism for seed dormancy alleviation. *Plant Journal*. 50: 452-465.
57. Caverzan, Casassola, A and Patussi Brammer, S Antioxidant responses of wheat plants under stress. Genet Mol Biol. 2016 Jan-Mar; 39(1): 1–6.
58. Passaia G, Fonini LS, Caverzan A, Jardim-Messeder D, Christoff AP, Gaeta ML, Mariath JEA, Margis R, Margis-Pinheiro M. The mitochondrial glutathione peroxidase GPX3 is essential for H_2O_2 homeostasis and root and shoot development in rice.
59. Passaia G, Caverzan A, Fonini LS, Carvalho FEL, Silveira JAG, Margis-Pinheiro M. Chloroplastic and mitochondrial GPX genes play a critical role in rice development. Biol Plantarum. 2014;58:375–378.
60. Ménard R, Alban S, de Ruffray P, Jamois F, Franz G, Fritig B, Yvin JC, and Kauffmann S .2004. β-1,3 Glucan sulfate, but not β-1,3 glucan, induces the salicylic acid signaling pathway in tobacco and Arabidopsis. *The Plant Cell* 16, 3020–3032.
61. Gauthier A, Trouvelot S, Kelloniemi J, Frettinger P, Wendehenne D, Daire X, Joubert JM, Ferrarini A, Delledonne M, Flors V, and Poinssot B 014The sulfated laminarin triggers a stress transcriptome before priming the SA- and ROS-Dependent defenses during grapevine's induced resistance against *Plasmopara viticola. PLoS One* 9, e88145. doi:10.1371/journal.pone.0088145.

© 2020 Global Journals

This page is intentionally left blank

© 2020 Global Journals

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 20 Issue 3 Version 1.0 Year 2020
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Nutrient Uptake, Post - Harvest Nutrient Availability and Nutrient balance Sheet under Integrated Nutrient Management Practices in Sweet Basil (*Ocimum Basilicum* L.) Cultivation

By Baraa AL-mansour, D. Kalaivanan, M. A. Suryanarayana, A. K. Nair & Basavaraj, G.

ICAR-Indian Institute of Horticultural Research

Abstract- An experiment was conducted to study the effect of integrated nutrient management on nutrient uptake post-harvest soil nutrient availability and nutrient balance of sweet basil (*Ocimum basilicum*) at ICAR - Indian Institute of Horticultural Research, Bengaluru during Kharif season of 2015 and 2016.There were nine treatments and three replication with Randomized complete block design. The results revealed that the maximum nutrient uptake in the main crop as N (155.67 and 113.19 kg ha^{-1}), P (43.80 and 32.43 kg ha^{-1}) and K (163.33 and 116.16 kg ha^{-1}) Similarly, in ratoon (56.43 and 26.65 kg ha^{-1}), (16.14 and 14.01 kg ha^{-1}) and (55.65 and 39.27 kg ha^{-1}) were reordered with application of both recommended FYM (10 t ha^{-1}) and NPK (160:80:80 kg ha^{-1}) during first and second year, respectively.

Keywords: farm yard manure, chemical fertilizers, microbial consortia, npk uptake, npk availability.

GJSFR-D Classification: FOR Code: 070307

Strictly as per the compliance and regulations of:

© 2020. Baraa AL-mansour, D. Kalaivanan, M. A. Suryanarayana, A. K. Nair & Basavaraj, G. This is a research/review paper, distributed under the terms of the Creative Commons Attribution-Noncommercial 3.0 Unported License http://creativecommons.org/licenses/by-nc/3.0/), permitting all non commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Nutrient Uptake, Post -Harvest Nutrient Availability and Nutrient balance Sheet under Integrated Nutrient Management Practices in Sweet Basil (*Ocimum Basilicum* L.) Cultivation

Baraa AL-mansour [α], D. Kalaivanan [σ], M. A. Suryanarayana [ρ], K. Nair [ω] & Basavaraj, G. [¥]

Abstract- An experiment was conducted to study the effect of integrated nutrient management on nutrient uptake post-harvest soil nutrient availability and nutrient balance of sweet basil (*Ocimum basilicum*) at ICAR - Indian Institute of Horticultural Research, Bengaluru during Kharif season of 2015 and 2016.There were nine treatments and three replication with Randomized complete block design. The results revealed that the maximum nutrient uptake in the main crop as N (155.67 and 113.19 kg ha^{-1}), P (43.80 and 32.43 kg ha^{-1}) and K (163.33 and 116.16 kg ha^{-1}) Similarly, in ratoon (56.43 and 26.65 kg ha^{-1}), (16.14 and 14.01 kg ha^{-1}) and (55.65 and 39.27 kg ha^{-1}) were reordered with application of both recommended FYM (10 t ha^{-1}) and NPK (160:80:80 kg ha^{-1}) during first and second year, respectively. Highest nitrogen (227 and 236.33 kg ha^{-1}) and potassium (296.80 and 340.60 kg ha^{-1})availability in post-harvest soils was gained with application of FYM (10 t ha^{-1}) + 100% recommended N through FYM + bio-fertilizer consortia*i.e.*, T_2 while, the application of 160:80:80 kg NPK ha^{-1} + FYM (10 t ha^{-1}) *i.e.*, T_9 recorded the highest available phosphorus (42.31 and 58.15 kg ha^{-1}) during 2015 and 2016, respectively. Also, T_2 recorded the maximum gain of available nitrogen and potassium in soil (42.4 and 96.8 kg ha^{-1}) in 2015.while the maximum gain of phosphorus was recorded in T_9 as (14.3 kg ha^{-1}). The results obtained from this study demonstrated that integrated nutrient management can maximize nutrient absorption as a result of increasing the soil fertility which reflected on nutrient balancesheet.

Keywords: farm yard manure, chemical fertilizers, microbial consortia, npk uptake, npk availability.

I. Introduction

Integrated nutrient management is becoming important agricultural approach towards sustainability, meanly in expanded growing of medicinal and aromatic plants.

Sweet basil (*Ocimum basilicum* L.) belonging to the *Lamiaceae* family, cultivated around the world (Bariaux *et al*. 1992). It is considered as a source of essential oils which are important for food and medicine industries (Palada *et al*. 2002).

Vegetative growth and obtained yield of basil, rely on available nutrients in the soil, especially of macro and microelements taken by(Dzida2010). Crop demand for important elements is met by a combination of inherent soil fertility and externally applied nutrients. However, highly depending systems on chemical fertilizer often lead to degradation of soil fertility, threaten there by the concept of sustainability (Anwar *et al.* 2007).

Maintenance of soil fertility reflecting positively on the crop yield (Mbonigaba2007). This can be reach by providing soil nutrients by using of different types of fertilizers and organic manures (Palm*et al*. 1997). So that integrated application of organic and inorganic fertilizers is rapidly gaining favor. However, in cultivation of medicinal and aromatic plants, such as basil, the real importance is given to the quality rather than quantity. So that, the sustainable agricultural methods by application of both organic and inorganic fertilizer improve the performance of aromatic plants side by side maintaining the nature balance (Malik *et al.* 2011).

The integrated application of organic and inorganic substances lead to a general improving in physical, chemical and biological characters of the soil, such as soil structure, ion-exchange system and microbial activity (Kirchner *et al*. 1993) .

Now, it could be considered that low soil productivity is due to degradation of organic matter. Therefore, it is urgent to follow suitable management of its content in the soil. One way of increasing (SOM) is by application of organic manures which give energy for living microbial component of the soil and provide plants nutrient (Gundale 2005). Vanlauwe & Giller (2006) claimed that increasing of SOM by organic manures lead to enhance productivity as the result of improving soil biology and its physical structure (Watson *et al*. 2002).Similarly, application of bio-fertilizer has positive effect on soil microbial population which produce organic nutrients in the soil easily absorbed by plants

Author α: Ph.D. Holder, Department of Plantation, Spices, Medicinal and Aromatic Crops, College of Horticulture, UHS Campus, Bengaluru. e-mail: baraaalmansour@yahoo.com
Author σ: Scientist, Division of Soil Science and Agricultural Chemistry, ICAR-Indian Institute of Horticultural Research, Bengaluru.
Author ρ: Principal Scientist, Division of Floriculture and Medicinal Crops, ICAR-Indian Institute of Horticultural Research, Bengaluru.
Author ω: Principal Scientist, Division of Vegetable Crops, ICAR-Indian Institute of Horticultural Research, Bengaluru.

© 2020 Global Journals

(Khosro 2012), increasing nutrient content by activation of bioactive substances in plants (Sundharaiya *et al*. 2000).

This study was conducted with different combination of inorganic nutrients, organic manure and bio- fertilizer to find out their effect on nutrient uptake, post -harvest nutrient availability and nutrient balance sheet in sweet basil (*Ocimum basilicum* L.) cultivation.

II. Material and Methods

a) Experimental location and treatment details

Field experiments were conducted in a randomized complete block design with three replications in an experimental field of ICAR-Indian Institute of Horticultural Research (IIHR), Bangalore during the kharif season of 2015 and 2016. The experimental station is located at an altitude of 890 m above mean sea level and 13°58" North latitude and 77°29" Eastlongitudes. The nine treatments of experiment contain T_1(FYM (10 t/ha) +100% recommended N through FYM), T_2(FYM (10 t/ha) + 100% recommended N through FYM +bio-fertilizer), T_3 (FYM (10 t/ha) +75% recommended N through FYM), T_4 (FYM (10 t/ha) + 75% recommended N through FYM + bio-fertilizer), T_5 (FYM (10 t/ha) + 50%recommended N through FYM), T_6 (FYM (10 t/ha) + 50%recommended N through FYM + bio-fertilizer), T_7(recommended FYM (10 t/ha) only), T_8 (recommended NPK(160:80:80 kg/ha) only), and T_9 (recommended FYM (10 t/ha) + recommended NPK (160:80:80 kg/ha).

b) Soil samples collection and treatments imposition

Soil samples before the experiment at (0-30 cm depth) were taken and analyzed using standard procedures (Piper, 1966; Jackson, 1973; Subbaiah and Asija, 1956). Table 1. Highlights on soil properties . urea (160 kg N/ha), single super phosphate (80 kg P_2O5/ha) and muriate of potash (80 kg K_2O/ha) were applied. Fifty per cent of nitrogen and hundred per cent of phosphorus and potash were supplied as basal and the remaining fifty per cent of N was given after 45 days of transplanting in T_8 and T_9 treatments. For bio-fertilizers, ICAR-IIHR was developed Arka Microbial Consortium (AMC) and was used in this trial. After 15 days of transplanting, recommended dose of AMC @ 5 kg/ha was applied at 2 cm deep to every plant and covered by soil. Similar application was done for ratoon crop after harvest of main crop in T_2, T_4, and T_6 treatments. Table 2. Represent the Quantities of added fertilizers.

c) Determination total nutrient uptake

Plant samples were dried and ground to a fine powder to determine of total nutrients (N, P and K) content by adopting standard procedures. The total nitrogen; total phosphorus and total potassium (%) was determined following standard procedures as depicted in Piper (1966), di-acid extract by Vanadomolybdate phosphoric acid yellow color method (Kitson & Mellon 1944) using spectrophotometer. di-acid extract by using flame photometer (Piper1966) respectively.

Total plant nutrient uptake was calculated by following the equation:

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Dry matter yield (kg/ha)} \times \text{nutrient content (\%)}}{100}$$

d) Determination Post harvest nutrient status and balance

After harvest of first and second ratoon crop,soil samples were collected and analyzed for N, P and K availability following standard procedures as depicted in Jackson (1973) and Piper (1926). The available nitrogen and and phosphorus was determined following (Subbaiah &Asija 1956) and (Jackson 1973) methods respectively and the available potassium was estimated by flame photometer method suggested by Jackson (1973).For NPK balance sheet, initial status of soil available nutrients, nutrients added through organic manures and inorganic fertilizer, plant uptake and available soil NPK after harvest was taken in to the account.

e) Statistical Analysis

The obtained data were analyzed using SAS 9.3 version of the statistical package (SAS Institute Inc,2011). Analysis of variance was performed using SAS PROC ANOVA procedure. Means were calculated using Fisher's protected least significant difference (LSD) test at a probability level of $p<0.01$.

III. Results and Discussion

a) Nutrient uptake by plants

Uptake of nutrients by sweet basil varied significantly due to different treatments. The data presented in Table 3 and 4. Showed that T_9 with application of NPK (160:80:80 kg /ha) + FYM (10 t/ha) recorded maximum uptake of nitrogen (155.67 and 113.19 kg/ha), phosphorus (43.80 and 32.43 kg/ha) and potassium (163.33 and 116.16 kg/ha) in the main crop during the year 2015 and 2016. Similar trend was observed in ratoon crop, that different treatments influenced significantly on nutrient uptake and T_9 resulted in highest uptake of N (56.43 and 26.65 kg/ha), P (16.14 and 14.01 kg/ha) and K (55.56 and 39.27 kg/ha) in 2015 and 2016, respectively. Whereas, the plants applied with FYM (10 t/ha) *i.e*., T_7 recorded lowest uptake of nutrient in the main crop i.e., N (55.92 and 53.81 kg/ha), P (20.54 and 14.22 kg/ha) and K (79.55 and 51.92 kg/ha). Similarly, in ratoon crop, application of FYM (10 t/ha) recorded the lowest uptake of N (15.95 and 13.16 kg/ha), P (6.97 and 5.28 kg/ha) and K (24.67 and 19.10 kg/ha) in 2015 and 2016.

© 2020 Global Journals

Soil quality such as physical characters, absorption of cations and microbial population improve by organic manure compared with NPK fertilizer (Pramnik & Mahapatra 1997),as well as FYM has chelating effect on nutrients thereby continued nutrient availability through the growing period subsequently plants will have higher nutrient uptake . So that, the gradual mineralization process with integrate nutrient practice lead to improvement in nutrient uptake by the plant (Preetha *et al*. 2005). These findings confirm those with Attia & Saad (2001) in periwinkle concluded that with judicious application of organic matter, the fixing of nutrients belonging to inorganic fertilizer could be reduced and consequently increase the nutrient uptake. These results were online with (Patra *et al*. 2000; Ravikumar *et al*. 2012; and Gupta *et al*. 2013).

b) Post harvest N status and N balance

The data on Availability of nitrogen in the soil after harvest as influenced by INM are presented in Table 5. The results revealed that highest available nitrogen (227 and 236.33 kg ha^{-1}) in the post-harvest soil was obtained with application of FYM (10 t ha^{-1}) + full dose of recommended N through FYM + bio-fertilizer (BF) *i.e*, T_2 during 2015 and 2016, respectively. While, The treatment T_7 recorded lowest available nitrogen (189.91 and 201.23 kg ha^{-1}) during the two years of the experiment. In general increasing the level of N through FYM lead to increase in the nitrogen availability. According to the results showed in Table 6 and 7. The treatmentT_2 gave the maximum nitrogen actual gain (42.40 kg ha^{-1}) in 2015, whereas T_9 recorded the highest nitrogen gain (20.58 kg ha^{-1}) after the harvest of basil in 2016. T_7 applied with FYM (10 t/ha) recorded the minimum actual gain of nitrogen in soil (4.91 and 12.10 kg ha^{-1}) in 2015 and 2016 respectively.

Integrated applied of bio-fertilizers along with organic manure and inorganic fertilizers increase nutrients uptake, regulate phytohormone synthesis and induce perfect condition for other microorganisms to multiply so it could show synergistic effect that result in net gain. (Patra *et al*. 2000). Jeyaselvin (1995) indicated that with organic manure the leaching of nutrients subjected to chemical fertilizer application could be reduced and moreover united application of organic and inorganic fertilizer can sustain soil fertility. Since that, organic manure influencing recirculation of nutrients, enhancing microbial activities and preventing nitrogen loss by leaching as recorded by (Tiwari *et al*.1989; Johnkutty & Menon1981).

c) Available P status after harvest and P balance

The data on Post -harvest available P content of the soil significantly influenced by integrated nutrient management Table 5.As the treatment applied with NPK (160:80:80 kg ha^{-1}) + FYM (10 t ha-1) *i.e*., T_9 gave the highest available phosphorus (42.31 and 58.15 kg ha^{-1}). Whereas, in T_7 the available P nutrients were low and recorded as 27.33 and 34.17 kg ha^{-1}during 2015 and 2016, respectively. The net gain over initial P status as showed in Table 8 and 9. was also higher in integrated management as FYM @ (10 t/ha) along with NPK (160:80:80 kg /ha) which registered (14.3 and 15.84 kg ha^{-1}) in 2015 and 2016 respectively. but in control treatment with application FYM @ (10 t/ha)alone the net gain was in lowest side as it registered (-0.67 and 6.84 kg ha^{-1}) during the sequencing two years of the experiment.

Raju & Reddy (2000) indicated that integrated nutrient management reduces the nutrient loss in the soil and enhances the nutrient availability throughout the cropping period hence sustaining the P status of the soil. It could enhance the action of mineral fertilizers improving phosphorus availability (Akanza & Yoro 2003). Organic matter increase the labile phosphorus in soil through complexing of calcium cations which are essential for phosphorus fixation(Kharche *et al*. 2011).

d) Post harvest K status and K balance

The data on Post -harvest available K content of the soil significantly influenced by integrated nutrient management Table 5. T_2 with application of FYM (10 t ha^{-1}) + full dose of recommended N through FYM + bio-fertilizer ,registered the highest amount of post-harvest soil available K (296.80 and 340.60 kg ha^{-1}) during 2015 and 2016, respectively. Whereas, The treatment T_7 recorded lowest available potassium at 212.8 and 234.90 kg ha^{-1} respectively. The net gain over initial K status as presented at Table 10. and 11.was highest in T_2 as it recorded (96.8 kg ha^{-1}) in 2015, whereas, in the second year the treatment T_9 recorded the maximum value as (105.4 kg ha^{-1}). however, the treatment T_7 with application of FYM @10 t ha^{-1} recorded the lowest gain as (12.8 and 22.1 kg ha^{-1}) in 2015 and 2016 respectively.

Decomposition of organic manure leads to produce specificorganic acids which has solubilizing actions holding potassium elements in available forms. Improving the soil chemical and physical characters increase the nutrient exchange reaching to good balance between nutrients in the soil solution (Bhandari *et al*. 1992) , microorganism has a strong effect in increasing the availability of nutrient through b bio-fertilizer application , leading to increment in potasium percentage (Sharma 2002).Combined application of manures and fertilizers caused a reduction of potassium fixation and release of more K due to interaction of organic matter with clay (Tondon 1988), this might have increased the available potassium in the soils (Goud & Konde 2007).

IV. Conclusion

The experiment concluded that integrated nutrient management practices is essential for sustainable basil cultivation. That the conjunctive use of

© 2020 Global Journals

FYM@10 t ha^{-1}along with chemical fertilizer NPK (160:80:80 kg/ha)had the best nutrient uptake, available nutrient status of the soil and nutrient balance sheet., While, another application as INM could beFYM (10 t/ha) +100%Rec. N through FYM + bio-fertilizer, as it also reflecting positively on the soil fertility, nutrient uptake and nutrients balance sheet.

References Références Referencias

1. Anwar M, Patra D D, Chand S, Alpesh K, Naqvi A A & Hanuja S P S 2007 Effect of organic manures and inorganic fertilizer on growth, herb and yield, nutrient accumulation, and oil quality French basil. Comm. Soil Sci. Plant Anal. 36 (13/14):1737-1746**.**
2. Akanza PK, Yoro G2003Synergetic effects of fertilizers and chicken manure on fertilityof a ferralitic soil in western Cote d'Ivoire. Agronomie Africaine, 15: 135-144
3. AnwarM, Patra, DD, Chand S 2007 Effect of Organic Manures and Inorganic Fertilizer on Growth, Herb and Oil Yield, Nutrient Accumulation, and Oil Quality of French Basil. Communications in Soil Science and Plant Analysis Journal. 36 (13-14): 1737-1746.
4. Attia FA, Saad OA 2001 Biofertilizers as partial alternative of chemical fertilizer for Catharanthus roseus. J. Agric. Sci. Mansoura Univ., 26 (11): 7193-7208.
5. Bhandari AL, Sood A, Sharma KN, Rana DS, Anil S1992Integrated nutrient management in a rice-wheat system. J. Indian Soc. Soil Sci., 40(4):742-747.
6. BaritauxO, Richard H, Touche J, Derbesy M 1992 Effects of drying and storage of herbs and spices on the essential oil. Part I. Basil, *Ocimum basilicum* L. Flavour Fragr. J., 7: 267–271.
7. Dzida K 2010 Nutrients contents in sweet basil (*Ocimum basilicum L.*) herb depending on calcium carbonate dose and cultivar. Acta Sci. Pol. Hortorum Cultus, 9 (4): 143–151.
8. Gundale M J 2005 Restoration treatments in a Montana ponderosa pine forest: Effects on soil physical, chemical and biological properties. Forest Eco. Manag.,213(1): 25.
9. Gupta L M, Sandeep K, VikasS 2013Integrated nutrient management for growth and yield in Glory Lily (*Gloriosa superba* L.). J. Med. Plants Res., 7(43: 3197-3201.
10. Goud VV, Konde NM 2007 Effect of integrated use of inorganic fertilizer and FYM on fertility of a Vertisol. PKV. Res. J., 31: 77-80.
11. Jackson M L1973Soil Chemical Analysis, Prentice Hall of India Pvt. Ltd., New Delhi, p. 498.
12. Kharche VK, Kulkarn AA, PatilSR, KatkarRN 2011 Long- term integrated nutrient management for securing soil quality under intensive cropping system on Vertisols of Maharashtra. Proceedings of National Seminar on Soil Security for Sustainable Agriculture held at College of Agriculture, Nagpur, Dr. PDKV., Akola (M.S.) on Feb 27 : 127-148 .
13. Johnkutty I, Menon PKG 1981 Permanent manorial experiments-emphasizing manure-cum-fertilizer approach. Farmers and Parliament, 16(3): 23-28.
14. Jeyaselvin I1995 Nutrient management in rice cotton sequential cropping system. M.Sc (Ag.), Thesis, TNAU, Coimbatore.
15. Khosro M2012Bacterial bio-fertilizers for sustainable crop production: A review. J. Agric.Bio. Sci.,7(5):307-3016
16. Kitson RE, Mellon MG1944 Colorimetric determination of phosphorus as molybdivan adophosphoric acid. Ind. Eng. Chern. Anal. Ed., 16: 379-383.
17. Kirchner MJ Wollum AF, King LD 1993Soil microbial populations and activities in reduced chemical input agroeco systems. Soil Sci. Society American J., 57:1289–1295.
18. Malik AA, Suryapani S, Ahmad J 2011 Chemical vs. organic cultivation of. Medicinal and Aromatic plants: the choice is clear. International Journal of Medicinal and Aromatic Plants, 1: 5-13.
19. Mbonigaba MJJ 2007 Etude de l'impact des composts a base de biomass vegetal sur ladyna mique des indicate urs physic chimiques, s et micro biologiques de la fertilite des ols: Application sur trios sols acides tropicaux du Rwanda. Ph.D. Thesis, FUSAGx, Gembloux.
20. Palada M Davis A, Crossman C and Chichester EA 2002 Sustainable crop management practices for improving production of culinary herbs in the Virgin Islands. In XXVI International Horticultural Congress: The Future for Medicinal and Aromatic Plants, 629: 289- 298.
21. Palm CA. Myers, R.J.K and NandwaS.M.1997 Combined Use of Organic and Inorganic Nutrient Sources for Soil Fertility Maintenance and Replenishment. In: Replenishing Soil Fertility in Africa, Buresh, R.J., P.A. Sanchez and F. Calhoun (Eds.). America Society of Agronomy and Soil Science Society of America, Madison WI., USA., pp: 193-217.
22. PatraDD, Anwar M, Chand S 2000 Integrated nutrient management and waste recycling for restoring soil fertility and productivity in Japanese mint *(Mentha arvensis*) and mustard (*Brassica juncea*) sequence in Utter Pardesh, India. Agric Ecosys Environ., 80: 267-275.
23. Piper C S 1966 Soil and Plant Analysis. Asian Reprint, Hans Publication Bombay, India, p. 368.
24. Pramnik SC Mahapatra BC1997 Effect of integrated use of inorganic and organic nitrogen sources on mineralization, uptake and grain yield of rice. Oryza,35: 181-184.

© 2020 Global Journals

25. Preetha D, Sushama PK, Marykutty K 2005 Vermicompost + inorganic fertilizers promote yield and nutrient uptake of amaranth (*Amaranthus tricolor* L.). J. of Trop. Agric., 43 (1-2): 87-89.
26. Raju RA, Reddy MN 2000 Integrated management of green leaf compost, crop residues and inorganic fertilizers in rice (*Orysa sativa*) – rice system. Indian J. Agron., 40:629-635.
27. Ravikumar M, Venkatesha J, Niranjana KS and Gurumurthy BR 2012 Effect of Integrated Nutrient Management on Tuber Yield and Quality and Nutrient Uptake in Coleus for skohlii Briq. J. Root Crops,38 (2): 142-146.
28. Sharma AK 2002 Biofertilizers for sustainable agriculture. Agrobios. India, 407 p.
29. Sheeba S, Chellamuthu S 1999 Long-term influence of organic and inorganic fertilization on the macronutrient status of Inceptisols. J. Indian Soc. Soil Sci., 47: 803-804.
30. Sundharaiya, K Nainar R, Ponnuswami V, Javajasmine A and Muthuswamy 2000 Effect of Inorganic nutrients and spacing on the yield of (*Solanum khasianum* Clarke). South Indian Hort. 48(1-6): 168-171.
31. Subbaiah BV, Asija GL 1956 A rapid procedure for the estimation of available nitrogen. soil.Curr. Sci., 25: 259.
32. Tiwari SC, Tiwari BK, Mishra RR 1989 Microbial populations, enzyme activities and nitrogen, phosphorus' and potassium enrichment in earth~ worm casts and in the surrounding soil of a pineapple plantation. Biol. Fert. Soil,8: 178-182.
33. Tondon HLS1988 Potassium Research and Agricultural Production in India, FDCO, New Delhi.
34. Vanlauwe B, GILLER K 2006 Popular myths around soil fertility management in sub-Saharan Africa. Agri. Eco. Envi., 116(2): 34–46.
35. Watson C A, Atkinson D, Gosling P, JacksonL R, Rayns FW 2002 Managing soil fertility in organic farming systems. soil use manag.,18: 239–24.

Table 1: Physical and chemical proprieties of initial experimental soil

Physical properties	
Bulk density (Mg m^{-3})	1.32
Particle Density (Mg m^{-3})	2.65
Pore space (%)	42
Chemical properties	
pH (1:2.5)	7.75
Electrical Conductivity (dSm^{-1})	0.36
Organic Carbon (g kg^{-1})	5.0
Available N (kg ha^{-1})	185
Available P (kg ha^{-1})	28
Available K (kg ha^{-1})	200
Exchangeable Ca ($cmol(p^{+})kg^{-1}$)	5.25
Exchangeable Mg ($cmol(p^{+})kg^{-1}$)	0.84
DTPA Fe (mg kg^{-1})	7.5
DTPA Mn (mg kg^{-1})	5.8
DTPA Cu (mg kg^{-1})	1.33
DTPA Zn (mg kg^{-1})	1.22

© 2020 Global Journals

Table 2: Different treatment combinations and applied nutrient levels under different treatment

Treatments	Inputs quantities			Total applied nutrients		
	FYM t ha^{-1}	NPK $kgha^{-1}$	BF* $kgha^{-1}$	N $kgha^{1}$	P kg ha^{-1}	K kg ha^{-1}
T_1:FYM (10 t ha^{-1}) +100% Rec. N through FYM	35	0	-	224	39.2	31.5
T_2:FYM (10 t ha^{-1}) +100% Rec. N through FYM + BF	35	0	5	224	39.2	31.5
T_3:FYM (10 t ha^{-1}) +75% Rec. N through FYM	28.75	0	-	184	32.2	25.9
T_4:FYM (10 t ha^{-1}) +75% Rec. N through FYM + BF	28.75	0	5	184	32.2	25.9
T_5:FYM (10 t ha^{-1}) +50% Rec. N through FYM	22.5	0	-	144	25.2	20.3
T_6:FYM (10 t ha^{-1}) +50% Rec. N through FYM+BF	22.5	0	5	144	25.2	20.3
T_7:Rec. FYM (10 t ha^{-1}) only	10	0	-	64	11.2	9
T_8: Rec. NPK(160:80:80 kg ha^{-1})	0	Rec	-	160	80	80
T_9:Rec.NPK (160:80:80 kg ha^{-1}) + Rec. FYM (10 t ha^{-1})	10	Rec	-	224	91.2	89

Table 3: Influence of inorganic fertilizer, organic manure and bio-fertilizer on macro nutrient uptake (kg ha^{-1}) by basil (*Ocimum basilicum* L.) during first year of the experiment (2015)

Treatments	Nitrogen		Phosphorus		Potassium	
	Main crop	Ratoon	Main crop	Ratoon	Main crop	Ratoon
T_1	82.63^{CD}	27.06^{D}	29.85^{BC}	12.87^{B}	99.16^{CD}	33.80^{DE}
T_2	112.69^{B}	40.24^{C}	36.76^{AB}	14.53^{B}	124.97^{B}	44.05^{BC}
T_3	82.88^{CD}	26.96^{D}	27.21^{BC}	10.47^{C}	108.55^{BC}	33.65^{DE}
T_4	95.72^{C}	32.92^{D}	32.49^{ABC}	13.67^{B}	122.89^{B}	38.94^{CD}
T_5	68.50^{DE}	20.84^{D}	22.16^{C}	8.77^{D}	87.02^{DE}	27.56^{E}
T_6	82.23^{CD}	25.96^{D}	28.36^{BC}	8.14^{D}	115.35^{BC}	30.14^{DE}
T_7	55.92^{E}	15.95^{D}	20.54^{C}	6.97^{D}	79.55^{E}	24.67^{E}
T_8	123.52^{B}	41.95^{B}	35.47^{AB}	12.58^{B}	125.19^{B}	49.15^{AB}
T_9	155.67^{A}	56.43^{A}	43.80^{A}	16.14^{A}	163.33^{A}	55.56^{A}
Mean	83.07	32.04	29.00	11.57	114.00	37.50
CV%	9.15	12.32	16.05	7.63	7.31	10.43
$LSD_{5\%}$	15.13	6.83	8.54	1.52	14.43	4.03

T_1: FYM (10 t/ha) +100% Rec. N through FYM; T_2: FYM (10 t/ha) +100% Rec. N through FYM + BF; T_3: FYM (10 t/ha)+75% Rec. N through FYM; T_4: FYM (10 t/ha) +75% Rec. N through FYM + BF T_5: FYM (10 t/ha) +50% Rec. N through FYM; T_6: FYM (10 t/ha) +50% Rec. N through FYM+BF; T_7: Rec. FYM (10 t/ha) only; T_8: Rec. NPK (160:80:80 kg /ha); T_9: Rec. NPK (160:80:80 kg /ha) + (10 t/ha)

© 2020 Global Journals

Table 4: Influence of inorganic fertilizer, organic manure and bio-fertilizer on macro nutrient uptake by basil (*Ocimum basilicum* L.) during second year of the experiment (2016)

Treatments	Nitrogen		Phosphorus		Potassium	
	Main crop	Ratoon	Main crop	Ratoon	Main crop	Ratoon
T_1	69.66 ^{CD}	17.33 ^{D}	24.07 ^{BC}	8.65 ^{BC}	77.64 ^{CD}	24.88 ^{CDE}
T_2	84.80 ^{B}	19.44 ^{C}	27.17 ^{AB}	12.54 ^{B}	85.23 ^{C}	29.44 ^{BC}
T_3	64.04 ^{CD}	15.29 ^{E}	17.74 ^{CD}	7.60 ^{CD}	62.31 ^{DE}	22.07 ^{DE}
T_4	68.15 ^{C}	17.57 ^{D}	19.95 ^{D}	7.79 ^{B}	68.69 ^{CDE}	26.63 ^{BCD}
T_5	61.36 ^{DE}	13.80 ^{F}	15.63 ^{D}	5.09 ^{CD}	57.20 ^{E}	20.02 ^{DE}
T_6	63.83 ^{CD}	15.80 ^{E}	17.27 ^{D}	9.41 ^{CD}	63.03 ^{DE}	23.40 ^{CDE}
T_7	53.81 ^{E}	13.16 ^{F}	14.22 ^{D}	5.28 ^{D}	51.92 ^{E}	19.10 ^{E}
T_8	97.35 ^{B}	21.69 ^{B}	25.36 ^{ABC}	10.27 ^{B}	99.33 ^{B}	31.37 ^{B}
T_9	113.19 ^{A}	26.65 ^{A}	32.43 ^{A}	14.01 ^{A}	116.16 ^{A}	39.27 ^{A}
Mean	75.13	17.86	21.32	8.96	75.72	26.24
CV%	8.15	3.74	12.14	12.29	10.56	10.53
$LSD_{5\%}$	10.6	1.15	4.47	1.66	13.84	4.03

