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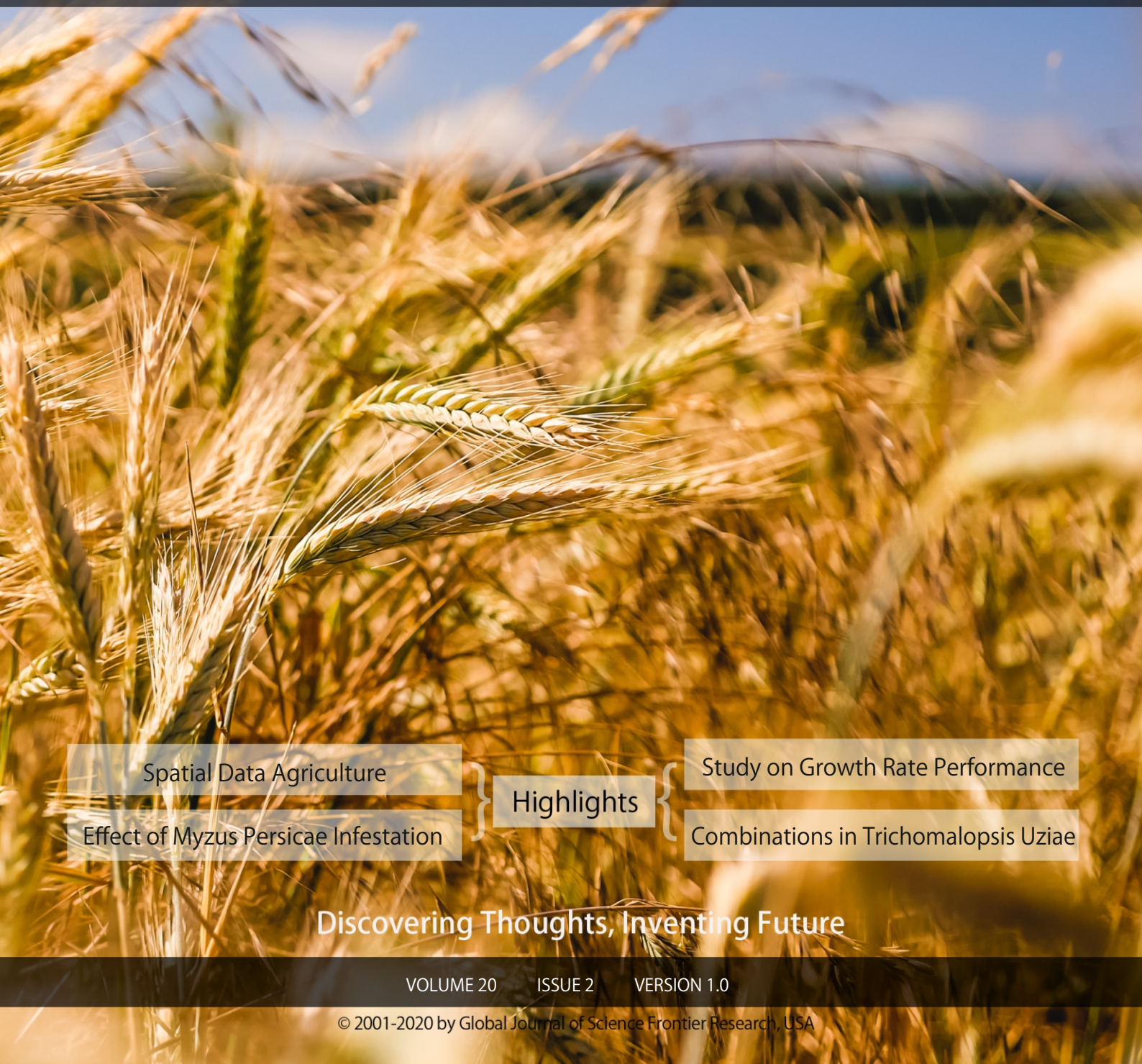

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VOLUME 20 ISSUE 2 VERSION 1.0

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Direct and Indirect Effect of *Myzus Persicae* Infestation on Buildup of Whitefly (*Bemisia Tabaci*) in Tomato Crop under Laboratory Conditions

By Khadija Javed, Humayun Javed & Dewen Qiu
Pir Mehr Ali Shah Arid Agriculture University

Abstract- The tomato crop is affected by a number of pests in the world as well as in China and Pakistan. The whitefly (*Bemisia tabaci*) is considered a very serious and damaging pest of tomato crop along with many other vegetables and field crops. Population buildup of whitefly is affected by many factors, including biotic and a biotic. One of the factors affecting the whitefly population in the tomato crop is green peach aphid (*Myzus persicae*) infestation before the whitefly attack. This project designed to note the direct and indirect effect of *Myzus persicae* infestation on the population setup of whitefly in tomato crops. The results revealed that whitefly prefers tomato plants without having aphids on them (choice) and can be settled on the tomato plants also when there are aphids present (no choice). The period after aphid infestation have a negative effect on the whitefly population, and the density of aphids/leaf has also influenced the whitefly population.

Keywords: *whitefly, myzus persicae, bemisia tabaci, tomato, induced resistance.*

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Khadija Javed [α], Humayun Javed [σ] & Dewen Qiu [ρ]

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Keywords: whitefly, myzus persicae, bemisia tabaci, tomato, induced resistance.

I. Introduction

Tomato whitefly (*Bemisia tabaci* Genn.) belonging to the order Hemiptera and family Aleyrodidae, is considered as a major threat to crops. Whitefly is responsible to transmit many types of viruses in field crops as well as in vegetables (Jones, 2003; Oliveira et al., 2001). Many biotypes of whitefly have reported as economic pests throughout the world. A well-known biotype B of *B. tabaci* is a major pest of beans, cotton, tomato, leafy vegetables, and soybean throughout the world were causing worth 714 million dollar losses per year (Oliveira et al., 2013; Fontes et al., 2012). Similarly, the aphid is also a devastating pest of a wide range of crops grown in greenhouses like pepper, tomato, and cucumber. *Sitobion avenae, Rophalosiphum padi, Schizaphis graminum, Metopolophium dirhodum* are reported species of aphid, causing severe damage to a large number of field crops and vegetables (Dana, 2006). Aphid and whitefly rapidly increase their populations and are mostly found in overlapping generations. Insecticides are used as the first choice to control these pests in greenhouses and field crops (Castle et al., 2014). Resultantly, resistance, resurgence, and finally, high input costs have reported due to increasing use of insecticides at higher doses. Farmers are facing problems due to individuals continuously selected as resistant (Longhurst et al., 2013; Basit et al., 2013).

Like many other crops, green peach aphid, *Myzus persicae*, attacks tomato. *M. persicae*, has reported from all around the world including Pakistan. *M. persicae* is an important pest in many areas of the world due to transmission of diseases and plant viruses. *M. persicae* can survive under wide range of environmental conditions in greenhouses as well as in open fields. The aphid is disseminated to other parts of a country through transportation, winds, and storms. It has a wide range of host plants, including tomato as a major host, due to which it can survive better as compared with other species (Heathcote 1962). Green peach aphid can survive on hardy plants and weeds during summer and reproduce under favorable conditions creating problems for key crops and vegetables (Tamaki 1975, Tamaki and Fox 1982). Essential weed hosts of this species include pigweed, *Chenopodium album, Convolvulus arvensis, Amaranthus retroflexus* and bindweeds (Annis et al. 1981).

Interspecific interactions between whiteflies and other herbivore insect species are present because of the wide host range of whitefly. Many chemical and behavioral changes have recorded when two different species of insects are feeding on the same host plant. Such interactions have also recorded between whitefly and the cabbage loopers (Inbar et al. 1999). There are reports that population of whitefly on tomato was negatively affected in the presence of *Liriomyza trifolii*

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Burgess (Zhang et al. 2005). These negative impacts on the population of other species are due to a reduction in the quality of plant sap after the attack of former species (McClure 1980, Olmstead et al. 1997). Studies have shown that aphids are significantly responsible for lowering the quality of plant sap and decreasing the concentration of chlorophyll (Ni et al. 2001,2002). Layla and Al-Shareef (2011) reported that whitefly could reduce plant sap and chlorophyll pigment up to 36%, which may deter the populations of secondary pests. These types of plant reactions and behavioral changes are known as induced resistance or acquired resistance and confined only to the previous invader or its activity. Arguing on the terminology, researchers agree to define these elicited responses used to protect plants against pests and diseases as induced resistance (Hammerschmidt et al. 2001). Some insects, bacteria, fungi, and viruses are eligible to induce resistance in plants against other insect pests and pathogens (Hammer schmidt et al., 200, Agrawal; et al. 1999, Siddiqui & Shaukat, 2004).

Expected outcomes form the present experimental study focuses on to confirm and evaluate these interactions in the presence of *B.tabaci* and *M.persicae* on, the same host (tomato).

II. Materials and Methods

a) Plant Materials

Tomato seeds of different varieties were collected from the laboratory of bio pesticides at the Chinese Academy of Agricultural Sciences, Beijing, China, and sown in seedling trays using peat moss for seed germination. All the necessary care followed for germination and growth of seedlings. After 35 days of seed germination, tomato plants shifted in black color plastic pots with the depth of 25 cm and diameter 20 cm these potted plants were kept in 2ft x 2ft clean cages properly covered with an insect net. When these plants reached to 35cm height with 8 to 10 healthy leaves, then bioassays were started. During experimentation, temperature and relative humidity were at 25±2C° and 65±5% respectively. The photo period was adjusted to 16:8 (L:D) with the help of artificial lights in each cage.

b) Insect Materials

Aphids (*Myzus persicae*) were collected from cabbage leaves in greenhouse conditions at the Chinese Academy of Agricultural Sciences, Beijing, China and this population was maintained on the same variety of cabbage grown in plastic pots, and caged with nylon nets in the laboratory conditions. These aphids reared up to five generations, and fourth in star aphids used for infestation on tomato plants and leaves during the bioassays.

Whitefly (*Bemisia tabaci*) population (mix of male and female) collected from the tomato crop grown at a chamber in green house conditions at the Chinese Academy of Agricultural Sciences, Beijing, China, and reared up to generations in the same laboratory conditions as mentioned above. The equal number of male and female whiteflies was chosen for experimentation.

c) Bioassays

Two types of experiments were conducted, one for monitoring the direct effects and second for the indirect effects. The direct effects monitored in the presence of aphid on the tomato plants, and indirect effects monitored when the infestation aphids removed from the tomato plant. For choice and no-choice experiment, whole plants used but for factorial observation, detached leaves used. The white fly adults (10 pairs) were collected from the rearing colony and released in the study cages for each treatment in every experiment. The settlement of white fly adults after each 30 minutes observed without any disturbance. This observation continued up to 10 hours after releasing the whitefly adults. The percentage of settled white flies used for purpose of record keeping and analysis. There total 40 cages for each treatment of all eight experiments, and these four cages counted as four replicates (mean of each 10 cages as one replicate).

d) Data Analysis

The data was collected and arranged on Microsoft excel for calculation of means and averages. The data was analyzed using the statistix 8.1 for analysis of variance, and mean percentages compared through LSD (P=0.05). In first four experiments, the data of last observation (10^{th} h) subjected for analysis.

III. Results

a) Aphid's infestation impact on Bemisia tabaci

This study has shown significant results regarding the association between the aphid infestation and whitefly population (Figures 1 to 4). The effect of infestation interval was significant (F=8.04 & P=0.02) on the population of the whitefly adults attracted toward the infested plants. After 10 hours of the white fly adults release, the maximum number (41.25%) of the white fly adults were settled on the tomato plants with a minimum interval of an aphid infestation (24h). 32.50% adult of whiteflies was sitting on leaves infested by aphids for 48hours followed by the minimum percentage of 30 % for 72 hour infested plants but non-significant with 48 h, infested plants as shown in figure 1. Moreover, the impact of aphid density on whitefly was also significant (F = 4.84, P = 0.0561) with maximum white fly settlement (41.25%) on an infected plant by 50aphid/plant followed by the 37.50 % whiteflies on aphid density of 25/plant. While the minimum whitefly population (30%) was settled on aphid density of 75/ plants as shown in figure 2.

The impact of time duration after releasing the white fly on aphid infested plants after removing the aphids was slightly significant (F=4.47, P=0.06) with the maximum population (36.25%) after 48 hours of aphid removal followed by the 27.5% just after removal of pre-infesting aphids. The minimum whitefly population (23.75%) settled after 24 hours of per-infesting aphid removal (Figure 3). There was non-significant (F = 0.53, P = 0.61) impacts on the white fly population on the grounds of leaf position referred with infested one (Figure 4).

b) Whitefly population fluctuation in Choice and No-Choice Experiments

i. *Direct Effect*

The direct effect of aphid infestation observed in the presence of aphid (pre-infested), and the experiment showed highly significant (F=95.53, P=0.00) influence on white fly population. The highest population (41.25%) observed in results of no-choice given to whitefly adults on plants infested with aphids followed by the aphid free plants when there was choice i.e., 37.81%. In all cases of choice and no choice, there was less settlement of whitefly population in non-infested plants, but the percentage increased on aphid free plant when there was a choice given to the white fly population, as shown in figure 5. The trend of whitefly population settlement has shown in figure 6 with half-hour interval between every two observations. The trend is revealing that the direct effect of aphid infestation keeps the whitefly population in choice as compared with the no-choice experiments.

ii. *Indirect Effect*

The highly significant (F=48.18, P=0.00) influence of aphid infestation after removal of aphids was observed in both options of choice and no-choice, as shown in figure 7. The high population settled on the aphid infested plant after their removal (indirect effect) containing 47.5% population when there was no-choice followed by the 38.25% population in aphid infested plants with the choice to choose pre infested plant or non-infested plants. These results cleared that whitefly response towards the aphid infestation was variable, especially in case of an indirect effect. The population settlement of the white fly population was higher in choice given as compared with the treatments with no-choice treatment as shown in figure 04. Initially, *B. tabaci* settlement difference was less after the release of adults in cages with choice and no choice, but with the passage of time, this difference was increased up to 10th hours of whitefly adults release.