T_1: FYM (10 t/ha) +100% Rec. N through FYM; T_2: FYM (10 t/ha) +100% Rec. N through FYM + BF; T_3: FYM (10 t/ha)+75% Rec. N through FYM; T_4: FYM (10 t/ha) +75% Rec. N through FYM + BF T_5: FYM (10 t/ha) +50% Rec. N through FYM; T_6: FYM (10 t/ha) +50% Rec. N through FYM+BF; T_7: Rec. FYM (10 t/ha) only; T_8: Rec. NPK (160:80:80 kg /ha); T_9: Rec. NPK (160:80:80 kg /ha) + (10 t/ha)

Table 5: Influence of inorganic fertilizer, organic manure and bio-fertilizer on post-harvest soil nutrient (NPK) availability (kg ha^{-1})

Treatments	Available N (kg ha^{-1})		Available P (kg ha^{-1})		Available K (kg ha^{-1})	
	2015	2016	2015	2016	2015	2016
T_1	220.15 ^{AB}	262.10	36.91 ^{ABC}	46.37 ^{ABC}	268.80 ^{ABC}	281.66 ^{ABC}
T_2	227.40 ^{A}	277.00	42.10 ^{A}	47.98 ^{ABC}	296.80 ^{ABC}	340.60 ^{A}
T_3	211.68 ^{ABC}	246.00	33.33 ^{ABC}	45.58 ^{ABC}	242.67 ^{ABC}	275.67 ^{ABC}
T_4	222.57 ^{AB}	266.70	38.74 ^{AB}	46.25 ^{ABC}	265.07 ^{ABC}	315.86 ^{AB}
T_5	203.21 ^{ABC}	228.00	30.33 ^{BC}	39.29 ^{BC}	250.13 ^{BC}	261.00 ^{BC}
T_6	211.68 ^{ABC}	246.40	36.41 ^{ABC}	43.25 ^{ABC}	259.47 ^{ABC}	324.53 ^{AB}
T_7	189.91 ^{C}	201.40	27.33 ^{C}	34.17 ^{C}	212.80 ^{C}	234.90 ^{C}
T_8	195.96 ^{BC}	214.20	40.40 ^{AB}	53.26 ^{AB}	229.60 ^{AB}	323.22 ^{AB}
T_9	199.58 ^{ABC}	222.00	42.31 ^{A}	58.15 ^{A}	235.20 ^{A}	333.33 ^{A}
Mean	209.13	240.42	36.42	46.03	251.17	298.97
CV%	5.09	5.20	11.54	11.08	8.49	8.46
$LSD_{5\%}$	10.46	20.04	4.19	13.91	36.92	43.94

T_1: FYM (10 t/ha) +100% Rec. N through FYM; T_2: FYM (10 t/ha) +100%Rec. N through FYM + BF; T_3: FYM (10 t/ha) +75% Rec. N through FYM; T_4: FYM (10 t/ha) +75% Rec. N through FYM + BF T_5: FYM (10 t/ha) +50% Rec. N through FYM; T_6: FYM (10 t/ha) +50% Rec. N through FYM+BF; T_7: Rec. FYM (10 t/ha) only; T_8: Rec. NPK (160:80:80 kg /ha); T_9: Rec. NPK (160:80:80 kg /ha) + (10 t/ha)

© 2020 Global Journals

Table 6: Impacts of different level of FYM, bio-fertilizers and inorganic fertilizer on Nitrogen balance during 2015

Treatment	Initial fertility (Kg ha^{-1})	N added (Kg ha^{-1})				Nitrogen uptake (Kg ha^{-1})	Expected balance	Actual Fertility after harvest	Apparent gain/losses (Kg ha^{-1})	Actual gain/losses (Kg ha^{-1})
	(A)	Mineral fertilizer	Rec. FYM	Rec. N through FYM	Total (B)	(C)	(D) = B - C	(E)	F=E-D	G=E-A
T1	185	0	64	160	409	117.84	291.16	220.15	-71.01	35.15
T2	185	0	64	160	409	150.62	258.38	227.40	-30.97	42.40
T3	185	0	64	120	369	107.51	261.49	211.68	-49.81	26.68
T4	185	0	64	120	369	134.02	234.98	222.57	-12.42	37.57
T5	185	0	64	80	329	89.10	239.90	203.21	-36.69	18.21
T6	185	0	64	80	329	105.95	223.05	211.68	-11.37	26.68
T7	185	0	64	0	249	78.04	170.96	189.91	18.95	4.91
T8	185	160	0	0	345	169.93	175.07	195.96	20.89	10.96
T9	185	160	64	0	409	208.20	200.80	199.58	-1.21	14.58

T1: FYM (10 t/ha) +100% Rec. N through FYM; T2: FYM (10 t/ha) +100%Rec. N through FYM + BF; T3: FYM (10 t/ha) +75% Rec. N through FYM; T4: FYM (10 t/ha) +75% Rec. N through FYM + BFT5: FYM (10 t/ha) +50% Rec. N through FYM; T6: FYM (10 t/ha) +50% Rec. N through FYM+BF; T7: Rec. FYM (10 t/ha) only; T8: Rec. NPK (160:80:80 Kg /ha); T9: Rec. NPK (160:80:80 Kg /ha)+ Rec. FYM (10 t/ha)

Table 7: Impacts of different level of FYM, bio-fertilizers and inorganic fertilizer on Nitrogen balance during 2016

Treatment	Initial fertility (Kg ha^{-1})	N added (Kg ha^{-1})				Nitrogenuptake (Kg ha^{-1})	Expected balance	Actual Fertility after harvest	Apparent gain/losses (Kg ha^{-1})	Actual gain/losses (Kg ha^{-1})
	(A)	Mineral fertilizer	Rec. FYM	Rec. N through FYM	Total (B)	(C)	(D) = B - C	(E)	F=E-D	G=E-A
T1	220.15	0	64	160	444.14	82.17	361.97	234.66	-127.31	14.52
T2	227.40	0	64	160	451.40	100.4	351.16	239.50	-111.66	12.10
T3	211.68	0	64	120	395.68	74.85	320.83	226.20	-94.63	14.52
T4	222.57	0	64	120	406.56	81.07	325.50	237.08	-88.42	14.52
T5	203.21	0	64	80	347.21	70.61	276.60	217.73	-58.87	14.52
T6	211.68	0	64	80	355.68	75.19	280.49	231.03	-49.46	19.35
T7	189.91	0	64	0	253.90	63.09	190.82	208.05	17.23	18.14
T8	195.96	160	0	0	355.95	115.99	239.96	211.87	-28.10	15.91
T9	199.58	160	64	0	423.58	134.31	289.28	220.17	-69.11	20.58

T1: FYM (10 t/ha) +100% Rec. N through FYM; T2: FYM (10 t/ha) +100%Rec. N through FYM + BF; T3: FYM (10 t/ha) +75% Rec. N through FYM; T4: FYM (10 t/ha) +75% Rec. N through FYM + BFT5: FYM (10 t/ha) +50% Rec. N through FYM; T6: FYM (10 t/ha) +50% Rec. N through FYM+BF; T7: Rec. FYM (10 t/ha) only; T8: Rec. NPK (160:80:80 Kg /ha); T9: Rec. NPK (160:80:80 Kg /ha)+ Rec. FYM (10 t/ha)

© 2020 Global Journals

Table 8: Impacts of different level of FYM, bio-fertilizers and inorganic fertilizer on Phosphor balance during 2015

Treatment	Initial fertility (Kg ha^{-1})	P added (Kg ha^{-1})				phosphor uptake (Kg ha^{-1})	Expected balance	Actual Fertility after harvest	Apparent gain/losses (Kg ha^{-1})	Actual gain/losses (Kg ha^{-1})
	(A)	Mineral fertilizer	Rec. FYM	Rec. P through FYM	Total (B)	(C)	(D) = B - C	(E)	F=E-D	G=E-A
T1	28	0	40	100	168	42.73	125.27	36.9	-88.37	8.9
T2	28	0	40	100	168	51.29	116.71	42.10	-74.61	14.1
T3	28	0	40	75	143	37.68	105.32	33.33	-71.99	5.33
T4	28	0	40	75	143	46.16	96.84	38.74	-58.1	10.74
T5	28	0	40	50	118	30.93	87.07	30.33	-56.74	2.33
T6	28	0	40	50	118	36.5	81.5	36.41	-45.09	8.41
T7	28	0	40	0	68	27.51	40.49	27.33	-13.16	-0.67
T8	28	80	0	0	108	48.05	59.95	40.40	-19.55	12.4
T9	28	80	40	0	148	40.57	107.43	42.31	-65.12	14.3

T1: FYM (10 t/ha) +100% Rec. N through FYM; T2: FYM (10 t/ha) +100%Rec. N through FYM + BF; T3: FYM (10 t/ha) +75% Rec. N through FYM; T4: FYM (10 t/ha) +75% Rec. N through FYM + BFT5: FYM (10 t/ha) +50% Rec. N through FYM; T6: FYM (10 t/ha) +50% Rec. N through FYM+BF; T7: Rec. FYM (10 t/ha) only; T8: Rec. NPK (160:80:80 Kg /ha); T9: Rec. NPK (160:80:80 Kg /ha)+ Rec. FYM (10 t/ha)

Table 9: Impacts of different level of FYM, bio-fertilizers and inorganic fertilizer on Phosphor balance during 2016

Treatment	Initial fertility (Kg ha^{-1})	P added (Kg ha^{-1})				Phosphr uptake (Kg ha^{-1})	Expected balance	Actual Fertility after harvest	Apparent gain/losses (Kg ha^{-1})	Actual gain/losse (Kg ha^{-1})
	(A)	Mineral fertilizer	Rec. FYM	Rec. P through FYM	Total (B)	(C)	(D) = B - C	(E)	F=E-D	G=E-A
T1	36.9	0	40	100	176.9	32.72	144.18	46.37	-97.81	9.74
T2	42.10	0	40	100	182.1	39.71	142.39	47.98	-94.41	5.88
T3	33.33	0	40	75	148.33	25.34	122.99	45.58	-77.41	12.25
T4	38.74	0	40	75	153.74	27.74	126	46.25	-79.75	7.51
T5	30.33	0	40	50	120.33	20.72	99.61	39.29	-60.32	8.96
T6	36.41	0	40	50	126.41	26.68	99.73	43.25	-56.48	6.86
T7	27.33	0	40	0	67.33	19.5	47.83	34.17	-13.66	6.84
T8	40.40	80	0	0	120.4	35.63	84.77	53.26	-31.51	12.86
T9	42.31	80	40	0	162.31	46.44	115.87	58.15	-57.72	15.84

T1: FYM (10 t/ha) +100% Rec. N through FYM; T2: FYM (10 t/ha) +100%Rec. N through FYM + BF; T3: FYM (10 t/ha) +75% Rec. N through FYM; T4: FYM (10 t/ha) +75% Rec. N through FYM + BFT5: FYM (10 t/ha) +50% Rec. N through FYM; T6: FYM (10 t/ha) +50% Rec. N through FYM+BF; T7: Rec. FYM (10 t/ha) only; T8: Rec. NPK (160:80:80 Kg /ha); T9: Rec. NPK (160:80:80 Kg /ha)+ Rec. FYM (10 t/ha)

© 2020 Global Journals

Table 10: Impacts of different level of FYM, bio-fertilizers and inorganic fertilizer on Potassium balance during 2015

Treatment	Initial fertility (Kg ha^{-1})	K added (Kg ha^{-1})				Potassium uptake (Kg ha^{-1})	Expected balance	Actual Fertility after harvest	Apparent gain/losses (Kg ha^{-1})	Actual gain/losses (Kg ha^{-1})
	(A)	Mineral fertilizer	Rec. FYM	Rec. K through FYM	Total (B)	(C)	(D) = B - C	(E)	F=E-D	G=E-A
T1	200	0	50	125	375	132.96	242.04	268.8	26.76	68.8
T2	200	0	50	125	375	169.02	205.98	296.80	90.82	96.8
T3	200	0	50	93.75	343.75	142.15	201.6	242.6	41	42.6
T4	200	0	50	93.75	343.75	161.83	181.92	265.1	83.18	65.1
T5	200	0	50	62.5	312.5	114.58	197.92	250.13	52.21	50.13
T6	200	0	50	62.5	312.5	145.49	167.01	259.5	92.49	59.5
T7	200	0	50	0	250	104.22	145.78	212.80	67.02	12.8
T8	200	80	0	0	280	174.34	105.66	229.60	123.94	29.6
T9	200	80	50	0	330	218.89	111.11	235.20	124.09	35.2

T1: FYM (10 t/ha) +100% Rec. N through FYM; T2: FYM (10 t/ha) +100%Rec. N through FYM + BF; T3: FYM (10 t/ha) +75% Rec. N through FYM; T4: FYM (10 t/ha) +75% Rec. N through FYM + BFT5: FYM (10 t/ha) +50% Rec. N through FYM; T6: FYM (10 t/ha) +50% Rec. N through FYM+BF; T7: Rec. FYM (10 t/ha) only; T8: Rec. NPK (160:80:80 Kg /ha); T9: Rec. NPK (160:80:80 Kg /ha)+ Rec. FYM (10 t/ha)

Table 11: Impacts of different level of FYM, bio-fertilizers and inorganic fertilizer on Potassium balance during 2016

Treatment	Initial fertility (Kg ha^{-1})	K added (Kg ha^{-1})				Potassium uptake (Kg ha^{-1})	Expected balance	Actual Fertility after harvest	Apparent gain/losses (Kg ha^{-1})	Actual gain/losses (Kg ha^{-1})
	(A)	Mineral fertilizer	Rec. FYM	Rec. K through FYM	Total (B)	(C)	(D) = B - C	(E)	F=E-D	G=E-A
T1	268.8	0	50	125	443.8	102.52	341.28	281.66	-59.62	12.86
T2	296.80	0	50	125	471.8	114.67	357.13	333.33	-23.8	36.53
T3	242.6	0	50	93.75	386.35	84.38	301.97	275.67	-26.3	33.07
T4	265.1	0	50	93.75	408.85	95.32	313.53	315.86	2.33	50.76
T5	250.13	0	50	62.5	362.63	77.22	285.57	261.00	-24.57	10.87
T6	259.5	0	50	62.5	372	86.43	285.41	324.53	39.12	65.03
T7	212.80	0	50	0	262.8	71.02	191.78	234.90	43.12	22.1
T8	229.60	80	0	0	309.6	130.7	178.9	323.22	144.32	93.62
T9	235.20	80	50	0	365.2	155.43	209.77	340.60	130.83	105.4

T1: FYM (10 t/ha) +100% Rec. N through FYM; T2: FYM (10 t/ha) +100%Rec. N through FYM + BF; T3: FYM (10 t/ha) +75% Rec. N through FYM; T4: FYM (10 t/ha) +75% Rec. N through FYM + BFT5: FYM (10 t/ha) +50% Rec. N through FYM; T6: FYM (10 t/ha) +50% Rec. N through FYM+BF; T7: Rec. FYM (10 t/ha) only; T8: Rec. NPK (160:80:80 Kg /ha); T9: Rec. NPK (160:80:80 Kg /ha)+ Rec. FYM (10 t/ha)

© 2020 Global Journals

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 20 Issue 3 Version 1.0 Year 2020
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Evaluation of Irrigation Regime for Onion (Allium Cepa L.), At Arbaminch Zuria District in SNNPR, Ethiopia

By Markos Habtewold & Gezimu Gelu

Abstract- This study was conducted for three consecutive years to find an optimum irrigation regime, which allows the maximum yield of onion at Chano-Mille Kebele of Arbaminch Zuria Woreda. The experiment has four levels of irrigation treatments (125%MAD, 100%MAD, 75%MAD and Farmers practice or irrigating with own practice), laid down in Randomized Completed Block Design (RCBD) with four Replications. The highest marketable yield (24.219ton/ha) was obtained from 100% (MAD) where as the lowest marketable yield (17.292ton/ha) was obtained from 75% of MAD. From the result, the highest total yield (28.347 ton/ha) was observed from 100% (MAD), which was significantly different from other treatments. But, statistically, there was no significant differences in total yield among treatments of 125% of MAD (24.026ton/ha), 75% of MAD (20.555ton/ha), and Farmers' practice (20.703ton/ha). Moreover, the application of irrigation water above MAD and below MAD interval reduced total onion yield in the study area.

Keywords: irrigation regime, onion yield, water use efficiency.

GJSFR-D Classification: FOR Code: 079999

Strictly as per the compliance and regulations of:

© 2020. Markos Habtewold & Gezimu Gelu. This is a research/review paper, distributed under the terms of the Creative Commons Attribution-Noncommercial 3.0 Unported License http://creativecommons.org/licenses/by-nc/3.0/), permitting all non commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Evaluation of Irrigation Regime for Onion (Allium Cepa L.), At Arbaminch Zuria District in SNNPR, Ethiopia

Markos Habtewold [α] & Gezimu Gelu [σ]

Abstract- This study was conducted for three consecutive years to find an optimum irrigation regime, which allows the maximum yield of onion at Chano-Mille Kebele of Arbaminch Zuria Woreda. The experiment has four levels of irrigation treatments (125%MAD, 100%MAD, 75%MAD and Farmers practice or irrigating with own practice), laid down in Randomized Completed Block Design (RCBD) with four Replications. The highest marketable yield (24.219ton/ha) was obtained from 100% (MAD) where as the lowest marketable yield (17.292ton/ha) was obtained from 75% of MAD. From the result, the highest total yield (28.347 ton/ha) was observed from 100% (MAD), which was significantly different from other treatments. But, statistically, there was no significant differences in total yield among treatments of 125% of MAD (24.026ton/ha), 75% of MAD (20.555ton/ha), and Farmers' practice (20.703ton/ha). Moreover, the application of irrigation water above MAD and below MAD interval reduced total onion yield in the study area. The highest water use efficiency (5.4092kg m^{-3}) was obtained from treatment of 100% (MAD) while the lowest water use efficiency (3.1029 kg m^{-3}) was observed from Farmer practice. Therefore, the application of irrigation water at 100 %(MAD) was an appropriate irrigation amount and interval to obtain better marketable yield, total yield, and water use efficiency without adversely reducing onion yield in the study area.

Keywords: irrigation regime, onion yield, water use efficiency.

I. Introduction

In Ethiopia, where the amount, timing, and distribution of rain fall is irregular, use of irrigation would significantly improve, and raise the level of production (Haile, 2014). The amount of water required by plants and the timing of irrigation is governed by prevailing climatic conditions, crop and stage of growth, soil moisture-holding capacity and the extent of root development as determined by crop type, stage of growth, and soil (Kirda, 2002). Thus, the amount of water required by plants varies from place to place. Irrigation scheduling has conventionally aimed to achieve an optimum water supply for productivity, with soil water content being maintained close to field capacity. In many ways, irrigation scheduling can be regarded as a mature research field that has moved from innovative science into the realms of use, or at most the refinement, of existing practical applications. Nevertheless, in recent years there has been a wide range of proposed novel approaches to irrigation scheduling, which have not yet been widely adopted; many of these are based on sensing the plant response to water deficits rather than sensing the soil moisture status directly (Jones, 1990a).

The increasing worldwide shortages of water and the costs of irrigation are leading to an emphasis on developing methods of irrigation that minimize water use (maximize the water use efficiency). The advent of precision irrigation methods such as trickle irrigation has played a major role in reducing the water required in agricultural and horticultural crops, but has highlighted the need for new methods of accurate irrigation scheduling and control. In recent years it has become clear that maintenance of a slight plant water deficit can improve the partitioning of carbohydrate to reproductive structures such as fruit and also control excessive vegetative growth (Chalmers et al., 1981), giving rise to what has been termed by Chalmers et al. (1986) as 'regulated deficit irrigation' (RDI). The irrigation scheduling consists of two parts; the first part is to determine the water requirement (the right amount of water). This can be done by different methods, like determination the amount of evapotranspiration of the crop. The second part is to estimate the right time to supply the water to plants. There are several methods that can be used to decide when to irrigate the onion crop. Therefore this study was intended to evaluate optimum irrigation regime for better onion yield.

II. Materials and Methods

a) Study Area Description

Arbaminch Zuria woreda is one of the 15th woredas of Gamo-Gofa Zone in SNNPR. Gamo-Gofa, one of the fourteen zones and four special woredas in SNNPR, which is 505km and 275 km far from Addis Ababa and Hawassa, respectively. The Zone includes 15 woredas with two colorful reform towns, Arbaminch and Sawla. The district comprises numerous hot springs, beautiful lakes, green mountains, forests, caves, cataracts, rivers, jungles, and a variety of flora and fauna with a pleasant climate. These make the zone

Author α: Irrigation and Drainage Researcher in Southern Agricultural Research Institute (SARI). e-mail: markokam@yahoo.com
Author σ: Irrigation and Drainage Researcher in Southern Agricultural Research Institute (SARI).

© 2020 Global Journals

a beautiful destination for tourists. The total area of the woreda is 168,172 hectares, which is divided in to 29 rural Pas, and its total population is 115,916, among them 54,080 male and 61,836 female with house hold 26,931 among the total HH 25,987 MHHH and 944 FHHH. This experiment was conducted in Chano mile kebele, which is geographically located at the longitude of 37°34'59'', the latitude of 06°75'25" and with an elevation of 1192 m a.s.l. The kebele is categorized under kola agro-ecology with hot temperatures and low annual rainfall. Potential crops grown in the woreda especially in the Chano mille kebele were banana, tomato, onion, maize, hot pepper, cotton, etc. But Onion, tomato, and pepper are highly practiced short-season crops. The study area has a high shortage of irrigation water due to inaccessible topography to use Hare Lake in gravity. There is a high competition of irrigation water among the community.

b) Soil Data

Soil is a basic parameter to fix the amount of irrigation water, and irrigation interval for irrigating crop onion. Soil physical and chemical properties like textural class, bulk density, field capacity, permanent wilting point and infiltration rate, acidity organic electric conductivity, organic matter and organic carbon content of the soil were measured in the laboratory.

c) Experimental Design

The experiment contained four treatments and was laid out in a randomized complete block design (RCBD) with four replications. The trial was conducted under the furrow irrigation method. All cultural practices and fertilizer application were done in accordance to the recommendation made for the crop. The amount of irrigation water to be applied at each irrigation application was measured using calibrated parshall flume. Time required to irrigate piece of plot and parshall flume head verses was recorded for each treatment. The treatments were 125% MAD, 100% MAD, 75%MAD and Farmer practice. The experimental field was divided into 16 plots and each plot size was 4m by 4m dimension .Space between plots been 1m and between replication 1.5 m. Space between rows 40 cm and 10 cm between the plants was used. The experimental plot was pre-irrigated one day before transplanting. Before the commencement of treatment, to three common light irrigations was supplied to all plots at three days interval to ensure better plant establishment.

d) Climate Data

Climate data like maximum and minimum air temperature, relative humidity, wind speed, sunshine hours, and rainfall were obtained from CLIMWAT for determination of irrigation schedule and crop water requirement for onion crop.

Table 1: Average climatic data of study area

Month	Min Temp (°C)	Max Temp (°C)	Humidity (%)	Wind (km/day)	rain fall (mm)	ETo (mm/day)
January	16.5	30.7	55	95	35	4.38
February	17.7	31.7	55	104	31	4.75
March	19.2	31.5	59	173	64	5.22
April	18.5	30.5	67	130	129	4.7
May	18.2	28.6	72	104	131	4.2
June	18.6	28.2	67	104	55	3.89
July	18	27.5	66	95	47	3.55
August	18.2	28.1	62	104	54	3.9
September	18.2	29.1	67	86	91	4.07
October	17.8	29.2	67	95	105	4.25
November	16.6	29.7	64	69	60	4.1
December	16.5	30.7	54	69	31	4.11
Average	17.8	29.6	63	102	833	4.26

e) Crop Data

The maximum root zone depth (Rz) of onion ranges between 0.3-0.6 m and has allowable soil water depletion fraction (P) of 0.25 (Andreas et al., 2002). Onion average Kc would be taken after adjustments have been made for initial, mid, and late-season stage to be 0.7, 1.05 and 0.95, respectively. Yield data like economic yield, unmarketable yield, and total yield were measured in the field.

f) Crop Water Determination

Crop water requirement refers to the amount of water that needs to be supplied, while crop evapotranspiration refers to the amount of water that is lost through evapotranspiration (Allen *et al*., 1998). For the determination of crop water requirement, the effect of climate on crop water requirement, which is the reference crop evapotranspiration (ET_O) and the effect of crop characteristics (Kc) are important (Doorenbos and Pruitt, 1977). The long term and daily climate data like

© 2020 Global Journals

maximum and minimum air temperature, relative humidity, wind speed, sunshine hours, and rainfall data of the study area were collected to determine reference evapotranspiration, crop data like crop coefficient, growing season and development stage, effective root depth, critical depletion factor of tomato and maximum infiltration rate and total available water of the soil was determined to calculate crop water requirement using CropWat model.

$$ETc = ETo \times Kc \quad ------(1)$$

Where: ETc- crop evapotranspiration, Kc-crop coefficient, ET_O-reference evapotranspiration.

g) Irrigation water management

The bulk density is also the ratio of the oven-dried mass of soil to its volume for undisturbed soil condition and is expressed on a dry weight basis of the soil as (Blake, 1965):-

$$Bd = \left(\frac{Md}{V_C}\right) - ------ \quad (2)$$

Where: Bd-bulk density, Md- dry mass of the soil, and Vc-volume of core sampling.

The total available water (TAW), stored in a unit volume of soil will be determined by the expression.

$$TAW = \frac{(FC-PWP)*Bd*Dz}{100} ------ (3)$$

Where: TAW-total available water, FC-field capacity, PWP-permanent wilting point, Bd-bulk density, and Dz-root depth.

For maximum crop production, the irrigation schedule should be fixed based on readily available soil water (RAW). The RAW could be computed from the expression:

$$RAW = (TAW * p) --------(4)$$

Where, RAW in mm, P is in fraction for allowable/permissible soil moisture depletion for no stress and TAW is total available water in mm.

The depth of irrigation supplied at any time can be obtained from the equation

$$Inet(mm) = (ETc_{mm} - Peff_{mm}) - --- (5)$$

The gross irrigation requirement was obtained from the expression:

$$GI = \frac{NI}{Ea} -- -------- (6)$$

Where: GI- gross irrigation, NI-net irrigation, and Ea-application efficiency but Ea=application efficiency of the furrows (60%)

The time required to deliver the desired depth of water into each furrow will be calculated using the equation:

$$t = \frac{l*w*dg}{6Q} -- ------- (7)$$

Where: - dg- gross depth of water applied (cm), t-application time (min), l- furrow length in (m), w- furrow width (m), and Q-flow rate (discharge) (l/s).

The amount of irrigation water to be applied at each irrigation application was measured using calibrated Parshall flume.

h) Data Collection

Climate data like maximum and minimum air temperature, relative humidity, wind speed, sunshine hours, and rainfall data were collected to calculate crop water requirement. Soil moisture was determined gravimetrically. The amount of applied water per each irrigation event in four fixed day intervals was measured using calibrated Parshall flume. During harvesting plant height, bulb weight, and bulb diameter were measured from the net harvested area of each plot.

i) Economic Analysis

An economic evaluation of irrigation regime is analyzing the cost that invested during growing season and benefit gained from yield produced by the application of water. Total cost considers variable cost (water cost, labor), and fixed cost (fertilizer cost, seed cost, chemical cost and weed cost) according to seasonal market value. Marginal Rate of Return (MRR) used for analysis following the CIMMYT method (CIMMYT, 1988). Economic water productivity was calculated based on the information obtained at the study site: the size of the irrigable area, the price of water applied, and the income gained from the sale of onion yield by considering the local market price. Yield and economic data were collected to evaluate the benefits of the application of different levels of water in deficit irrigation treatments. Economic data includes input costs like a cost for water (water pricing), seeds, fertilizers, fuel, and labor. However, the cost of water pricing and yield sale price were the only costs that vary between treatments. The net income (NI) treatments were calculated by subtracting total cost (TC) from gross income (GI) and were computed as:

$$NI = (GI - TC) -------- \quad (8)$$

j) Statistical Analysis

Data were analyzed using SAS 9.0 software at the probability of a 5% confidence level. The factor of the experiment was considered a single factorial Randomized Complete Block Design (RCBD) for analysis.

III. Result and Discussion

a) Physical and Chemical Properties of Soil in the Study Area

The soil result of the study area showed that the average composition of sand, silt, and clay percentages was 13% 21% and 66%, respectively. Thus, according to the USDA soil textural classification, the percent particle size determination for the experimental site revealed that

© 2020 Global Journals

the soil texture could be classified as clay soil. The top soil surface had a bulk density of 1.32 g/cm^3. In general, the average bulk density of the study area was 1.32g/cm^3, which is below the critical threshold level 1.4 g/cm^3, and it was suitable for crop root growth. The critical value of bulk density for restricting root growth varies with soil type (Hunt and Gilkes, 1992), but the general bulk density greater than 1.6 g/cm^3 tends to restrict root growth (McKenzie *et al*., 2004). Sandy soils usually have higher bulk densities (1.3–1.7 g/cm^3) than fine silts and clays (1.1–1.6 g/cm^3) because they have larger, but fewer, pore spaces. In clay soils with good soil structure, there is a greater amount of pore space because the particles are very small, and many small pore spaces fit between them. The average moisture content at field capacity of the experimental site soils were 34% and at the permanent wilting point had 16% through one-meter soil depth. Soil pH was found to be at the optimum value (6.0) for onion and other crops. The value of ECe (1.12dS/m) was lower, considering the standard rates in the literature (Landon, 1991). Generally, according to USDA soil classification, a soil with electrical conductivity of less than 2.0 dS/m at 25°C and pH less than 8.5 are classified as normal. Therefore, the soils of the study area are normal soils. The infiltration rate of the study site soil was 6mm/hours.

Table 1: Analyzed soil physical and chemical parameters

Soil data	pH	ECe (dS/m)	%Sand	%clay	%silt	Textural class	Bd (g/cm^3)	PWP (mm/m)	FC (mm/m)
Results	6.0	1.12	13	66	21	Clay	1.32	211.2	448.8

b) The Response of Onion to Different Irrigation Regimes

Analysis of variance revealed that the effects of irrigation amount and irrigation interval resulted in significant variation in marketable yield of onion. The highest marketable yield (24.22ton/ha) was obtained from 100% MAD with using a total of 317.38mm seasonal amount of irrigation water where as the lowest marketable yield (17.29ton/ha) was obtained from treatment of 75% of MAD by using a total of 238.43mm seasonal amount of irrigation water consumed. From analyzed result; highest total yield (28.347 ton/ha) was observed from 100% MAD, but statistically, there was no significant difference among treatments of 125%MAD (24.026ton/ha) with 397.38mm seasonal amount of irrigation water, 75% of MAD (20.555 ton/ha) and Farmer practice (20.703 ton/ha) with 365.59mm amount of irrigation water used. Even though there was no significant difference among the three treatments, the highest total yield was obtained from 125% of MAD (397.38mm amount of irrigation water) next to 100% MAD. Furthermore, from an analyzed result of total yield, the application of irrigation water above MAD and below MAD can reduce onion yield in the study area. Highest water use efficiencies (5.41kg m^{-3}) and (5.22kg m^{-3}) were obtained from treatments of 100% crop water requirement and 75% of MAD respectively while lowest water use efficiencies (3.74 kg m^{-3}) and (3.10 kg m^{-3}) were observed from treatments of 125% of MAD and Farmer practice respectively. From the findings of the experiment, the application of more irrigation water than optimum irrigation water to the field cannot improve water use efficiency with in fixed irrigation intervals.

Table 2: Mean combined values of onion to irrigation amount and interval

Treatments	MY(ton/ha)	UNMY(ton/ha)	TY (ton/ha)	WUE(kg m^{-3})
125% of MAD	20.796^{ab}	3.2295^{ab}	24.026^{b}	3.7362^{b}
MAD	24.219^{a}	4.1278^{a}	28.347^{a}	5.4092^{a}
75% of MAD	17.292^{b}	3.2938^{ab}	20.555^{b}	5.2231^{a}
Farmer Practice	18.839^{b}	1.8634^{b}	20.703^{b}	3.1029^{b}
CV (%)	31.04	77.01	20.90	33.61
LSD (5%)	5.1918	1.9865	4.0336	1.2104

MY–Marketable Yield, TY-Total Yield, WUE-Water Use Efficiency, LSD-Least Significant Difference CV- Coefficient of Variation.

Table 3: The total amount of irrigation water applied in each growing season for each treatment

Growing Stages	Net Irrigation(mm)				Gross irrigation requirement(mm)			
	125% MAD	100% MAD	75% MAD	FP	125% MAD	100% MAD	75% MAD	FP
Initial	27.6	22.1	16.58	25.42	55.13	44.7	33.08	50.72
Dev	85	68.4	51.3	78.66	170.75	136.6	102.6	157.10
Mid	137.25	109.8	82.35	126.3	274.38	219.5	164.63	252.43
End	147	117.6	88.2	135.3	294.13	235.3	176.48	270.60

c) Economic Analysis

The cost-benefit analysis depicted that the highest net income (185,679Birr/ha) was obtained from the treatment level of 100% crop water requirement and the lowest net income (127,586 Birr/ha) was incurred from treatment level of 75% of MAD. The highest benefit-

© 2020 Global Journals

cost ratio, 5.75 was recorded by the full level of water application, and lowest benefit cost ration (4.12) obtained from treatment level of 125% of MAD. Therefore application of full irrigation was economically better and viable for future onion production in the area.

Table 4: Average Partial Budget Analysis

Treatment	MY (kg/ha)	AY (kg/ha)	GI (Birr/ha)	FC (Birr/ha)	VC (Birr/ha)	TC (Birr/ha)	NIR (Birr/ha	B/C ratio
125%MAD	20,796	18,716.4	187,164	15,292	21,250	36542	150,622	4.12
MAD	24,219	21,797.1	217,971	15,292	17,000	32,292	185,679	5.75
75% MAD	17,292	15562.8	155,628	15,292	12,750	28042	127,586	4.55
FP	18,839	16955.1	169,551	15,292	13,223.6	28515.6	141035.4	4.95

MY- Marketable Yield, AY- Adjusted Yield(-10% of MY), GI –Gross Income, FC- Fixed Cost, VC-Variable Cost, TC –Total Cost, NI – net income, B/C – Benefit Cost ratio

IV. Conclusion and Recommendation

Application of the desired amount of irrigation water with appropriate irrigation interval has a significant effect on the yield of onion. From the study, it was observed that the highest marketable yield was obtained from the treatment grown with 100% (MAD) while the lowest highest marketable yield was obtained from 75% of MAD. Application of the amount of irrigation water below and above 100% MAD interval can affect total yield of onion significantly. Maximum water use efficiency was obtained from the treatment level of 100% (MAD). The application of 125% of MAD cannot improve water use efficiency and total yield of Onion. Therefore, it was recommended that the application of 100% (MAD) amount of irrigation water was advisable to improve marketable yield, total yield, and water use efficiency of the Onion crop without affecting yield and water use efficiency in the study area.

Acknowledgements

First of all, I must thank the Almighty God, who helped me starting from the earlier to the end of this journey. I feel deeply indebted to express my special gratitude to Dr. Tilahun Hordofa for his heart-full unreserved support infield practice. My particular gratitude goes to Southern Agricultural Research Institute (SARI); for funding of research budget on time and field materials.

References Références Referencias

1. Allen, R., L. Pereira, D. Raes and M. Smith, (1998). Crop Evapotranspiration:- Guidelines for analysis of irrigation system performance assessment of Bhadra command area at disaggregated level. GIS Development net. http://www.gisdevelopmen 002pf.htm. Accessed in April 2010.
2. Andreas, P. and F. Karen.,(2002). Crop Water Requirements and Irrigation Scheduling. Irrigation Manual Module 4.Harare.P.86.
3. Blake, G.R.(1965). Bulk density in Methods of Soil Analysis,(Agronomy, No. 9, part 1), C.A. Black, ed. pp. 374-390.
4. Chalmers DJ, Burge G, Jerie PH, Mitchell PD. (1986). The mechanism of regulation of Bartlett pear fruit and vegetative growth by irrigation withholding and regulated deficit irrigation. Journal of the American Society of Horticultural Science 111, 904–907.
5. CIMMYT (International Maize and Wheat Improvement Center). (1988). from agronomic data to farmer recommendations: An economics-training manual. Completely Revised Edition. CIMMYT, D.F, Mexico.
6. Doorenbos, J. and W.O. Pruitt., (1977). Guidelines for predicting crop water requirements. FAO, Irrigation and Drainage Paper No. 24.FAO, Rome, Italy. 179 p.
7. Haile G., (2014). Adoption of modern agricultural technologies in urban Agriculture a case study in mekelle city vegetable growers. Mekelle University College of business and economics department of management.
8. Hunt, N. and Gilkes, R., (1992) Farm Monitering Hand Book. The University of Western Australia: Nedlands, WA.
9. Jones HG.(1990a). Plant water relations and implications for irrigation scheduling. At Horticulture 278, 67–76.
10. Jones HG.(1990a). Plant water relations and implications for irrigation scheduling. Acta Horticulture 278, 67–76.
11. Kirda, C., (2002). Deficit irrigation scheduling based on plant growth stages showing water stress tolerance. Deficit Irrigation Practice (pp. 3-10). Water Report 22. FAO, Rome.
12. Landon J. R.,(1991). Booker Tropical Soil manual: A handbook for Survey and Agricultural Land Evaluation in the Tropics and Sub Tropics. Longman Scientific and Technical Press, McKenzie, N., Coughlan, K. and Cresswell, H., (2002). Soil Physical Measurement Interpretation for Land Evaluation. CSIRO Publishing Collingwood, Victoria.

© 2020 Global Journals

This page is intentionally left blank

© 2020 Global Journals

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 20 Issue 3 Version 1.0 Year 2020
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Classification and Suitability Assessment of Soils on a Fine Grained Biotite Schist Toposequence for Maize and Cassava Production in Ife Area, Southwestern Nigeria

By Fawole, Olakunle A., Smart Michael O., Ojedokun Ruth O. & Adesida O. A

Forestry Research Institute of Nigeria

Abstract- The study characterized and assessed the suitability for production of maize and cassava, of soils on a toposequence underlain by fine grained biotite schist in Ife Area and developed management plans with a view to providing information on the suitability of the soils for maize and cassava production in the area. The taxonomic classes of the soils were also indicated.

The established toposequence in the study area was delineated into five (5) different physiographic units and a total of five soil profile pits were established, described and sampled at each unit. The soil samples collected from each genetic horizons were subjected to routine analyses. Taxonomic and suitability classification of the soils were carried out.

GJSFR-D Classification: *FOR Code: 070199*

Strictly as per the compliance and regulations of:

© 2020. Fawole, Olakunle A., Smart Michael O., Ojedokun Ruth O. & Adesida O. A. This is a research/review paper, distributed under the terms of the Creative Commons Attribution-Noncommercial 3.0 Unported License http://creativecommons.org/licenses/by-nc/3.0/), permitting all non commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Classification and Suitability Assessment of Soils on a Fine Grained Biotite Schist Toposequence for Maize and Cassava Production in Ife Area, Southwestern Nigeria

Fawole, Olakunle A. [α], Smart Michael O. [σ], Ojedokun Ruth O. [ρ] & Adesida O. A [ω]

Abstract- The study characterized and assessed the suitability for production of maize and cassava, of soils on a toposequence underlain by fine grained biotite schist in Ife Area and developed management plans with a view to providing information on the suitability of the soils for maize and cassava production in the area. The taxonomic classes of the soils were also indicated.

The established toposequence in the study area was delineated into five (5) different physiographic units and a total of five soil profile pits were established, described and sampled at each unit. The soil samples collected from each genetic horizons were subjected to routine analyses. Taxonomic and suitability classification of the soils were carried out.

Results showed that the colour, depth and texture of the soils varied in response to changes in slope position and drainage condition. Soil colour ranged from reddish brown to dusky red (5YR 3/2-2.5YR 3/2) in the surface and yellowish red (5YR 4/8) to reddish yellow (7.5YR 6/6) in the subsoil. Texturally, the soils were sandy clay loam in the surface to sandy clay in the subsoil. The solum was moderately acidic to neutral (5.20 – 6.70) at the surface and strongly acidic to moderately acidic (4.40 - 5.70) in the sub soils. They are characterized by low exchangeable bases which were in the order Ca> Mg> Na> K irrespective of slope position with low to moderate organic matter. The effective cation exchange capacity of the soils was positively correlated with pH (0.52**), organic carbon (0.96**) and available P (0.64**). Bedrock thin section confirmed that the soils were derived from the weathering of the fine grained biotite gneisses and mica schist.

Soils along the toposequemce were described as ultisols (Order), ustult suborder and as Typic Kanhaplustults (Family level) soil taxonomy. The FAO-UNESCO soil legend equates all the soils under consideration as Luvisols.

The results of the actual (a) suitability evaluation showed that the soils are not presently suitable (NS) for commercial cultivation of maize, and cassava in their current condition. However, potential suitability of the soils were ranked moderately suitable (S2) for maize and soils of Olorunda and Oba series were rated marginally suitable for cassava while others still remain (NS) for cassava.

This study, therefore, provided evidence for the need to adopt different management practices to suit each soil type at the different physiographic positions as indicated by the agronomic constraints to ensure sustainable use of the soil resources.

Author α σ ρ ω: Sustainable Forest Management Department, Forestry Research Institute of Nigeria, Jericho, Ibadan, Oyo State.
e-mail: fawole.oa@frin.gov.ng

I. Introduction

Soil is a valuable non-renewable resource that exists throughout the World in a broad diversity. Different types of soil exhibit diverse behaviour and physical properties, provide essential support to ecosystems, human life and society (FAO, 2015). All activities that constitute the cycle of life including procreation and extinction, and adverse environmental events one way or the other relate to it. Therefore, it is important to maintain soil functions and qualities to sustain the ecosystem and the human being (De Groot *et al*., 2002; European Commission, 2006).

Knowledge about soil is fundamental to its utilization and management and therefore to the ecology and economy as a whole (Nkwunonwo and Okeke, 2013). Knowing the soil can be said to involve obtaining information about it, mapping and describing its varied features to suit different uses the resource is put to. It has been recognized that the quality of land suitability assessment and the reliability of land use decisions depend largely on the quality of soil information used to derive them (Salehi *et al*., 2003; Ziadat, 2007). However, studies have shown that there remain only a few landscapes on Earth which are currently in their natural state (Opeyemi, 2008). Due to anthropogenic activities, the Earth' surface is being significantly altered and the presence on the Earth of man and his use of land has had a profound effect upon the natural environment (Briney, 2008). As a result, vast transformations have occurred in the land use and land cover patterns as evidenced by persistent expansion in cultivated land, decrease in natural woodland and grassland in the world (Sumner and Miller, 1996). In the same vein, competition for land is becoming intense with the continuous rise in human population and urbanization with continuous use of land for agricultural activities year after year (Agyarko, *et al.,* 2014).

In recognition of the current global food crises, Nigeria currently pursues policy of expanding the land

© 2020 Global Journals

area under cultivation as well as intensifying crop productions by continuous cropping system of which certain arable crops due to their importance globally are included. Therefore, adoption of more sustainable strategies for the maintenance of soil fertility under such conditions becomes imperative to sustain crop yield.

The area under investigation falls under tropical rainforest zones of southwestern Nigeria and is characterized with a prolonged rainy season, resulting in high annual rainfall above 1400mm, thereby ensuring an adequate supply of water and promoting perennial tree growth. Of all the zones it contains the most valuable species of vegetation, economic cash crops and some principal staple food crops that include the selected crops Cassava and Maize. This zone therefore is very important in terms of food production and timber for construction and cabinet making (Oyenuga, 1967). In the same vein, the food sub-sector of Nigerian agriculture parades a large array of staple crops, made possible by the diversity of agro-ecological production systems, out of which Maize (*Zea mays*) and Cassava (*Manihot esculenta*) are among the most important food crops playing dominant roles in the rural economy of Southwestern (SW) Nigeria where the study area is located.

Maize is one of the most important cereal crop in Sub-Saharan Africa because of its usage that cuts across both human and livestock importance that thus, necessitated the need to improve on its production in Nigeria

Cassava belongs to the family of *Euphorbiaceae* and the genus *Manihot* and is an important root crop popularly grown in Sub-Saharan Africa more especially in the humid tropics. It requires a good amount of rainfall and humid climate with a temperature range of 25°C to 29°C. Cassava can grow in all types of soil but best grown in a well-drained sandy loam soil of average fertility. In Nigeria, there is an ongoing campaign for the use of cassava flour as a substitute for wheat flour in baking and bread- making in order to reduce reliance on wheat flour importation and therefore, increase dependence on local raw material. Increased production of the crop can only be enhanced when there is greater improvement on the understanding of the suitability of the area used for production. Therefore, a sound knowledge of the prevailing cropping systems and soil suitability potential in any agro ecological zone is pertinent to the generation of agricultural and food security policies for the country.

The present study is aimed at dwelling on the taxonomic classification, suitability evaluation, land use planning and managements of the soils occurring in the study areas for optimum production of the selected arable crops (Maize and Cassava) employing the use of parametric approach. The information obtained can further be extrapolated to many of those soils closely related in genesis, classification and geography.

II. Materials and Methods

a) The study area

The study area is located approximately between latitudes 7° 32´N and 7° 33´N and longitudes 4° 39´E and 4° 40´E. The site is about 2.5 km away from Kajola village, a suburb of the Obafemi Awolowo University (O.A.U.) Teaching and Research Farm (T&R-F) which is located within the schist belt of southwestern Nigeria (Rahaman, 1988). The site is in the same ecological zone (tropical rainforest) as Ile-Ife with hot, humid tropical climate having distinct dry and bimodal rainy seasons. The mean annual rainfall is about 1527mm and the mean monthly air temperature is approximately 31°C. The wet season starts from mid-March to late October, and the bimodal rainfall pattern has peak periods in June/July and September/October. The dry season runs from early November to early March. The influence of the north-east trade wind, is felt in the study area as 'harmattan' (cold dry wind) between late December and early January (FMANR, 1990). Atmospheric temperature is moderately high throughout the year, with a low range between the monthly mean minimum and maximum temperatures. The peak of the maximum is usually between February and March (34.3-33.8°C) just before the onset of rains while the lowest minimum temperatures are between July and August (27.1 - 27.9°C) during the peak periods of rainfall. The area also records the following average monthly data: humidity 73.8%, and sunshine 6.6 hours. The wind speed was 114.6 km d^{-1} while potential evaporation is 4.36 mm d^{-1} (Meterological data bank, T&R-F, O.A.U., Ile-Ife, 2016). The mean monthly soil temperature at 50 cm depth in Ile-Ife, for June, July and August is 27.7°C and for December, January and February is 29.4°C. Since these differ by less than 5°C, the soil temperature regime in the study area is isohyperthermic (Soil Survey Staff, 2006).

b) Vegetation and land use in the study area

The native vegetation was originally rainforest characterized by very tall, big trees and thick shrubs. However, as a result of human interferences, the vegetation now consists of admixture of bush regrowth, arable crop farms and tree crop plantations. In the study area, the crest (summit) and the shoulder are presently being used for arable crop cultivation (cassava (*Manihot spp)*; yam (*Discorea spp*); maize (*Zea mays*) and scattered banana/ plantain (*Musa spp.*). The upper slope area was cultivated to cocoa (*Theobroma cacao*), but was unkept and gradually transforming into secondary forest. The mid slope area was under bush fallow with mostly *Chromolaena odorata* and scattered oil palm (*Elaeis guinensis)*. The lower slope supported cocoa plantation inter-planted with cassava (*Manihot*

© 2020 Global Journals

spp.) and banana/ plantain (*Musa spp.*), while plantain/ banana (*Musa spp.*) and cocoa (*Theobroma cacao*) were grown in the valley bottom area.

c) The geology of the area under study

The study area is underlain by the Precambrian rocks which are part of what is collectively referred to as the basement complex of southwestern Nigeria (Smyth and Montgomery, 1962). The rocks of the area can be divided into two major groups: migmatite-gneiss-quartz complex and the Ife-Ilesa schist belt (Rahaman 1988), the study area was within the latter. The most important rock types in the schist belt are the mica schist, amphibolites, amphibole schist, and metamorphosed mafic to ultramafic rocks (Rahaman, 1988). Previous studies indicated the underlying rock in the study area as mica schist.

d) Field study

Guided by the geological map of the study area produced by the Department of Geology, O.A.U. Ile-Ife, a toposequence underlain by mica schist was selected for the study. The toposequence is slightly undulating with relatively flat top and is approximately 2.5 km southeast of Kajola village with an elevation of 295.9 m above mean sea level (amsl) at the crest and 268.6 m amsl at the valley bottom. The other physiographic positions were clearly identified and the upper slope, sedentary and hill-wash areas were 293.6 m, 283.5 m and 276.9 m amsl respectively.

Five (5) soil profile pits were established along the toposequence at different physiographic positions. All the pedons were described following the procedures in the guidelines for soil profile description (F.A.O. 2001) and horizon designations of the Soil Survey Staff (2006). Soil samples were collected from each of the identified genetic horizons for physical and chemical analyses in the laboratory. Undisturbed core soil samples were collected and used for bulk density determination.

e) Laboratory analyses

The soil samples meant for physical and chemical analysis were air dried, gently crushed in ceramic mortal with pestle and passed through 2-mm sieve to separate materials that were greater than 2-mm which was used for the laboratory analyses other than the bulk density determination

f) Physical analyses

The bulk density was determined by the core method as reported by (Blake and Hartge, 1986). The core samples were oven dried at 105°C in the laboratory and weighed at interval until constant weight was attained. Then the ratio of the mass of dried solid to the bulk volume of the soil that is, volume of the solid and pore spaces was determined as the bulk density.

The particle size distribution was evaluated by the modified Bouyoucos hydrometer method as reported by (Gee and Or., 2002) using 5% w/v sodium hexametaphosphate (calgon) as the dispersing agent.

g) Chemical analyses

The soil pH was determined both in distilled water and 1.0 M KCl (1:1 soil: solution ratio) using glass electrode pH meter (Kent model 720) after equilibration for 30 minutes (Thomas, 1996). The exchangeable bases (Ca, Mg, K and Na) were extracted with 1.0 M ammonium acetate (NH_4OAC) solution at pH 7.0 (Thomas and Throp, 1985). Calcium, Ca^{2+}, sodium, Na^{+}, and potassium, K^{+} ions in the extract were determined with the use of flame photometer (Gallenkamp Model FH 500), while magnesium (Mg^{2+}) ion in the extract was determined by titration.

The exchangeable acidity was determined by extraction with 1.0 M KCl solution and titrated with NaOH and HCl solutions to measure total acidity (Al^{3+} and H^{+}) concentrations respectively (McLean, 1965) as reported by (Bertsch and Bloom, 1996). Effective cation exchange capacity (ECEC) was computed as the summation of NH_4OAC extractable bases (Ca^{2+}, Mg^{2+}, Na^{+} and K^{+}) and KCl extractable aluminium (Al^{3+}) (Soil Survey Staff, 2008). The organic carbon was determined by the Walkley Black method as reported by (Nelson and Sommers, 1996), and the available phosphorous by Bray No. 1 method as reported by (Kuo, 1996).

h) Statistical analyses

Correlation coefficients and simple regression analysis between the selected soil properties were calculated. All statistical analyses were carried out using SAS 9.1 version (2002-2004) software programme.

i) Land suitability evaluation

The aim was to evaluate the land and soil resources of the study area with particular reference to genesis, ecological and agronomic aspects, which was carried out using parametric approach. Land characteristics recognizable on the field were combined with those determined in the laboratory and were rated according to their importance to make the preferred land qualities used as the basis of assessment for each crop. The land characteristics that were selected for the rating were those that have been found to contribute to the growth and yield of maize and cassava.

j) Land qualities/ characteristics

The following land qualities/characteristics were used as basis for assessment in the parametric approach for maize and cassava suitability.

(i) Climate: annual rainfall, mean temperature (c)
(ii) Soil physical characteristics: soil depth, texture, clay content (s)
(iii) Wetness: drainage (w)
(iv) Topography: slope percent (t)
(v) Nutrient availability (f): pH, N, P, K, Mn, Fe, Cu, Zn

© 2020 Global Journals

(vi) Nutrient retention capacity (n): organic matter, base status and effective cation exchange capacity (ECEC).

Maize and cassava were put into suitability classes based on their respective land requirements in relation to their land characteristics and qualities.

k) Application of the ratings

The land characteristics (LC) for each soil type was matched with the land use requirements for maize and cassava. Suitability classes were then derived from the matching.

Land indices were calculated before converting them to suitability classes using the equation as developed by Storie (1978):

$$S_i = A \times \frac{B}{100} \times \frac{C}{100} \ldots \frac{n}{100}$$

Where;
S_i = Index of suitability
A = Index of the most limiting characteristic
B = Index of topography
C = Index of moisture availability
n = Index of nth characteristic

The index of suitability (S_i) would then be converted to suitability class using Sys (1978) conversion table.

Index 75-100 = S1 (Highly suitable)
50-75 = S2 (Moderately suitable)
25-50 = S3 (Marginally suitable)
<25 = NS (Non suitable)

Table 1a: Land requirements and suitability classes for rainfed maize production

Land characteristics	SI1 100	SI2 95	S2 85	S3 60	N1 40	N2 25
Topography (t)						
(a) Slope (%)	0-2	2-4	4-8	8-16	16-20	>20
(b) Slope (%)	0-4	4-8	8-16	>16	-	-
Moisture availability (c)						
Total rainfall during the growing season (mm)	800-1200	700-800	600-700	500-600	<500	-
Oxygen availability (w)						
Drainage	Good	Moderate	imperfect/rapid	poor/very excess	poor but drainable	poor but not drainable
Nutrient availability (0-20cm) (f)						
Total N (%)	>0.15	0.08-0.15	0.08-0.04	0.02-0.04	<0.02	any less
Avail P (mg/kg)	>22	13-22	6-13	3-6	<3	any less
Extractable K (meq/100g soil)	>0.5	0.3-0.5	0.2-0.3	0.1-0.2	<0.1	Any
Mn (mg/kg)	>20	15-20	12-15	5-12	<5	Any
Zn (mg/kg)	>15	12-15	8-12	3-8	<3	Any
Cu (mg/kg)	>10	6-10	4-6	1-4	<1	Any
Nutrient retention capacity (n)						
(c) ECEC (meq/100g soil)	>15	10-15	5-10	3-5	<3	Any
(d) ECEC (meq/100g clay)	>24	16-24	8-16	<8	-	-
Base saturation						
(c) (%)	>80	30-50	35-50	20-50	<20	-
(d) (%)	>70	50-70	35-70	<35	-	-
Organic matter						
(c) (%)	>3	1-3	0.8-1	0.4-0.8	<0.4	-
Physical soil characteristics						
Texture/structure Gravel	CL	SC, SCL, L	SL, LS	LS, fS	Cm, S, cS	-
(ac) (%)	<15	15-40	40-60	60-75	75-90	>90
(b) (%)	<40	40-75	75-80	80-90	>90	-
(e) (%)	<20	20-40	40-75	>75	-	-
Soil depth (cm)	>90	50-90	30-50	20-30	10-20	<10
Bulk density (g/cm^3)	<1.0	1.0-1.21	1.22-1.51	1.51-1.63	1.63-2	>2

a = mechanized; b = non-mechanized; c = AP or A horizon, d = B or sub horizon; CL = clayloam; S = sand; SC = sandy clay; SCL = sandy clay loam; L = loam; cS = coarse sand; SL = sandy loam; LS = loamy sand; fS = fine sand; Cm = massive clay.
Source: Oluwatosin and Ogunkunle (1991)

© 2020 Global Journals

Table 1b: Land requirements and suitability classes for cassava production

Land qualities	SI1 100	SI2 95	S2 85	S3 60	N1 40	N2 25
Climate (c)						
Annual rainfall (mm)	>1000	900-1000	800-900	600-800	500-600	<500
Temperature (°C)	>25	22-25	20-22	18-20	16-18	<16
Topography (t)						
Slope (%)	<2	2-4	4-8	8-16	16-20	>20
Drainage (w)						
Wetness	WD	MWD	MD	ID	PD	PD
Soil physical properties (s)						
Texture	L	LS	SCL	SC	S	-
Gravel (%)	<10	10-20	20-30	30-40	>40	-
Soil depth (m)	>100	80-100	60-80	50-60	35-50	<35
Nutrient availability (f)						
Ph	>8	7-8	4.5-7	3.5-4.5	<3.5	-
Total N (%)	>0.15	0.08-0.15	0.04-0.08	0.02-0.04	<0.02	-
Avail P (mg/kg)	>15	10-15	8-10	5-8	3-5	-
Extract. K (cmol/kg)	>0.25	0.20-0.25	0.15-0.20	0.10-0.15	<0.10	-
Cu (mg/kg)	>5	1-5	0.3-1	0.1-0.3	<0.1	-
Mn (mg/kg)	>250	100-250	10-100	5-10	<5	-
Fe (mg/kg)	>120	100-120	10-100	1-10	<10	-
Zn (mg/kg)	>50	5-50	1-5	0.5-1	<0.5	-
Nutrient retention (n)						
Organic matter (%)	>4	3-4	2-3	1-2	<1	-
ECEC (cmol/kg)	>15	10-15	5-10	3-5	<3	-
Base saturation (%)	>80	50-80	35-50	20-35	<20	-

WD = Well Drained; MWD; = Moderately Well Drained; ID = Imperfectly Drained; PD = Poorly Drained; L = Loamy; SC= Sandy clay; LS =Loamy sand; S = sand; SCL =Sandy Clay Loam.
Source: Ande 2011.

III. Results and Discussion

a) Soil morphology and landform relationship

The summary of the important morphological characteristics of the soil types identified on the landscape positions on the toposequence is presented in Table 2. The soils along the toposequence are derived from fined-grained biotite gneisses and schist and are very extensive in southwestern Nigeria, the parent rocks are very easily weathered and give rise to very deep soils. Similar soils overlying same rock types were grouped as Egbeda Association by Smyth and Montgomery (1962). Soils of Egbeda Association are found on gently undulating topography, and the sequence of soils along such topography is Egbeda, Olorunda, Makun, Oba and Jago series from the crestal (upper slope) position to the valley bottom (Smyth and Montgomery, 1962). The colour and texture of the soils changes in response to changes in slope position and drainage condition down to Jago series. The soils that occupied the higher topographical sites were well drained with sandy loam topsoil overlying clay to clay loam subsoil. These are typified by Pedons 01 to 04 of the toposequence and are Egbeda, Olorunda, Makun and Oba series. The colour varies from dark reddish brown (5YR 3/2) moist at the upper soil layers to yellowish red (5YR 4/8) in the subsoil. Roots are concentrated in the upper 50 cm but were found all through the profile in various degree of composition. Iron stones and concretions occur very frequently throughout the pedons.

© 2020 Global Journals

© 2020 Global Journals

Table 3: Field morphological description of the soils studied.

Horizon	Depth (cm)	Colour Moist	Texture[t]	Structure[x]	Consistence[y]	Concretions[b]	Boundary	Notes
Profile 01 Egbeda series								
Ap	0-18	5YR 3/2	SL	2mcsbk	Nstnplvfr	Cfrgr	cs	Abundant very fine, fine, and few medium roots
AB	18-24	10YR 4/4	SCL	2msbk	Nplfrnst	Cfrstgr	cs	Abundant fine and medium roots
B	24-51	2.5YR 4/4	SC	2msbk	Sstfrspl	Cfrstgr	gw	Few fine and medium roots
BC	51-70	5YR 4/8	SC	3psbk	Sstsplfr	Cfrstgr	cs	Very few fine roots
Profile 02 Olorunda series								
Ap	0-18	5YR 3/3	SCL	Cmsbk	Sstsplfr	Vfgr	cs	Abundant fine, medium to coarse roots
AB	18-28	2.5YR 4/4	SCL	2mcr	Sstsplfr	vfrgrvfst	ds	Common fine and very fine and few medium roots
B21	28-72	2.5YR 4/8	SC	1msbk	Nstnplfr	Vfgr	s	Frequent fine roots
B22	72-132	2.5YR 4/4	SC	2msbk	Sstspl	vfrgrfst	cs	Few gravels
BC1	132-185	5YR 4/6	SC	3csbk	Fmstpl	-	ds	Thick cutans of clay and iron oxides on ped
BC2	185-210	5YR 6/6	SC	3msbk	Vfr	-	-	Few mottles, frequent pieces of weathered rock, devoid of roots.
Profile 03 Makun series								
Ap	0-18	5YR 4/2	SCL	2msbk	Nstnplfr	-	cs	Common coarse fine to medium roots
BA	18-33	2.5YR 4/2, (5YR 5/6)	CL	2m1sbk	Sstspl	-	ds	Abundant very fine and few coarse and medium roots
B21	33-65	2.5YR 4/6 (5YR 5/6)	SC	2msbk	Frstpl	Frgr	Ds	Common medium and coarse roots
B22	65-120	2.55YR 4/6	SC	2msbk	Sstsplfr	Vfgrrd	Ds	Medium to fine prominent mottles, Weathered quartz stones with few patchy cutans
BC	120-200	5YR 4/6	SC	2msbk	Sstsplfr	Vfgrrd	-	Frequent quartz materials. Devoid of roots
Profile 04 Oba series								
Ap	0-20	7.5YR 4/2	SCL	2fcr	Vfrnstnpl	-	cs	Common medium frequent fine and few coarse roots
BA	20-40	5YR 4/6	SCL	2msbk	Frsstspl	Fst	cs	Few medium, common fine and few very fine roots
B1	40-71	2.5YR 4/6	SC	2msbk	Frsstspl	Vfgrvfst	ds	Few patchy cutans, common fine and medium roots
2BtC1	71-115	2.5YR 4/8	SC	2msbk	Vstspl	Vfgfst	gs	Few patchy cutans with stonelines, few medium to fine roots
2BC2	115-170	5YR 5/8	SC	2msbk	Frstpl	Vfrgfst	-	Few roots with frequent black hard concretions present.
					Profile 05	Jago series		
Ap	0-18	2.5YR 3/2	SCL	2mcr	Sstnp	-	gw	Common medium frequent fine roots
AB	18-40	2.5YR 4/4, (5YR 6/1)	SC	2msbk	Sstspl	Fgr	gw	Common medium frequent fine roots
B	40-60	2.5YR 4/6 (5YR 6/1)	SC	1msbk	Fmstpl	Fgr	gw	Frequent medium and few fine roots
Btg	60-75	7.5YR 6/6	SC	2f	Fmvstvpl	Nd	-	Common medium roots merging into a water saturated layers

The variation in soil colour among the soils was primarily due to differences in physiographic position of each profile and drainage condition of the soils. As moisture condition increases and drainage becomes poorer down the landscape, hues become yellower. Similar colour changes from crest to valley bottom were reported by (Okusami and Oyediran (1985). The soils are clayey in nature, this could be ascribed to the nature of the parent rock and their susceptibility to weathering (Smyth and Montgomery, 1962; Ojanuga, 1978). The pedons have horizon boundaries that are not easily discerned being either diffuse or gradual and either irregular or wavy. This indicates a good degree of relationship between one horizon and the next and an evidence of advanced weathering. The soils have moderate, medium granular or sub-angular blocky structure in the surface horizons and weak, coarse blocky to moderate medium sub-angular blocky structure in sub-surface horizons. Morphologic observation suggested a lithologic break at $2BtC_1$ (71-115 cm) horizon in Pedon 04. This was corroborated by the differences in the sand fraction.

b) Physical properties of the soils

The soil texture varied from sandy loam to sandy clay loam for surface horizons except in Pedon 05 which has clay texture. The B and C-horizons have clay loam texture except in Pedons 03 and 04 that were more clayey in the B and BC horizons. The sand content ranged from 29 to 67 ±12.83% and decreased with increasing depth except at certain depths where the BC-horizon contained more of sand as in Pedons 03 and 04. The silt content ranged from 11 to 25 ±3.31%, although the value fluctuated within all the pedons with increasing depth. Generally, the silt content is low, a characteristic which the soils shared with most Nigerian soils (Ojanuga, 1978). The clay values ranged from 18 to 59 ±13.98% in the Bt horizons. The clay content increased generally with increasing depth to a maximum (probably due to illuviation/ eluviation interplay or possibly clay migration) and then decreased in the BC horizons. Similar trend was observed by Ojanuga (1978) in soils of Ife and Ondo areas of southwestern Nigeria. The bulk density varied with the structural conditions of the soils particularly those related to packing hence, it is often used as a measure of soil texture and structure (Hamblin *et al.,* 1988). Values obtained ranged from 0.74 g cm^{-3} in the Ap horizons to 1.7 g cm^{-3} in the Bt horizons. The higher values in surface soils are due to compaction (e.g pedons 02 and 03).

c) Chemical properties of the soils

Tables 5 show the chemical properties of the pedons studied. The soils studied fall within the neutral to very strongly acid class (Ojanuga, 1975; Landon, 1991; Soil Survey Staff, 2003), with pH (H_2O) values ranging from 5.6 to 7.0. The pH decreased with increasing soil depth except in Pedon 03 where no definite pattern was observed.