IV. Discussion

The results of the present study proved that there is an interaction between insect behavior, and plant odors and this phenomenon used as a tool for the pest management in the coming days. The same behavior of the plant-eating insects have described by Tosh and Brogan (2015) that plant volatiles are useful for pest management and harmless to the end consumers if used in pest management programs. The actual thing is to create confusion effect between host plant and the whitefly feeding on tomato plant, which can be produced by application of volatiles compounds or induction through pre-infestation of other pests like a green peach aphid. This study also proved that resistance in tomato plants was successfully induced against *Bemisia tabaci* through pre-infestation of *Myzus persicae* @ 50 aphids per plant. The similar findings observed by Agrawal et al. (2000) that the whitefly population in the crop was directly or indirectly negatively affected through the pre-infestation of spider mites crossing 30 mites approximately. The similar studies of Wool and Hales (1996), Quiroz et al., (1997), Sauge et al., (2002) and Messina et al., (2002), also presented the induced resistance by *Myzus persicae*, the same species as in this study. There were some other studies, which show negative impacts or limited impact on the subsequent infestation of the pre-infested plant by the same aphid species (Messina et al., 2002).

According to the expected outcomes in our study suggested, that population settlement of whitefly was higher throughout the observational period in case of the choice experiment after infestation with green peach aphid. The Sauge et al. (2002), who found that the pest population enhanced slightly, observed the similar results. 10-15% higher growth rate of *S. Exigua* larvae reported when it was fed on pre-infested leaves by *M. Persicae,* similar to our indirect effect experiment results (Stout et al. 1998). Different plant responses reviewed by Thompson And Goggin (2006), depending on the pest species, density, and infestation interval, which reveals that the mechanism of induced resistance was not clear, the similar impact of our study has recorded that exact figures can't be given for response of whitefly on tomato plant infested with green peach aphid. In some cases, research outcomes revealed that pre-infestation reduces plant quality for whitefly as reported by Wool and Hales (1996), but with an increase of aphid population not supported because of induced resistance as it might cause some initial damage to the crop. There was beneficial interaction between tomato plants and the aphid infestation through induction of resistance against the whitefly, but in some cases, it was negative for the tomato crop in accordance with Zhu-Salzman et al., (2005).

V. Conclusion

We may conclude that the pre-infestation of *Myzus persicae* on tomato plants has direct and indirect impacts on *Bemisia tabaci* and its population settlement. The duration of infestation screened out as a major

factor affecting the whitefly population, followed by the density of pre-infesting aphids/leaf. There was a higher population of whitefly in choice on pre infested tomato plant as compared with the non-choice experiments. The current study has presented a brief insect-plant interaction against whitefly as a considerable tool for the pest management. The research study provided an important understanding regarding host selection, and population buildup by the whitefly, which will be helpful in future for the integrated pest management in tomato crop.

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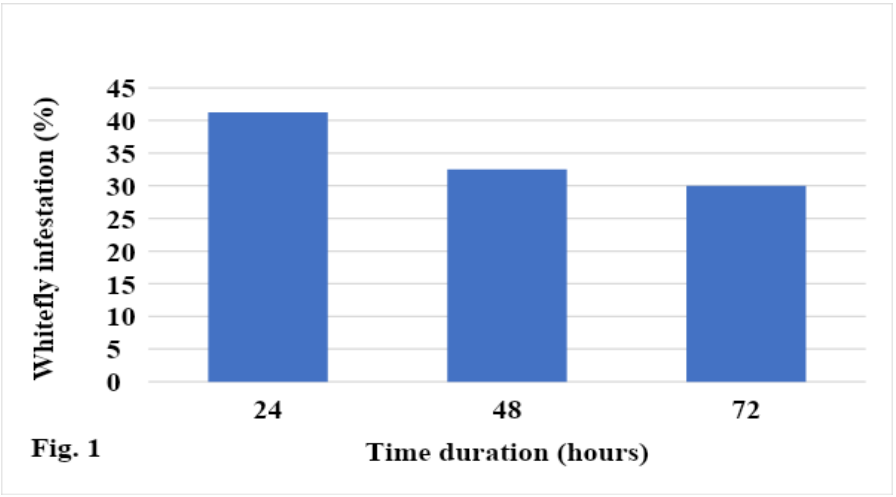

Fig. 1: Effect of infestation interval on the population of whitefly adult attracted toward the infested plants

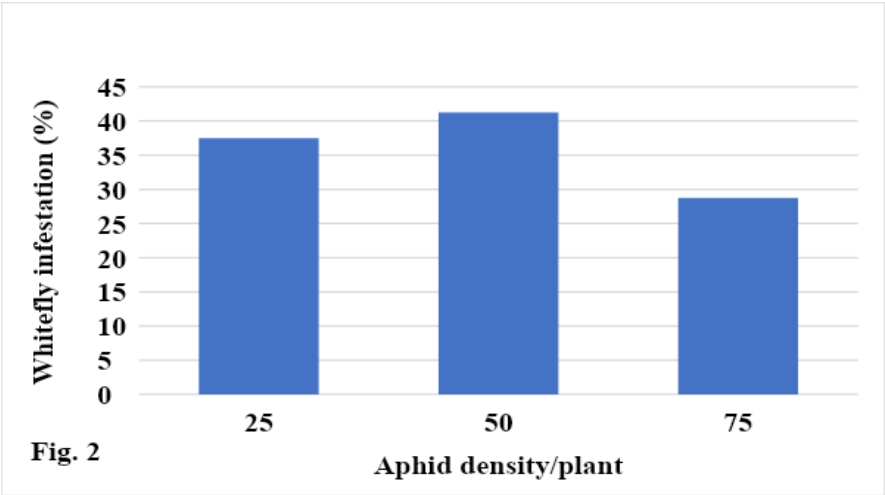

Fig. 2: Effect of aphid density on the population of whitefly adult attracted toward the infested plants

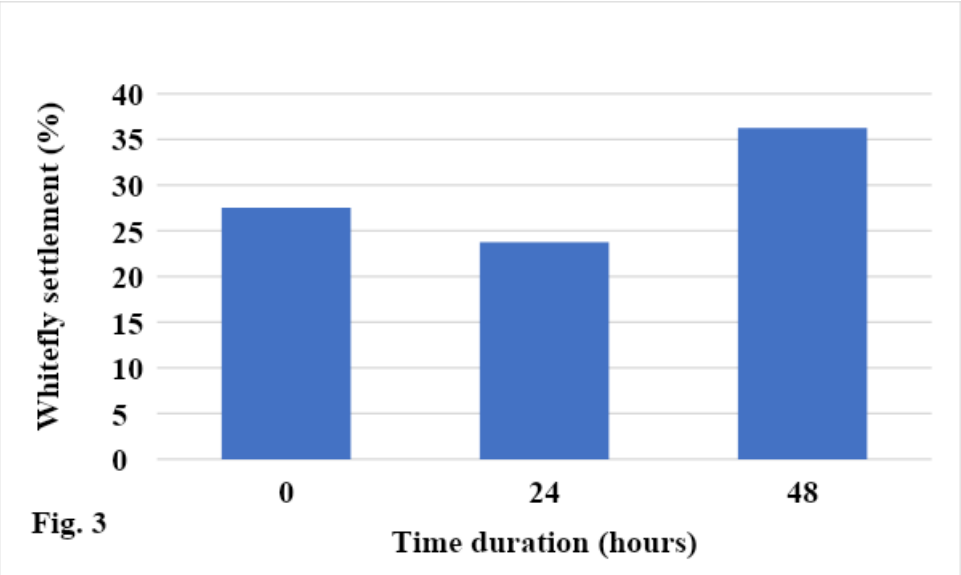

Fig. 3

Fig. 3: Effect time duration after releasing the white fly on aphid infested plants after removing the aphids

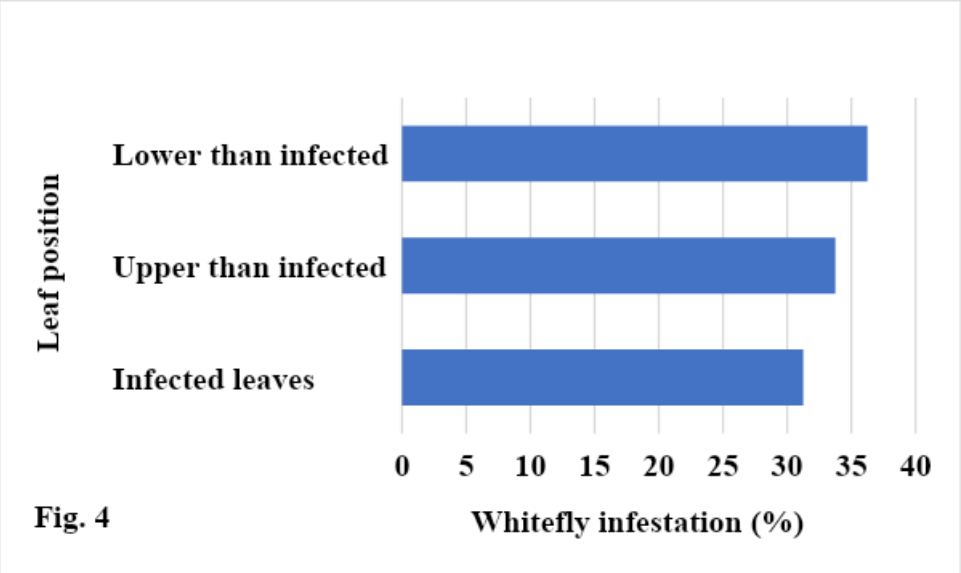

Fig. 4

Fig. 4: Effect of leaf position on white fly infestation

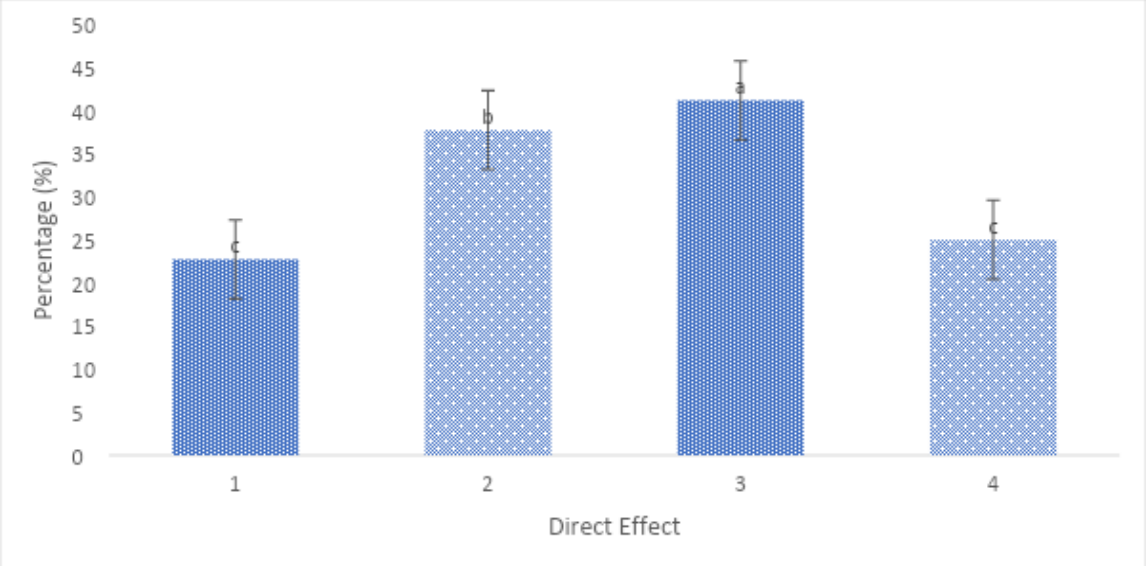

Fig. 5: Mean percentages of whitefly adults on treated and untreated plants with aphids (direct effects)

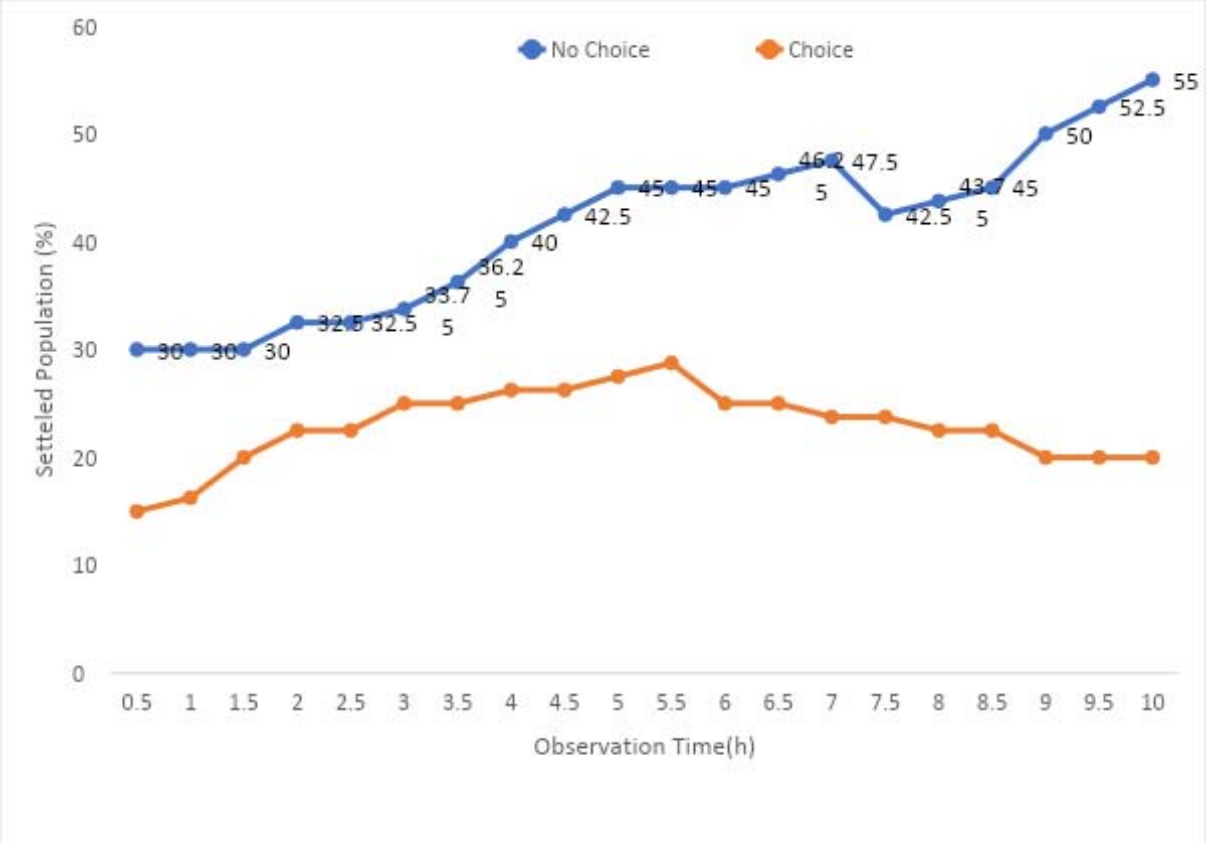

Fig. 6: Mean percentages whitefly adults on treated leaves over different observation times in direct leaves with aphids) bioassays