The pH (1M KCl) ranged from 4.4 to 5.7. Generally, the surface horizons of the pedons were medium to slightly acid (pH 5.2 - 5.7), while B and C-horizon were strong to very strong acid with pH values ranging from 4.4 - 5.7. The acid nature of the soil can be ascribed to high rate of leaching of bases which is prevalent in the humid tropics, and the acidic nature of the parent rock (granite-gneiss). The higher pH values observed at the soil surface horizons according to Fasina *et al.* (2005) might be due to liming effect of bush burning and bio cycling of nutrients.

Table 4: Physical properties of the soils on the toposequence that was studied

Horizon	Depth (cm)	Total sand	Silt	Clay	BD (g/cm³)	Textural class
Profile 01 Egbeda series						
Ap	0-18	49	21	30	1.06	Sandy loam
AB	18-24	47	25	28	1.54	Sandy clay loam
B	24-51	31	11	58	1.62	Sandy clay
BC	51-70	29	13	58	1.59	Sandy clay
Profile 02 Olorunda series						
Ap	0-18	55	17	28	1.01	Sandy clay loam
AB	18-28	51	11	38	1.57	Sandy clay loam
B21	28-72	39	13	48	1.63	Sandy clay
B22	72-132	33	13	54	1.68	Sandy clay
BC1	132-185	35	17	48	1.73	Sandy clay
BC2	185-210	43	15	42	1.48	Sandy clay
Profile 03 Makun series						
Ap	0-18	55	17	28	1.34	Sandy clay loam
BA	18-33	51	15	34	1.42	Clay loam
B21	33-65	34	13	53	1.45	Sandy clay
B22	65-120	30	11	59	1.65	Sandy clay
BC	120-200	39	15	46	1.40	Sandy clay
Profile 04 Oba series						
Ap	0-20	57	15	28	1.54	Sandy clay loam
BA	20-40	39	13	48	1.48	Sandy clay loam
B1	40-71	31	11	58	1.30	Sandy clay
2BtC1	71-115	31	13	56	1.71	Sandy clay
2BC2	115-170	39	13	48	1.40	Sandy clay

© 2020 Global Journals

Profile 05 Jago series						
Ap	0-18	67	15	18	0.74	Sandy clay
AB	18-40	65	13	22	1.21	Sandy clay
B	40-60	67	11	22	1.31	Sandy clay
Btg	60-75	65	15	20	1.13	Sandy clay

Table 5: Chemical properties of the soils studied

Horizon	Depth (cm)	pH (H_20)	pH KCl	ΔpH	Exchangeable Bases			Exchangeable Acidity			Sum of Bases	ECEC	Base sat. (%)	Al. Sat. (%)	OM (%)	Avail. P (ppm)
					Ca^{2+}	Mg^{2+}	Na^{+}	K^{+}	Al^{3+}	H^{+}						
Profile 01 Egbeda series																
Ap	0-18	6.9	6.0	-0.9	7.2	4.86	0.21	0.30	0.4	0.2	12.57	12.97	97	3	2.55	11.2
AB	18-24	6.8	5.4	-1.4	6.6	4.86	0.26	0.26	0.2	0.3	11.98	12.18	98	2	1.61	7.4
B	24-51	6.5	5.0	-1.5	6.7	4.10	0.25	0.30	0.3	0.3	11.30	11.60	97	3	1.21	3.4
BC	51-70	6.0	4.6	-1.4	5.8	3.20	0.20	0.24	0.7	0.3	9.44	10.10	93	7	1.07	3.2
Profile 02 Olorunda series																
Ap	0-18	6.5	5.3	-1.2	5.3	4.86	0.19	0.24	0.4	0.2	10.58	10.98	96	4	1.68	6.3
AB	18-28	6.4	5.0	-1.4	4.9	4.05	0.19	0.22	0.4	0.3	9.35	9.75	96	4	1.14	8.2
B21	28-72	6.2	5.0	-1.2	5.5	1.62	0.21	0.28	0.1	0.4	7.69	7.79	99	1	0.87	4.1
B22	72-132	6.1	5.0	-1.1	5.3	5.67	0.19	0.26	0.4	0.3	11.42	11.82	97	3	0.67	3.3
BC1	132-185	5.9	4.9	-1.0	5.3	4.05	0.20	0.26	0.1	0.3	9.81	9.91	99	1	0.60	3.0
BC2	185-210	5.6	4.8	-0.8	5.0	4.86	0.17	0.26	0.2	0.2	10.29	10.49	98	2	0.07	2.6
Profile 03 Makun series																
Ap	0-18	6.8	5.6	-1.2	4.0	7.29	0.14	0.22	0.4	0.3	11.64	12.04	97	3	1.54	8.4
BA	18-33	6.7	5.5	-1.2	4.9	4.05	0.19	0.24	0.3	0.3	9.38	9.68	97	3	0.94	10.5
B21	33-65	6.6	5.5	-1.1	5.3	1.62	0.21	0.30	0.2	0.2	7.44	7.64	97	3	0.94	7.0
B22	65-120	6.4	5.5	-0.9	4.1	6.48	0.14	0.20	0.2	0.3	10.91	11.11	98	2	0.87	5.8
BC	120-200	6.7	5.7	-1.0	3.1	10.53	0.11	0.22	0.3	0.2	13.96	14.26	95	2	0.40	3.2
Profile 04 Oba series																
Ap	0-20	6.4	5.2	-1.2	4.7	4.05	0.23	0.24	0.2	9.22	0.9	9.92	93	7	1.74	7.7
BA	20-40	6.2	4.8	-1.4	3.2	5.67	0.12	0.22	0.2	9.21	0.3	9.31	99	1	0.93	8.4
BC1	40-71	6.0	4.8	-1.2	2.2	5.67	0.08	0.24	0.2	8.19	0.3	8.29	99	1	0.67	5.8
2BtC1	71-115	5.8	4.6	-1.2	2.1	4.05	0.10	0.24	0.3	6.49	0.4	6.59	99	2	0.60	6.2
2BC2	115-170	5.6	4.4	-1.2	2.8	3.24	0.16	0.26	0.2	6.46	0.3	6.56	99	2	0.40	4.5
Profile 05 Jago series																
Ap	0-18	7.0	6.7	-1.3	1.5	4.86	0.08	0.15	0.2	6.59	0.6	6.99	94	6	1.74	6.9
AB	18-40	6.6	5.2	-1.4	1.9	4.86	0.08	0.24	0.3	7.08	0.6	7.38	96	4	0.74	8.9
B	40-60	6.5	5.0	-1.5	0.6	2.43	0.08	0.22	0.2	3.33	0.6	3.73	89	11	0.40	5.4
Btg	60-75	6.3	5.0	-1.3	1.5	2.43	0.08	0.21	0.2	4.22	0.6	4.62	91	9	0.13	5.2

Generally, there was higher accumulation of bases in the surface horizons 6.59 - 12.57 cmol(+)kg^{-1} of the soil, and the total exchangeable bases decreased with soil depth except in some cases owing to nutrient biocycling (Ajiboye and Ogunwale, 2010), and differential weathering that had taken place or as a result of plant uptake and leaching losses. Like in most tropical soils, the exchangeable sites of the soils studied were dominated by exchangeable calcium and magnesium. The low values K^{+} and Na^{+} indicated that the soils under investigation developed from materials that are either low in K^{+} and Na^{+} content or have been exhausted by plant uptake or leaching due to their mobility within the soil. The higher values obtained at the surface horizon of the pedons could be attributed to higher organic matter content (Ano, 1991). However, the values fluctuated irregularly down the soil profile. Exchangeable acidity values ranged from 0.3 to 1.0 cmol (+) kg^{-1} soil. All the pedons examined showed little variation in the exchangeable acidity (Al^{3+} and H^{+}) and the values were almost uniform with soil depth.

Effective cations exchange capacity (ECEC) was generally low with values ranging from 3.73 to 14.26 cmol (+) kg^{-1} soil. There were higher values in the surface horizons of all the soils examined than in the sub-soil, probably due to the influence of organic carbon on the exchange sites of the soils. However, in those profiles where higher values were noticed in the sub-soil as in Pedons 02 (B22) and 03 (BC) with more of clay content, this could be due to the process of pedoturbation either by fauna or flora. In all the pedons examined, the ECEC values decreased with increasing soil depth. The organic matter content of the surface horizons of the pedons under examination ranged from

© 2020 Global Journals

1.54 to 2.55% and decreased with increasing soil depth. The sub-soil horizons were generally lower in organic carbon than the surface horizons of all the pedons examined. The reasons for this may be due to the fact that the surface horizons are the points where decomposition and humification of organic materials take place. The organic matter content of the entire soils studied was generally low, mostly less than 2% except in the surface horizon of Pedon 01. The low organic matter obtained may be partly due to the effect of high temperature and relative humidity which favour rapid mineralization of organic matter (Fashina *et al.,* 2006). It might also not be unconnected with the degradative effect of cultivation and other land use and management activities. In all the pedons examined, the exchangeable bases, ECEC, percent base saturation and organic matter contents were slightly higher in the surface horizons than in the sub-soils in general. Probable reason is that the surface horizons, although the most exposed to leaching and runoff, are indeed continuously recharged by phytocycling (Amusan and Ashaye, 1991).

Available phosphorous (P) contents of the soils varied from 2.6 to 11.2 ppm in all the horizons in the profiles with the highest values at the surface horizons, The relatively high concentration of the available P and organic carbon in the surface horizons may imply significant organic or biocycled P in the soils and also an indication that organic matter contributes significantly to the available phosphorus in these soils. The available P values are considered low at some horizons as they were below or only slightly above the 10 ppm critical limit recommended for most commonly cultivated crops in the area. The low value of available P might be due to the fixation of phosphorus by iron and aluminum sesquioxides under well drained and acidic conditions of the soils (Onyekwere *et al*., 2001; Uzoho and Oti, 2004).

d) Classification of the soils studied

i. *Local system*

The soils studied were classified based on the report of the soil survey work carried out by Smyth and Montgomery (1962), taken into considerations the nature of the bedrock, the form of parent material, physiographic position, soil colour, presence or absence of mottles, soil texture and general profile morphology. The soils on the toposequence studied were classified as Egbeda Association (Smyth and Montgomery, (1962). The parent rock is very easily weathered and gives rise to deep soils as observed in the pedons studied. Pedon 01 is classified as Egbeda series. Pedon 02 classified as Olorunda series. Pedon 03 as Makun series. Pedon 04 occupied gently sloping section of the lower slope area of the toposequence and are classified as Oba series and Pedon 05 as Jago series.

ii. *Taxonomic classification*

All the pedons observed showed increasing trend in clay content with soil depth to a certain level, a kind of trend that was indicative of argillic horizon. Low level of fertility as observed from the organic matter content and other soil mineral composition which are the two most important differentiating characteristics of the Ultisols.

The pedons studied are mineral soils with ochric epipedon, low in organic matter, high in colour values and chromas. The soils are dry for more than 90 cumulative days but less than 180. The upland soils of southwestern Nigeria is primarily under ustic moisture regime (Periaswamy and Ashaye, 1982), therefore, the soils are in Ustults suborder. Pedon 05 qualifies as Aqults because of the hydromorphic properties right from the soil surface and the gleyed subsurface horizons. The presence of Kandic horizons are established in most pedons because they meet the following requirements: coarse textured surface horizon over vertically continuous sub-surface horizons; ECEC values within the sub-surface B-horizons that are less than 12cmol(+)/kgclay; a regular decrease in organic carbon contents with increasing soil depth (Table 4) (Soil Survey Staff, 2003).

Soils of Pedons 01, 02, 03 and 04 have no evidence of hydromorphic properties within 125 cm of the mineral soil surface but have clay distribution such that the percentage clay decreased from its maximum by 20% or more within 125 cm of the mineral soil surface. These soils therefore, classify as Typic Kanhaplustults, they have ECEC of less than 12 cmol/kg soil. Soils of pedon 05 show evidence of redox depletion within 75 cm of the mineral soil surface and therefore, qualify as Aquic Haplustults. In the FAO-UNESCO soil legend, all the pedons under consideration qualify as Luvisols because of the presence of argillic horizon and humus surface horizon that is separated from the mineral horizon (Bruand *et al.,* 2004), a horizon eluviated of clay minerals and a horizon of at least 5 cm. thick with illuvial clays (Bruand *et al.,* 2004). The soils of pedon 03 and 04 classify as Plinthic Luvisols because of the presence of indurated coherent plinthite within 100 cm of the soil mineral surface. Soil of pedon 05 classifies as Gleyic Luvisols because of evidence of gleyic properties within 100 cm of the soil surface. The soils of pedon 01 and 02 classify as Eutric Luvisols because of the high base saturation (IUSS, 2006).

e) Suitability evaluation using parametric approach

The parametric approach attributes a numerical rating to the limitation as follows no limitation (highly suitable) as 100%, low limitation (highly suitable) as 95%, moderate limitation (moderately suitable) as 85%, severe limitation (marginally suitable) as 60% and very severe limitation (not suitable) as 40%, defined with

© 2020 Global Journals

regards to the type and intensity of the limitations. Soils were placed in classes according to their suitability for the production of selected crop. The determination of the scores for rating involved matching of land characteristics/land qualities and crop requirements to evolve suitability classes for the different mapping units in the area of study.

The assessment of the soils for crop production involved the use of properties that are permanent in nature and that cannot be changed or modified without exorbitant cost. Such properties include soil depth, slope, drainage, texture and amount of coarse fragments. These properties are known to constitute some kind of hindrance to crop production. Chemical properties that are usually considered (e.g. fertility) can be changed by minor improvement (Sys, 1985).

Table 6a: Land characteristics and quality of the study area for maize production

Land characteristics	Egbeda (1)	Olorunda (2)	Makun (3)	Oba (4)	Jago (5)
Topography (t)					
Slope (%)	7	6	4	2	2
Moisture availability (c)					
Rainfall during growing season(mm)	1200	1200	1200	1200	1200
Oxygen availability (w)					
Drainage	Good	Good	Good	Good	Imperfect
Nutrient availability (f)					
Total N (%)	0.12	0.13	0.12	0.10	0.12
Available P (mg/kg)	11.2	6.3	8.4	7.7	6.9
Extract. K (cmol/kg)	0.30	0.24	0.22	0.24	0.15
Mn (mg/kg)	12.60	14.66	12.11	11.89	9.56
Zn (mg/kg)	1.80	0.6	2.00	0.5	0.80
Cu (mg/kg)	393.05	399.82	333.15	383.58	332.36
Nutrient retention capacity (n)					
ECEC (0-20cm) (cmol/kg)	12.97	10.98	12.04	9.92	6.99
Base saturation (0-20) (%)	97	96	97	93	94
Base saturation (20-100) (%)	93	97	98	99	89
Organic matter (0-20) (%)	2.55	1.68	1.54	1.74	1.74
Physical soil characteristics (s)					
Textural class	SL	SCL	SCL	SCL	SC
Gravel (0-20cm) (%)	35	41	43	8	26
Soil depth	70	210	200	170	75

Tables 6b: Land characteristics and quality of the study area for cassava

Land characteristics	Egbeda (1)	Olorunda (2)	Makun (3)	Oba (4)	Jago (5)
Climate (c)					
Annual Rainfall (mm)	1200	1200	1200	1200	1200
Temperature (°C)	28	28	28	28	28
Topography (t)					
Slope (%)	7	6	4	2	2
Drainage (w)					
Wetness	Good	Good	Good	Good	Imperfect
Soil physical properties (s)					
Texture	SL	SCL	SCL	SCL	SC
Gravel (%)	35	41	43	8	26
Soil depth (m)	70	210	200	170	75
Nutrient availability (f)					
pH	6.9	6.5	6.8	6.4	7.0
Total N (%)	0.12	0.13	0.12	0.10	0.12
Avail. P (mg/kg)	11.2	6.3	8.4	7.7	6.9
Extract. K (cmol/kg)s	0.30	0.24	0.22	0.24	0.15
Cu (mg/kg)	393.05	399.82	333.15	383.58	332.36
Mn (mg/kg)	12.60	14.66	12.11	11.89	9.56
Fe (mg/kg)	396.12	523.01	322.64	338.26	257.28
Zn (mg/kg)	1.80	0.6	2.00	0.5	0.80
Nutrient retention (n)					
Organic matter (%)	2.55	1.68	1.54	1.74	1.74
ECEC (cmol/kg)	12.97	10.98	12.04	9.92	6.99
Base sat. (%)	97	96	97	93	94

© 2020 Global Journals

Table 7a: Suitability evaluation of the soils for maize production using parametric approach

Soil Profile	Soil series name	Topography slope (t)	Drainage (w)	Moisture Avail (m)	Physical soil properties (s)			Nutrient availability (f)						Nutrient retention (n)			Suitability	
					Texture	Gravel	Soil Depth	N	P	K	Mn	Zn	Cu	ECEC	Base Sat	Organic Matter	Index	Class
1	Egbeda	85	100	100	85	95	95	95	85	95	85	40	100	95	100	95	15	NSa
		85	100	100	85	95	95	-	-	-	-	-	-	95	100	95	59	S2p
2	Olorunda	85	100	100	95	85	100	95	85	85	85	40	100	95	100	95	14	NSa
		85	100	100	95	85	100	-	-	-	-	-	-	95	100	95	62	S2p
3	Makun	85	100	100	95	85	100	95	85	85	85	40	100	95	100	95	14	NSa
		85	100	100	95	85	100	-	-	-	-	-	-	95	100	95	62	S2p
4	Oba	95	100	100	95	95	100	95	85	85	60	40	100	85	100	95	11	NSa
		95	100	100	95	95	100	-	-	-	-	-	-	85	100	95	69	S2p
5	Jago	95	85	100	95	95	95	95	85	60	60	40	100	85	100	95	7	NSa
		95	85	100	95	95	95	-	-	-	-	-	-	85	100	95	56	S2p

a = actual suitability when characteristics (f) is not corrected by fertilizer application.
p = potential suitability after the correction of characteristics (f) by fertilizer applicatio

© 2020 Global Journals

© 2020 Global Journals

Table 7b: Suitability evaluation of the soils for cassava production using parametric approach

Soil Profile	Soil series name	Topography slope (t)	Drainage (w)	Moisture Avail (m)	Physical soil properties (s)			Nutrient availability (f)							Nutrient retention (n)			Suitability	
					Texture	Gravel	Soil Depth	N	P	K	Fe	Mn	Zn	Cu	ECEC	Base Sat	Organic Matter	Index	Class
1	Egbeda	85	100	100	100	60	85	95	95	100	100	85	85	100	95	100	85	22	NSa
		85	100	100	100	60	85	-	-	-	-	-	-	-	95	100	85	35	S3p
2	Olorunda	85	100	100	85	40	100	95	60	95	100	85	60-	100	95	100	60	5	NSa
		85	100	100	85	40	100	-	-	-	-	-	-	-	95	100	60	16	NSp
3	Makun	95	100	100	85	40	100	95	85	95	100	85	85	100	95	100	60	10	NSa
		95	100	100	85	40	100	-	-	-	-	-	-	-	95	100	60	18	NSp
4	Oba	95	100	100	85	100	100	95	60	95	100	85	60	100	85	100	60	11	NSa
		95	100	100	85	100	100	-	-	-	-	-	-	-	85	100	60	41	S3p
5	Jago	95	60	100	60	85	85	95	60	85	100	60	60	100	85	100	85	3	NSa
		95	60	100	60	85	85	-	-	-	-	-	-	-	85	100	85	18	NSp

a = actual suitability when characteristics (f) is not corrected by fertilizer application.

p = potential suitability after the correction of characteristics (f) by fertilizer application.

The actual suitability implies the suitability of the soils for crop production in its present condition when correctable limitations (i.e. in this case nutrient availability – N. P, K, Mn, Cu, Fe, Zn) are not corrected. Potential suitability (p) assesses performance when fertilizers are added to correct fertility limitations during cropping. This presentation is necessary since the difference between actual and potential suitability is simply a management factor. Soils were placed in classes according to their suitability for the production of the selected crop.

The results of the actual (a) suitability evaluation showed that the soils are not presently suitable (N1) for commercial cultivation of maize, and cassava in their current condition. However, potential suitability of the soils were ranked moderately suitable (S2) for maize and soils of Olorunda and Oba series were rated marginally suitable for cassava while others still remain (N1) for cassava (Tables 7a, and b). The major agronomic constraints of these soils are physical characteristics, nutrient availability, nutrient retention and perhaps the topography in the order of severity.

Management practices that can improve these limitations should be employed. Such management practices are mulching to conserve moisture contents at the upper positions, organic materials or incorporation of plant residues into the soil to improve the soils fertility, vegetation covers to reduce erosion. Soils of Jago series in the study area could be considered for alternative uses.

IV. Conclusion

The study was conducted to assess the suitability of the soils of the study area for the sustainable production of maize and cassava using parametric approach with a view to characterizing the soils, produce their suitability classes for sustainable production of the selected crops and suggest land management strategy for optimum sustainable crop production.

The soil samples collected were subjected to routine analyses. The morphology, physical and chemical characteristics alongside the taxonomic and suitability classifications of the soils were determined to generate valuable information about the soils' properties, their management requirements and their agronomic constraints. The landscape selected for the study depicts a complete toposequence with all the physiographic positions clearly defined namely the crest, the upper slope, mid-slope/ sedentary, hillwash and valley bottom. The soils at the summit, upper, middle and lower slopes of the toposequence are well drained as evidenced by their reddish brown hues in the A-horizon and brighter hues in the subsoil B and C-horizons (2.5YR-10R). The soils at the valley bottom are poorly drained as shown by the water table closer to the soil surface and mottles within the sub-soil horizon.

The soils are predominantly ultisols according to Soil Taxonomy and are placed in ustults suborder. Soils of pedons 03 and 04 further classify as Typic Plinthustults. Pedons 01 and 02 classify as Typic Kanhaplustults while soils of pedon 05 are Aquic Haplustults. The FAO-UNESCO soil legend equates all the pedons under consideration as Luvisols. The soils of pedons 03 and 04 are Plinthic Luvisols, pedons 01 and 02 as Eutric Luvisols. and pedon 05 as Gleyic Luvisols.

The results of the actual (a) suitability evaluation showed that the soils are not presently suitable (N1) for commercial cultivation of maize, and cassava in their current condition. However, potential suitability of the soils were ranked moderately suitable (S2) for maize and soils of Olorunda and Oba series were rated marginally suitable for cassava while others still remain (NS) for cassava.

In conclusion, the study showed that the soils are closely related but are not homogenous, the soils vary in their potentiality with different physiographic units for maize, cassava and rice production. Pedogenesis in the study area was influenced by physiography resulting in different soil types on the landscape. The predominant pedogenetic processes that seem to have evolved the soils are hydrolytic weathering and leaching of bases, with lessivation, mobilization and immobilization of iron and cyclic change of climate as other dominant pedogenetic processes. This study, therefore, provided evidence for the need to adopt different management practices to suit each soil type at the different physiographic positions as indicated by the agronomic constraints to ensure sustainable use of the soil resources.

References Références Referencias

1. Aduayi, E. A., Chude, V. O., Adebusiyi, B. A. and Olayiwola, S. O. (2002). Fertilizer use and management. Edition Produced by FFP, FMARD, Abuja. Pp188
2. Ajiboye, G. A. and Ogunwale, J. A. (2010). Characteristics and classification of Soils Developed over talc at Ejiba, Kogi State, Nigeria. *Nigeria Journal of Soil Science*. 20 (1): 184- 206
3. Allison, L. E. (1965). Organic Carbon. Pp 1367-1378. In C.A. Black *et al*., (edition). Methods of soil analysis. Part 2. Agronomy Monograph 9 ASA. Madison, WI.
4. Aliyu Abdu, I. (2012). Formation of A toll Garnets in the Banded Iron Formation of Maru Schist Belt. *American International Journal of Contemporary Research* 2 (5): 66- 68.
5. Ano, A. A. (1991). Potassium status of the Nigerian coastal plain sands. *Journal of potassium Research* 7 (4): 247-254.

© 2020 Global Journals

6. Ashaye, T. Y. (1969). Sesquioxides status and particle size distribution in twelve Nigeria soils derived from sand stones. *Journal of African Soils* 14: 85 – 96.
7. Ayoub, A. T. (1999). Fertilizers and the environment. *Nutrient Cycling in Agroecosystems* 55:117-121.
8. Bamijoko, V. O., Ojo-Atere, J. O. and Olomu, E. I. (1982). Morphology and classification of some ferrallitic soils of Southern Nigeria. *Nigeria Journal of Science* 4: 38 – 57.
9. Bouyoucos, G. H. (1951). A decalibration of hydrometer for making mechanical analysis of soil. *Agronomic Journal* 43: 434 – 438.
10. Brevik, E. C. (2002). Problems And Suggestions Related to Soil Classification As Presented In Introduction to Physical Geology, *Journal of geoscience education* 50: 539-543.
11. Brubakar, S. C., A. J. Jones, D. T. Lewis and Frank K. (1993). Soil properties associated with landscape position. *Soil Science Society of America Journal* 57: 235-239.
12. Buol, S. W., F. D. Hole, R. J. Mc Cracken and Southard, R. J. (1997). Soil genesis and classification. 4th Edition, Iowa State University Press, Ames.
13. Chukwu, O. G., Tessy, U. M., Emilia, C. C. and Nkoli, H. A. (2013). Pedologists' approach to agro-technology transfer: Case study of Ikwuano, Abia State, Nigeria. *African Journal of Agricultural Research* Vol. 8(2), pp. 148-152.
14. FMANR (Federal Ministry of Agriculture and Natural Resources) (1990). Literature review on soil fertility investigations in Nigeria.5 2:92-95; 5:252-261.
15. FAO, (2001). Lecture notes on the major soils of the world. World Soil Resources Reports, 94. Rome. Pp 334.
16. Fasina, A. S., J. O., Aruleba, F. O., Omolayo, S. O., Omotoso, O. S. Shittu and Okusami, T. A. (2005). Properties and classification of five soils formed on Granitic Parent material of humid southwest Nigeria. *Nigeria Journal of Soil Science* Vol. 15 Pp 21-29.
17. Harpstead, M. I. (1974). The classification of some Nigerian soils. *Soil Science Society of America Journal* 116 (6) Pp 437-442.
18. Maynard, D. G., Curran, M. P., Heninger, R.. L. and Powers, R. F. (2005). Harvesting effects on soils, tree growth and long-term productivity. p. 3–17 in *Productivity of Western Forests – A Forest Products Focus*, C.A. Harrington and S.H. Schoenholtz (eds.). General Technical Report PNW-GTR-642. Portland, OR: USDA Forest Service, Pacific Northwest Research Station.
19. Mclean, E. O. (1965). Aluminum. In : Methods of soil analysis. C. A. Black (ed). Agronomy No 9. American Society of Agronomy. Pp 978- 998.
20. Obigbesan, G. O. (2009). Impact of Liebig's Reseach on the development of Agriculture in Africa. A paper presented at the 33nd Conference. of the Soil Science.Society. of Nigeria at Ado-Ekiti. Pp51.
21. Ogban, P. I., Babalola, O. and Okoji, A. M. (1999). Profile Characteristics of a typical toposequence in Southern Nigeria. *Africa Soils*. Vol.28 Pp 147 – 165.
22. Ogunwale, J. A. and Ashaye, T. I. (1975). Sandstone derived soils of a catena at Iperu Nigeria. *Nigeria Journal of Soil Science*. 26: 22-31.
23. Ojanuga, A. G.(1978). Genesis of soils in the metamorphic forest & region of southwestern Nigeria Pedolomorphic pedologie xxviii. 1: 105-117.
24. Ololade, I. A., Ajayi, I. R., Gbadamosi, A. E., Mohammed, O. Z. and Sunday, A. G. (2010). A Study on Effects of Soil Physico-Chemical Properties on Cocoa Production in Ondo State, *Journal of Modern Applied Science* Vol. 4, pp 35- 43.
25. Payne, D. (1988). Soil structure, tilth and mechanical behaviour. p. 378–411. *In* A Wild (ed.) Russell's soil conditions & plant growth. Longman Scientific & Technical, Burnt Mill, England.
26. Periaswamy, S. P. and Ashaye, T. I. (1982). Updated classification of some southwestern Nigeria soils. *Ife Journal of Agriculture* 4: 25-41.
27. Quideau, S. A., O. A. Chadwick, R. C. Graham, S. E. Trumbire, J. L. Johnson- Maynard and M. A. Anderson. (2001). vegetation control on soil organic matter dynamics. Org. Geochem; 32: 247-252.
28. Rahaman, M. A (1988). Recent advances in the study of the basement complex of Nigeria. *In: Geological Survey of Nigeria (Ed)Precambrian Geol Nigeria*, 11–43 pp.
29. Sheldrick, W. F., J. K. Syers and J. Lingard, (2002). A conceptual model for conducting nutrient audits at national, regional and global scales. *Nutrient Cycling in Agroecosystems* 62:61-72.
30. Soil Survey Division Staff, (2006). Soil Survey Manual. USDA Handbook No. 18. Govt. printing office, Washington D.C. Pp 279.
31. Smyth, A. J. and Montogomery, R. F. (1962). Soils and land use in central western Nigeria. Western Nigeria Government, Ibadan Pp 265.
32. Temgoua, E., Tchapnga, I. D., Tanawa, E., Guenat, E. and Pfiefer, H. (2005). Ground Water Fluctuation and Foot Slope Ferricrete Soils in the Humid Tropical Zone of Southern Cameroon. Hydrol. Process 19; 3097-3111.
33. Thomas, G. W. (1982). Exchangeable cations. Pp. 159–165. *In* A.L. Page *et al.*, (ed.) Methods of soil analysis. Part 2. 2nd ed. Agron.Monogr.1 9. ASA and SSSA, Madison, WI.
34. Thomas, M. F. and Throp, M. B. (1985). Environmental Change and Episodic Ectoplantation in the Humid Tropics of Sierra Leone: The Koidu Etchplain: In Douglas, and Spencer, T. (ed.) Environmental Change and Tropical

© 2020 Global Journals

Geomorphology. George Allen and Unwin, London,pp.239-267.
35. Uponi, J. I. and Adeoye, G. O. (2000). Soil Testing and Plant Analysis: an overview. Agronomy in Nigeria pp.177.
36. Wang, Jung, Projietu, Vaug Quil and Liding Chen (2001), Soil nutrients in relation to land use and landscape position in the semi-arid small catchment on the loess plateu in China- *Journal of Arid. Environment* Vol. 48: 537-550.
37. Weltjea, G. J. and Eynatten, H. V. (2004). Quantitative provenance analysis of sediments: review and outlook. *Journal of Sedimentary Geology Science @ Direct* 171, Pp 1-11.