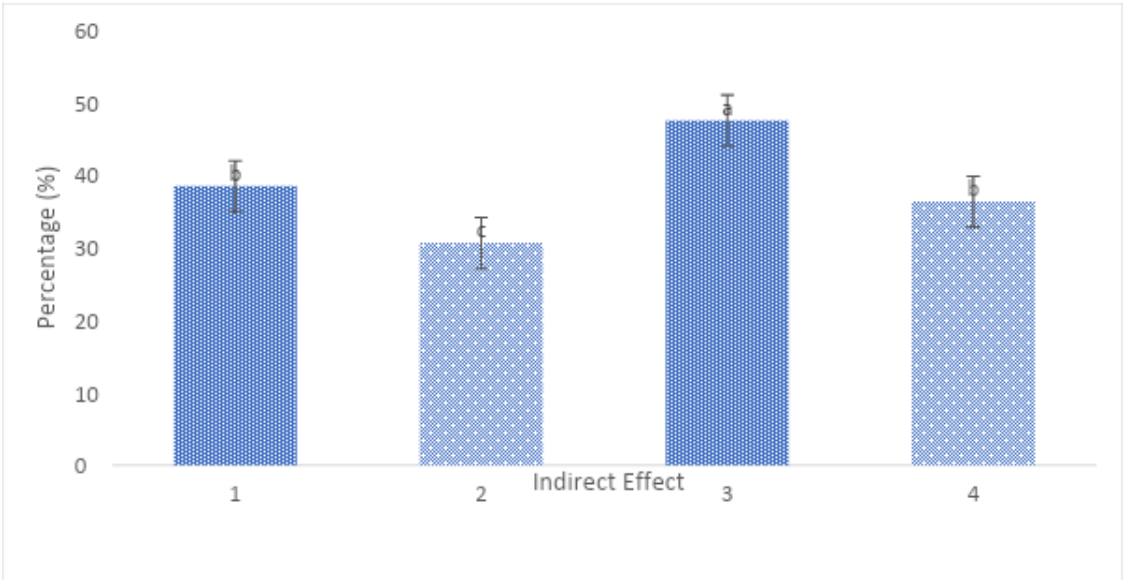

Fig. 7: Mean percentages of whitefly adults on treated and untreated plants after removal of aphids infesting the leaves (indirect effect)

Fig. 8: Mean percentages whitefly adults on treated leaves over different observation times in indirect (leaves after removing the aphids) bioassays

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Study on Growth Rate Performance of Sheep Fed with Super Napier Grass Silage Treated with *Lactobacillus Buchneri* and *Lactobacillus Plantarum*

By Noemi C. Liangco, Joel L. Reyes, Estrelita M. Pascua, Virapol Jamsawat, Chongko Seatung & Vorrapol Jamsawat

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Strictly as per the compliance and regulations of :

Study on Growth Rate Performance of Sheep Fed with Super Napier Grass Silage Treated with *Lactobacillus Buchneri* and *Lactobacillus Plantarum*

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Abstract- This research was aimed to study the growth rate performance of sheep fed with super Napier grass silage treated with *Lactobacillus buchneri* and *Lactobacillus plantarum*. Thirty (30) growing sheep were randomly distributed to three treatments with ten sheep serving as replications per treatment. The treatments were as follows:

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The effect on the growth rate performance of sheep were measured and analyzed by using analysis of variance in a completely randomized design (CRD).

The results revealed that super Napier grass (SNG) silages treated with inoculants had a higher levels of crude protein, crude fiber, crude fat, ash and nutrient detergent fiber compared with the untreated SNG silages. The DM fraction of the SNG treated silages was increased in contrast to the untreated where the moisture content increased. The experiment trial indicated that SNG silage treated with *Lactobacillus buchneri* and *Lactobacillus plantarum*(T2 and T3) influenced. In terms of the growth parameters, significant ($P<0.01$) differences were noted on body weight, weight gained, average daily gain (ADG) feed consumption and feed efficiency (FCR). The feeding trial indicated that SNG silage treated with *Lactobacillus buchneri*and*Lactobacillus plantarum* (T2 and T3) influenced sheep growth rate performance, weight gain, feed intake and days to market. Thus, addition of beneficial microbes improve the nutritional quality of silage and increased nutrients levels resulting to higher growth of sheep.

Keywords: growth rate performance, super napier grass silage, lactobacillus buchneri and lactobacillus plantarum.

I. Introduction

Feed resources for ruminant livestock production in the country(Philippines and Thailand)normally are natural forage crops, natural pastures and natural plants but almost are low in quality of grasses which are limited in supply during the dry season. Today, ruminant animals are now fed with fermented or preserve feeds and has been very popular especially with dairy and beef cattle that require high level of nutrition in order to achieve high milk and beef production. Nowadays, the use of corn silage and others fodder crops as green forage in ruminant feeding has increased rapidly due to its high yielding properties, relatively high content of energy, palatability and easy incorporation in total mixed ration. Scarcity of feed for ruminants is one of the important problems for rearing livestock during summer especially in the country and other tropical countries (Jamsawat, 2017). However, livestock raisers can conserve feed resources by producing silages when feed resources are abundant during rainy season. Since silage is an alternative for ruminants especially in production situations that require consistent nutrition on a daily basis, condition of silage has a significant impact on its quality for reasons that forage often contains many detrimental types of bacteria. In fact, the primary goal of making silage is to maximize the preservation of original nutritional value of the forage crop at the highest value possible during storage for feeding at a later date. The traditional method of fermentation in the silo however, is a much uncontrolled process usually leading to less than optimal preservation of nutrients.

Feed shortage and low quality of forage crops in the country are the major constraints to the development of ruminant industry. To overcome these problems, feeding of ruminants with conserved forages which is becoming popular among enterprising livestock raisers in the country is an important feeding strategy to ensure the success of ruminant production in the country. (Khaini et al., 2015). Small ruminant production is a very significant component of livestock production throughout the world and more specifically in the developing countries. Small ruminants has the ability not only to survive different environmental conditions but also able to utilize poor quality feed.

In recent times, the use of corn silage and others fodder crops silage as green forage in ruminant

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feeding has increased rapidly due to its high yielding properties, relatively high content of energy, palatability and easy incorporation in total mixed ration. The concept of adding a microbial inoculant to silage was to add fast-growing homo fermentative lactic acid bacteria (LAB) in order to dominate the fermentation resulting in a higher quality silage, (Kung and Ranjit, 2001). *Lactobacillus buchneri* and *Lactobacillus plantarum* are some of the most common LAB inoculants in the fermentation of silage. Poorly preserved silages have poor fermentation quality; they are unpalatable to stock and reduced feed intake. These silages are also likely to have suffered extensive degradation of protein, resulting in poor utilization of the silage nitrogen by animals. In order to assist in the fermentation process, various silage additives have been used to improve the nutrient and energy recovery in silage, and when fed to livestock it will subsequently improve animal performances. The different species of lactobacillus were tested to find out the effectiveness of the lactobacillus species as additives in ensiling "super Napier" known as "Pakchong 1" which was developed and produced in Thailand. The "Super Napier Grass" (SNG) is a cross of ordinary Napier grass (*Pennisetum purpureum*) and Pearl Millet (*Pennisetum glaucum*) can yields more crude protein of about 16 to 18 percent (Kiyothong, 2014). This grass requires lower inputs and easier to establish compared to corn and can be a good alternative, especially in production situations that require consistent nutrition on a daily basis. It is for this reason that two silage additives were tested to find out the effectiveness of preserving the quality of super Napier grass and its effect on the growth rate performance of sheep.

II. Methodology

a) Silaging and Evaluation

The *L. buchneri* and *L. plantarum* additives that were used in this experiment were purchased in Korean Culture Collection of Microorganism. Cultures that were cultivated an aerobically in De Man, Rogasa and Sharpe (MRS) agar medium in 250 ml flasks incubated at 30°C for 2 day in an orbital shaker(Thermo Scientific Max Q 2000, USA) at 100 rpm. Cultures were diluted in demineralized water before use. Inoculant wadded at a theoretical rate $1.0x10^5$cfu/g. prior to inoculation, inoculant will be diluted with distilled water to achieve the required concentration and keep for silage production.

Super Napier grass were sourced out from Isabella State University, Enchague, Isabella farm. The SNG were manually harvested at the maturing stage approximately 80 to 90 day of re growth and were chopped into 2-3 centimeters.

Fifteen plastic drum silos with a capacity of 20 L were randomly assigned to three treatments by four factor experiment. The SNG were ensiled into 20-L drum silo and stored in dark and ambient temperature(5°C - 10°C)for 0, 7, 15 and 30 days. The treatments were the following:

Treatment 1- Super Napier grass without inoculants(control).

Treatment 2- Super Napier grass treated with *Lactobacillus buchneri.*

Treatment 3- Super Napier grass treated30°C with *Lactobacillus plantarum.*

b) Ensiling Procedure for Super Napier Grass

Fifteen kilogram of SNG grass each replication were inoculated with or without 3% (w/v) of *L. buchneri* or *L. plantarum* through spray method followed by thorough mixing. The samples were ensiled into 20-L drum silo and stored in dark and ambient temperature for 0, 7, 15, and 30 days. Triplicate silos were opened and the upper part 1/5 of silages were discarded before sampling of approximately 100 g. after each incubation period. Silage extracts will be prepared immediately by macerating a 50 g. silage samples with a 300 ml. of distilled water. These were collected through double cheesecloth and used to determine pH value and concentrations of volatile fatty acids (VFA) and volatile basic nitrogen and ethanol. Dry matter (DM) content of grass and silages were determined by a vacuum freeze-drying method (Uchida, 1986). The dried samples were grinded and then the crude protein was determined by the Kjeldahl method. NDF, ADF, and ADL were measured by the method of Goering and Van Soest (1970). Water soluble extracts was prepared by macerating 40 g of fresh silage sample in 400ml distilled water. The pH of the extracts were measured by using electric pH meter (PH71/PH72 personal pH / ORP meter, Yokogawa Electric Corporation, Japan). Fermentation products, pH and ammonia were determined in silage extracts, prepared by adding 270g demineralized water to 30g silage and homogenizing for 5min in a laboratory blender. Volatile fatty acids were analyzed using an HPLC device (Agilent Technologies 1200 series).

c) Data Gathered and Statistical Analysis

The chemical analysis of SNG and the chemical analysis of super Napier grass silage were determined, recorded and served as basis of evaluating the quality of silages as affected by the different additives/inoculants. All data gathered were tabulated and analyzed using analysis of variance in Completely Randomized Design (CRD). Significant differences among treatments were also analyzed using the Least Significant Difference (LSD).

d) Growth Rate Performance of Sheep

A total of thirty (30) heads of growing sheep were acquired from a commercial farm in Bulacan and

Nueva Ecija, Philippines. The animals were randomly distributed into three (3) treatments. There were ten (10) animals assigned for each treatment each serves as replication. The experiment was laid out using the Completely Randomized Design (CRD) with the following treatments:

Treatment 1- Super Napier grass silage without inoculants (control).

Treatment 2- Super Napier grass silage with *L. buchneri*.

Treatment 3- Super Napier grass silage with *L. plantarum.*

e) Feeding and Management of Experimental Animals

The sheep were gradually introduce to their respective diet over two week's period and were fed ad libitum before the feeding trial officially began. Each experimental sheep were given the assigned diet throughout the feeding period. The amount of silage offered daily is computed approximately 4-5 % of body weight on a dry matter basis. The total amount of daily feed required were divided into morning (8:00) and afternoon (17:00) feeding. All animals were given free access to fresh drinking water and trace mineral salts throughout the experiment. The experimental sheep were permitted to adapt to the diets for two weeks prior to the actual feeding trial. Initial weights of the animals were measured after the acclimatization period. Clean and fresh drinking water were given at all times. The water was changed two times a day, morning and afternoon or as needed. Identical care and management were provided to the sheep throughout the feeding trial.

f) Weighing of Experimental Animals

The initial weight were recorded. Bi-weekly weighing were done during the entire observation period in the morning before feeding every times. The final body weights were determined and blood samples were collected at the end of the feeding trial. The experimental animals were weighed before feeding in the morning. All data gathered on the growth rate performance parameters of sheep were recorded, evaluated and analyzed using analysis of variance in Completely Randomized Design (CRD). Significant differences among treatments were also analyzed using the Least Significant Difference (LSD).

III. Results and Discussion

a) Chemical Analysis of Super Napier Grass

The chemical analysis of SNG was shown in Table 1. Results of the chemical analysis of super Napier grass as fresh and as dry matter bases were analyzed. The basis analysis were as follows: crude protein content was 1.21 %, crude fiber, 5.37%, crude fat, 10.12%, moisture, 85.09 %, ash, 1.01% and neutral detergent fiber, 10.20 percent. Likewise, the analysis as dry matter basis were as follows: crude protein content, 8.12%, crude fiber, 36.02%, crude fat, 67.87%, ash, 6.87% and neutral detergent fiber, 68.41%.

Table 1: Chemical analysis of super Napier grass

Parameters	Fresh	Dry Matter
Crude Protein, %	1.21	8.12
Crude Fiber, %	5.37	36.02
Crude Fat, %	10.12	67.87
Moisture, %	85.09	-
Ash, %	1.01	6.77
Neutral Detergent Fiber, %	10.20	68.41

The chemical analysis used in this study is below the findings of percent (Kiyothong 2014) with a CP. concentration of 16−18 percent of a 45 days cutting interval. The low CP. concentrations of Napier grass was attributed to the high structural cell wall carbohydrates that increase rapidly with maturity causing decline in CP. concentration and digestibility (Van Soest 1994). Likewise, studies of (Cuomo et al., 1996), also demonstrated the effects of cutting interval on yield and quality vary with cultivars management practices and environmental conditions. Therefore, appropriate cutting management is essential for high production and quality of this species (Tessema et al., 2010).

b) Chemical Analysis of Untreated and Treated Super Napier Grass Silage

The chemical analysis(composition) of SNG treated and untreated (DM basis) was shown in Table 2. Results of the analysis of the different silages treated and untreated varied among the treatments. After 7 days of fermentation, it was observed that the level of crude protein content of silage treated with inoculants had increased by 20% in T2 and 16% in T3, while those silage treated with plain water, (T1) had a reduction of 19.17 percent. Similar observation of improvement with silages treated with inoculant was noted on crude fiber, ash and neutral detergent fiber. The pH level prior to ensiling ranged from 6.5 to 7.0 and at the end of 30 days fermentation, the pH level drop due to lactic acid production with pH ranged from 4 to 4.5. The variation on the pH levels was probably due to the different inoculants used. It is worthy to mention that at the end of the 30th day of fermentation nutrient levels was improved. There was a noticeable improvement of ash and crude fiber content in all treatments, treated or untreated. Although there was a slight reduction on the crude protein content of SNG in all treatments from the start, the crude protein content of the treated silages were higher than the untreated ones. On the other hand, there was a substantial increase of crude fat in the untreated silages compared to the treated silages; however, at the end of 30 days of fermentation, there was a marked increase in the level of crude fat in treated silages higher than the untreated silages.

Table 2: Chemical composition of untreated and treated SNG silage with bacterial inoculant at DM basis

Parameters	T1 – w/o inoculant		T2 - *Lacto. buchneri*		T3 - *Lacto. Plantarum*	
	Day 0	Day 7	Day 0	Day 7	Day 0	Day 7
Crude Protein, %	2.66	2.15	1.72	2.07	2.24	2.59
Crude Fiber, %	5.79	5.17	5.23	6.00	5.17	6.92
Crude Fat, %	1.09	13.55	2.47	1.39	8.88	1.29
Ash, %	2.28	1.93	1.93	2.21	1.51	2.09
NDF, %	11.69	10.31	11.96	13.06	10.84	12.56
Dry Matter, %	82.05	84.33	83.17	81.08	83.93	80.90

The result of the study conforms to the main objective of manufacturing silages which is to maximize the preservation of original nutrients in the forage crop for feeding at a later date. The result likewise confirmed reports that fermentation is really an uncontrolled process usually leading to less than optimal preservation of nutrients. The used of inoculants is therefore necessary to assist in the fermentation process. Silage additives have been used to improve the nutrient and energy recovery in silage, and when fed to livestock it will subsequently improve animal performances. In conclusion, these studies confirmed that the applying of molasses improved fermentative quality, feed intake and digestibility of Napier grass (Bureenok, etal., 2012).

The graphical presentation of the untreated and treated super Napier grass is illustrated in figure 1, 2 and 3. The moisture content in T1- control increases as fermentation progresses then dropped starting on the 15th day to 30th day of fermentation. Whereas, the treated silages decreases consistently from day 7 to day 30 of fermentation. It is interesting to note that there were clear differences on the nutrient levels among the different treatments with higher levels in the treated silages. The illustration is a clear indication that nutrient levels in silaging is improved and preserved as manifested by the absence of mold. The result of this study is supported by Driehuis and Wikselaar (2000) in corn silage treated with *L. buchneri* was more stable than untreated silage. They suggest that improved aerobic stability was due to the ability of *L.buchneri* to ferment lactic acid to acetic acid and 1, 2 propanediol.

Although the result are encouraging, it should be noted that other literature reports varied markedly among due to environmental factors. The variability in results from this experiments involving silage fermentation indicates that further evaluations are necessary to broaden the database of additives for the ensilage of super Napier grass.

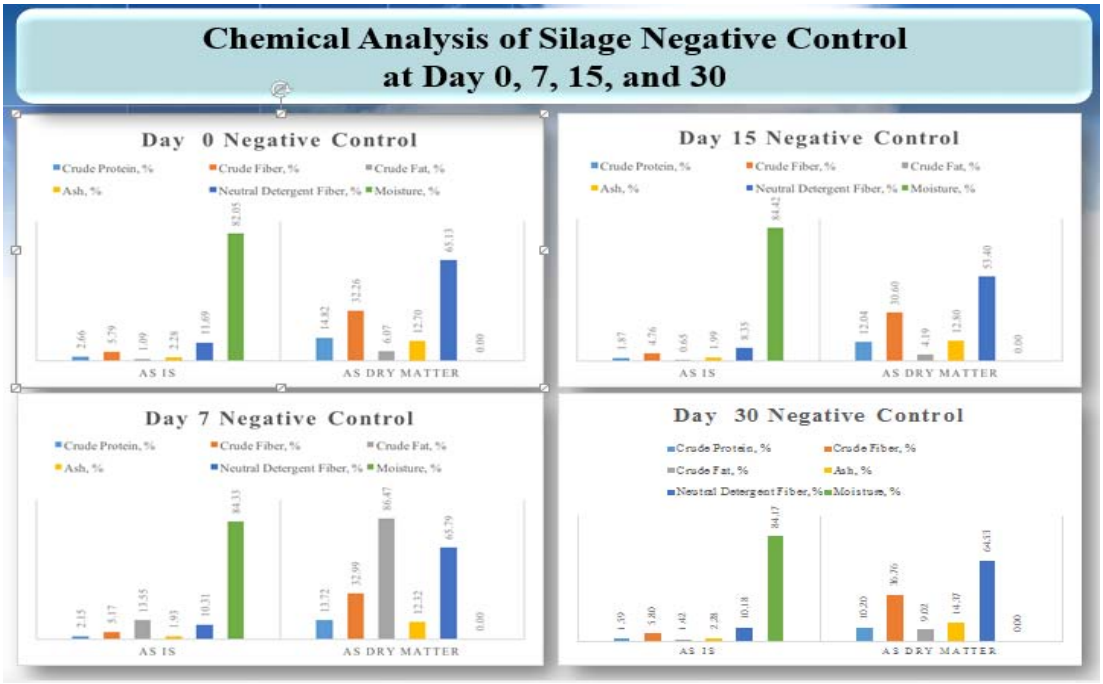

Figure 1: Graphical Presentation of Super Napier Grass Silage Treated with Plain Water (control) from day 0 to day 30 of Fermentation

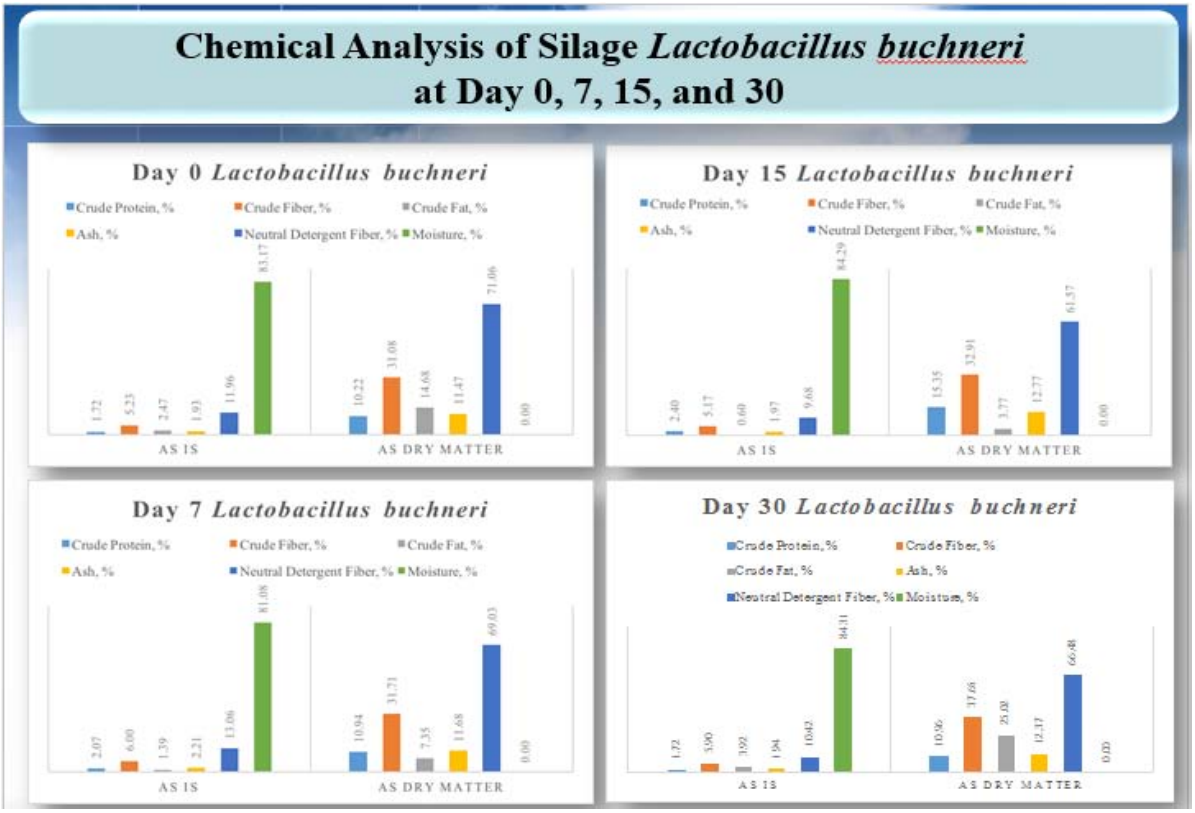

Figure 2: Graphical Presentation of Super Napier Grass Silage Treated with *L. buchneri* from day 0 to day 30 of Fermentation

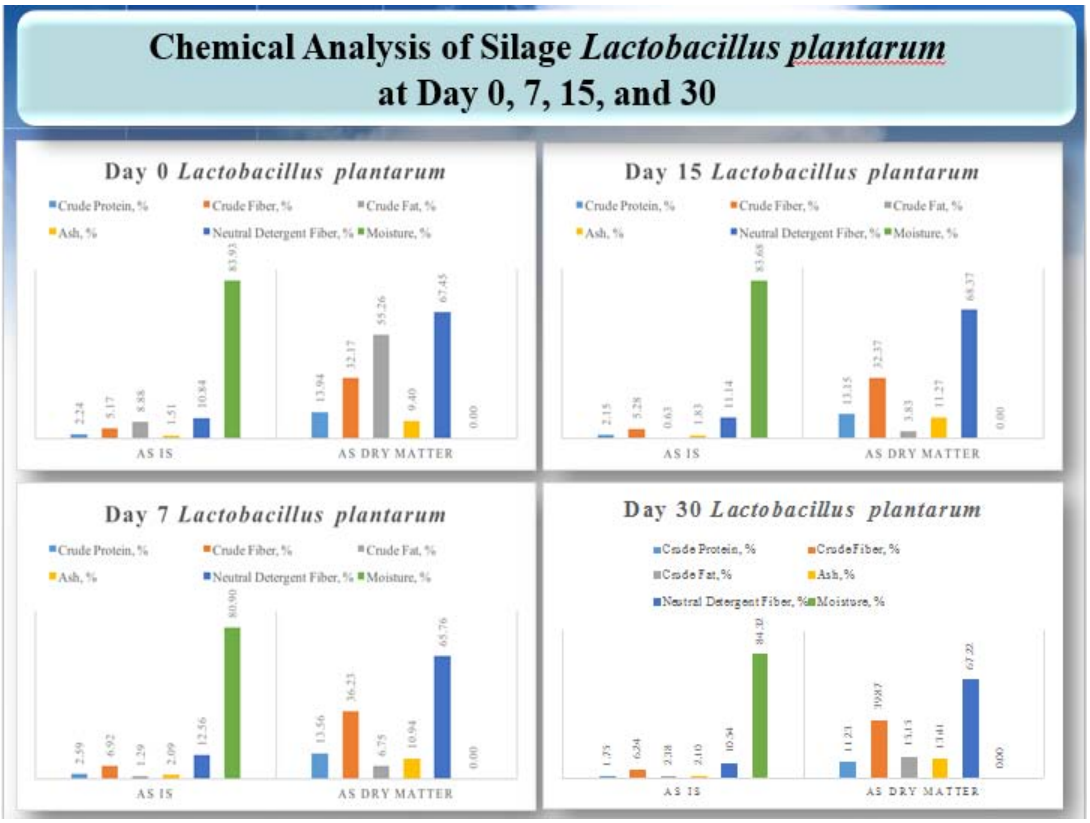

Figure 3: Graphical Presentation of Super Napier Grass Silage Treated with *L. Plantarum* from day 0 to day 30 of Fermentation

c) *Growth Rate Performance of Sheep*

The health and vigor of the experimental sheep were generally normal throughout the duration of the feeding trial. No apparent signs or symptoms of diseases were observed.

d) *Body Weight*

Significant differences were noted on the body weight of the experimental sheep (Table 3 and figure 4). At the end of the 42nd day of feeding, significant differences ($P<0.05$) was noted among the different treatments. Treatment 2 and 3 significantly had a higher BW over Treatment 1 (control) but no significant difference was observed between Treatment 2 and 3. Though similar growth pattern was observed, the result at the end of the 56th day of feeding revealed that Treatment 3 obtained the heaviest BW that is significantly heavier than T2 and T1 (control).