© 2020 Global Journals

This page is intentionally left blank

© 2020 Global Journals

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 20 Issue 3 Version 1.0 Year 2020
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Sheep and Goat Fattening Practice and Marketing System in Anlemoworeda, Hadiya Zone, S/N/N/P/R/S, Ethiopia

By Deginet Hailemeskel & Abiy Defar
Wachemo University Department of Animal Sciences

Abstract- This Research was Conducted in S/N/N/P/R/S; Hadiya Zone; Analemo Woreda; on Title of Sheep and Goat Fattening Practice and Marketing System in 2011 E.C. The Objective of the Study was Assessing Sheep and Goat Fattening Practice and Marketing System of in the Study Area. The Kebeles of the Study Area were Purposively Selected Based on the Accessibility, Sheep and Goat Fattening Practice, and from These Kebeles Respondents were Selected by Systematic Random Method. In this Study Both Primary and Secondary Data; Both Qualitative and Quantitative Data were Collected and Adequate Information about Sheep and Goat Fattening and Marketing System by using Structured and Semi-Structured Questionnaire, Interview, and through Direct Observation was Collected and Finally The Data was Analyzed by using Statistical Package for Social Science (Spss Version. 22) Software and Microsoft Excel Program Prior to Analysis and then by using Descriptive Statistics Such as Table, Number, Graph, Figure, and Others.

Keywords: *fattening practice, marketing system, sheep and goat.*

GJSFR-D Classification: *FOR Code: 070799*

Strictly as per the compliance and regulations of:

© 2020. Deginet Hailemeskel & Abiy Defar. This is a research/review paper, distributed under the terms of the Creative Commons Attribution-Noncommercial 3.0 Unported License http://creativecommons.org /licenses/by-nc/3.0/), permitting all non commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Sheep and Goat Fattening Practice and Marketing System in Anlemoworeda, Hadiya Zone, S/N/N/P/R/S, Ethiopia

Deginet Hailemeskel [α] & Abiy Defar [σ]

Abstract- This Research Was Conducted In S/N/N/P/R/S; Hadiya Zone; Analemo Woreda; On Title Of Sheep And Goat Fattening Practice And Marketing System In 2011 E.C. The Objective Of The Study Was Assessing Sheep And Goat Fattening Practice And Marketing System Of In The Study Area. The Kebeles Of The Study Area Were Purposively Selected Based On The Accessibility, Sheep And Goat Fattening Practice, And From These Kebeles Respondents Were Selected By Systematic Random Method. In This Study Both Primary And Secondary Data; Both Qualitative And Quantitative Data Were Collected And Adequate Information About Sheep And Goat Fattening And Marketing System By Using Structured And Semi-Structured Questionnaire, Interview, And Through Direct Observation Was Collected And Finally The Data Was Analyzed By Using Statistical Package For Social Science (Spss Version. 22) Software And Microsoft Excel Program Prior To Analysis And Then By Using Descriptive Statistics Such As Table, Number, Graph, Figure, And Others.The Sheep And Goat Fattening Practice In The Study Area Assessed The General Husbandry Issues Such As, Major Feed Resources, Management Practice, Major Constraints And Marketing System. In The Study Area The Most Fattening System Were Traditional Especially In The Chingo Kebele This Was Due To Most Of Households Are Illiterate And They Have No Awareness For Modern Fattening System In This Kebele. The Finishing Of Shoat Was Described As Within The Range Of 3-6 Months With The Percentage Of Three Months 40%, Four Months 33.33%, Five Months 22.22%, And Six Months 4.44%. The Marketing Systems In The Study Area Were From Producer-Consumers And Producer-Local Traders-Consumers.Generally, In The Study Area The Sheep And Goat Fatteners Were Lead Traditional Shoat Fattening Practice And They Use Different Activities To Increase Their Profile By Utilizing Locally Available Feed Resources Especially Khat Residue. The Marketing System Of Sheep And Goat Were Predominantly Characterized As Producer-Consumer And Followed By Producer-Local Trader-Consumer In Some Extent. Farmers Should Enhance Availability Of Feed By Using Different Mechanism. This Can Be Done, As Farmers Should Practice Supplementation Of Available Fed And Production Of Green Feed Even If The Distribution Of The Land Is Too Small. Sheep And Goat Producers Should Have Access To Market Information So As To Adjust Their Marketing Activities.

Keywords: fattening practice, marketing system, sheep and goat.

Author α σ: (Msc) principal Author, wachemo university Department of Animal Sciences. e-mail: degu.ab2020@gmail.com

I. Introduction

a) Background Information

Ethiopia has diverse agro-ecological zones suitable for livestock production. Agricultural scenario in Ethiopia is characterized by the pastoralism in low land area, and mixed farming system in mid and highland areas (CSA, 2012). Ethiopia is a home for many livestock species and suitable for livestock production and believed to have the largest livestock population in Africa (Tilahun and Schnidt 2012). The economic contribution of the livestock subsector in Ethiopia is about 12% of the total and 33% of agricultural gross domestic product (GDP) and provides livelihood for 65% of the population (Ayele *etal.,* 2003). An estimate indicates that the country is a home for about 54 million cattle, 25.5 million sheep and 24.06 million goats. From this 99.8% of the sheep and nearly all goats' population of the country are local breeds (CSA, 2013).

Sheep and goats are owned by smallholder farmers as an integral part of the livestock subsector and contribute to both subsistence and cash income generation (Ehuis *et al*., 2000). Sheep and goat are rear in various agro-ecological condition of the country. The suitability of an area for either animal or crop production, and the type of animal or crop to be produced depends on the agro-ecological conditions of the area(Tolera and Abebe, 2007).

Sheep and goat fattening in Ethiopia has been recognized as a potential profitable activity that enhances the income of smallholder farmers (Pasha, 2006). In spite of the large population of sheep and goat, and the role of sheep and goat both to the livelihood of resource-poor farmers and the national economy at large; the current level of on-farm productivity in the smallholder production systems is low; with off-take rate 33% and average lamb carcass weight of 10 kg (EPA, 2002).

Different research report presents the characteristics of the prevailing sheep and goat fattening activities in Ethiopia as described by stakeholders across various regions, the challenges likely to slow productivity and the prospects for improving sustained productivity (Getachew and Jane, 2014).

© 2020 Global Journals

The total annual meat production (in %) are cattle (63%), sheep (25%) and goats (12%).At the national level, sheep and goat account for about 90% of the live animal/meat and92% of skin and hide export trade value. Sheep and goats represent an importantcomponent of the farming system by providing about 12% of the value of livestockproducts consumed and 48% of the cash income generated at the farm level (FAO,2004).

It has been long recognized that the limitation to increase sheep and goat development (increasing fattening practices and their productivity) in Ethiopia are multi-dimensional. Constraints can be grouped into socio-economic limitation (infrastructure: Ethiopia has one of the lowest density of roads of any country, those forcing shoat in almost all cases to trek long distance; policy issues: sheep and goat fattening and natural resources management are influenced by absence of sheep and goat fattening policy, pricing policy, community organization and participation), and technical limitation: feed quantity and quality, breeds of sheep and goat, and pests and disease (Alemayehu, 2002).

As our country, there is still a gap of information available on sheep and goat fattening practices in Anlemo woreda. Therefore, to plan and develop improved sheep and goat fattening practices in the sub-sector, it is very important to investigate the existing sheep and goat fattening practices and marketing systems.

b) Statement of the Problem

Although Ethiopia has a high population of sheep and goat but their productivity for fattening is low due to lack of knowledge for mutton shoat selection, poor management system and poor marketing system and other limiting factors of shoat fattening and marketing. There were no adequate or documented information about sheep and goat fattening and marketing techniques in Anlemo woreda. In addition to this, poor linkages have been observed among different organizations involved with sheep and goat. Therefore, it is an urgent need to investigate various management factors (feeding, watering, housing, health care) related to fattening, and marketing techniques of sheep and goat in Anlemo woreda. As a result, this title was selected as a topic of study to justify this factors that concerned with shoat fattening practice and marketing system based on the following objectives.

c) Objective of the Study

i. *General objective*

- To assess sheep and goat fattening practice and marketing system in Anlemo woreda

ii. Specific objective

- To identify sheep and goat fattening practice and related activities
- To identify marketing system of sheep and goat and its structures and performance
- To identify problems related with sheep and goat fattening and marketing

d) Research Question

a. How farmers practice sheep and goat fattening program in their farm land?
b. What looks like the marketing system of sheep and goat?
c. What problems are facing the system of sheep and goat fattening and marketing?

e) Significance of the Study

The significance of this study was to address some elements of the system in adoption process of the small ruminants' fattening and marketing in Anlemo woreda. The information obtained in the area has paramount significance to evaluate the national proposed small ruminants' fattening practice and marketing system in Ethiopia in general and in study area in particular.

Hence this helps Anlemo woreda as baseline information for its future fattening practices and knowing local available market for small ruminant fatteners especially for small holder farmers. As a baseline this work also provides directions for further research extensions, development schemes for formulating appropriate policy for managing sheep and goat fattening and marketing systems, for academic purposes and gives information for farmer who employed in small ruminants fattening in private.

f) Scope and Limitation of the Study

The study has identified the potential and the extent of utilization of existing sheep and goat for fattening and marketing system in the study area. This study was also be limited to one woreda, which is Anlemo especially Fonko town in Hadiya zone of S/N/N/P/R/S. This was mainly because of limited financial access and time scarcity to undertake the study on a wider scale; although, the study was limited in both sample size and area coverage.

II. Literature Review

Small ruminants are playing an important role in the economy of farmers in Ethiopia. In Ethiopia, sheep and goats are accountable for about 25% of the domestic meat consumption and 58% of the national annual hide and skin production. However attempts to improve their performance under the prevailing condition must take into consideration in order to increase their specific purpose in the production and fattening system and their potential under varying management levels (Adane and Girma, 2008). Therefore, to help our study as a guideline we want to refer literatures related with production, fattening and marketing of shoat in this portion.

© 2020 Global Journals

a) Sheep and Goat Production System in Ethiopia

Mode of livestock production in Ethiopia is broadly classified into pastoral, agro-pastoral and mixed crop-livestock, peri-urban and urban production systems (Solomon *et al.,* 2010). There are a number of basic classification criteria for sheep and goat production systems in Ethiopia. Its usual to classify production systems as intensive, semi-intensive, extensive based on the develop inputs and intensify of production and based on agro-ecology, length of growth period and relation to land and type of commodity to be produced , there are five sheep and goat production systems, the three are major production systems such as high land sheep barley system, mixed crop livestock and pastoral and agro-pastoral production systems; whereas the minor production system are ranching and urban and per-urban production systems (Solomon and Girma, 2008).

b) Constraints of Sheep and Goat Production

Adane and Girma (2008) reported that sheep and goats production and productivity in Ethiopia are constrained by many factors. The major ones are; scarcity of feed, lack of infrastructure (transport facility), high mortality rates, inadequate veterinary coverage, long marketing channels and lack of market information, lower product quality (live animals and meat) for export market penetration, inadequate provision of credit services and low average reproductive rates (55 lambs and 56 kids born per 100 mature females per year in the central highlands).

c) Breed of Sheep and Goat

Indigenous sheep and goat genetic resources have developed specific adaptations to survive and produce under adverse local environmental conditions and to perform better under low input system (IBC, 2004; Markos, 2006).

There are about 14 traditionally recognized sheep populations in Ethiopia. These populations are called sheep typesin some literatures. They are also designated as breeds according to some definitions of 'breed'. These are *Menz*, *Sekota*, *Semen*, *Tukur*, *Wollo*, *Farta*, *Washera*, *Adilo*, *Arsi-Bale*, *Horro*, *Bonga*, BHS, *Afar* and *Gumz*, (Solomon, 2009). According to earlier characterization of work Ethiopian indigenous goats have been classified in to different classes. These includes *Afar*, *Abergelle*, *Arsi bale*, *Begayit*, Central highland, *Hararghe* Highland, *Keffa*, *Somali*, Western highland, Western lowland and *Woyto-Guji* goats (Tesfsye, 2009).

d) Sheep and Goat Fattening System

Sheep and goat fattening is a common practice in different parts of the country, though the degree of fattening and resource base differs markedly. Less than 39.0% of the farmers owning small ruminants practice some form of fattening before marketing and majority of the farmers sale their animals early before attaining optimum market weight (Solomon *et al.*, 2005; Getahun, 2008). Sheep and goat fattening practice should consider the general husbandry practice issues like major feed resources, management practice, records and marketing system (Shitahun, 2009).

i. *Traditional fattening systems*

This system generally depends on grazing natural or planted pastures with variable degrees of supplementation. Animals require a long period of time to attain market weight and condition. It is also associated with huge fluctuations in the weights and conditions of the animals depending on feed availability. This system can be improved to supply animals of acceptable condition to slaughter houses for ultimate export. The conditioned animals may also go into a finishing operation targeted to supply the local market (Alemu, n.d).

ii. *Agro-industrial by product based fattening*

Fattening of sheep and goat based on agro-industrial by products is practiced in different areas of the country. About 2740, 2296 and 2493 tons of oil seed cakes were produced in the year 2003/4, 2004/5 and 2005/6, respectively in Ethiopia (Adugna, 2008). Though the contribution to the total animal feed resource is limited (1.45%), agro-industrial by-products are one of the important feed resources available in Ethiopia (CSA, 2003).

Agro-industrial byproducts produced in Ethiopia include; by-products from flour milling, oil processing, sugar factory and brewery by-products. These products are mainly used for dairy and fattening animals (Alemayehu, 2004). Oil seed meals are produced from a variety of crops that have seeds that are high in oil (Kellems and Church, 2002). Oil seed cakes are rich in protein and most are valuable foods for animals (Mc Donald *et al*., 2002).

e) Management Practice and Risks Associated with Sheep and Goat Fattening

The fattening program should be started after the necessary feed supplies are secured. Underfeeding and incorrect timing are the most common causes of failures in fattening activities. The objective in a fattening operation is to convert as much of the feed to body tissue as possible. It is, thus, necessary to minimize the movement of animals during the fattening period. The success of a finishing operation depends on the first two weeks after arrival of animals. They may have traveled long distances and will be stressed, hungry, and thirsty. They are generally gathered, sorted; often stand for a long time without feed and water. It is recommended that the following guidelines be followed under such circumstances: Rest the animals for a few hours in a dry, clean, sheltered area with access to fresh water after arrival. Then offer grass hay or mixed grass-legume hay.

© 2020 Global Journals

Hand feed salt during the first two weeks; then provide trace mineral salt in a separate feeder. Afterwards, these supplements can be mixed in the complete diet, but salt should continue to be provided *ad libitum* (free choice). Animals should have feed available at all times including evenings. If there is no feed left in the morning, feed supply should be increased for the following day (Alemu, n.d).

i. *Housing system and hygiene*

Housing for fattening sheep and goat varies from fattener to fattener. In Keffa zone, sheep and goat houses are attached to the side of the main house. Farmers in Basona Worena district of North Shewa zone have separate house for sheep and goat being fattened. Most of the peri-urban and urban sheep fatteners use a separate house for fattening sheep. Cooperative fatteners use separate housing for sheep and goat. Most housing is unclean, poorly ventilated; lacks proper floor bedding and stocking rates are sometimes too high. This is due to lack of awareness and lack of understanding on the space requirement of fattening sheep and goats by most producers (Animut and Jane, 2014).

ii. *Feed resource and feeding practice*

Feeds can be classified according to some of their general properties. The classification used hears is typical of that used in the feed industry. Feedstuffs can be classified as either concentrates or roughages (Birhanu *et al.,* 2009).The availability of feed resource in the highlands of Ethiopia depends on the mode and intensity of crop production as well as population pressure. The major basal feed in the highlands of Ethiopia are a natural pasture, crop residue and stubble grazing, and their contribution to the total feed resource vary from area to area based on cropping intensity (Seyoum *etal.*, 2001).

a. *Roughages*

A wide variety of roughages can be fed to growing and finishing lambs. The amount of roughage to feed depends on the objective of feeding the roughage. Roughages are bulky feeds that contains relatively large amount of poorly digestible materials. It contains more than 18% CF. They can be of two categories, namely dry and succulent roughages based up on their moisture content. Succulent feeds usually contain more than 75% moisture and it include pasture, cultivate fodder crops, grasses, tree leaves and silage available for fattening animals. Dry roughages contain only 10-15 moisture includes hay and crop residues (Ablack and Smith, 2003).

b. *Concentrate*

Concentrates have low fiber content and a high content of either protein or energy or both. Cereal grains for example are considered as primary energy sources but also contribute a significant amount of protein. Energy source concentrates: are includes cereal grain (corn, sorghum and buck wheat), grain milling by-products (wheat bran and corn gluten meal), root and tubers (cassava and potatoes), food processing by-products (molasses, bakery waste, citrus pulp distiller and brewers by-products), industrial by-products such as wood molasses. Protein source concentrates: Protein supplements generally are products with more than 20% crude protein. Some of these feeds are; oil seed meals (soybean, cottonseed, rapeseed, canola, linseed, peanut, sunflower and sunflower meals), grain legumes (beans, peens and lupines) and animal protein (meat meal, tank ages, fishmeal's and whey (Birhanu *et al.,* 2009).

c. *Watering practice*

The water intake of fattening animals depends on environmental temperature, the temperature of drinking water itself, the activity of fattening animals, the moisture content of the feed and the amount of feeds feed per day. Most fatteners give waters for fattening animals twice a day and once a day respectively. These are due to the shortage of water for small scale fatteners (Nelson, 2000).

iii. *Healthcare practice*

An important environmental challenges as a party of fattening animal health program is the control of internal and external parasites. In general any problems associated with animal health can largely prevented if proper management practices are followed. Therefore, the veterinarian involved in sheep and goat health management program should have the necessary depth of knowledge about the elements that must be addressed in crucial on animal health control (Edwards, 1998).

Prevention of disease is a key aspect of minimizing health risks in your herd. Strict sanitation is necessary to prevent disease outbreaks. Although sanitation requires time and money, it is time and money well spent since prevention of the diseases is more economical than treatment. The housing for small ruminants, feed and water must be kept fresh and sanitary (Heidi and Chelsey, 2010).

Internal parasites are one of the biggest disease issues for small ruminants. Parasites can not only kill both young and old sheep and goats, but also contribute to poor growth rates, an unthrifty appearance, coughing, diarrhea and other digestive problems. Depending on your operation (grazing density, past history of dewormer use, other health issues) a deworming schedule should be developed with help from a consulting veterinarian. Some deworming products may have poor efficacy against some types of internal parasites that affect small ruminants. Your veterinarian can assist you with conducting fecal examinations for worm eggs, and help you make critical decisions when selecting a dewormer that will be effective for your operation (Heidi and Chelsey, 2010).

© 2020 Global Journals

iv. *Fattening cycle of sheep and goat*

For most rural and peri-urban and urban sheep and goat fatteners, the fattening activities are seasonal. This is mainly associated with market demand seasons for fattened sheep and goat and to a smaller extent due to feed availability for fattening. Informants from regional research offices and Bureau of Agriculture or Livestock Development Agency of the Amhara region, Wollega, Keffa, and Woliata Zones noted that 2 to 3 fattening cycles to be commonly used by rural farmers. The dominantly 2 fattening cycles practiced by majority of rural, peri-urban and urban fatteners in the country target two peak demand seasons for fattened sheep and goat that are highly profitable (Animut and Jane, 2014).

The peak demand is during the Ethiopian Easter (April) and New Year (September). The third fattening cycle practiced by some producers considers Ethiopian Christmas (January). It has been noted by many fatteners that demand for fattened sheep and goat is highest in Easter followed by New Year and then by Christmas. In Muslim dominated areas like Afar, ED Al Adeha (*Arefa*), a religious ceremony, is the high peak demand time for fattened sheep and goat for the live animal exporters. The length of sheep and goat fattening varies depending primarily on the availability of sufficient and quality feed for fattening. Generally the length of the fattening period is dictated by feed availability and partly on market. If there is good management, sheep and goat takes three rounds of fattening in a year (90 days are required for each round). Considering a minimum fattening length of 2 months, a maximum of 4-5 annual fattening cycles can be achieved (Animut and Jane, 2014).

v. *Risks associated with sheep and goat fattening*

The main risk associated with sheep and goat fattening activity is the loss of animals. This could be due to disease, predators or theft. Price fluctuation is another risk associated with sheep and goat fattening. To minimize risks associated with disease there is a need to enhance the service delivery system and ensure availability of enough health services. Strategic deforming and proper vaccination must be developed and in place. Risks associated with predators and theft can be minimized using proper housing (Animut and Jane, 2014).

f) Marketing System and Constraints

In Ethiopia, marketing of livestock and livestock products is underdeveloped. The major problems are the traditional management systems which are not market oriented, underdeveloped marketing systems and poor infrastructure, poor financial facility, and presence of cross-border trade. Despite the above major problems, there is an increase in demand of Ethiopian small ruminants both for local and export markets. However, there has been fluctuating demand of Ethiopian small-ruminants in importing countries due to disease, sanitary and phyto-sanitary reasons (Azage *et al.,* 2006; Berhanu *et al.,* 2006).

In Ethiopia the marketing process in general follows a three-step system with primary,intermediate and terminal markets through which marketable animal and animal products pass from producers to small traders and on to large traders or butchers.However, most producers sale their stock and livestock products at local markets directly or consumers or small traders at relatively low price (Alemayehu, 2003).

An important aspect of production and its response to demand and supply is knowledge of markets and marketing systems. Marketing of sheep and goats is characterized by strong seasonality and subject to fluctuation. Demand and price increases during festival periods. Factors affecting market supply, as measured by the number offered, include high demand during religious festivals, lambing season, quality and quantity of grazing, as well as cash needs for crop inputs and, later, for food purchase before harvesting (EARO, 2000).

i. *Structure and performance of small ruminant markets*

Animals are sold on a per-head basis and price agreement reached by a long one-on-one bargaining between a seller and a buyer. Under such circumstances, prices paid will reflect buyers' preference for various animal characteristics (weight, sex, age, condition, breed, and color), the purpose of animals purchased (for resale, slaughter, fattening or reproduction), the season of the year (occurrence of religious and cultural festivals) and the bargaining skills of buyers and sellers (Ehui *et al.,* 2000).

According to Ayele *et al.,* (2003), the livestock marketing structure of Ethiopia follows a four-tier system. The main actors of the 1st tier are local farmers and rural traders/rural assemblers who transact at farm level. Those small traders from different corners bring their animals to the local market (2nd tier). Traders/wholesalers purchase a few large animals or a fairly large number of small animals for selling to the secondary markets. In the secondary market (3rd tier), both smaller and larger traders operate and traders (wholesalers or retailers) and butchers from terminal markets come to buy animals. In the terminal markets (4th tier), big traders and butcher (wholesalers or retailers) transact larger number of mainly slaughter type animals. Consumers get meat through purchase of the animals from terminal markets and slaughters at home or they may get meat from markets or they may access from butchers who process the meat via abattoirs. Marketing of sheep and goats is characterized by strong seasonality and subject to fluctuation. Demand and

© 2020 Global Journals

price increases during festival periods. Factors affecting market supply, as measured by the number offered, include high demand during religious festivals, lambing season, quality and quantity of grazing, as well as cash needs for crop inputs and, later, for food purchase before harvesting (EARO, 2000).

ii. *Marketing constraints*

Improving marketing success of livestock producers provides incentives to adopt technological interventions that improve livestock productivity, which in turn improves marketing success. Access to local market is the most important economic determinant to adopt technologies (Zelalem 2007) and choice of fattening enterprises. Market locations in primary and secondary markets are usually not fenced; there are no permanent animal routes and no feed and watering infrastructures. Yet, buyers and sellers are subjected to various service charges by the local authorities as well as other bodies (Ayele et al. 2003). Nearly in all parts of the country, there is no regular market information on prices and supplies, nor formalized grades and standards of sheep and goats and other livestock (Kebede and Ray 1992; Ayele *et al.,* 2003). As a result, there is excess supply of animals beyond demands in some seasons. The more mobile trader is better informed on market prices which combined with excess supply places the trader in a better position during price negotiation. Illegal market in Ethiopia is identified as a constraint to fatteners and traders (Tesfaye, 2009).

Traders and exporters are also faced with marketing problems. A survey in IPMS (Berhanu *et al.*, 2007) identified lack of adequate supply of good condition animals, inadequate market places, lack of holding (concentration) places, feed supply, lack of market information, and multiple taxation at checkpoints (especially when animals are trekked or trucked through towns) and lack of efficient vaccination services for export animals as the major problems. Problems identified by exporters include lack of adequate supply of appropriate and good quality animals, poor marketing infrastructure, livestock diseases, lack of adequate sanitary and phytosanitary services to support exports, long market channels (usually 3–5 stages between producer and the abattoirs), and problems with airfreight transport services.

III. Materials and Methods

In this portion of the proposal we have discussed methodology that was undertaken in the study and preparation of the research report. These includes: information about the study area, research design used, size of sample selected and technique of sampling, what source of data collected and utilized, data collection and its instruments used, and management and analysis of collected data. All these are discussed as following.

a) Description of the Study Area

The study was conducted in Anlemo woreda, Hadiya Zone, Southern Ethiopia, which is geographically located between 7^0 54′-7^0 73′N latitude and 37^0 89′-38^0 06′E longitudes. According to Anlemo woreda agricultural and development office annual report (2018), Anlemo woreda is characterized by the topography of hill, valleys, plains and mountains and the altitude ranges from 1500 to 2500 meters above sea level. The total area of the woreda is 224 km^2 (22,414 ha) of which 14,885 cultivated lands, 427 covered by natural forest, 583 grazing land and the remaining covered by uncultivated land, bush grassland and others.

Based on the traditional agro ecological classification, its weather condition includes *dega* zones (cool and humid with altitude above 2500 m) and *woina-dega* zones (cool and semi-arid with altitude 1500-2500 m) the mean annual rainfall ranges from 1000mm to 1200mm, and the mean annual temperature ranges from 15-20^0C. Its neighboring is Silte zones in north and northwestern part, Shashogo woreda in eastern part, Lemo woreda in southern and southwestern part (AWFEDO, 2018). In addition, Anlemo woreda is 18 km far from Hosanna town, capital of Hadiya Zone in SNNPR, 175 km from Hawassa, the capital of SNNPRS and it is about 216 km far from Addis Ababa, the capital city of Ethiopia.

Based on Ethiopian CSA (2017) census, the total population of the woreda is 87,265 from this 42,914 (49.2%) is male and 44,351 (50.8%) is female. Most of the total population of the woreda, 83,636 (96%) are rural dwellers while only 3629 (4%) are urban dwellers (AWFEDO, 2018).

The dominant religions in the woreda are Muslim, Protestant and Orthodox. The most livelihoods economic activity in the study area is agriculture (mixed farming) which consists of crop production and animal rearing. The major agricultural crops include wheat, maize, *teff*, barley, bean, pea, *enset* and sorghum. The livestock population in the woreda includes cows, oxen, goat, sheep, horse, mule, and chickens. Administratively, the woreda is divided into 27 rural kebeles. The number of livestock population in study area is 85581 cattle, 31142 sheep, 19470 goat, 15876 equines, and 211359 poultry flocks (AWADO, 2018).

b) Research Design

The method of research for this study was survey method. The reason to conduct the study with this design is that it enabled us to describe the fattening practice and marketing system that have being performed in the study area precisely. In order to assess the stated objectives we have used both qualitative and

© 2020 Global Journals

quantitative types. This was because the proposed study needs the collection of statistical (numerical) data for the quantitative approach.

Qualitative method was applied to describe the word-based information about the study and by using qualitative data, activities that have been hold and processes that have being going on regarding to increase productivity were assessed on the study.

c) Sample Size and Sampling Techniques

The study was conducted in three kebeles of Anlemo woreda. Both purposive sampling and random sampling method were used to identify the samples. Purposive sampling technique was utilized to select kebeles and simple random sampling was used for farmer's selection. A total of 3 kebeles were purposively selected. Selection criteria for selecting kebeles mainly included availability of infrastructure/accessibility, and relative sheep and goat production and fattening potential. A total of households that are involve in sheep and goat fattening were assigned as a total target population and we have taken representative sample of farmers from the total target population.

Selection of kebeles was mainly based on the information obtained from the woreda's livestock development and health agency and selection of farmers was based on the information obtained from the kebele's livestock development and health agency. Then after 95% Confidence level and 5% precision level were used and the sample size was determined and calculated by the Slovin's formula as indicated below according to Yamane, (1967).

$$n = \frac{N}{1 + Ne^2}; \alpha = 5\%$$

Where: n – is desired sample size
N – is total target population of the study
e – is margin of error
α– is degree of precision

The population size was 118 for three selected kebeles and as inserted in the formula mentioned above we have got 91 as a sample size. But for facilitating proper sample division for each kebeles we have taken 90 samples and this means we have got 30 samples from each kebeles.

d) Sources of Data

The research writing involved both the combination of the primary and secondary data sources.

i. *Primary sources*

The primary data was collected from the primary sources of data through; open ended and close ended semi-structured questionnaires, structured/semi-structured interviews and direct observations.

ii. *Secondary sources*

The secondary sources of data have also been collected from different secondary data sources such as annual kebele report documents, various registers and publications (like books, journals, research reports and papers, magazines, documents available on different profiles on World Wide Web and others.

e) Data Collection Instrument

The most important instruments that have been employed to generate relevant information were questionnaires, key informants, direct observation and interview. The data was collected from each randomly selected respondent on pre agreed mutually convenient time.

i. *Questionnaire*

The researchers have used similarly semi-structured questionnaire for all respondents of the selected sample. The questionnaire was primarily prepared in English languages and then has been translated to Amharic. The items of questionnaire were both closed ended and open ended. The closed ended items have been used for quantitative analysis. After the questionnaire distributed to the respondents the researchers have collected it themselves.

ii. *Interview*

The researchers have prepared an interview guides for displaced farmers, experts of the sector office, community members and kebele administration extension servants.

iii. *Direct observation*

First hand data on the field has been collected by direct observation on the selected area for this study. The researchers have observed and collected the necessary visual information with the help of camera from the study area. Observation has been used by the researchers in order to get more information to accurate the information gets from the other tools.

f) Data Collection

Basically two types of data sources which are primary and secondary data were collected. The primary data has been collected directly from the field assessment; while the secondary data like agro-ecological zone, livestock population, and human population were collected from Rural Agricultural offices of Anlemo woreda. The data was then gathered by using semi-structured questionnaire, interview, and through direct observation. The parameters have been collected were; breed of sheep and goat, types of sheep and goat fattening system, management of sheep and goat in fattening, cycle and duration of fattening period, marketing system of sheep and goat, and risks associated with shoat fattening.

g) Methods of Data Management and Analysis

The data that has been acquired through questionnaires from primary source was processed and

© 2020 Global Journals

analyzed by using Statistical Package for Social Science (SPSS version. 22) Software and Microsoft excel program prior to analysis; completed questionnaires were coded, inputted and organized. After the completion of coding, all valid questionnaires were inputted in a coherent format of SPSS database. Finally, descriptive parameters such as percentages, tables, graphs and figures were employed and used for interpreting and presenting the survey data.

IV. Result And Discussion

a) *Socio-Economic Characteristics of Household*

Table 1: General household characteristics of respondents in the study area

Household characteristics	Kebele						Total	
	West Fonko		South Fonko		Chingo			
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Sex								
Female	2	6.67	4	13.33	2	6.67	8	8.89%
Male	28	93.33	26	86.67	28	93.33	82	91.11%
Total	30	100	30	100	30	100	90	100%
Age								
<30	14	46.67	20	66.67	8	26.67	42	46.67%
31-40	14	46.67	8	26.67	10	33.33	32	35.56%
41-50	2	6.67	0	-	7	23.33	9	10%
>50	0	-	2	6.67	5	16.67	7	7.78%
Total	30	100	30	100	30	100	90	100%
Educational status								
Illiterate	14	46.67	13	43.33	18	60	45	50%
Reading and writing	0	-	0	-	4	13.33	4	4.44%
Elementary school	4	13.33	12	40	6	20	22	24.44%
Above secondary school	12	40	5	16.67	2	6.67	19	21.11%
Total	30	100	30	100	30	100	90	100%
Family size								
1-5	15	50	17	56.67	14	46.67	46	51.11%
6-9	15	50	13	43.33	16	53.33	44	48.89%
Total	30	100	30	100	30	100	90	100%

i. *Household sex characteristics of respondents*

The household characteristics of respondents (Table 1) shown that the proportion of female respondents (with value of 8.89%) were less than males (with value of 91.11%) in three Kebeles (West Fonko, South Fonko and Chingo); this is because of culture, custom and individual perspective. So the participation of females in sheep and goat fattening is less and dominated by males.

ii. *Household age characteristics of respondents*

In the study area the age intervals who participate on shoat production is <30, 31-40, 41-50, and >50, and the percentage is 35.56, 46.67, 10 and 7.78 respectively as shown figure 2. The majority age of respondents was less than 30 year (46.67%) because at the time being there is different work creativity because shortage of land and high population growth.

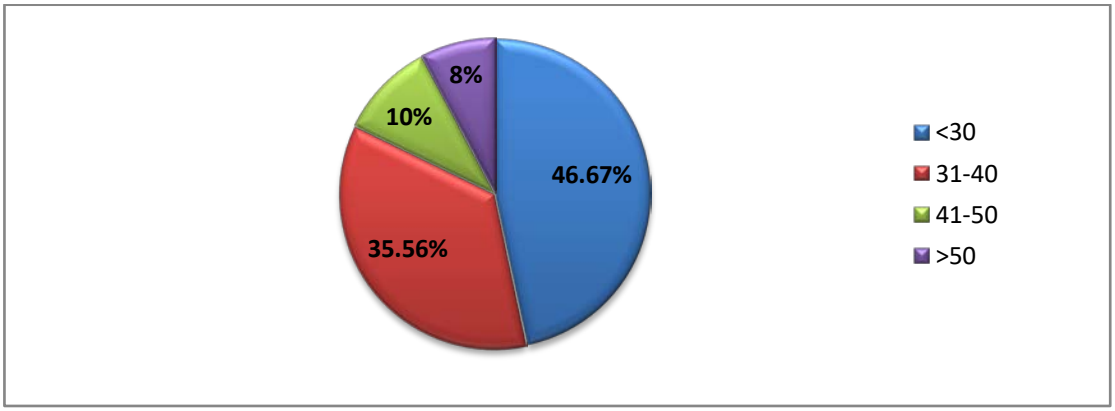

Figure 1: Household age characteristics of respondents in the study area

© 2020 Global Journals

iii. *Household educational status of respondents*

According to our survey in the study area the educational status of the respondents are characterized as 50% illiterate, 4.44% reading and writing, 24.44% elementary school and 21.11% above secondary school respectively as shown in figure 2.

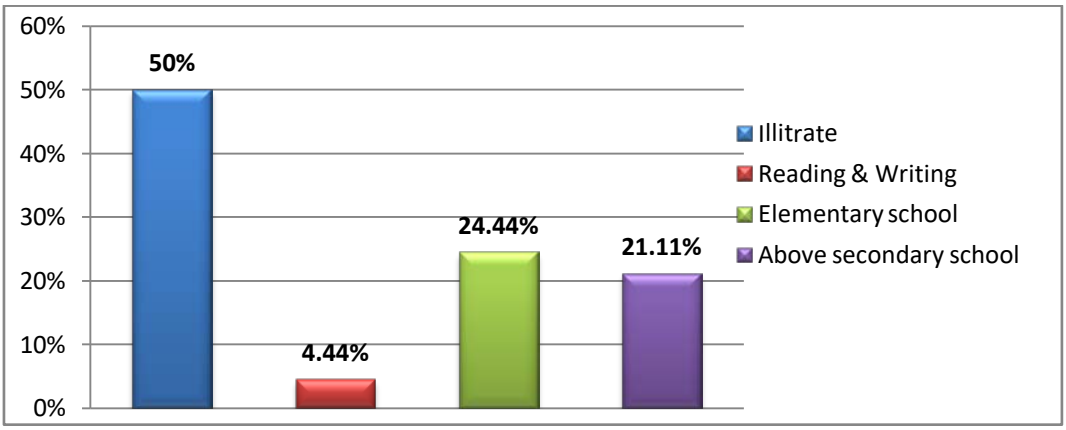

Figure 2: Household educational status of respondents in the study area

iv. *Household family size of respondents*

The family size intervals of respondents in the study area were characterized by from one-five and six-nine and the percentage is 51.11 and 48.89 respectively. In the study area greater part of the average family size run from 1-5 (51.11%) because lack of efficient money to teach their children and lack of land for cultivation of cereal crops.

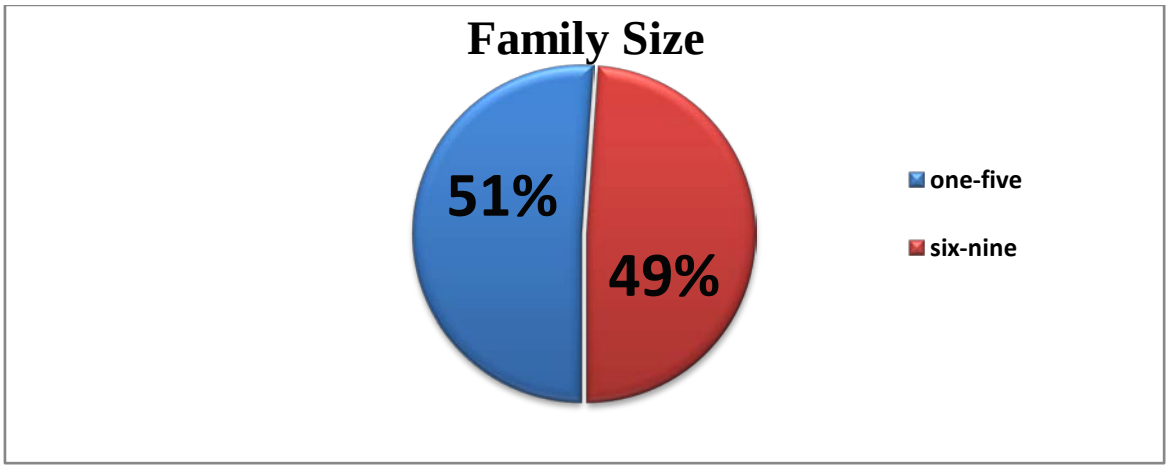

Figure 3: Household family size of respondents in the study area

v. *Households having Sheep and goat in the study area*

Table 2: Sheep and goat producers in three kebeles

Animal species	West Fonko		South Fonko		Chingo		Total	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Sheep	12	40	10	33.33	17	56.67	36	40%
Goat	18	60	20	66.67	13	43.33	51	60%
Total	30	100	30	100	30	100	90	100

In the study area according to the data obtained from respondents having goats were greater than having sheep with the percentage of 60% and 40% respectively. So from this data in West Fonko and South Fonko kebeles the goat producers are higher than sheep producers because this kebeles is towns so goat can be reared or managed in an easy way by feeding household wastes, market area wastes/ residuals, mill leftover, and khat residues. In this kebele sheep production is not favorable because of limited land to grazing lands since, they needs to graze rather than browse. But in Chingo kebele the sheep producers are high from goat producer because the area is a rural area and there is grazing lands and also in this area the agro-ecology of the area is comfortable for sheep production.

© 2020 Global Journals

b) *Production System*

Table 3: Sheep and goat production system in the study area

Production system	Kebeles			Total	
	West Fonko (N =30)	South Fonko (N =30)	Chingo (N =30)	Frequency	%
Extensive	27	27	30	84	93.33%
Semi-intensive	3	3	0	6	6.67%
Intensive	0	0	0	0	0%
Total	30(33.33)	30(33.33)	30(33.33)	90	100%

N=Number of respondents

According to table 3, we have obtained the data from the respondent's that the main sheep and goat production system in the study area were extensive and semi-intensive production systems with the high value of extensive (93.33%), and the lowest value of semi-intensive (6.67%). Based on the result of the study extensive production system were highly practiced in the study area and followed by semi-intensive production system. This is due to the housing system is poor (cleaned once per day, all three kebele use loose housing system, feeding system is mostly natural grazing and khat residue in the study area). From the result of the study we concluded that intensive production system is little or no due to general poor management. The report of Solomon and Girma (2008), says that it is usual to classify production systems as intensive, semi-intensive, extensive based on the develop inputs and intensify of production.

c) *Constraints of Sheep and Goat Production*

Table 4: Constraints of sheep and goat production

Constraints	Kebeles			Total	
	West Fonko (N =30)	South Fonko (N =30)	Chingo (N =30)	Frequency	%
Lack of feed	14 (46. 67%)	18(60%)	14(46. 67%)	46	(51.11%)
Disease	7(23.33%)	6(20%)	5(16.67%)	18	(20%)
Lack of infrastructure	6(20%)	2(6.67%)	8(26.67%)	16	(17.78%)
Inadequate veterinary service	3(10%)	4(13.33%)	3(10%)	10	(11.11%)
Total	30(100%)	30(100%)	30(100%)	90	(100%)

N=Number of respondents

According to table 4, sheep and goat production and productivity in the study area were constrained by many factors like scarcity of feed (51.11%), disease (20%), lack of infrastructure like; transportation facility, market (17.78%) and inadequate veterinary coverage (11.11%). According to key informants of Analemo woreda agricultural office lack of feed is the major constraints of sheep and goat production in the study area that accounts more than 50%. In other finding sheep and goat's production and productivity in Ethiopia are constrained by many factors. The major ones are; scarcity of feed, lack of infrastructure (transport facility), high mortality rates, inadequate veterinary coverage, long marketing channels and lack of market information (Adane and Girma, 2008).

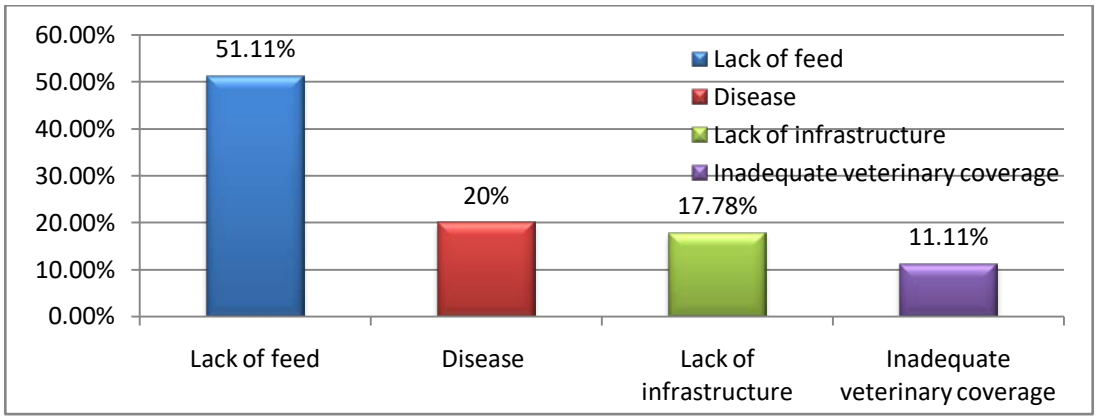

Figure 4: Constraints of sheep and goat production

© 2020 Global Journals

d) Types of Breed Exist in the Study Area

Table 5: Sheep and goat breed type in the study area

Breed types		West Fonko		South Fonko		Chingo		Total	
		Frequency	%	Frequency	%	Frequency	%	Frequency	%
Sheep	Local breed	10	33.33	8	26.67	17	56.67	35	38.89%
	Doyogena breed	1	3.33	2	6.67	0	-	3	3.33
	Bonga breed	1	3.33	0				1	1.11
Goat	Local breed	16	53.33	19	63.33	13	43.33	48	53.33
	Konso breed	2	6.67	1	3.33	0		3	3.33
Total		30	100	30	100	30	100	90	100

The interviewed households said that most of the producers use local breeds. The proportioned value of the result showed that: As shown in the table above, the households in the study area were used sheep breeds like local sheep breed (38.89), doyogena breed (3.33) and the remaining respondents were use bonga breed (1.11%). And for goat they were used Local breed (53.33%) and Konso breed (3.33). This was because of the attitude of people to use improved breeds as they were not aware to use improved breeds and they thinks as it has no additional value from using improved breed and as these breeds need high management but local breeds need few management and they save labor of humans to manage them.

e) Sheep and Goat Fattening System

The sheep and goat fattening practice in the study area were assessed the general husbandry issues such as, major feed resources, management practice, major constraints and marketing system. In the study area the most fattening system were traditional especially in the Chingo kebele this is due to most of households are illiterate and they have no awareness for modern fattening system in this kebele. In West Fonko kebele there is some level of agro-industrial by-product and khat residue based fattening relative to Chingo because this kebele is town and they have access for different infrastructure that can promote sheep and goat fattening. But South Fonko kebele were better from two kebeles in using agro-industrial by-product and khat residue based fattening system, the housing system is also better than from two kebeles. Animal fattening practice should consider the general husbandry practice issues like major feed resources, management practice, records and marketing system (Shitahun, 2009).

f) Management Practice of Sheep and Goat Fattening

i. *Housing*

Table 6: Considerations of housing in the study area

Considerations during house constructions	West Fonko		South Fonko		Chingo		Total	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Wind direction	16	53.33	22	73.33	20	66.67%	58	64.44%
Ventilation	14	46.67	8	26.67	10	33.33%	32	35.56%
Total	30	100	30	100	30	100	90	100%

According to table 6, in the study area the considerations during house construction were various depending on the fattener and it is described with the highest value of wind direction (64.44 %) this is due to the environment is windy and wind blow in the autumn so they gives special care for wind direction and the remaining 35.56% is constructed based on ventilation in order to prevent the animal from exposing of sun and hot temperature at the day time. This finding is related with Animut and Jane (2014), report in that housing for fattening sheep and goat varies from fattener to fattener.

ii. *Feed resource and feeding practice*

a. *Feed resource*

Table 7: Feed availability in the study area

Feeds	West Fonko		South Fonko		Chingo		Total	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Natural grazing	5	16.67	5	16.67	16	53.33	26	28.89%
Khat Residue	10	33.33	13	43.33	3	10	26	28.89%
Crop residue	6	20	0	-	10	33.33	16	17.78%
Industrial by products	6	20	10	33.33	0	-	16	17.78%
Conserved hay	3	10	2	6.67	1	3.33	6	6.67%
Total	15	100	15	100	15	100	45	100%

© 2020 Global Journals

As shown table above the most used feed in the study area were natural pasture and khat residue in equal proportion (28.89%) because of lack of capital and lack of awareness to use improved forage and agro-industrial by-products and there is access of khat residue in the study area and the least used feed in the study area isIndustrial by products (17.78%), crop residue (17.78%) and conserved hay (6.67%). So from this can say that in the study area IBP like furishka and roughage feed is highly used than concentrate feed because of lack of capital to buy concentrate feed, absence of different factory, and lack of awareness in using concentrate feed. This finding is partially similar to the report of Seyoum *etal.* (2001), who indicated that the major basal feed in the highlands of Ethiopia are a natural pasture, crop residue and stubble grazing, and their contribution to the total feed resource vary from area to area based on cropping intensity.

b. *Feeding practice*

Table 8: Feeding practice in the study area

Feeding system	West Fonko		South Fonko		Chingo		Total	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Free grazing	6	20	8	26.67	14	46.67	28	31.11%
Stall feeding	24	80	22	73.33	16	53.33	62	68.89%
Total	30	100	30	100	30	100	90	100%

As we have collected the data in the study area two types of feeding systems were observed stall feeding and free grazing from those stall feeding were the most used feeding system with the percentage of 68.89% this is because to finish animals within a short period of time they should not move longer and next to this free grazing were present with the percentage of 31.11%.

iii. *Watering practice*

Table 9: Source of water in the study area

Source of water	West Fonko		South Fonko		Chingo		Total	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
River	11	36.67	12	40	23	76.67	46	51.11%
Pond	6	20	6	20	4	13.33	16	17.78%
Stream	7	23.33	5	16.67	3	10	15	16.67%
Tap water	6	20	7	23.33	0	-	13	14.44%
Total	30	100	30	100	30	100	90	100%

The watering practices in the study area were assessed as sources of water for fattening sheep and goat. Water is the main concern of the study. Source of water found in the study area were river, pond, stream and tap water. And the frequency of watering per day varies among different households. As shown table above watering from a river (51.11%) was the major one especially in Chingo kebele. This is due to presence of river around the area. The followers were pond and stream water with 17.78% and 16.67% respectively. But, the contribution of tap water is less with 14.44% because according to the respondents especially in Chingo kebele, it is difficult to get tap water. On West Fonko and South Fonko kebeles also there was inaccessibility of tap water. The water intake of fattening animals depends on environmental temperature, the temperature of drinking water itself, the activity of fattening animals; the moisture content of the feed and the amount of feed fed per day (Nelson, 2000).

iv. *Health care practice*

Table 10: Disease controlling method in the study area

Controlling Method	West Fonko		South Fonko		Chingo		Total	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Spraying	11	36.67	9	30	24	80	44	48.89%
De worming	19	63.33	21	70	6	20	46	51.11%
Total	30	100	30	100	30	100	90	100%

In the study area both internal and external parasites were assessed and the controlling method is shown on the above table. According to the data obtained from the respondents the highest value (51.11%) of households use deworming because the respondent says the effect of internal parasite is much more than external parasite in cold agro-ecological environment and the remaining part use spraying

© 2020 Global Journals

(48.89%) for controlling external parasite like tick and mange from their animal. This finding is related with Edwards (1998), report who describes in terms of parasite controlling method and important environmental challenges as a party of fattening animal health program is the control of internal and external parasites.

v. *Fattening cycle of sheep and goat*

Table 11: Fattening cycle in the study area

Fattening cycle	West Fonko		South Fonko		Chingo		Total	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
1x/year	7	23.33	7	23.33	12	40	26	28.89%
2x/year	11	36.67	17	56.67	10	33.33	38	42.22%
3x/year	12	40	4	13.33	8	26.67	24	26.67%
4x/year	0	0	2	6.67	0	0	2	2.22%
Total	30	100	30	100	30		90	100%

According to our survey the fattening cycle in the study area were 1x/year, 2x/year, 3x/year, and 4x/year and the percentage for each cycle were 28.89%, 42.22%, 26.67% and 2.22% respectively. The reason for this variation was due to feed availability, season, and fasting. This finding is similar with the report of Animut and Jane (2014), who indicated as if there is good management sheep and goat takes three rounds of fattening in a year (90 days are required for each round). The length of sheep and goat fattening varies depending primarily on the availability of sufficient and quality feed for fattening.

vi. *Duration of fattening of sheep and goat*

Table 12: Duration of fattening

Duration of fattening	West Fonko		South Fonko		Chingo		Total	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
3 month	12	40	14	46.67	20	33.33	36	40%
4 month	12	40	4	13.33	14	46.67	30	33.33%
5 month	6	20	10	33.33	4	13.33	20	22.22%
6 month	0	0	2	6.67	2	6.67	4	4.44%
Total	30	100	30	100	30	100	90	100%

According to the data collected from the respondents the finishing of shoat were described as within the range of 3-6 months with the percentage of three months 40%, four months 33.33%, five months 22.22%, and six months 4.44%. The length of fattening is varies due to feed availability and quality of feed, feed allowance per day, feed conversion efficiency of the animal, variation of environment from place to place, types of feed that are fed, initial body weight of the animal, age, and health management. This finding is related with the report of Animut and Jane (2014), who indicated the length of sheep and goat fattening varies depending primarily on the availability of sufficient and quality feed for fattening.

g) Marketing System and Constraints

i. *Marketing System*

Table 13: Marketing systems in the study area

Marketing channel	West Fonko		South Fonko		Chingo		Total	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Producer- consumers	22	73.33	9	60	13	86.67	66	73.33%
Producer-local traders-consumers	8	26.67	6	40	2	13.33	24	26.67%
Total	30	100	30	100	30	100	90	100%

As shown table above the marketing system in the study area were from Producer-consumers and Producer-local traders-consumers with the percentage of 73.33% and 26.67% respectively. In Ethiopia the marketing process in general follows a three-step system with primary, intermediate and terminal markets (Alemayehu, 2003)

© 2020 Global Journals

ii. *Marketing constraints*

Table 14: Marketing constraints

Marketing constraints	West Fonko		South Fonko		Chingo		Total	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Fasting	18	60	17	50	23	76.67	58	64.44%
Season	12	40	13	50	7	23.33	32	35.56%
Total	30	100	30	100	30	100	90	100%

According to the data obtained from the respondents the major constraints of marketing system were fasting and season. As shown table above fasting were the major marketing constraint (64.44%) since there are long fasting periods in our country and season were the subsequent marketing constraint (35.56%) in the study area. According to EARO (2000), marketing of sheep and goats is characterized by strong seasonality and subject to fluctuation. Demand and price increases during festival periods.

iii. *Structure and performance of small ruminant markets*

As we had assessed from the respondents in the study area animals were sold on a per-head basis and price agreement reached by negotiation of buyers and sellers on the market. The buying and selling system were based on animal characteristics (weight, sex, age, condition, breed, and color). This finding is related with EARO (2000), who describes as animals are sold on a per-head basis and price agreement reached by a long one-on-one bargaining between a seller and a buyer.

h) Risks Associated with Sheep and Goat Fattening

Table 15: Risks during fattening operation

Risks	West Fonko		South Fonko		Chingo		Total	
	Frequency	%	Frequency	%	Frequency	%	Frequency	%
Price risk	18	60	22	73.33	14	46.67	54	60%
Loss of animals	12	40	8	26.67	16	53.33	36	40%
Total	30	100	30	100	30	100	90	100%

According to the data obtained from the respondents, the major risk during fattening operation in the study area were price risk (60%) during selling of the animal the price will be fall down so due to this price fluctuation the owner will goes to risk, and the next were loss of animals 40% due to disease, thief and predators. This finding is contrary with the report of Animut and Jane (2014), the main risk associated with sheep and goat fattening activity is the loss of animals. This could be due to disease, predators or theft. Price fluctuation is another risk associated with sheep and goat fattening.

V. Conclusion and Recomendation

a) Conclusion

Availability of feed was not sufficient for better sheep and goat production system in the study area. Generally, in the study area the sheep and goat fatteners were lead traditional shoat fattening practice and they use different activities to increase their profile by utilizing locally available feed resources especially khat residue. But their profit was not satisfactory because they had no enough awareness about the general husbandry practice of sheep and goat fattening system. In the study area both internal and external parasite controlling method were involved like deworming and spraying. In general any problems associated with animal health can largely be prevented if proper management practice is followed. Finally the marketing system of sheep and goat were predominantly characterized as producer-consumer and followed by producer-local trader-consumer in some extent.

b) Recommendation

- As the result showed that there was feed shortage in the study area, so the government, stakeholder and other concerning body should be support by creating awareness for about feeding, how to treat feed and how to use improved forage.
- The woreda as agricultural and rural development office must be take especial responsibility to develop appropriate policy to improve breed and feed resource to the farmers.
- Extension workers should spent time for adjusting the farmer who to formulate good feed ration to be given to the fattening small ruminants for good quality meat and growth performance.
- The small ruminant fetteners should plant improved grass species that have high biomass

© 2020 Global Journals

yield and conserve some important feeds for the time of feed scarcity.

- The farmers should work on feeding requirements of fattening shoats and its management system
- To increase the profile obtained from the sheep and goat fattening activity the farmers should be aware before starting the sheep and goat fattening activity
- From the result health problem is one factor of sheep and goat fattening, so there should be adequate veterinary service.
- Sheep and goat producers should have access to market information so as to adjust their marketing activities.
- Training should be given to small holder small ruminant fatteners about feed conservation and feeding system by extension workers.

References Références Referencias

1. Ablack H. and SmithA.H., 2003. Forage Intake and Rumination by Fattening Animal. *J Animal Science.*Vol. 4. Pp. 119-125.
2. Adane H. and Girma A., 2008. Economic Significance of Sheep and Goats. *J Animal Science.* Vol. 3. pp.1-4.
3. Alemayehu M., 2002. Forage Production in Ethiopia: A case study with implications for livestock production. Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia. Pp. 67-72.
4. Alemayehu M., 2003.Forage Production in Ethiopia: A case study with multiplication for livestock production. Ethiopian Society of Animal Production ESAP, Addis Ababa, Ethiopia. Pp. 45-51.
5. Alemayehu M., 2004. Rangeland: Biodiversity Concepts, Approaches and the Way Forward. Addis Ababa University,Faculty of Science,Addis Ababa, Ethiopia. Pp. 80-81.
6. Alemu Y., n.d.. Short Term Intensive Fattening of Sheep and Goats for Rapid Improvement in Weight, Condition and also Producer Incomes.*Technical bulletin no.11.* URL: http://www. ESGPIP.org.
7. Animut G. and Jane W., 2014. Prospects to Improve the Productivity of Sheep Fattening inEthiopia: Status, challenges and opportunities. Addis Ababa: ICARDA.
8. AWADO, 2018. Anlemo Woreda Agricultural office Annual Progressive Report: Unpublished.
9. AWFEDO, 2018. Anlemo Woreda Financial, Socio-economic Data and Annual Progressive Report: Unpublished.
10. Ayele S, Assegid W, Jabbar MA, Ahmed MM and Belachew H. 2003. Livestock marketing in Ethiopia: A review of structure, performance and development initiatives. Socio-economics and Policy Research Working Paper 52. ILRI (International Livestock Research Institute), Nairobi, Kenya.
11. Azage T., Berhanu G. and HoockstraD., 2006. Institutional Arrangements and Challenges in Market-Oriented Livestock Agriculture in Ethiopia:Proceedings of the14thAnnual Conference of the Ethiopian Society of Animal Production(ESAP) held in Addis Ababa, Ethiopia, September 5-7, 2006. pp.1-20.
12. Berhanu G., Hoekstra D. and Azege T., 2006. Improving the Competitiveness of Agricultural Input Markets in Ethiopia: Experiences since 1991. Paper Presented at the Symposium on Seed-Fertilizer Technology, Cereal Productivity and Pro-Poor Growth in Africa: Time for New Thinking 26th Triennial Conference of the InternationalAssociation of Agricultural Economics(IAAE), August 12-18, 2006, Gold Coast, Australia.
13. Berhanu Gebremedhin, Hoekstra D and Samson Jemaneh. 2007. Heading towards commercialization? The case of live animal marketing in Ethiopia. Improving Productivity and Market Success (IPMS) of Ethiopian Farmers Project Working Paper 5. ILRI (International Livestock Research Institute), Nairobi, Kenya. 73 pp.
14. Birhanu T., Shiferaw B. and Kahsay B., 2009. The Major Feed Resource in Ethiopia: Natural Pasture Grazing and By-Product Animal Feed Resource in Ethiopia. *Journal in Animal Science.* Vol. 4. Pp. 9-17.
15. CSA, 2013. Central Statistics Authority of the Federal Democratic Republic of Ethiopia. Ethiopian Agricultural Sample Enumeration. Result at Country Level. Central Statistics Authority, Addis Ababa, Ethiopia. pp. 250-350.
16. CSA, 2012. Central Statistical Agency of the Federal Democratic Republic of Ethiopia. Agricultural Sample Survey of 2011/12 (2004 E.C).Report on Livestock and characteristics (Private peasant Holdings), Central Statistical Agency, Addis Ababa, Ethiopia. Vol.2. Pp. 25-27.
17. CSA (2018). Ethiopian Demography and Health Survey, Addis Ababa, Ethiopia. Summary and Statistical Report of the 2017 Population and Housing Census. ORC Macro.
18. EARO, 2000. National Small Ruminants Research Strategy Document. ERAO, Addis Ababa, Ethiopia.
19. Edwards A., 1998. Respiratory Disease of Feed Lot Cattle. *Can 1435*. Vol. 2.Pp. 53-55.
20. Ehuis K., Benin S. and Gebreselassie N., 2000. Factors Affecting Urban Demand for Live Sheep: The case of Adiss Abeba, Ethiopia. Socio-economics and policy research working paper 31. ILRI (International Livestock Research Institute), Nairobi, Kenya, 32 pp.
21. EPA, 2002. Ethiopian Privatization Agency. Available at web: http://www.telecom.net.et/~epa/Sectors/leather.html
22. FAO, 2004. The State of Agricultural Commodity Markets. FAO. Rome, Italy. Http://www.fao.org.

© 2020 Global Journals

23. Getahun L., 2008. Productive and Economic Performance of Small Ruminant Production in Production System of the Highlands of Ethiopia. Ph.D. dissertation. University of Hohenheim, Stuttgart-Hoheinheim, Germany.
24. Heidi M. and Chelsey A., 2010. Sheep and Goat Herd Healthcare. Dale Bumpers Collage of Agricultural, Food and Life Science. Online Courses: Assessed on March 19, 2019. https://www.uaex.edu /farm-ranch/animals-forages/sheep-goats/herd-health.aspx
25. IBC, 2004. The State of Ethiopias Farm Animal Genetic Resources. Country Report. A Contribution to the First Report on the State of the World"s Animal Genetic Resources.IBC, Addis Ababa, Ethiopia.
26. Kebede Andargachew and Ray B. 1992. Intra-annual sheep price patterns and factors underlying price variations in the central highlands of Ethiopia. In: Rey B, Lebbie SHB and Reynolds L (eds), Small ruminant research and development in Africa. Proceedings of the first biennial conference of the African small ruminant research network, ILRAD, Nairobi, Kenya, 10–14 December 1990.
27. Markos T., 2006. Productivity and Health of Indigenous Sheep Breeds and Crossbreds in the Central Ethiopian Highlands. Faculty of Medicine and Animal Science, Department of Animal Breeding and Genetics. Doctoral Dissertation, Swedish University of Agricultural Sciences, Uppsala, Sweden.
28. McDonald P., Edwards R.A., Greenhalgh J.F.D and Morgan C.A., 2002. Animal Nutrition. 6th edition. *Pearson Educational Limited*. Edinburgh, Great Britain.
29. Mohammad A., 2006. Livestock and Dairy Development Board.
30. Nelson R.H., 2000. An Introduction to the Feeding of Farm Livestock. 2nd ed. PergamonPress. Pp. 156.
31. Pasha T., 2006. Feedlot Fattening of Sheep and Goats for Quality Mutton Production. Islamabad: Livestock and Dairy Development Board. www. iddb.org.pk/forms/Sheep Book.pdf.
32. Pereira C., Pavanin A., and Santos B. (2014).American Collage of Medical Genetics and Genomics. Retrieved March 19, 2019, from Springer Open: https://springerplus.springeropen.com/ articles/10.1186/2193-1801-3-301
33. Seyum B. and Abate T., 2001. Present Status and Future Direction in Feed Resource and Nutrition Research Targeted for Wheat Based Crop-Livestock Production System in Ethiopia.
34. Shitahun B., 2009.Short Term Intensive Fattening of Sheep and Goats for Rapid Improvement in Weight, Condition and also Producer Incomes. *Technical bulletin no.14.* URL: https://www.ESGPIP.org.
35. Solomon A., Gemeda D., Takele K., Birhanu S., Dereje B., Bizunesh M., FayoD., Ulfina G. and Birhan F., 2005. On-Farm Verification of Sheep Finishing Technology in Eastern Wollega Zone. In: Participatory Innovation and Research: Lessons for Livestock Development.
36. Solomon Abegaz, Girma Abebe and Kassahun Awgichew, 2008.Sheep Production System in the Tropics. Pp. 213-245.
37. Solomon Gizaw, 2009. Technical Bulletin No.28. Sheep Breeds of Ethiopia: A Guide for Identification and Utilization. Ethiopia Sheep and Goat Productivity Improvement Program (ESGPIP).
38. Solomon Gizaw, Azage Tegegne, Berhanu Gebremedhin and Dirk Hoekstra, 2010. Sheep and Goat Production and Marketing Systems in Ethiopia: Characteristics and Strategies for Improvement. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 23. ILRI (International Livestock Research Institute), Nairobi, Kenya. Pp. 58.
39. Tesfaye Tsegaye. 2009. Characterization of goat production systems and on-farm evaluation of the growth performance of grazing goats supplemented with different protein sources in Metema woreda, Amhara region, Ethiopia. MSc thesis. Haramaya University, Haramaya, Ethiopia.
40. Tilahun H. and Schmid E., (2012). Spatial analysis of livestock production patterns in Ethiopia. ESSP 2 Working paper 44. International food policy research institute Ethiopia strategy support program 2, Addis Ababa, Ethiopia.
41. ToleraAbebe and Abebe Adugna, 2007. Livestock Production in Pastoral and Agro-Pastoral Production Systems of Southern Ethiopia. Livestock Research for Rural Development. Volume 19, No 177, http://www.lrrd.org/lrrd19/12/tole19177.htm.
42. Tsedeke Kocho, 2007. Production and Marketing of Sheep and Goats in Alaba, SNNPR. MSc. Thesis, Hawassa University, Awassa, Ethiopia.
43. Yamane G. 1967. *Sampling Techniques, 2nd edition*, New York: John Wiley and Sons, *Inc. in Development Projects*. Washington, DC: The World Bank.
44. Zelalem Tamrat. 2007. Adoption of small ruminant fattening package in agropastoral areas, Meiso wereda, Eastern Oromia. MSc thesis. Haramaya University, Haramaya, Ethiopia.