At the end (70th day) of the feeding trial, Treatment 3 with *Lactobacillus buchneri* was observed to be significantly heavier ($P<0.05$) than Treatment 2 with *Lactobacillus plantarum* and 1 (control without additives). Although Treatment 2 and 1 were statistically the same, there is a clear indication that sheep fed SNG treated silage (T2) is numerically higher than the sheep fed with untreated silage (T1). The higher BW of sheep fed with SNG treated silage might be due to the additives that could have improved digestibility resulted to higher nutrient intake as the result to rapid rate of fermentation occurring in the rumen This observation is supported by the findings of Kung and Ranjit (2001) that animals respond positively to microbial inoculants for ensiling in terms of intake, gain, and milk production.

Table 3: Initial Body Weight and Bi-Weekly Body Weight of Sheep Fed with Silage

Treatments	Ave. Bi-weekly Body Weight (BW), kg.					
	Initial	0-14	15-28	29-42	43-56	57-70
1- Control	16.50	17.05	17.95	19.30_b	20.05_b	20.75_b
2 - *Lactobacillus buchneri*	16.00	17.20	18.25	20.35_a	20.85_b	21.70_b
3 - *Lactobacillus plantarum*	16.25	17.50	19.20	20.75_a	21.55_a	22.05_a
Result	ns	ns	ns	*	*	*
% C.V.	6.09	5.67	5.23	4.02	3.83	3.51

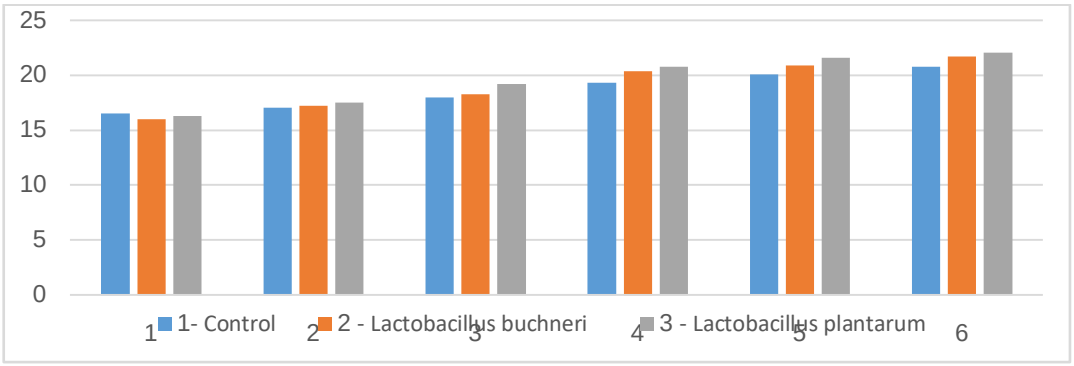

Figure 4: Graphical Presentation on Bi-weekly Body Weight of Sheep Fed with Super Napier Grass Silage

Result of the study showed that feeding of super Napier grass silage washigher than the sheep fed with untreated silage as similar with the studies conducted by Khaini et al., (2015) in cattle reported that feeding of silage influenced steer growth rate. The result of the study on the feeding of silage to sheep was supported by the studies of Kung and Ranjit (2001) with corn silage as the main source of feed for cattle but also as a combination with other forages including pasture grass. Studies on the effect of lactic acid bacteria (LAB) on animal performance indicated that feeding cattle with silages treated with LABs improve ruminant performance. Likewise, in several trials conducted by Muck, (1993) reported that inoculants exhibited substantial effect on performance on live weight gain, milk production, increase in intake and feed efficiency. This suggest the ensiling of SNG with microbial inoculants to improve the nutritional quality of SNG especially when there is abundant supply of grasses and feeding them to sheep during summer time when there is scarcity of roughages.

e) Feed Consumption

The average bi-weekly DM intake of silage of the experimental animals is shown in Table 4 and graphically presented in Figure 5. Non-significant result was observed on the DM intake of silage on the early stages(14thto 28th) of the experiment but results showed significant variation (P<0.05) as noted on the 29th to 42th day of feeding period but from 56th to 70th day of feeding, significant differences (P<0.01) were noted among the experimental animals. The cumulative feed consumption likewise showed significant (P<0.01) differences among the treatments.

Based on the result of the feeding trial, the DMI increased linearly with the silage containing inoculants. This could be due to the higher palatability and good fermentation characteristics of feeds which attracted the sheep to consume more amount of SNG silage. Another reason for the increased in the DM intake of the feed might be due to the chemical composition of the SNG silage and probably due to higher amount of fermentable carbohydrate and energy which increases the digestibility of the SNG silage with inoculants. Likewise, the DM intake differences may be attributed to rapid rate of fermentation occurring in the rumen. In a study conducted by Wiese et al., (2003) on the growth and carcass characteristics of prime lambs fed diets containing urea, lupines or canola meal as a crude protein source, he reported that higher DMI was due to a better availability of nutrients which are readily been degraded by rumen microbes.

Table 4: Average Bi-weekly and Total Dry Matter Intake of experimental animals (kg.)

Treatments	Average Bi-weekly Feed Consumption (Dry Matter), kg.					
	0-14	15-28	29-42	43-56	57-70	Total
1- Control	8.51	9.05	9.70b	10.05bc	10.40b	47.71^{b}
2 - *Lactobacillus buchneri*	8.70	9.65	10.15b	10.70ab	11.15a	50.35^{b}
3- *Lactobacillus plantarum*	8.80	10.00	10.35a	10.80a	11.25a	51.20^{a}
Result	ns	ns	*	**	**	*
% C.V.	6.18	6.18	4.12	3.43	6.09	3.98

Means with common letter are not significantly different with each other using LSD

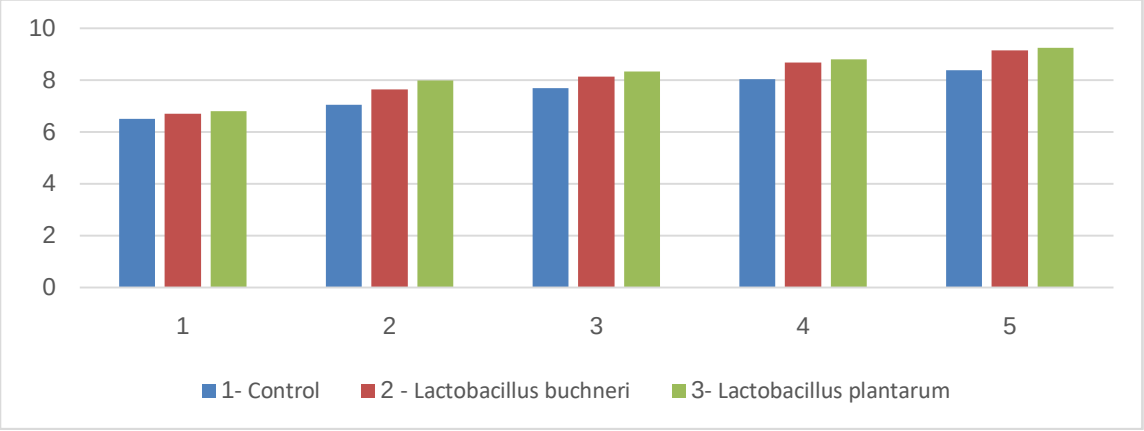

Figure 5: Graphical Presentation on Bi-weekly Feed Consumption (DM) of Sheep Fed with Super Napier Grass Silage

f) Body Weight Gain, Average Daily Gain, DM Intake and Feed Conversion Ratio

Table 5 present the total body weight (BW)gain, average daily gain, dry matter intake and feed conversion ratio of sheep fed silage diet during the 70 days of feeding trial. Significant differences (P<0.01) were observed among treatments on the total BW gain of sheep fed with SNG Silage treated with additives. The average daily gain (ADG) as a measure for growth also revealed significant (P<0.01) differences among the treatments. The positive improvement of Treatment 2 and 3 was the result of higher nutritive values of silages with additives as compared to the silages without additives. This implies that *Lactobacillus buchneri* and *Lactobacillus plantarum* (T2 and T3) additives can improve quality of silages that can provide higher nutritive value and therefore influence growth rate of sheep.

Sheep fed with SNG silage diet treated with *Lactobacillus plantarum* additives (T3) was the most efficient feed converter and this could be due to higher levels of nutrients as reflected in the chemical composition of silages at 7days of treatment.

Table 5: Average Body Weight Gain (ABW), Average Daily Gain (ADG), Dry Matter (DM) intake, and Feed Conversion Rate (FCR) of sheep fed with SNG silage

Treatments	Ave. Bi- weekly Body Weight (BW) Gain, kg			
	Body Wt. Gain (Kg.)	ADG, Grams	DM intake (Kg.)	FCR (DM)
1- Control	4.25b	60.72b	47.71[b]	8.94b
2 – *Lacto. buchneri*	5.60a	80.00a	50.35[b]	7.26ab
3- *Lacto. plantarum*	5.80a	82.85a	51.20[a]	7.21a
Result	**	**	*	**
%C.V.	3.98	6.50	5.79	10.24

Means with common letter are not significantly different with each other using LSD

The result of the study on the feeding of silage to sheep was also supported by the studies of Kung and Shaver (2001) with corn silage as the main source of feed for cattle but also as a combination with other forages including pasture grass. Weinberg (2013) described the effect of lactic acid bacteria (LAB) on animal performance that feeding cattle with silages treated with LABs improve ruminant performance. Likewise, in several trials conducted by Spoelstra(1991) and Muck(1993) reported that inoculants exhibited substantial effect on performance on live weight gain, milk production, increase in intake and feed efficiency. Result of the study was similar with the studies conducted by Khani et al.,(2015) in cattle that feeding of silage influenced steer growth rate. This suggest the ensiling of SNG with microbial inoculants to improve the nutritional quality of SNG especially when there is abundant supply of grasses and feeding them to sheep during summer time when there is scarcity of roughages. In conclusion, these studies confirmed that the applying of inoculants improved fermentative quality, feed intake and digestibility of Napier grass (Bureenok, etal., 2012).

IV. Conclusion and Recommendation

The trial revealed that there is a great potential for improvement with the addition of beneficial microbes such *Lactobacillus buchneri* and *Lactobacillus plantarum* as it improves nutritional quality of SNG silage thus influenced ruminant animals (sheep) growth rate performance, average daily gain (ADG),DM feed intake and feed efficiency.

It is recommended that more research is needed to broaden the database of additives for the ensilage of SNG and to determine the nutrient digestibility and the combination of grasses to silage to reduce feed costs. Likewise, there is a need to find out if there is a deleterious effect to the end product's taste, tenderness, palatability and overall acceptability of mutton. However more research is needed to elucidate the mode of action of SNG treated silages.

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Qualitative Composition of Amaranth Plants Depending on the Altitude Zone of Mountains and Foothills

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Abstract- Amaranth is a multifunctional culture that surpasses many others by the amount of high-grade protein, vitamins, macro- and microelements from a unit of sown area. Amaranth grains (mature seeds) contain 14-18% of protein, up to 8% of oil, about 7% of N-free extractives and up to 4% of ash. It is used as dietary cereal, for the production of baby food, medical products, in the bakery and confectionery industries, as well as in feed production. Amaranth protein in its amino-acid composition approaches the ideal protein. Amaranth protein concentrates are not inferior to soy ones. Leaves of amaranth of vegetable cultivars are used for preparing salads, soups, fried, baked, boiled and dried food products. The green mass of amaranth is a valuable feed for pigs, cattle and other animals rich in proteins and vitamins.

Keywords: *altitudinal zonation, highlands, foothills, photosynthesis, foliage, quality.*

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Qualitative Composition of Amaranth Plants Depending on the Altitude Zone of Mountains and Foothills

Bekuzarova S. A. [α], Kuznetsov, I. Yu. [σ] & Dzampaeva M. V. [ρ]

Abstract- Amaranth is a multifunctional culture that surpasses many others by the amount of high-grade protein, vitamins, macro- and microelements from a unit of sown area. Amaranth grains (mature seeds) contain 14-18% of protein, up to 8% of oil, about 7% of N-free extractives and up to 4% of ash. It is used as dietary cereal, for the production of baby food, medical products, in the bakery and confectionery industries, as well as in feed production. Amaranth protein in its amino-acid composition approaches the ideal protein. Amaranth protein concentrates are not inferior to soy ones. Leaves of amaranth of vegetable cultivars are used for preparing salads, soups, fried, baked, boiled and dried food products. The green mass of amaranth is a valuable feed for pigs, cattle and other animals rich in proteins and vitamins.

In order to study the biological characteristics of amaranth in the mountain and piedmont zones of the Northern Caucasus, three species of the amaranth were sown for the first time: fodder (Amaranthus caudatus L.), grain (Amaranthus cruentus L.) and ornamental (Amaranthus hipochondriacus L.) ones. Taking into account the biological characteristics of amaranth, we studied its qualitative characteristics in contrasting conditions of growth of mountains and foothills. It was shown that, due to a number of biological features, amaranth seedlings in high mountains appear 7 days earlier than in the foothills and plants undergo a full development cycle. The difference between the species of amaranth depending on the altitude was revealed. The leaf area and the height of amaranth plants increase with increasing elevation above sea level, which positively affects the growth of biomass. In the conditions of high altitude the amount of pigments of the photosynthetic apparatus, vitamins, and carotene increases by 1.5–2 times. The studied species of amaranth (grain, fodder, decorative) are of interest for international practice as a starting material for accelerating selection work on productivity and stability in contrasting conditions of mountains and foothills.