© 2020 Global Journals

Appendices

Appendix 1: Questionnaires for household respondents

The questionnaire of our study had the following formats and permission for the respondents:

Wachemo University

Collage of Agricultural Science

Department of Animal Science

Study Questioner Paper to Be Filled By Respondents

- **Dear respondents**

The purpose of this questionnaire will have to assess the sheep and goat fattening and marketing system for determining successful study. Thus you are kindly and honestly requested to complete each questionnaire carefully.

Thanks for your cooperation!!!

- **Direction**

1. Please answer by writing "X" mark in box for close ended questionnaires.
2. Circle the letter you chosen for the questions on which you think to be an answer.
3. We would like to ask you in a polite manner to write short and precise answers for open ended questions and some close ended questions in space provided.

1. General Information

I. Owner sex: Male ☐ Female ☐ Date _____

II. Region _____ Zone _____ Woreda _____

2. Household fatteners

I. Position in the household

A. Husband C.SonE. Other

B. WifeD. Daughter

II. Household head sex_____ Age_____ Occupation_____

II. Household education level

A. IlliterateC. Elementary schoolE. Other

B. Reading and writing D. Above secondary school

IV. Do you practice sheep and goat fattening?

Yes ☐ ☐

3. Study Related Questions

3.1. Animals fattened

I. How many animals do you fatten now _____

II. Breed of fattening animals (is the animal local or cross breed):_____

III. From what age do you start to fatten:_____ Sex:_____

3.2. Feed resource and feeding

I. What type of feed are locally available?

A. Natural grazing D. Industrial by product

B. Crop residue E. Conserved hay

C. Cultivated F. other

II. What type of feeding system you follow?

A. Stall feedingB. Free grazingC. Others

3.3. Housing

I. Which type of housing is used for your fattening shoat?

A. ConventionalB. loose house C. Others

II. Which condition is fulfilling during construction of fattening shoat house?

A. Location B. ventilation C. Direction D. Others

III. What facilities are fulfilling in your fattening shoat house? List:

_____

© 2020 Global Journals

3.4. Health care

I. How many time you will clean the house per day?

A. Once B. Twice C. Three times

II. Which type of parasitic disease control strategies is used?

A. Deworming B. Spraying C. Dipping D. Others

III. Is there technical assistance you employ? If yes, in what work?

Yes ☐ No ☐

_____

_____

_____

IV. Is there any sheep and goat fattening constraint? If yes list them?

_____

_____

3.5. Water resource and watering practice

What is the water resource for sheep and goat?

A. River C. Pipe water E. Tap water

B. Pond D. Stream water F. Others

3.6. Cycle and duration of fattening

I. How money months take to fatten your shoat_____?

II. How money times do you fatten per year (cycle) _____?

3.7. Risk if there

Is there risk during the fattening operation? If yes list: Yes ☐ ☐

_____

_____

_____

3.8. Marketing

I. Where you get market information

A. Market information sources C. Traders

B. Market visit D. Relatives, neighbors and market visits

II. Factors for market fluctuation

A. Season B. Fasting C. others

III. Which type of marketing system do you follow?

A. Primary C. Terminal

B. Intermediate D. Others

Appendix 2: Questions for key informants

1. What types of sheep and goat production system are commonly practiced in Anlemo woreda?
2. What are the major constraints of sheep and goat production in Anlemo woreda?
3. What are the major breeds exist in Anlemo woreda?
4. Which fattening system is practiced more commonly in Anlemo woreda? Why?
5. What are the major feed resource for sheep and goat fattening in Anlemo woreda?
6. What looks like the marketing system of sheep and goat in Anlemo woreda?

© 2020 Global Journals

Global Journal of Science Frontier Research: D
Agriculture and Veterinary
Volume 20 Issue 3 Version 1.0 Year 2020
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Environmental Impact of Agrochemical uses on the Island's Agricultural Production Area in Maranhão, Brazil

By Sérgio Henrique Pinto Silva, Mélanie Martins Gonçalves, Fábio Henrique Ramos Braga, Neuriane Silva Lima, Wallace Ribeiro Nunes Neto, Márcio Anderson Sousa Nunes, Diana Karla Lourenço Bastos, Andrea de Souza Monteiro, Darlan Ferreira da Silva, Wellyson da Cunha Araujo Firmo, Maycon Henrique Frazão de Melo, Maurício Eduardo Salgado Rangel, Rita de Cássia Mendonça de Miranda & Maria Raimunda Chagas Silva

Ceuma University

Abstract- Agriculture is the foundation of society, has provided humanity with its food needs for over ten thousand years. The use of pesticides in Brazil and the world has grown exponentially in recent decades. The objective of this study was assessment the use of agrochemicals and their environmental impact on agricultural production of the Island of Maranhão. The study area is located in Paço do Lumiar, Maranhão, Brazil. Soil samples were collected from agricultural land during the wet season (between the months of February and May) and dry season (between the months of September and October) seasons of 2018.

Keywords: *agriculture, soil, pesticides, adsorption.*

GJSFR-D Classification: *FOR Code: 309901*

Strictly as per the compliance and regulations of:

© 2020. Sérgio Henrique Pinto Silva, Mélanie Martins Gonçalves, Fábio Henrique Ramos Braga, Neuriane Silva Lima, Wallace Ribeiro Nunes Neto, Márcio Anderson Sousa Nunes, Diana Karla Lourenço Bastos, Andrea de Souza Monteiro, Darlan Ferreira da Silva, Wellyson da Cunha Araujo Firmo, Maycon Henrique Frazão de Melo, Maurício Eduardo Salgado Rangel, Rita de Cássia Mendonça de Miranda & Maria Raimunda Chagas Silva. This is a research/review paper, distributed under the terms of the Creative Commons Attribution-Noncommercial 3.0 Unported License http://creativecommons.org /licenses/by-nc/3.0/), permitting all non commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

Environmental Impact of Agrochemical uses on the Island's Agricultural Production Area in Maranhão, Brazil

Sérgio Henrique Pinto Silva [α], Mélanie Martins Gonçalves [σ], Fábio Henrique Ramos Braga [ρ], Neuriane Silva Lima [ω], Wallace Ribeiro Nunes Neto [¥], Márcio Anderson Sousa Nunes [§], Diana Karla Lourenço Bastos [χ], Andrea de Souza Monteiro [ν], Darlan Ferreira da Silva [Θ], Wellyson da Cunha Araujo Firmo [ζ], Maycon Henrique Frazão de Melo [£], Maurício Eduardo Salgado Rangel [€], Rita de Cássia Mendonça de Miranda [₣] & Maria Raimunda Chagas Silva [₴]

Abstract- Agriculture is the foundation of society, has provided humanity with its food needs for over ten thousand years. The use of pesticides in Brazil and the world has grown exponentially in recent decades. The objective of this study was assessment the use of agrochemicals and their environmental impact on agricultural production of the Island of Maranhão. The study area is located in Paço do Lumiar, Maranhão, Brazil. Soil samples were collected from agricultural land during the wet season (between the months of February and May) and dry season (between the months of September and October) seasons of 2018. We analyzed the soil Physico-Chemical characteristics, organic matter, organic carbon, moisture content, granulometry, pH, nutrient concentrations (nitrate and nitrite, total phosphorus), adsorption isotherms, and microorganisms in the Environmental Sciences Laboratory of the University Ceuma. The results of the physical and chemical analysis of the soil samples suggest the soils could be classified as sandy and silty to clay. There is a concern that the levels of nitrate, nitrite, and phosphorus, especially in rural areas, as well as runoff occurring during production increase due to the use of fertilizers. Microbiological examination showed the presence of gram-negative bacteria of the genus, *Pseudomonas* and *Escherichia coli*. Isotherm models show Kf values of <10 have a low adsorption capacity for the pesticide malathion, suggesting that the soil has the potential to increase contaminant availability to plants and contaminate the water table; however, other soil factors and climatic conditions should be evaluated when evaluating the behavior of pesticides in soil.

Keywords: *agriculture, soil, pesticides, adsorption.*

Resumo- A agricultura funciona como o alicerce da sociedade, pois há mais de dez mil anos fornece à humanidade o seu alimento. O uso de agrotóxicos no Brasil e no mundo cresceu de forma exponencial nas últimas décadas. O objetivo desse trabalho foi analisar a utilização de agroquímico e seu impacto ambiental na produção agrícola da ilha maranhense. A área de estudo localiza-se em Paço do Lumiar Maranhão, as amostras foram coletadas em três pontos do solo de produção agrícola, no período sazonal (chuvoso e seco) nos meses (fevereiro e maio) e (setembro e outubro) de 2018. Foram analisadas, as caracterizações físico-químicas, matéria orgânica, carbono orgânico, umidade, granulometria, determinação do pH, concentrações dos nutrientes (nitrato e nitrito, fósforo total), isotermas de adsorção e isolamento de microrganismo no Laboratório de Ciências Ambientais da Universidade Ceuma. O resultado da classificação físico e química das amostras de solo variando entre os pontos, classificaram o solo como areia média à fina, e como siltoso à argiloso. Há uma preocupação com o aumento nos níveis dos íons nitrato, nitrito e fosforo, especialmente em áreas rurais, além do escoamento superficial que ocorre nas áreas de produção devido ao uso de fertilizantes. A análise microbiológica mostrou um aparecimento de bactérias Gram negativas do gênero *Pseudomonas spp* e *Escherichia coli*. Observando os modelos das isotermas mostram, pelos valores de Kf < 10, tem uma baixa capacidade de adsorção do pesticida Malathion. Portanto o solo mostrou ter potencial para disponibilizar contaminantes para as plantas e para o lençol freático, porém para uma melhor avaliação, devem ser considerados outros fatores como comportamento do agrotóxico no solo e condições climáticas.

Palavras-chave: *agricultura, solo, pesticida, adsorção.*

I. Introduction

Agriculture is the foundation of society, has provided humanity with its food needs for over ten thousand years. Over time, agriculture has undergone a series of changes resulting in the modernization of production processes, leading to the emergence of new methodologies and mechanization of systems (PEREIRA; JÉSUS; SILVA, 2015).

According to the National Sanitary Surveillance Agency (ANVISA, 2013), the Brazilian agrochemicals market has expanded rapidly in the last decade, with a growth rate (190%) that is twice that of the global market (93%). The Brazil is in first place in the world ranking, with a consumption of one million tons since 2008 (INCA, 2013).

The use of pesticides is considered one of the most important causes of environmental degradation owing to the contamination of natural resources. The

Author: *Ceuma University. e-mail: darlanveggito@hotmail.com*

© 2020 Global Journals

behavior of pesticides in nature is quite complex, with the potential to pollute many agricultural products. Ferreira and Santos (2018) emphasize that the Ministry of the Environment should evaluate the efficacy of agrochemicals intended for use in aquatic environments, native forests, and other ecosystems, and carry out environmental evaluations of pesticides, including their components, with the view to establishing their classification as potential ecological hazards when applied to plants or when water contamination occurs.

Soil pollution during crop cultivation occurs in two stages; when pesticides are applied to plants, or when water contamination occurs. Because soil is a great accumulator of microorganisms and minerals, it can also retain large amounts of chemical residues. Over time, fertility is reduced not only by the continuous use of pesticides but also by the practice of monoculture, which does not allow for the necessary rest for proper restoration of soil fertility, thereby diminishing biodiversity and increasing acidity. When this happens, agricultural productivity is reduced, the volume of water decreases, leading to desertification (PAREJO, 2013).

Significant advances in organophosphorus insecticides for agriculture use and the scientific knowledge of the structure-activity relationship have taken place owing to the discovery of the compound parathion by Schrader in 1944, the first product of a new group of revolutionary insecticides. Despite their relative toxicity, other less toxic insecticides such as Clorthion®, Fenthion®, and Fenitrothion® have been developed with few structural modifications.

Malathion, an organophosphate, is an acetylcholinesterase inhibitor that does not exist naturally. It is a colorless liquid in its pure state. It is used to control insects, diseases, or weeds that cause damage to crops. Technical grade malathion is more than 90% pure. It is a yellowish-brown liquid with a strong odor. This compound has a thioether group and exhibits high insecticidal activity (INCA, 2013).

In the study of soils in agro toxic application areas, the soil classification is determined the evaluation of the morphological, physical, chemical, and mineralogical data of the profile. Environmental aspects of the profile location, such as climate, vegetation, relief, raw material, water conditions, external characteristics, and soil-landscape relationships, are also used (SANTOS et al., 2007).

The objective of this study was assessment the impact of the use of pesticides on the agricultural production soil of Pindoba in the municipality of Paço do Lumiar, Maranhão, Brazil, as well as to determine the possible environmental changes due to the use of agrochemicals, and to evaluate existing data from the area. The data can support future studies and sustainable management with monitoring in the area studied.

II. Materials and Methods

a) Characterization of the study area

The study area, Paço do Lumiar, is 38 meters above sea level, has the following geographical coordinates: Latitude: 2 ° 31 '50' 'South, Longitude: 44 ° 6' 19 " West. It is located in the western portion of the Island of Maranhão. It comprises the region between the municipalities of São Luís and São José de Ribamar (Figure1).

© 2020 Global Journals

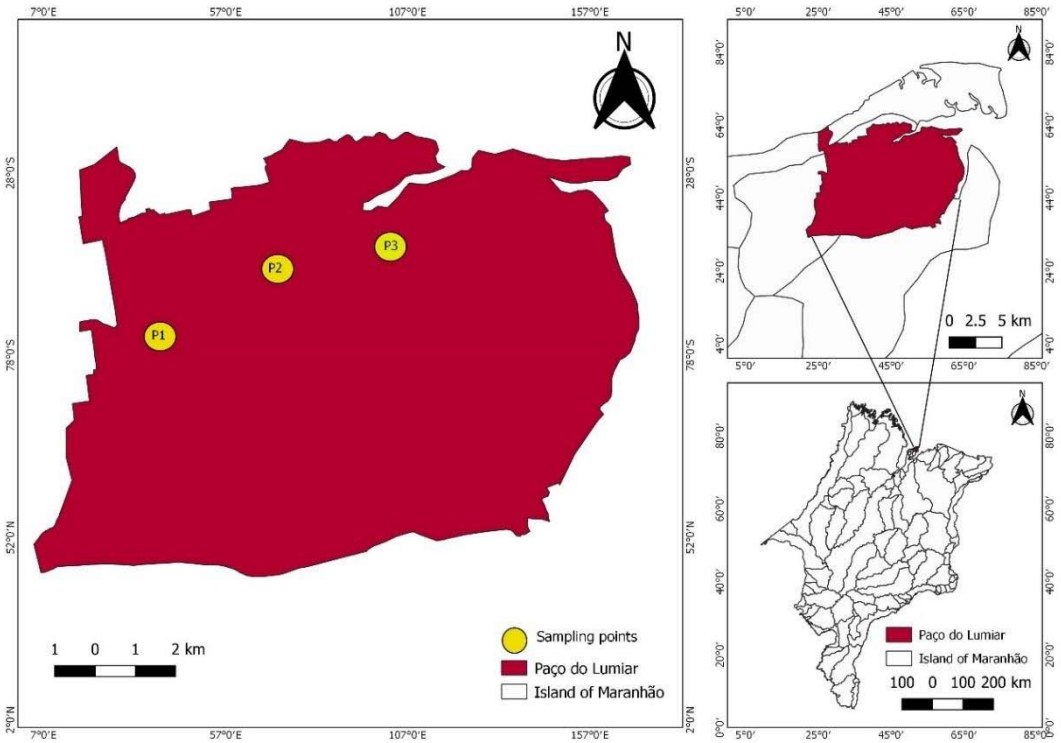

Figure 1: Study area and soil sampling points

Initially, the area of agricultural production was identified in a 4,500-ha private property where that grows vegetables like lettuce and cabbage and is located in the municipality of Paço do Lumiar, in the village of Pindoba. The soil sampling points were demarcated by the geographic coordinates using Garmin GPS Striker4 (Garmin, U.S.A.) The soil sampling coordinates are as follows: P1 (S02 29 '44.1 "and W440 07' 59.6"), P2 (S02 29 '44.4 "and W44 08 '01.3'), and P3 (S02^{o} 29' 44.5 " and W 44^{o} 07 '58.7'). Soil samples were collected during the wet (February and May) and dry (September and October) seasons of 2018. Soil samples were collected with a stainless-steel core, from up to 15 cm depth of soil. Materials from a couple of sampling were homogenized as a function of the size of the area, and a portion of approximately 500 g of each sample was placed separately in a plastic bag and stored at 4±2°C. The physical and chemical properties, organic matter, organic carbon, moisture, particle size, pH, and nutrient concentrations (nitrate and nitrite, total phosphorus) characteristics were determined by methods described by EMBRAPA (2017).

b) Isolation of microorganisms

Microorganisms were isolated from soil from three sample points where organophosphorus agrochemicals had been applied. Three soil samples were collected equidistantly from a single plot of the same garden. After collection, the samples were stored in hermetically sealed bags and stored under refrigeration for subsequent isolation of microorganisms.

Isolation: for the insulation of the microorganisms, composite soil samples were subjected to the serial dilution technique recommended by Costa et al. (2017). Composite soil samples (10 g) were weighed and diluted with 90 mL of sterilized water. From this solution, serial dilutions (1:10, 1:100, and 1:1000) were carried out in test tubes containing sterile water. Dilutions were plated on Muller Hinton (MH), Eosin Methylene Blue Agar (EMB), and Centremide Agar (CEN) selective culture media. All processing was performed in triplicate and incubated at 28 °C for up to 72 hours. After incubation, colonies were quantified. Bacteria were selected for purification through the sowing methodology by exhaustion from their macromorphological characteristics. For the identification of the bacterial groups and micromorphological observation of the isolates, the Gram staining technique was performed to classify the bacteria into gram-positive and gram-negative based on the cell wall staining.

Adsorption: for the determination of adsorption isotherms. Langmuir and Freundlich's isotherms were used to determine the sorption process. To determine the adsorption of Malathion in soil, working solutions were prepared from the stock solution at concentrations of 0, 0.5, 1, 2, 3, 4, and 5.0 g.mL^{-1} of malathion in 0.01 mol L^{-1} $CaCl_2$ with pH 5.67. Aliquots of 20.0 ml were added to polypropylene tubes containing 2.0 g of soil. Absorption was then measured using the UV-vis spectrophotometry technique (Spectroquant prove 600), at wavelength $\lambda = 212$ nm (ALVES, 2013).

© 2020 Global Journals

All statistical analysis was performed using the software Origin Pro 8.0. (OriginLab, MA, USA). Multivariate analysis techniques were also used as an additional tool, specifically Principal Component Analysis (PCA), using the Minitab 17 software (Minitab; USA) (HONGYU, 2015).

The Tukey test and PCA were used to verify the association between the soil variables (sand, silt, clay, organic matter, moisture, organic carbon, pH, nitrite, nitrate, and total phosphorus), as well as the influences of the different seasonal periods.

c) Determination of the adsorption isotherm

The standard malathion solutions were analyzed directly, without any pretreatment, in the spectrometer, to verify the analytical parameters. The concentrations were 0, 0.5 to 5.0 $g.mL^{-1}$. The standard malathion curve was 0.5 to 3.5 $g.mL^{-1}$ and was read in UV-vis spectrophotometer at a wavelength (λ = 212 nm). After obtaining the analytical curve, adsorption isotherms were calculated using the equation of a straight line with a = 0.4719, b = 0.4008, and R^2 = 0.9945.

III. Results and Discussion

a) Physical-chemical characteristics

The physical-chemical properties of the three soil sample points during the two seasonal periods are shown in Table 1.

Table 1: Physical and chemical characteristics of sample points during rainy and dry seasons

Sampling points	pH	NO_3^-	NO_2^-	PO_4^-	Sand	Silt	Clay	O.M	Humidity	O.C
		mg L^{-1}			%					
Rainy season										
P1	6.35±0.49[a]	5.30±2.40[a]	3.03±4.20[a]	1.45±1.06[a]	62.32±3.08[a]	36.42±3.23[a]	1.26±0.15[a]	7.35±5.69[a]	5.85±2.33[a]	0.23±0.19[a]
P2	6.20±0.28[a]	10.45±4.87[a]	1.53±2.07[a]	1.75±0.63[a]	73.32±0.70[a]	24.25±2.36[a]	2.42±1.66[a]	19.62±7.96[a]	9.10±0.42[a]	4.10±0.01[b]
P3	6.50±0.14[a]	8.65±9.82[a]	0.28±0.30[a]	2.40±0.98[a]	67.12±20.71[a]	27.11±21.76[a]	3.31±0.41[a]	7.98±1.68[a]	10.25±4.73[a]	0.38±0.16[a]
Dry season										
P1	6.75±0.07[a]	7.40±0.14[a]	0.30±0.141[a]	3.60±0.14[a]	62.07±0.10[a]	35.63±0.72[a]	1.77±0.12[a]	12.76±2.35[a]	8.70±0.84[a]	0.22±0.03[a]
P2	5.45±0.07[b]	12.00±1.41[b]	0.12±0.007[a]	5.95±0.77[b]	77.21±6.44[a]	12.23±0.72[b]	5.88±0.89[b]	11.59±0.71[a]	5.80±0.70[a]	4.18±0.11[b]
P3	4.95±0.07[c]	2.05±0.07[c]	0.27±0.176[a]	1.40±0.28[c]	68.69±12.28[a]	14.30±2.82[b]	4.55±0.74[ab]	9.84±5.35[a]	12.87±0.88[b]	0.59±0.07[c]

**Values in mean (n = 3). Means followed by the same letter in the same column do not differ statistically from each other by the Tukey test (p <0.05). NO_3^- (Nitrate), NO_2^- (Nitrite), PO_4^- (Phosphorus), O. M. (Organic Matter), O. C. (Organic Carbon).*

The results of the particle size analysis of the soil samples in the rainy and dry period (points P1, P2, and P3) were observed, 62.32 to 73.32 % related to sand content in the rainy season. In the dry season, the values varied from 62.07 to 77.21% of sand content. It was clear the classification of the soil as being sandy, silty to clay because their rating influences environmental conditions. The sand fraction dominated all three samples. However, based on organic matter values, it can be considered that the soil is vulnerable to the percolation of contaminants, indicating losses to underground aquifers.

There was a variation in the maximum and minimum values for the particle size analysis in the dry period, probably as a function of the soil characteristics of the region. The soils could be classified as being medium to fine sand and silty to silty sand SILVA e SILVA (2014). Percentages of the sand fraction in the soil samples are typical of the characteristics of the region. The soil of the study area is quite porous, which reduces its potential to prevent agrochemical residues from getting through its profile. However, other characteristics of the soil environment need to be analyzed to determine the soils' ability to retain contaminants. Moreover, clay minerals have superior activity due to the specific surface area of the particles and cation exchange capacity BARBOSA (2012).

Organic matter ranged from 7.35 ± 5.69 to 7.98% ± 1.68 in the rainy season and 9.84% ± 5.35 to 11.59% ± 2 in the dry season. Organic matter values above 10% suggest an anthropic intervention and below 10% are considered to indicate soils made up of predominantly silica and clay minerals combined with fertilizer compounds. Blainski et al. (2012) evaluated the influence of plant and residues on the density, porosity, and other physical attributes of a sandy-loam soil under no-tillage, and reported a considerable improvement in the physical quality, with a decrease in density, in contrast to the increase in density treatments without plant cover.

The organic matter in the soil determines the sorption index of the agrochemicals. Soils with higher organic matter content have a higher amount of pesticides. MURAKAMI et al. (2014). There were significant variations in moisture content among sampling points. It varied from 5.85to 10.25 % in the rainy season, while in the dry season, it ranged from 8.70to 12.87 %. The presence of water containing dissolved minerals and soluble organic materials is essential for agricultural soils. According to COSTA et al.

© 2020 Global Journals

(2017) coefficients of moisture variation can be classified as low (CV <4.04), medium (4.04 <CV <17.50), high (17.50 <CV <24.22), and very high (CV> 24.22). The moisture content of the soils in this study could be classified as a medium for agricultural production. According to Ávila et al. (2011), soil moisture plays an important role in surface hydrologic processes and sediment transport due to the significant participation in the separation of precipitation into infiltration and surface runoff. Also, it exerts influence on the soil-atmosphere interaction, especially in evapotranspiration and in the interference of the processes related to water erosion. It is also useful for a wide range of applications aimed at soil and water conservation, for understanding alternative and rapid techniques of moisture determination, and may also help in decisions regarding agricultural operations, such as irrigation management.

Organic carbon from P1 and P3 were 0.23 to 4.10 % and 0.22 to 4.18 % in the rainy and dry seasons, respectively. The organic carbon content for P2 was the highest in the dry period indicating the stability of organic matter by the formation of organo-mineral complex, due to the presence of sandy-silty and clayey sediments. The organic carbon content may have been caused by high biomass production through the application of animal manure and leaves of pindoba and carnaúba palm.

The results of the carbon content in the humic fractions of the studied soils corroborate those of Campos et al. (2012), who showed that environments with the presence of vegetal residue (VR) had a higher organic carbon content in Q2 (0.49 g kg^{-1}) and the lowest in Q3 (0.16 g kg^{-1}). VR on the soil surface is source of carbon, nitrogen, and other elements that contribute to the maintenance of soil organic matter levels and nutrient cycling. Plant residues are initially colonized by microorganisms and at the same time, adsorb minerals. In the 0 cm to 20 cm layer the clayey P1 had a lower organic carbon content of 0.10 g, which can be explained by the intensity of the processes of the addition of vegetal residues with low decomposition rates at the soil surface, and increasing with depth Schenato, Eltz, and Rovedder (2007). The fact that P1 presents a minor organic carbon content is probably due to the difficulty of the formation of organo-mineral complexes that prevent organic acid formation from the decomposition of plant residues in the soil. Thus, clay soils have lower decomposition rates of organic matter and, consequently, excellent chemical stability.

pH values varied from 4.9 to 6.8 in the dry period (mean = 6.75 ± 0.07) and 6.4 to 6.7 in the rainy season with a mean value of 6.35 ± 0.07. These values are within limits allowed by EMBRAPA (2017).

Nitrate in the dry period ranged from 0.13 mg L^{-1} to 0.4 mg L^{-1} (7.40 ± 0.14) and from 15.6 mg L^{-1} to 1.7 mg L^{-1} (5.30 ± 2.40) in the rainy period. The increase in the levels of nitrate, nitrite, and phosphorus ions, especially in rural areas is of concern due to their high concentration in the applied chicken bed substrate, in addition to the surface runoff that occurs in the production areas due to the use of fertilizers.

Extensive soil cultivation, even with the application of fertilizers or manure, is currently believed to facilitate oxidation to reduce nitrogen nitrate in organic matter decomposed in the soil through the effect of aeration and moisture (BAIRD; CANN; GRASSI, 2011). According to Bastos, Bezerra, and Bevilacqua (2007), nitrite are unstable in the presence of oxygen, occurring as an intermediate form. The presence of the nitrite ion indicates the occurrence of active biological processes influenced by organic pollution.

Total phosphorus values ranged from 1.45 to 2.40 mg L^{-1} in the rainy season and from 1.40 to 5.95 mg L^{-1} in the dry season. The highest phosphorus content was found in P2, in the dry period, and P3, in the rainy season, what can be associated with the nutrients, organic matter content, and herbicides content of the substrates and fertilizers. These results are within the scope of the Embrapa (2017) resolution.

Berwanger (2006) and Klein and Agne (2012) evaluated the changes in soil P content saturation of adsorption sites with the continuous use of liquid swine manure and chicken litter. They observed increases in the levels of phosphorus, nitrate, and nitrite, and a decrease in pH. Applications of liquid waste can increase the transfer of total phosphorus, nitrate, and nitrite using flow and percolation, leading to concentrations higher than those established by legislation. The eutrophication contributing to the increase of biological processes and can be affect the planting of cabbage, lettuce, and other vegetables cultivated in the Pindoba region.

b) Statistical analysis

For the physical-chemical analysis, the results were expressed as mean and standard deviation (± SD). The comparative test between the averages of all parameters was performed using the Tukey test ($p < 0.05$). For the physical and chemical properties, a principal component analysis (PCA) was applied to the mean values of three replicates to identify correlations between the data and to group them according to the influence of seasonality.

Cluster and Principal Component Analysis to verify the association between soil variables and the influences of the different seasonal periods are shown in Figure 2. The first two dimensions of the PCA of all physicochemical parameters explained 60.04% of the variance. Five clusters can be identified: Cluster 1 includes sampling point P1 in rainy period), Cluster 2 include sampling point P1 in dry period), which showed correlation with high levels of silty, nitrite, and pH, but, low values of sand and clay. Cluster 4 include P3-dry

© 2020 Global Journals

period with high levels of moisture and clay, but low levels of silt. Grouping 4 consists of sampling point P2 in the rainy season, Cluster 5 consist of sampling point P3 in the dry period.

The PCA technique was used to investigate possible correlations between all variables studied and to evaluate hypothetical models for the classification of samples. Initially, an evaluation of the relationships between the ten variables related to the two periods studied was performed by PCA based on a matrix of correlation data in which the variables were standardized and given equal weight. The graph of the score (Figure 2) revealed that the distribution of the analyzed points was not significant. Based on axis 1 (PC1), P2, and P3 of the rainy and dry periods presented a positive correlation. P1 and P2 of the rainy and dry periods showed a negative correlation. The first component (PC1) was the most significant to describe the model, accounting for 38.80% of the total variance.

The first three principal components (PCs 1-3) are the most significant in the model description and together accounted for 75.60% of the total variance (Table 2). However, most of the system information (i.e., 60.04% of the cumulative variance) is attributed to PC1 (38.80%) and PC2 (21.60%).