Keywords: altitudinal zonation, highlands, foothills, photosynthesis, foliage, quality.

I. Introduction

Many agricultural experts rightly call amaranth one of the most promising plant resources (Kalac et al., 2000; Kuznetsov, 2012; Dinssa et al., 2019). A high-protein feed crop with a high productivity potential attracts the attention of many researchers (Noelting et al., 2019). Our research confirms the high productivity of green mass and seed production over the past 20 years (photo 1). With high productivity and productivity potential, the amaranth crop is able to generate a green mass yield of 100 tons or more per 1 ha.

Photo 1: High productivity of green mass and amaranth seeds (Kuznetsov I. Yu., 2008)

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In recent years, the ability of amaranth to adapt to any growing conditions has been established due to its high acclimatization and reduced soil toxicity (Bekuzarova et al., 2014). The use of amaranth becomes even more relevant due to its unique ability to adapt to different environmental conditions (Wegerle et al., 1995; Filatov et al., 2000).

A review of scientific publications only for the last year 2019 on issues related to the use of amaranth shows a sharply increased interest in this culture in different parts of the world in different areas of use. China (feed production) - in research by scientists (Li et al.,, 2019) noted the high efficiency of amaranth silage when mixed with soybean meal. There is an increase in the feed value and quality of the final product. Nigeria (aquaponics) - a high positive correlation was found between the dry biomass of amaranth shoots and the density of fish stocks. Analysis of amaranth cultivation in an experiment (Babatunde et al., 2019) showed that amaranth plants effectively use nitrogenous waste from aquariums to create their biomass. Brazil (plant protection) - spots on the leaves of the thin amaranth Amaranthus viridis caused by Cercospora brachiata are first reported in Brazil.

The identity of the etiological agent was confirmed by a combination of morphological and molecular information (Vieira et al., 2019). South Africa (vegetable growing) - the country has not escaped the scourge of malnutrition, poor health and even hunger, especially in rural areas. Calls to increase the consumption of local leafy vegetables are generally ignored and underused by modern agricultural systems. These vegetables are cheap and rich in nutrients and contain many healthy substances. Amaranthus hybridus L. it is one of these local leafy vegetables that has been rediscovered as a promising food crop mainly because of its excellent nutritional value of both seeds and leaves (Ngoroyemoto et al., 2019). Bangladesh (crop production) - studies have shown that the use of biohumus with legume crop rotations has the potential to significantly increase amaranth yields (Islam et al., 2019).

Mountain territories, located on all continents of the world and occupying significant areas on them, are the centers of the most important national, regional and international strategic interests.

In contrast to foothills and plains, mountain territories differ both in appearance and in tectonic structure, magmatism, and manifestations of various natural processes, where a significant amount and variety of resources and dynamic processes are accounted for per unit area (Abdurakhmanov et al., 2007). With changes in the altitude of the area above sea level, the entire complex of environmental factors changes: terrain, soil, air and soil temperature, moisture content and illumination, the duration of solar radiation during the day, there are significant changes in the physiological state of plants, affecting the morphology and their biochemical features (Budun, 1994).

The combination of a complex of the most important environmental factors that determine the vital activity of morphogenesis and plant productivity characteristic of high mountains cannot be reproduced in artificial controlled conditions. Therefore, testing different plant species in high-altitude conditions, primarily for agricultural purposes, is of great importance for their further selection for productivity, which is indicated by the ecological stability of plants, considered as a genetically determined ability to withstand abiotic and biotic stresses, and a number of other host-valuable traits (Bekuzarova et al., 2014).

A review of the research carried out on current areas of application of amaranth plants shows the need for research on different types of amaranth adapted to specific growing conditions. Research on amaranth plants in high-altitude zones of mountains and foothills is particularly relevant. In this regard, the purpose of our research (2017-2019) was to study the vegetation period, plant morphologies, the content of chlorophylls a and b, carotenoids, vitamins and carotene in amaranth plants of different species depending on the height above sea level. It was found that the altitude range of mountains and foothills has an impact on the duration of vegetation, quality indicators of amaranth plants of different species.

In accordance with this, the research was aimed at solving a number of problems, including: - the influence of the altitude zone on the course of the vegetation period of amaranth plants; - the morphology of amaranth plants of different species depending on the height above sea level; - the content of chlorophylls a and b, carotenoids in amaranth plants depending on the height above sea level;-the content of vitamins and carotene in amaranth plants depending on the height above sea level. The object of research is the amaranth plant of three species – forage (Amaranthus caudatus L.), grain (Amaranthus cruentus L.) and decorative (Amaran-thus hipochondriacus L.).

II. Materials and Methods

The study was conducted in 2017-2019 on the territory of the Republic of North Ossetia-Alania in two contrasting conditions: in the foothill zone (Mikhailovskoye village - 605 m above sea level) and in the mountains (Verkhny Fiagdon village - 1350 m above sea level) using three types of amaranth: forage (Amaranthus caudatus L.), grain (Amaranthus cruentus L.) and ornamental (Amaranthus hipochondriacus L.).

Sampling was carried out in mountain forest and meadow-steppe zones within 610-1400 m above sea level. The sum of daily average air temperatures above 10°C in these zones is 2200°C. Annual

precipitation in the mountain-forest zone of broadleaf forests is 166–950 mm, and in the meadow-steppe belt it is from 520 to 750 mm, up to 890 in some years.

With an increase in altitude in the mountains every 100 m, the air temperature decreases by about 0.62 °C, hence the role of temperature as a limiting factor increases, solar radiation increases (the intensity of solar radiation increases by approximately 10% for each kilometer of altitude), and hence the degree of warming of the upper layers of the soil and the ground layer of the soil, increases the difference in daily temperatures, low pressure of carbon dioxide and water vapor (Sosnina et al., 2001; Khusnullin et al., 2008).

The greatest shortage of precipitation was observed in the summer months. The second half of the summer was characterized by a very high temperature and almost no precipitation. The first decade of May was characterized by the unstable behavior of the weather. The average daily air temperature reached 12.7°C. In the second decade of May, the unstable nature of the weather remained. The average air temperature was 11.30 °C. Precipitation was noted only at the end of the month, when the average daily air temperature was 13.50 °C. The monthly precipitation total amounted 75 mm. Such differences in temperature and the amount of precipitation did not significantly affect the productivity of amaranth culture.

The results of study showed that although the effect of climatic factors in different years varied, but on average the weather conditions for three years were favorable for the development of amaranth plants. Therefore, the results of the study are given below as three years average.

Figure 2: Amaranth plant nursery (Bekuzarova S. A., 2019)

The variants in the experiment were placed in a systematic way, by sequentially placing the plots in one tier. The experience is repeated four times. Plot length – 13 meters width – 1.6 m, the distance between 40 cm protective strip - 2 m Total area 1 option 20,8 m^2, 1 m^2 account. The experience area is 800 m^2. In the experiment, the following studies and observations were carried out using generally accepted methods: phenological and biochemical studies were conducted to identify changes in amaranth characteristics with change in altitudinal zonation. In our analysis we applied the most expressive plant characters: plant height, number of leaves, leaf surface area, mass of grains from one panicle, mass of 1000 grains, date of occurrence of phenophases, content of vitamins, carotene, chlorophyll as decisive indicators of ecological plasticity and survival of amaranth in extreme conditions of high mountains.

(Blankenship, 2002; Strzalka et al., 2003; Cai et al., 2003). The research was conducted in accordance with the guidelines of B. A. Dospekhov (1987), the state Commission for variety testing of agricultural crops

(1983), and the guidelines of the Russian academy of agricultural sciences (1997). Experimental data were analyzed using statistical methods (variance, regression, and correlation analyses) on a PC using STATISTICA 9.0 for Windows.

III. Results

The altitude gradient has a significant effect on the duration of the ripening period and the total length of the growing season. The main stress factors, increasing with altitude are a high diurnal temperature variation (from +7 to +35 ^{0}C) and windiness (Table 1).

Table 1: The effect of altitude zonation on the timing of vegetation period (2017-2019)

Plant species	Phenological phases					
	Sowing	Seedlings	Panicle panning	Phase of flowering	Milk Wax Phase	Full ripening phase
605 m above sea level						
Fodder amaranth (Amaranthus caudatus L.)	16.05	05.06	02.07	31.07	21.08	31.08
Cereal amaranth (Amaranthus cruentus L.)	16.05	06.06	01.07	31.07	19.08	02.09
Ornamental amaranth (Amaranthus hipochondriacus L.)	16.05	07.06	03.07	31.07	22.08	04.09
1350 m above sea level						
Fodder amaranth (Amaranthus caudatus L.)	15.05	30.05	23.06	26.07	12.08	24.08
Cereal amaranth (Amaranthus cruentus L.)	15.05	29.05	22.06	27.07	13.08	23.08
Ornamental amaranth (Amaranthus hipochondriacus L.)	15.05	31.05	24.06	28.07	14.08	27.08

Table 1 shows that the length of the growing season decreases with increasing altitude. On the plot of 605 m above sea level, the amaranth species went through a full development cycle, and the length of the growing season was 87-89 days depending on the species, and on the plot located at the altitude of 1350 m, the growing season was reduced by several days. Moreover, shoots in the mountain zone appeared 7 days earlier. This is due to the peculiarities of the light regime in the mountains, namely by the effect of increased solar radiation, despite the low temperatures at the beginning of the growing season. The duration of the germination-maturation period depended on the amount of precipitation ($r = 0.856$) and the GTC (hydrothermal coefficient) ($r = 0.905$). Precipitation increased the duration of the full growing season ($r = 0.871$).

The plant organism adapts to environmental conditions, and this affects the characteristics of the pigment apparatus. Structural elements of the assimilating cell involved in the absorption and conversion of the energy of sunlight may change. Various conditions of solar radiation cause changes in the number of leaves, their surface area, thickness, number of plastids, the size of chloroplasts, also they affect the height of plants (Mathur et al., 2015).

With changing environmental conditions, the growth rate and the size of the leaf surface change. The photosynthetic activity of the plant directly depends on the area of the leaf surface and the amount of chlorophyll in the leaves (Andreo et al., 1990).

Our results showed that with the rise in the mountains, some of morphological and biological indicators of the amaranth species under study change (Table 2).

Table 2: The morphology of plants in dependence on the altitude above sea level (2017-2019)

Plant species	Morphological and biological indicators (averaged)				
	Plant height, cm	Number of leaves, items.	Leaf area thousands of m^2/ha	Mass of grains in one panicle, g	Mass of 1000 grains, g
605 m above sea level					
Fodder amaranth (Amaranthus caudatus L.)	145	23	51,2	29,69	0,60
Cereal amaranth (Amaranthus cruentus L.)	129	22	85,7	29,83	0,57
Ornamental amaranth (Amaranthus hipochondriacus L.)	127	21	66,1	29,55	0,52
Smallest significant difference 05	1,6	0,7	9,4	0,09	0,02
1350 m above sea level					
Fodder amaranth (Amaranthus caudatus L.)	162	16	38,7	29,21	0,64
Cereal amaranth (Amaranthus cruentus L.)	167	15	51,2	29,54	0,43
Ornamental amaranth (Amaranthus hipochondriacus L.)	166	17	46,3	29,19	0,49
Smallest significant difference 05	2,1	0,6	6,7	0,01	0,04

Based on the table data, a natural difference in the increase in the leaf area and the height of amaranth plants with the ascent to the mountains was established, since amaranth belongs to the group of plants with C_4-type of photosynthesis, with a range of high temperatures up to + 35 °C, which provides a higher increase in biomass.

However, the the panicle mass and the mass of 1000 grains showed inverse dependence on altitude. This is due to the fact that the period for determining these indicators falls on the beginning of the end of August and the beginning of September, when the temperature difference between day and night (+32°C / +7°C) functions as a stress factor. Another abiotic factor is wind speed, which reaches in the studied mountain zone 7 m/s. Consequently, leaves sharply reduce stomatal conductance, the diffusion resistance of leaves occurs at high temperature, PAR and relatively low relative humidity, acting as a regulator of the water balance of amaranth plants. This significantly increases the water deficit, the amount of moisture in the leaves drops significantly, the water potential decreases, the osmotic pressure rises and the conductivity of the water necessary for the development of inflorescences decreases (Javadmanesh et al., 2015).

Amaranth plants in the mountains are exposed to powerful flux of ultraviolet rays, and they have a high ratio of chlorophyll *a* and *b*. At noon, when sunlight contains a maximum of short-wave high-intensity radiation, their content increases. Based on this, it seems very important to determine the number of chlorophylls a and b, carotenoids and vitamins, as one of the groups of active metabolites that are of particular importance in the life of the plant itself, as growth and development factors also actively involved in oxidation-reduction processes (Table 3).

Table 3: The content of chlorophylls *a* and *b* and carotenoids in dependence on the altitude above sea level (2017-2019)

lant species	Pigment content in plant material, mg/g of fresh mass		
	Chlorophyll *a*	Chlorophyll *b*	Carotenoids
605 m above sea level			
Fodder amaranth (Amaranthus caudatus L.)	1.4	0.4	0.5
Cereal amaranth (Amaranthus cruentus L.)	1.9	0.8	0.4
Ornamental amaranth (Amaranthus hipochondriacus L.)	1.6	1.0	0.5
Smallest significant difference 05	0,12	0,15	0,08
1350 m above sea level			
Fodder amaranth (Amaranthus caudatus L.)	2.1	0.7	0.6
Cereal amaranth (Amaranthus cruentus L.)	2.5	0.7	0.7
Ornamental amaranth (Amaranthus hipochondriacus L.)	2.3	1.3	0.6
Smallest significant difference 05	0,14	0,01	0,03

It was found that in the mountain zone of the North Ossetia-Alania, with an increase in the temperature of air and soil, under an excessive amount of solar radiation in all types of amaranth plants, the number of pigments of the photosynthetic apparatus increases by 1.5-2 times. Heat effect is reduced, and the risk of possible plant overheating decreases. The absorption maximum shifts to the short-wavelength direction, where light quanta at high energy have a lower thermal effect. Thus, the most of chlorophylls belong to the photo-absorbing complex of photosystem. The shift in the ratio of chlorophylls, apparently, is the result of genetic effect, i.e., adaptation to lighting conditions.