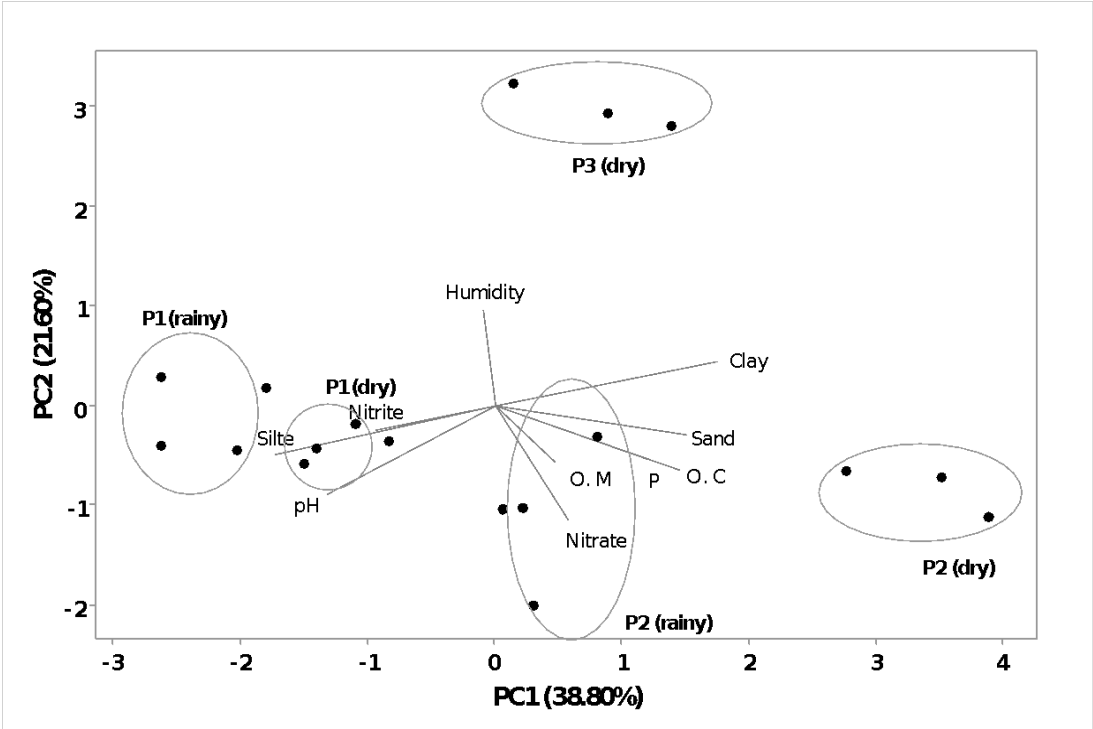

Figure 2: Principal component analysis (PCA) for dimensions 1 and 2. The vectors represent the physicochemical variables. (rainy): rainy season; (dry): dry season; Sampling points: (P1), (P2), and (P3). The ellipses represent the main groupings between sampling points in the dry and rainy seasons

Table 2: Correlation coefficients of the Principal components (Factors 1, 2, 3, and 4) for the physical-chemical parameters

Variables	PC1	PC2	PC3	PC4
pH	-0,341549	-0,415674	0,246645	-0,024025
Nitrate	0,147901	-0,534413	0,219691	-0,123296
Nitrite	-0,240838	-0,114391	-0,668571	0,107265
Phosphorus	0,307993	-0,248119	0,241546	-0,412945
Sand	0,389760	-0,138153	-0,237190	0,090509
Silt	-0,445924	-0,230172	0,201121	-0,104355
Clay	0,449893	0,201932	0,058884	-0,241226
O.M.	0,122310	-0,262082	0,171175	0,727492
Moisture	-0,022381	0,443007	0,495836	0,334562
O.C.	0,374142	-0,298639	-0,101194	0,289384
Eigenvalues	3.88	2.15	1.44	1.28
Total Variance (%)	38.80	21.60	14.50	12.90
Cumulative Variance(%)	38.80	60.04	74.90	87.80

** Bold values indicate significant factors. O. M. (Organic Matter); O. C. (Organic Carbon).*

© 2020 Global Journals

According to the PCA, there were differences between the sampling points in February and September, what can be explained by the proximity to the sampling time. Axis 1, which accounts for 38.80% of cumulative variance explained the variations of silty, pH, nitrite in the rainy season at points P1 and P2. Axis 2 explains 60.04% of the sand, clay, organic matter, organic carbon, humidity, nitrite, and phosphorus variations during dry periods at P2 and P3. Thus, the temporal variation of the studied parameters can be confirmed through the separation of the months and grouping of the sampling points.

c) Malathion adsorption in soil

The results of the Langmuir (A) and Freundlich (B) isotherms are shown in Figure 3 and Table 3. There are several results of adsorption isotherms models describing the adsorption ratios for more media and substances. The partition coefficient (Kd) at the three sampling points ranged from 9.95 to 10.45 μg mL^{-1}, while correlation coefficients ranged from (0.99 to 1) for the Langmuir A isotherm and Freundlich isotherm B (Figure 3).

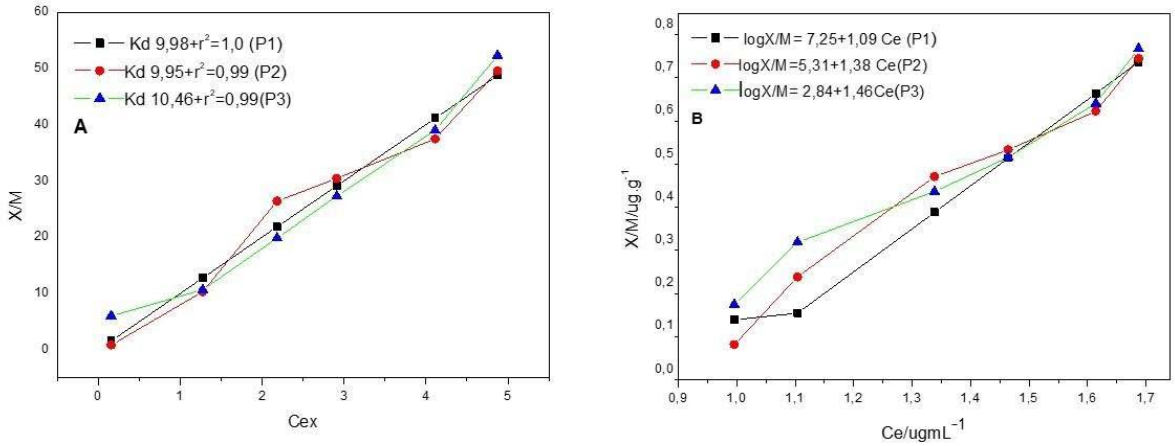

Figure 3: Langmuir (A) and Freundlich (B) Isotherms of Malathion absorption by three agricultural soil samples

Table 3: Partition coefficients (Kd), organic carbon constant (Koc), organic matter constant (Km), Freundlich coefficient of linearity of the isotherm (1/n), and the correlation coefficient (R2) for the pesticide Malathion, at the three soil sampling points

Sampling Point	Kd	Koc %	Km %	K_f	1/N	R^2
P1	9.98	171.10	99.25	7.25	1.09	1.0
P2	9.95	110.38	64.03	5.31	1.38	0.99
P3	10.45	202.22	117.38	2.83	1.46	0.99

The degree of linearity (1/n) varies between 1.09 and 1.46, that in this concentration range, the isotherms are type C, amenable to linearization. We can assume that the low values of K_f in P2 and P3 varied from 2.83 kg L^{-1} to 5.31 kg L^{-1}. The P1 value was 7.25 kg L^{-1}, showing its low affinity for the solid phase of the soils and a high availability of this insecticide in the soil solution and great potential for leaching and or biodegradation.

Isotherms with Kf <10, suggests low adsorption capacity of malathion, following the criterion of IBAMA (1990) and IBAMA (2017). This behavior is in agreement with the influence of the soil on the degradation of malathion.

The slope of an isotherm from Souza et al. (2007) is given by the adsorption coefficient, Kd. This coefficient is an index of the adsorption energy, which allows for a comparison of the performance of different soils concerning to the adsorption of solute. The linearized form of the Freundlich isotherms proved to be satisfactory for most of the combinations versus the herbicide. Therefore, according to the adsorption intensity, identified in the curve, (n) is close to 1. The significant similarity between the coefficients obtained by the Freundlich isotherms, and their linearized form can be used to describe the sorptive behavior of the compounds. The degradation rate of Malathion varies depending on the type of soil and is closely linked to sorption phenomena.

In studies such as Luchini et al. (1984), the pesticide carbendazim and parathion had intermediate Rf (0.10 to 0.31), whereas malathion and lindane showed the good mobility in the soils studied, according to their Rf (0.57 to 0.96), therefore, there is an inverse relationship between the movement of pesticides in the 0 cm to 5 cm layers of soil and their partitioning behavior. These values reported are smaller than what we have presented in this study.

The organic carbon coefficient for the soils varied between 110.38% and 202.22%, and from

© 2020 Global Journals

64.03% to 117.38% to Km. These values suggest that the nature of the organic matter and other attributes of the soils can influence the sorption of malathion in soil.

After leaving samples in dark bottles wrapped with aluminum foil. Malathion under laboratory conditions is degraded by light at a constant and slower rate. Therefore, this pesticide in the environment undergoes soil degradation, indicating a ongoing degradation half-life over time.

When studying the sorption of thiamethoxam in soils with different organic matter contents, Schmidt, Salton, and Scorza, Júnior (2015) observed a high correlation between organic matter content and its sorption. Thus, it is possible that the lower values of K_f are due to the organic matter content found in this soil.

Isolations of the microorganisms in the three selective culture media are presented in Figure 4.

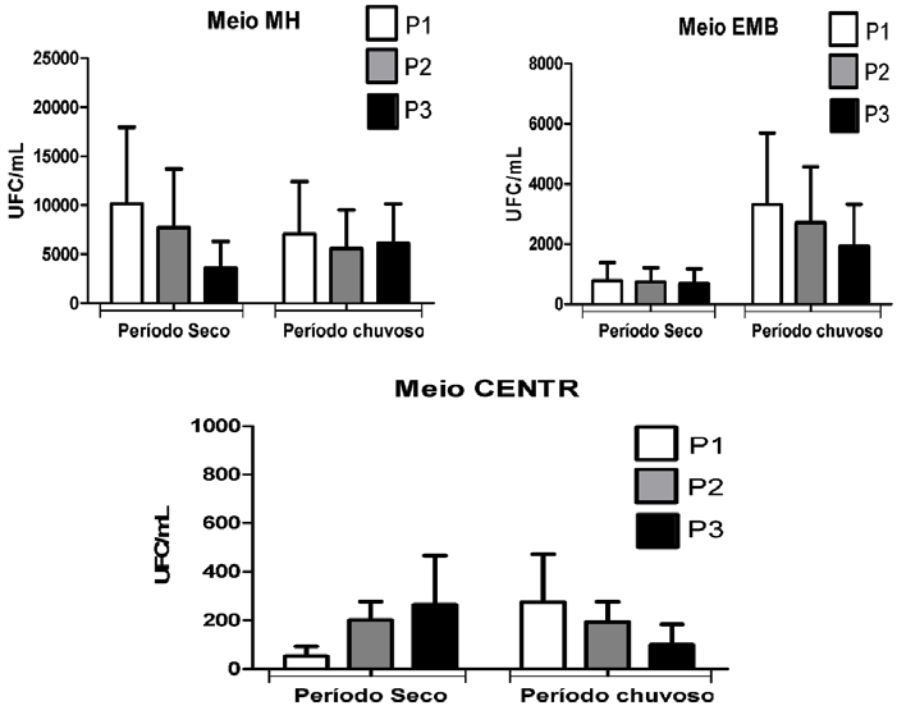

Figure 4: Isolation of microorganisms in the three-culture media in soil samples

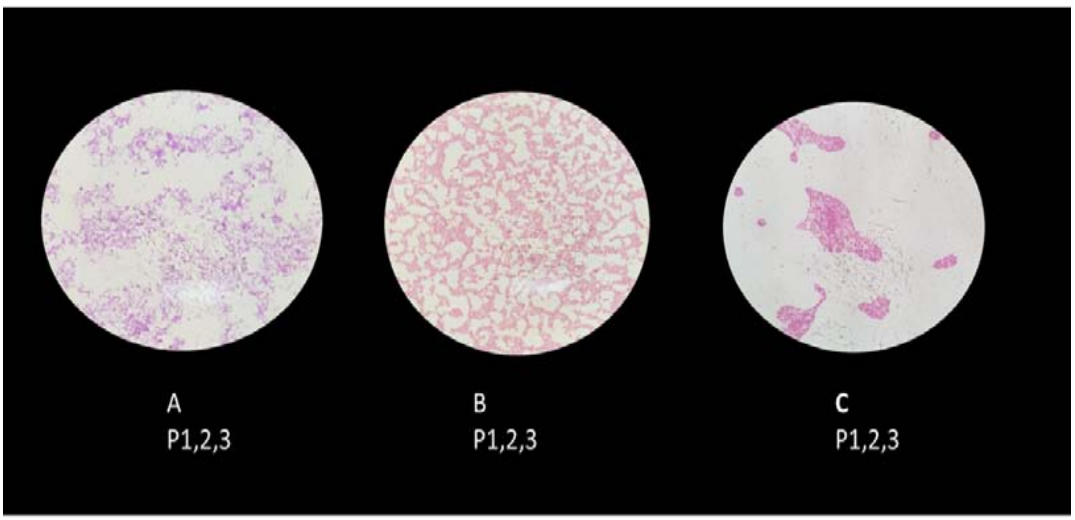

Figure 5: Morphological characterization of Gram-negative bacteria from the sampling points

© 2020 Global Journals

A variation in the microbial quantities among soil samples can be observed depending on the culture medium used. The Muller Hinton culture medium presented the highest number of bacteria in the two seasonal periods studied. P1 had 10,000 CFU/mL in the dry period, while in the rainy period, 800 CFU/mL was observed. P2 had almost the same microbial quantity in both periods when the isolation was done in MH medium, whereas P3 was the only one that presented the highest number of bacteria in the rainy period with 700 CFU/mL, and 300 UFC/mL in the dry period. The MH medium is complex, and therefore perfect for the isolation of all types of bacteria, which explains the high number of colonies in this medium. The highest microbial quantity in the dry period can be explained by a higher pH than in the rainy season. This pH range favors the growth of bacteria, while acidic pH favors the growth of fungi. The EMB culture medium showed larger counts of bacteria in the rainy season in all three samples. P1 presented the highest bacterial quantification with 3,800 CFU/mL in the rainy season, while in the dry period, it was 1,000 CFU/mL. P2 and P3 presented similar bacterial quantification in the dry period, while in the rainy season, P2 showed 3,000 CFU/mL and P3 2,000 CFU/mL.

The Methylene Blue Eosin medium is a differential selective medium, which may indicate that Gram-negative bacteria prevail in soils contaminated with pesticides in the rainy season, proven by the higher soil moisture in this period, and by the ability of most bacteria to form a colony and hence biofilm, thereby protecting their cells from stress caused by environmental changes. The Cetrimide agar medium presented the smallest amount of bacteria since it is a selective culture medium for *Pseudomonas pyocyanea* bacteria. These bacteria have adaptive capacity to environmental changes by forming a biofilm, and are known to be producers of bioactive substances such as rhamnolipids. Semedo-Lemsaddek et al. (2018) *Pseudomonas* bacteria have nutritional characteristics of oligotrophy; that is, they need only little nutrient to survive. This fact can be observed by the inverse relationship between growth and the nitrogen and phosphorus contents during both dry and rainy periods.

Based on the characterization of the soils analyzed, it was possible to determine that agricultural of the region is very vulnerable to impacts from the excessive use of pesticides. The occurrence of pesticide residues is a potentially problem, based on the micromorphology of the isolated microorganisms. The presence of Gram-negative, rod-shaped bacteria reinforces the adaptive capacity of this microbial group. Some authors have reported the isolation of microorganisms from soils contaminated with agrochemicals. Costa et al. (2018) isolated microorganisms from soil with the organochlorine pesticide DMA 806 BR, obtaining large quantities using Muller Hinton culture medium. However, in the same study, the authors reported the isolation of a few Gram-negative rod-shaped bacteria. Costa et al. (2017) isolated microorganisms from soil contaminated with Chlorpyrifos, an organophosphate, and reported the presence of Gram-Negative bacteria. Their results showed a higher bacterial count in the dry period than in the rainy season.

IV. Conclusions

Based on the characterization of the soils, it was possible to determine that the agricultural region is very vulnerable to the effects of the excessive use of pesticides. Pesticide residues are a potentially problem impacting the preservation of the environment. The use of pesticides for prolonged periods can cause radical changes in soil structure. Sorption is the mechanism for the interaction between pesticides and the soil or sediments. It occurs commonly when solute (adsorbate) passes from the aqueous phase to the surface of an adsorbent solid. Understanding the physical and chemical properties of a pesticide often allows for an estimation of its adsorption behavior.

The increases in the levels of nitrate, nitrite, and phosphorus ions is due to the high concentration of these ions in chicken litter substrate applied to these soils, in addition to surface runoff that occurs in the production areas due to the use of fertilizers. Soil characteristics interfere with the selection of bacteria.

The application of pesticides should be carried out in appropriate way, with the view to maximizing the protection of the environment. Agricultural strategies for the reduction of contamination and pollution of natural resources, soil, and water should seek to reduce runoff and the use of agrochemicals on crops. Reducing environmental pollution will only be possible by raising farmers' awareness of the importance of preserving these finite natural resources.

References Références Referencias

1. Alves, M. S. Soil microbiological diversity of soil and its potential for soil quality assessment. Monograph (Completion of course). Biological Sciences. Federal University of Pelotas. Institute of Biology. Pelotas. 2013.
2. Ávila, L. F.; Mello, C. R.; Mello, J. M.; Silva, A. M. Spatial-temporal pattern of soil volumetric moisture in a basin with a predominance of latosols. Brazilian Journal of Soil Science, v. 35, p. 1801-1810, 2011.
3. Baird, C.; Cann, M.; Grassi, M. T. Química Ambiental. 4. ed. Porto Alegre: Bookman, 2011. 844 p.
4. Barbosa, S. C. B. Determination of pesticide residues in products of plant origin. Master's Dissertation in Human Biology and Environment.

© 2020 Global Journals

University of Lisbon, Faculty of Science. Lisbon. 2012.
5. Bastos, R. K.; Bezerra, N. R.; Bevilacqua, P. D. Water Safety Plans: New Paradigms in Water Quality Control for Human Consumption in Consistency with Brazilian Legislation. In: Brazilian Congress of Sanitary and Environmental Engineering, Belo Horizonte, 2007.
6. Berwarger, A. L. Changes and transfers of phosphorus from the soil to the aquatic environment with the use of swine net waste. Master's Dissertation, Federal University of Santa Maria, 2006.
7. Blainski, E.; Tormena, C. A.; Guimarães, R. M. L.; Nanni, M. R. Physical quality of a latosol under no-tillage influenced by soil cover. Brazilian Journal of Soil Science, v. 36, p. 79-87, 2012.
8. Campos, M. C. C.; Ribeiro, M. R.; Souza Júnior, V. S.; Ribeiro Filho, M. R.; Almeida, M. C. Topossequence of soils in the transition Natural Fields-Forest in the region of Humaitá, Amazonas. Acta Amazônica, v. 42, n. 3, p. 387-398, 2012.
9. Costa, M. S.; Araújo, T. R. R.; Martins, A. J.; Silva, Q. H. S.; Costa, C. H.; Miranda, R. C. M. Isolation of microorganisms of biotechnological interest originated from areas contaminated with agrochemical. Revista de Investigação Biomédica, v. 9, n.1, p. 17-23, 2017.
10. Costa, C. H. J.; Ramos Filho, A. J.; Sousa, J. S. S.; Castro, E. J. M.; Pereira, C. D. S.; Miranda, R. C. M. Bioprospecting for microorganisms of biotechnological importance in soils contaminated with agrochemicals. Ciência e Natura, v.40, p.02-18, 2018.
11. EMBRAPA. Empresa Brasileira de Pesquisa Agropecuária. National Center for Soil Research (Rio de Janeiro, RJ). Manual of soil analysis methods. 2. ed. Rio de Janeiro: EMBRAPA, 2017.
12. Ferreira, R. A.; Santos, M. B. The right to environmental protection of port work. Available. Disponível em: <http://www.tractorfinder.com.br/artigos/seguranca%20e%20medicina/artigo_05.pdf >. Acesso em: 10 out 2018.
13. Hongyu, K. Comparison of weighted GGE-biplot and MIA-weighted with other genotype × environment interaction models. Thesis (Ph.D. in Statistics and Agronomic Experimentation) - Luiz de Queiroz College of Agriculture, University of São Paulo, Piracicaba, 2015.
14. IBAMA. Instituto Brasileiro do Meio Ambiente e dos Recursos Renováveis. Manual de Pesticidas para Avaliação da Ecotoxicidade de Agentes Químicos. Brasília: IBAMA, 1990, v.1, 351p.
15. IBAMA. Instituto Brasileiro do Meio Ambiente e dos Recursos Renováveis. Manual de Pesticidas para Avaliação da Ecotoxicidade de Agentes Químicos. Brasília: IBAMA. 2017. Disponivel em: <ibama.gov.br/phocadownload/agrotoxicos/reavaliacao-ambiental/2017/2017-07-25-Manual-IBAMA.> Acesso em: 25 jun 2018.
16. INCA. Instituto Nacional de Câncer. Brasil lidera o ranking de consumo de agrotóxicos. Rio de janeiro, 2013.
17. Klein, C.; Agne, S. A. A Phosphorus: from nutrient to pollutant! Rev. Elet. in Environmental Management, Education and Technology, v. 8, n. 10, p. 1713-1721, 2012.
18. Luchini, C. L.; Hirata R.; Rüegg, E. F. Sorption and mobility of pesticides associated with physico-chemical properties of cerrado soils of the State of São Paulo. Pesq. agropec. bras., v. 19, n. 2, p. 157-162, 1984.
19. Murakami, L. Y.; Ferreira, R. C. B.; Souza, G. S.; Luchini, L. C. Mineralization and sorption of the fungicide fluopicolide of samples of neosol and latosol soils in preserved areas and treated areas. Pesticides: r. ecotoxicol. and environment, v. 24, p. 33-42, 2014.
20. PAREJO, L. C. Desertification: Causes and consequences of land misuse. 2013 .
21. Pereira, J. A.; Jesus, J. F. V.; Silva, N. C. The use of pesticides by farmers in the community of Baixa do Juá, Santana de Mangueira-PB. Revista Verde, v.10, n. 2, p. 126-131, 2015.
22. Santos, V. M. R.; Donnici, C. L.; Costa, J. B. N.; Caixeiro, J. M. R. Pentavalent organophosphorus compounds: history, synthetic methods of preparation and applications as insecticides and antitumor agents. Química Nova, v. 30, n. 1, p.159-179, 2007.
23. Schenato, R. B.; Eltz, F. L. F.; Rovedder, A. P. Teor de carbono em solos arenosos: comparativa entre área de revegetação, campo nativo e solo arenizado. In: Periódico XXXVI (Congresso Brasileiro de Ciência do Solo). Gramado –RS. 2007.
24. Schmidt, T. D.; Salton, J. C.; Scorza Júnior, R. P. Sorption and desorption of thiamethoxam and atrazine in soil under different management systems. Brazilian Journal of Agricultural and Environmental Engineering, v. 19, n. 6, p. 613-618, 2015.
25. Semedo-Lemsaddek, T.; Pedroso, N. M.; Freire, D.; Nunes, T.; Tavares, L.; Verdade, L. M.; Oliveira, M. Otter fecal enterococci as general indicators of antimicrobial resistance dissemination in aquatic environments. Ecological Indicators, v. 85, p. 1113–1120, 2018.
26. SILVA, V. L.; SILVA, M. R. C. Caracterização físico-química da água e sedimento do rio Pindaré, nos trechos correspondentes aos municípios de Pindaré-Mirim, Tufilândia e Alto Alegre). Monografia (Graduação em Química). São Luís. Universidade Federal do Maranhão. 2014.

© 2020 Global Journals

27. Souza, D.; Toledo, R. A.; Galli, A.; Banda, G. R. S. Determination of triazine herbicides: development of an electroanalytical method utilizing a solid amalgam electrode that minimizes toxic waste residues, and a comparative study between voltammetric and chromatographic techniques. Analytical and Bioanalytical Chemistry, v.187, n.6, p.2245-2253, 2007.

© 2020 Global Journals

Global Journals Guidelines Handbook 2020

www.GlobalJournals.org

Memberships

Fellows/Associates of Science Frontier Research Council

FSFRC/ASFRC Memberships

Introduction

FSFRC/ASFRC is the most prestigious membership of Global Journals accredited by Open Association of Research Society, U.S.A (OARS). The credentials of Fellow and Associate designations signify that the researcher has gained the knowledge of the fundamental and high-level concepts, and is a subject matter expert, proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice. The credentials are designated only to the researchers, scientists, and professionals that have been selected by a rigorous process by our Editorial Board and Management Board.

Associates of FSFRC/ASFRC are scientists and researchers from around the world are working on projects/researches that have huge potentials. Members support Global Journals' mission to advance technology for humanity and the profession.

FSFRC

Fellow of Science Frontier Research Council

FELLOW OF SCIENCE FRONTIER RESEARCH COUNCIL is the most prestigious membership of Global Journals. It is an award and membership granted to individuals that the Open Association of Research Society judges to have made a 'substantial contribution to the improvement of computer science, technology, and electronics engineering.

The primary objective is to recognize the leaders in research and scientific fields of the current era with a global perspective and to create a channel between them and other researchers for better exposure and knowledge sharing. Members are most eminent scientists, engineers, and technologists from all across the world. Fellows are elected for life through a peer review process on the basis of excellence in the respective domain. There is no limit on the number of new nominations made in any year. Each year, the Open Association of Research Society elect up to 12 new Fellow Members.

Benefit

To the institution

Get letter of appreciation

Global Journals sends a letter of appreciation of author to the Dean or CEO of the University or Company of which author is a part, signed by editor in chief or chief author.

Exclusive Network

Get access to a closed network

A FSFRC member gets access to a closed network of Tier 1 researchers and scientists with direct communication channel through our website. Fellows can reach out to other members or researchers directly. They should also be open to reaching out by other.

Career | Credibility | Exclusive | Reputation

Certificate

Receive a print ed copy of a certificate

Fellows receive a printed copy of a certificate signed by our Chief Author that may be used for academic purposes and a personal recommendation letter to the dean of member's university.

Career | Credibility | Exclusive | Reputation

Designation

Get honored title of membership

Fellows can use the honored title of membership. The “FSFRC” is an honored title which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., FSFRC or William Walldroff, M.S., FSFRC.

Career | Credibility | Exclusive | Reputation

Recognition on the Platform

Better visibility and citation

All the Fellow members of FSFRC get a badge of "Leading Member of Global Journals" on the Research Community that distinguishes them from others. Additionally, the profile is also partially maintained by our team for better visibility and citation. All fellows get a dedicated page on the website with their biography.

Career | Credibility | Reputation

© Copyright by Global Journals | Guidelines Handbook

Future Work

Get discounts on the future publications

Fellows receive discounts on future publications with Global Journals up to 60%. Through our recommendation programs, members also receive discounts on publications made with OARS affiliated organizations.

Career | Financial

GJ Internal Account

Unlimited forward of Emails

Fellows get secure and fast GJ work emails with unlimited forward of emails that they may use them as their primary email. For example,
john [AT] globaljournals [DOT] org.

Career | Credibility | Reputation

Premium Tools

Access to all the premium tools

To take future researches to the zenith, fellows and associates receive access to all the premium tools that Global Journals have to offer along with the partnership with some of the best marketing leading tools out there.

Financial

Conferences & Events

Organize seminar/conference

Fellows are authorized to organize symposium/seminar/conference on behalf of Global Journal Incorporation (USA). They can also participate in the same organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent. Additionally, they get free research conferences (and others) alerts.

Career | Credibility | Financial

Early Invitations

Early invitations to all the symposiums, seminars, conferences

All fellows receive the early invitations to all the symposiums, seminars, conferences and webinars hosted by Global Journals in their subject.

Exclusive

Publishing Articles & Books

Earn 60% of sales proceeds

Fellows can publish articles (limited) without any fees. Also, they can earn up to 60% of sales proceeds from the sale of reference/review books/literature/ publishing of research paper. The FSFRC member can decide its price and we can help in making the right decision.

Exclusive | Financial

Reviewers

Get a remuneration of 15% of author fees

Fellow members are eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get a remuneration of 15% of author fees, taken from the author of a respective paper.

Financial

Access to Editorial Board

Become a member of the Editorial Board

Fellows may join as a member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. Additionally, Fellows get a chance to nominate other members for Editorial Board.

Career | Credibility | Exclusive | Reputation

And Much More

Get access to scientific museums and observatories across the globe

All members get access to 5 selected scientific museums and observatories across the globe. All researches published with Global Journals will be kept under deep archival facilities across regions for future protections and disaster recovery. They get 10 GB free secure cloud access for storing research files.

ASSOCIATE OF SCIENCE FRONTIER RESEARCH COUNCIL

ASSOCIATE OF SCIENCE FRONTIER RESEARCH COUNCIL is the membership of Global Journals awarded to individuals that the Open Association of Research Society judges to have made a 'substantial contribution to the improvement of computer science, technology, and electronics engineering.

The primary objective is to recognize the leaders in research and scientific fields of the current era with a global perspective and to create a channel between them and other researchers for better exposure and knowledge sharing. Members are most eminent scientists, engineers, and technologists from all across the world. Associate membership can later be promoted to Fellow Membership. Associates are elected for life through a peer review process on the basis of excellence in the respective domain. There is no limit on the number of new nominations made in any year. Each year, the Open Association of Research Society elect up to 12 new Associate Members.

Benefit

To the institution

Get letter of appreciation

Global Journals sends a letter of appreciation of author to the Dean or CEO of the University or Company of which author is a part, signed by editor in chief or chief author.

Exclusive Network

Get access to a closed network

A ASFRC member gets access to a closed network of Tier 1 researchers and scientists with direct communication channel through our website. Associates can reach out to other members or researchers directly. They should also be open to reaching out by other.

Career | Credibility | Exclusive | Reputation

Certificate

Receive a print ed copy of a certificate

Associates receive a printed copy of a certificate signed by our Chief Author that may be used for academic purposes and a personal recommendation letter to the dean of member's university.

Career | Credibility | Exclusive | Reputation

Designation

Get honored title of membership

Associates can use the honored title of membership. The “ASFRC” is an honored title which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., ASFRC or William Walldroff, M.S., ASFRC.

Career | Credibility | Exclusive | Reputation

Recognition on the Platform

Better visibility and citation

All the Associate members of ASFRC get a badge of "Leading Member of Global Journals" on the Research Community that distinguishes them from others. Additionally, the profile is also partially maintained by our team for better visibility and citation. All associates get a dedicated page on the website with their biography.

Career | Credibility | Reputation

Future Work

Get discounts on the future publications

Associates receive discounts on the future publications with Global Journals up to 60%. Through our recommendation programs, members also receive discounts on publications made with OARS affiliated organizations.

Career | Financial

GJ Internal Account

Unlimited forward of Emails

Associates get secure and fast GJ work emails with unlimited forward of emails that they may use them as their primary email. For example,
john [AT] globaljournals [DOT] org.

Career | Credibility | Reputation

Premium Tools

Access to all the premium tools

To take future researches to the zenith, fellows receive access to almost all the premium tools that Global Journals have to offer along with the partnership with some of the best marketing leading tools out there.

Financial

Conferences & Events

Organize seminar/conference

Associates are authorized to organize symposium/seminar/conference on behalf of Global Journal Incorporation (USA). They can also participate in the same organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent. Additionally, they get free research conferences (and others) alerts.

Career | Credibility | Financial

Early Invitations

Early invitations to all the symposiums, seminars, conferences

All associates receive the early invitations to all the symposiums, seminars, conferences and webinars hosted by Global Journals in their subject.

Exclusive

Publishing Articles & Books

Earn 30-40% of sales proceeds

Associates can publish articles (limited) without any fees. Also, they can earn up to 30-40% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.

Exclusive | Financial

Reviewers

Get a remuneration of 15% of author fees

Associate members are eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get a remuneration of 15% of author fees, taken from the author of a respective paper.

Financial

And Much More

Get access to scientific museums and observatories across the globe

All members get access to 2 selected scientific museums and observatories across the globe. All researches published with Global Journals will be kept under deep archival facilities across regions for future protections and disaster recovery. They get 5 GB free secure cloud access for storing research files.

Associate	Fellow	Research Group	Basic
$4800 **lifetime designation**	$6800 **lifetime designation**	$12500.00 **organizational**	APC **per article**
Certificate, LoR and Momento **2** discounted publishing/year **Gradation** of Research **10** research contacts/day **1 GB** Cloud Storage **GJ** Community Access	**Certificate,** LoR and Momento **Unlimited** discounted publishing/year **Gradation** of Research **Unlimited** research contacts/day **5 GB** Cloud Storage **Online Presense** Assistance **GJ** Community Access	**Certificates,** LoRs and Momentos **Unlimited** free publishing/year **Gradation** of Research **Unlimited** research contacts/day **Unlimited** Cloud Storage **Online Presense** Assistance **GJ** Community Access	**GJ** Community Access

Preferred Author Guidelines

We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

Before and during Submission

Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

1. Authors must go through the complete author guideline and understand and *agree to Global Journals' ethics and code of conduct,* along with author responsibilities.
2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

Policy on Plagiarism

Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

Authorship Policies

Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

Copyright

During submission of the manuscript, the author is confirming an exclusive license agreement with Global Journals which gives Global Journals the authority to reproduce, reuse, and republish authors' research. We also believe in flexible copyright terms where copyright may remain with authors/employers/institutions as well. Contact your editor after acceptance to choose your copyright policy. You may follow this form for copyright transfers.

Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

© Copyright by Global Journals | Guidelines Handbook

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

© Copyright by Global Journals | Guidelines Handbook

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

Global Journal of Science Frontier Research

Visit us on the Web at www.GlobalJournals.org | www.JournalofScience.org
or email us at helpdesk@globaljournals.org

ISSN 9755896

© Global Journals