Thus, the pigment complex of plants is a complex and labile system that is sensitive to changes in environmental conditions.

Also, vitamins, being structural elements of plant enzymes, respond to changes in environmental conditions, in particular, altitude gradient. We found that the content of certain vitamins in amaranth plants increases with increasing altitude (Table 4).

Table 4: Vitamin and carotene content in dependance on altitude above sea level (2017-2019)

Plant species	Vitamin and carotene content, mg%				
	Vitamin A	Vitamin C	Riboflavin	Rutin, %	Carotene, mg/kg
605 m above sea level					
Fodder amaranth (Amaranthus caudatus L.)	21,2	387,5	1,27	1,7	53,7
Cereal amaranth (Amaranthus cruentus L.)	23,1	353,2	2,1	2,1	54,0
Ornamental amaranth (Amaranthus hipochondriacus L.)	17,3	367,2	1,45	1,6	53,2
1350 m above sea level					
Fodder amaranth (Amaranthus caudatus L.)	22,4	697,2	1,65	2,3	57,6
Cereal amaranth (Amaranthus cruentus L.)	26,7	693,0	2,98	2,7	59,3
Ornamental amaranth (Amaranthus hipochondriacus L.)	19,3	684,2	1,83	1,9	58,5

According to the table, the altitudinal gradient affects the accumulation and increase in the amount of vitamins and carotene. Apparently, in the mountains in amaranth plants, a protective mechanism is activated that protects vitamins from radiation destruction. This feature is practically valuable, and is significant in relation to the quality of the forage base of the highlands.

IV. Discussion

The use of amaranth in agricultural production is more relevant than ever before. The use of amaranth is increasingly finding support from both science and industry (Yao et al., 2019). At the same time, other uses of amaranth are being tested.

According to Barros R. I. et al. (2020) the edible flowers of Amaranthus hypochondriacus are gaining new interest as potential sources of biologically active compounds. Amaranth culture has demonstrated high antioxidant capacity for ORAC and FRAP analysis. Thus, this study showed the variety and abundance of natural antioxidants present in edible flowers that can be investigated for use in functional foods and pharmaceuticals. This study coincides with the results of our studies, which show a high content of vitamins and carotene, thereby confirming the high value of amaranth in the human diet.

The changes that occur in our experiments with amaranth plants of different species depending on the altitude above sea level are consistent with the results of research by Artemyeva E. P. et al. ((2019). Temperature and humidity had a great influence on amaranth plants. In years of low yields associated with high temperatures and arid-moderate humidity, the studied amaranth species realized the ability to rapidly develop and transition to seed production. At that time, when the temperature and excessive humidity decreased, the seed productivity of the crop decreased or was absent.

In favor of the high value of amaranth in human and animal nutrition, a study by Sarker U. et al. ((2019). A correlation study showed that all the antioxidant components of red amaranth have strong antioxidant activity. The present study showed that two of the genotype of red are a great source of antioxidants,

which require a detailed pharmacological studies. These results add value to our research and are consistent with it.

According to the results of research in 2017-2019, we can conclude that the studied species of amaranth in the highlands of the Republic of North Ossetia-Alania showed a good adaptive potential under extreme loads of climatic factors. The experiments showed an increase in the content of chlorophylls *a* and *b*, carotenoids in the studied species of amaranth with an increase in altitude above sea level. The high-altitude gradient affects the accumulation and increase in the amount of vitamins and carotene in amaranth plants, which is of practical importance in relation to the quality of the food base of the highlands.

V. Conclusions

According to the results of research in 2017-2019, it can be concluded that the studied species of amaranth in the highlands of the Republic of North Ossetia Alania showed a good adaptive potential under extreme loads of climatic factors, in which a full cycle of development took place over a shorter growing season due to good leaf migration, taking into account C_4-type photosynthesis.

The length of the growing season for amaranth plants decreases as the altitude rises above sea level and the experimental site is located along the altitude gradient. On a plot of 605 m above sea level, the length of the vegetation period for amaranth plants is 87-89 days depending on the species, and on a plot located at an altitude of 1350 m, the vegetative period has been reduced by several days. At the same time, seedlings in the mountain zone appeared earlier by 7 days.

There is a natural difference between the increase in leaf area and the height of amaranth plants with the ascent to the mountains, but the indicators of the panicle grain mass and the mass of 1000 grains have an inverse relationship. It was found that in the mountain zone of the RSO - Alania with an increase in air and soil temperature, with an excess amount of solar radiation, the number of pigments of the photosynthetic apparatus increases by 1.5-2 times in all types of amaranth plants. The thermal effect is reduced, and the plant reduces the risk of possible overheating.

With an increase in altitude, the amount of solar radiation increases, which leads to an increase in the content of chlorophyls *a* and *b*, and carotenoids in the studied species of amaranth. The altitude gradient affects the accumulation and increase in the amount of vitamins and carotene in amaranth plants, which is of practical importance in relation to the quality of the forage base of the highlands.

The studied species of amaranth (grain, fodder, decorative) are of interest for international practice as a source material for accelerating selection work on productivity and stability in contrasting conditions of mountains and foothills.

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Evaluation of Some Kenyan and Nigerian Livestock Feedstuffs

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Abstract- This experiment was carried out to respectively evaluate the nutritive and anti-nutritive constituents of some feedstuffs and forages that are abundantly found in Kenya and Industrial rice milling wastes and Umucass 36 cassava plant meal abundantly found in Nigeria with the aim of producing them in commercial quantity for the enhancement of livestock development and feeding in Kenya and Nigeria and the entire African continent. The forages obtained in Kenya are Napier grass, Guatemala giant panicum, Boma Rhodes, Giant setaria, Mulatto and Green leaf desmodium. Rose coco, Green grams pea and Sorghum are livestock grains obtained from Kakamega County market. Rice milling waste and Umucass 36 cassava root meal (gari) were obtained from Abia State, Nigeria. They were all evaluated for their nutritive content using internationally acceptable stands. The results showed that these feedstuffs are rich in dietary nutrients and the digestibility coefficients of the forages and the feedstuffs are encouraging. Processing or non-processing of Rose coco, Green gram peas and Sorghum showed no definite pattern of response that can be traced to the processing methods used in this trial. In conclusion, the richness of these feedstuff has the potential of enhancing livestock feeding and production in these two countries if properly applied.

Keywords: *forages, feeed stuffs, nutritive content and livestock.*

GJSFR-D Classification: *FOR Code: 070103*

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Evaluation of Some Kenyan and Nigerian Livestock Feedstuffs

Ojewola, G. S [α], Baraza, D. L [σ], Olwenyo, G. [ρ], Mugun, G [ω], Unah, U. L [¥], Adedokun, O. O [§], Onabanjo, R. S [χ] & Adeniji, C.A. [ν]

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I. Introduction

Animal agriculture, poverty, food security, people's health and nation's economy are inextricably linked. According to Kosgey *et al*. (2011), Adams (2016) and Alarcon *et al*. (2017), beef industry made the largest contribution (35 percent) to agricultural gross domestic product (GDP) in the Kenyan's economy, while about 61.1 percent of the people are employed in agriculture related business. According to Nigerian Bureau of Statistics (2017), the livestock sector contributed 28.68 and 22.93 percent respectively in the third quarter of 2016 and second quarter of 2017 while 29.15% was contributed to overall GPP in real terms in Nigeria. It was further stated that cattle sector is the highest component of the total livestock cash income which contributes an average of 12 percent of the total Nigerian livestock cash income (NBS, 2010). Despite animal agriculture's contribution to the national economy and people's livelihood as a major source of food (protein) and employment in virtually all nations of Africa; its activities are dominated by small producers and their primitive subsistence-inclined practices. Kenya and Nigeria are two of a kind and are blessed with good climatic environment that can encourage expansive production of livestock. For instance, Kakamega County has a tropical, high rainfall climate due to its proximity to the equator, temperatures are constant throughout the year. Average afternoon temperature are around 28°C/82°F, but night time is cool at around 11°C/52°F. It often rains throughout the year, but peaks in April and May (Kenyan National Bureau of Statistics, 2019). Nigeria, on the other hand has tropical climate with variable rainy and dry seasons, depending on location. It is hot and wet most of the year in the Southeast but dry in the Southwest and farther inland. Rainfall decreases progressively away from the coast, the far north receives no more than 2 inches (500mm) a year. Abia state lies on 52m above sea level. The climate here is tropical with average annual temperature of 26.9°C/78.78°F and precipitation averages2193mm. In view of the convivial climatic environment and the contributions of animal agriculture to the economy of these two countries, there is the need to consciously harness the environment to further enhance the country's livestock development through efficient commercial and large scale production of forages and other feed resources which would bring about efficient livestock feeding. It is on this premise that selected forages, feedstuffs and agricultural byproducts obtained from these two countries were evaluated for their nutritive content so as to know which of these feed resources could be cultivated on a large scale.

II. Materials and Methods

Eight (8) matured forages were harvested from the Masinde Muliro University of Science and Technology Teaching and Research Farms, Kakamega County, Kenya, while feedstuffs such as rose coco beans, raw green grains pea and Sorghum were purchased from the open market within the Kakamega County. These feedstuffs were processed by using either toasting, roasting and or soaking in water. The dry

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sampleswere milled and respectively analyzed for their proximate, crude fibre fractions and anti-nutrients according to the procedures described by AOAC (1980; 1984 and 2006).

Umucass 36 cassava plant, a new species of cassava and earlier introduced by IITA (2011) being cultivated on a large scale in Nigeria was also obtained from Umuahia, Abia State, while rice milling waste was obtained from Bendel (also Abia state). They were all respectively analyzed for their proximate, fibre fractions, minerals, amino acids and anti-nutrients using the procedures described by AOAC (1984; 1980 and 2006)

Rice milling waste is a round-the-year highly available mixture of all the by-products obtained in the rice milling process in Nigeria.

III. Results and Dicussion

The results of the nutrient content and digestibility coefficients of some forages obtained at the Masinde Muliro University of Science and Technology Research Farm, Kakamega County is resented in Table 1.

Table 1: The nutrient content and digestibility coefficients of some forages obtained in Kakamega County

Forages	Proximate (%)			Digestibility Coefficients		
	DM	Ash	CP	OMD (%)	OMg/KgDM	DMD (%)
Napier grass (South Africa)	91.21	9.59	12.62	25.76	232.99	30.25
Guatemala	92.70	11.08	13.03	26.17	232.69	29.25
Giant Panicum	92.69	9.75	13.18	25.11	226.64	29.78
Napier grass (Ouma)	85.52	13.73	11.56	26.45	230.92	33.67
Boma Rhodes	91.83	8.24	17.44	35.33	324.14	36.21
Giant Setaria	91.45	7.47	9.91	45.67	422.56	48.54
Mulatto	92.30	10.49	10.43	59.48	532.47	61.92
Green leaf Desmodium	92.36	6.08	18.20	25.73	241.66	30.06

OMD- Organic matter digestibility; DMD- Dry matter digestibility.

The result shows that the DM values for the 8 types of forages ranged from 85.52 to 92.69 percent. Napier grass (Ouma) has the highest (13.73%), which is closely followed by Guatemala (11.08%) and Mulatto (10.49%), while Giant Setaria gave the least value (7.47%) of ash. The percent crude protein value ranged between 9.91 (Giant Setaria) and 18.20 (Green leaf Desmodium). The highest organic matter digestibility was obtained from Mulatto and this was closely and respectively followed by Giant Setaria (45.67) and Boma Rhodes (35.33) while the value of others ranged between 25.11 and 26.45. The organic matter/dry matter digestibility ranged from 226.64 (OMg/kgDM) to 532.47 (OMg/kgDM). The percent dry matter digestible value was highest for Mulatto (61.92) and closely followed by the Giant Setaria (48.54), while the others ranged from 29.45 to 36.21. From the foregoing, the DM values of these forages showed that they can easily be baled and or ensiled. The CP values also showed these forages as having higher protein values than most of the grains (maize, sorghum and millet) often used as feed supplements inanimal nutrition while the ash value of these forages are higher than that obtained by Zafar (2008). The nutritive value of these forages could have been influenced by one or all of these factors which include stage of maturity, edaphic influences, plant species, climate, range condition and animal class. According to Schroeder (2018), the stage of growth seems to be the most important factor affecting the chemical composition and digestibility of forages.

Table 2: The percent Neutral detergent fibre of the forages obtained from Kakamega County, Kenya

Forages	NDF (%)
Napier grass (South Africa)	79.00
Guatemala	80.50
Giant panicum	66.10
Napier grass (Ouma)	58.90
Boma Rhodes	61.40
Giant setaria	65.50
Mulatto	68.20
Green leaf desmodium	61.10

NDF: Neutral detergent fibre

The percent NDF ranged from 58.90 (Napier grass – Ouma) to 80.50 (Guatemala). The neutral detergent fibre, commonly referred to as cell wall fraction is the insoluble portion of the forage which contains the cellulose, hemicellulose, lignin and silica. According to Schroeder (2018), NDF is negatively correlated with dry matter intake. In other words, as the NDF in forages increases, animal would consume less of such forage. This agrees with the less than 50% digestibility coefficient values obtained in most of the

forage considered in this trial, only with the exception of Mulatto forage which respectively has 59.48 OMD and 61.92 DMD percent digestibility values. It is pertinent to know that NDF increases with the advancement in maturity of forages and a better prediction of forage intake can therefore be made using NDF.

Table 3: The nutrient content and digestibility coefficients of some selected but differently processed and unprocessed feedstuffs (grains) obtained from Kakamega County market

Feedstuffs	Proximate (%)			Digestibility Coefficients		
	DM	Ash	CP	OMD (%)	DoMD	DMD (%)
Rose coco (raw)	87.55	3.60	17.19	89.56	863.35	90.83
Rose coco (toasted)	93.51	5.38	22.61	81.96	775.56	83.39
Rose coco (roasted)	92.80	3.75	17.40	75.06	722.46	76.55
Raw green grams (specie I)	92.51	3.41	24.13	90.59	874.94	91.30
Raw green grams (specie II)	91.79	2.34	23.88	92.08	899.27	93.07
Sorghum (raw/unsprouted)	9.89	1.07	11.33	80.64	797.78	80.53
Sprouted sorghum	91.84	1.16	10.91	71.24	704.12	71.90

OMD- Organic matter digestibility; DoMD- Digestibility organic matter in dry matter; DMD- Dry matter digestibility.

The dry matter content values ranged from 87.55 (Raw rose coco) to 93.51 percent (Toasted rose coco), while the percent ash and crude protein content ranged from 1.07 (unsprouted sorghum) to 5.38 (toasted rose coco) and 10.91 (sprouted sorghum) to 24.13 (raw green grams pea). The OMD, DoMD and DMD digestible coefficient of all the test material were comparable and commendable. Processed or unprocessed, they are feedstuffs that hold great promise for livestock production in our clime.

Table 4: The nutritive content and gross energy of Rice Milling Waste obtained from Bendel, Abia State, Nigeria

Parameter	Percent Nutritive Content
Dry matter	89.84
Crude protein	10.80
Crude fibre	24.09
Ether extract	4.15
Ash	15.08
Nitrogen free extract (NFE)	35.72
Neutral detergent fibre (NDF)	65.73
Acid detergent fibre (ADF)	49.68
Acid detergent lignin (ADL)	17.57
Hemicellulose	16.05
Cellulose	32.16
Gross energy (Kcal/kg)	37.89

The result showed that rice milling waste is rich in nutrients. The percent crude protein (10.80), crude fibre (24.09), ash (15.08) and NFE (35.72) makes it a feedstuff of choice in livestock nutrition. With the exception of neutral detergent fibre (65.73) and all the other fibre fractions are within the range that could be tolerated by both ruminants and non-ruminants.

Table 5: The nutritive content and gross energy of the various parts of Umucass 36 cassava plant

Parameter (%)	CRM	CFM	CTSM	CCM	S.E.M
Dry matter	91.7^{ab}	90.00^{b}	90.00^{b}	92.80^{a}	0.02
Crude protein	2.29^{d}	21.79^{a}	5.93^{c}	19.83^{b}	0.04
Ether extract	4.10^{b}	2.36^{d}	2.71^{c}	7.67^{a}	0.00
Crude fibre	6.45^{b}	19.77^{a}	19.74^{a}	5.87^{c}	0.00
Ash	7.56b	8.70^{a}	6.33^{c}	4.74^{d}	0.02
Nitrogen free extract	70.67^{a}	37.80^{d}	56.13^{b}	54.71^{c}	0.05
Gross energy (Kcal/kg)	3.66^{b}	3.42^{c}	2.89^{d}	3.77^{a}	0.00

Means within the same row with different superscript (a-d) are significantly ($P<0.05$) different. CRM- cassava root meal; CFM- cassava foliage meal; CTSM- cassava tender stem meal; CCM- cassava composite meal; SEM- standard error of mean.

From the above table, cassava foliage meal and cassava composite meal respectively have 21.79 and 19.83% crude protein which can be exploited as a protein meal in both ruminant and non-ruminant nutrition. The ash content which ranges from 4.74 and 8.70% were also significantly ($P<0.05$) higher for cassava foliage meal (19.77%) and cassava tender stem meal (19.74%). From the foregoing, the fibre provided by the inclusion of these dietary resources in animal diets has the propensity to enhance proper digestion in

the animals (Kurai *et al*. 2004). The implication of this is that utilizing cassava plants which hitherto are often regarded as wastes in our climecould become a link in the food chain (Shroider, 2018) just like the forages.

Table 6: The macro and micro mineral constituents of the various parts of the Umucass 35 cassava plant.

Parameter	CRM	CFM	CTSM	CCM	S.E.M
		Macro minerals (%)			
Sodium	0.24[b]	0.27[a]	0.23[a]	0.21[d]	0.00
Potassium	0.70[c]	0.88[a]	0.88[a]	0.73[b]	0.00
Calcium	0.29[a]	0.28[b]	0.25[c]	0.23[d]	0.00
Phosphorous	0.36	0.38	0.32	0.34	0.00
Magnesium	0.28	0.29	0.25	0.34	0.00
		Micro mineral (mg/kg)			
Iron	93.55[d]	221.65[a]	189.40[b]	178.50[c]	0.37
Copper	6.95[b]	5.55[b]	22.25[a]	3.95[bc]	0.10
Zinc	36.00[b]	41.55[a]	5.35[c]	4.05[c]	0.35
Manganese	15.00[d]	17.70[c]	28.50[a]	22.15[b]	0.00

Means within the same row with different superscript (a-d) are significantly (P<0.05) different. CRM- cassava root meal; CFM- cassava foliage meal; CTSM- cassava tender stem meal; CCM- cassava composite meal; SEM- standard error of mean.

Table 7: The amino acid profile of Umucass 36 cassava foliage meal

Parameters (%)	Value
Alanine	2.19
Arginine	6.46
Aspartic acid	2.16
Cysteine	3.09
Glutamic acid	8.67
Glycine	3.07
Histidine	1.34
Isoleucine	1.75
Leucine	3.44
Lysine	1.94
Methionine	0.54
Phenylalanine	3.14
Proline	2.64
Threonine	1.53
Tryptophan	1.26
Tyrosine	3.27
Ornithine	0.24
Serine	0.90
Valine	8.27

Table 8: The anti-nutritional constituents that are present in the various parts of the Umucass 36 cassava plant

Parameter	CRM	CFM	CTSM	CCM	S.E.M
HCN (mg/kg)	4.6[b]	1.26[d]	1.74[c]	6.57[a]	0.00
Trypsin inhibitor (TIUmg)	9.62[a]	2.25[c]	2.37[c]	8.74[b]	0.00
Tannin (%)	0.014[b]	0.086[a]	0.005[c]	0.00[d]	0.00

Means within the same row with different superscript (a-d) are significantly (P<0.05) different; SEM- standard error of mean.

Tables 6 and 7 show the macro and micro minerals and amino acid constituents of the various meals produced from the various parts of Umucass 36 cassava plant.

The macro and micro minerals are significantly (P<0.05) available in virtually all the components parts of Umucass 36 cassava plant and can therefore be included in animal feed. Table 7 also show a rich amino acid profile of Umucass 36 cassava plant, thus making it a rich source of dietary plant protein in livestock nutrition.

Table 8 shows the anti-nutritional constituents that are present in the various parts of Umucass 35 cassava plant. The HCN, Trypsin inhibitor and tannin were significantly (P<0.05) influenced. The HCN level ranged from 1.26 (cassava foliage meal) to 6.57 (cassava composite meal) which is within an accepted tolerable level.

IV. Conclusion

The results of the resent study indicate that these forages, rice milling waste and Umucass 36 cassava plants components are rich in dietary nutrients and have the potentiality of being used as major feedstuffs in livestock nutrition. It can also be used to further enhance livestock feeding, first in Kenya and Nigeria and the entire continent of Africa. Lastly, it is pertinent to begin to think about the business of cultivating these forages on a commercial/large scale and thereafter harvested and sold to farmers who are involved in animal production.

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Optimization of Agrometeorological and Climatological Information to Reduce Risk Based on Spatial Data Agriculture

By Charitas Fibriani
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Abstract- Indonesia is an agricultural country that relies on the agricultural sector to support the lives of its people. The agricultural sector is dependent on climatic and weather conditions which often cause failure and success in farming. At this time the agriculture department has never conducted an analysis of climatology data to manage agricultural data so that it is difficult to analyze accurate data. For spatial analysis, climatological data is needed in spatial form. This journal will discuss the process of analyzing climatological spatial data, food security data and crop data of an area combined with the overlay method. So we get a rule related to the relationship between client data and plant data. The output of this journal is spatial-based climatology data modeling for climate visualization and agricultural commodities suitable for planting in certain regions and more accurate agrometeorological data.

Keywords: *farming, spatial data, gis.*

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Optimization of Agrometeorological and Climatological Information to Reduce Risk Based on Spatial Data Agriculture

Charitas Fibriani

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I. Introduction

Indonesia is an agricultural country that relies on the agricultural sector to support the lives of its people. The agricultural sector is dependent on climatic and weather conditions which often cause failure and success in farming (Effendy, 2001). Concrete impacts of climate on agricultural production, especially food crops, include crop failures due to mismatches between climate and commodities, decline in agricultural production due to climate distortions that affect periods of growth. If this happens permanently, it will cause losses to farmers and will ultimately threaten national food security.

Food independence is one of the government's program. Food independence can be achieved when food self-sufficiency can survive according to a predetermined target for the amount of agricultural production. The term agriculture appears when humans can benefit from regulating plant growth. The agricultural products are still the mainstay of several countries including Indonesia to meet people's needs and to contribute to foreign exchange. However, at present, almost all plant productivity is still far from its potential, on the other hand, the cost of production goes up. Climate change and environmental conditions also influence agricultural conditions. Agricultural production that does not provide results according to these targets raises several concepts, one of the technologies used to address these problems is Precision Farming (PF) technology (Khanal, 2019). The basic concept of Precision Farming is to measure the diversity of land conditions (soil, climate, plants) and then manage that diversity through the provision of agrochemical inputs and all other cultivation actions according to the Physico-chemical characters of the soil and plants' needs as effectively and efficiently as possible, by integrating agronomy principles and technological applications. This means that precision care is needed for each plant by following the plant's characteristics condition, in which the treatment applies to technology. Through the effective, selective and efficient management, then the plant productivity will be obtained to its potential, maximizing profitability, managing risks and being environmentally friendly both physically and socially (Susilowardani, 2015).

At this time the agriculture department has never conducted an analysis of climatology data to manage agricultural data so that it is difficult to analyze accurate data. For spatial analysis, climatological data is needed in spatial form, the advantage of using spatial data for analysis is data in clear format, cheaper because it does not have to be a field survey, data can be recalled, data management processes can be carried out so that the analysis process can be carried out efficiently (Prahasta, 2002). The area to be used as a case study is Boyolali District, Central Java, Indonesia.

This journal will discuss the process of analyzing climatological spatial data, and crop data of an area combined with the overlay method. In order to obtain a rule related to the relationship between client data and plant data that can be useful to reduce the risk of failure of farming, increase and availability of local food production and reduce the risk of food and nutrition insecurity. So that it will produce modeling for spatial-based climatology data for visualization of climate and agricultural commodities suitable for planting in certain regions and more accurate agrometeorological data. This modeling will enrich theoretical studies regarding the implementation of information technology. The purpose of this modeling is to reduce agricultural risks and prevent high production costs. This model is expected to be able to add climatology indicator references for the future to be able

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to know the effects of changes in the global environment on climate change.

II. Literatur Review

The research entitled "Food Stability Mapping of Madiun Regency" discusses the mapping of food stability in Madiun Regency into the Geographic Information System (GIS). This research was conducted to measure the magnitude of the food identification indicator in Madiun Regency and determine the food stability status for each sub-regency in Madiun Regency. The indicators used are (1) aspects of food availability, (2) percentage of population living below the poverty line, percentage of population without access to clean water, percentage of illiterate women, percentage of population without four-wheel access, (3) percentage of under-weight infant, life expectancy, percentage of infant mortality rate, percentage of population without access to clean water, percentage of population living far from the Community Health Center. The method used in this study is descriptive quantitative and uses secondary data taken from the related agencies. The results of this study are data on food stability levels in the Madiun Regency that are resistant to food based on the determined composite (Addibi, 2016).

The study entitled "Factors Affecting Food Stability and Instability and Its Policy Implications in Rembang Regency" has discussed several issues that threaten food stability, namely socio-economic problems, reduced agricultural land as well as a decrease in production caused by climate change. research in the form of spatial and statistical analysis. Spatial analysis was used to map the distribution of stability status and village level of food instability with weighted overlays by overlaying maps and weighting scoring on observed variables. The statistical analysis uses factor analysis to find out the factors that lead to food stability and instability in each village in Rembang Regency. This study aims to identify resistant and food-prone villages with spatial analysis and statistical analysis using factor analysis to determine factors causes of food stability and instability. The results showed that most of the villages in Rembang were in a status of low-medium food stability (105 villages), followed by food-resistant villages (90 villages) but there were still 10 villages that were classified as highly food-insecure which required major attention (Hapsari, 2017).

III. Data Spasial

Spatial data is a type of data that has a spatial reference, meaning that every point in the data is related to the real world. Spatial data consists of 2 parts, namely the geometric and attribute tables of the map. There are 2 types of spatial data, namely: (1) Raster Data, (2) Vector data. Raster data is data that is represented in the form of a grid, meaning that each grid represents an area. Examples of raster data are aerial photography and remote sensing. While vector data is a type of data that represents the condition of the earth's geography, both human geography and physical geography, using the shape of points, lines and polygons (Fibriani, 2019). The data model is a representation of recorded geographic objects so that they can be recognized and processed by computers. (Gumelar, 2007) describes the vector data model into several more sections (can be seen in Figure 4), while the explanation of the data model will be discussed in the following sections.

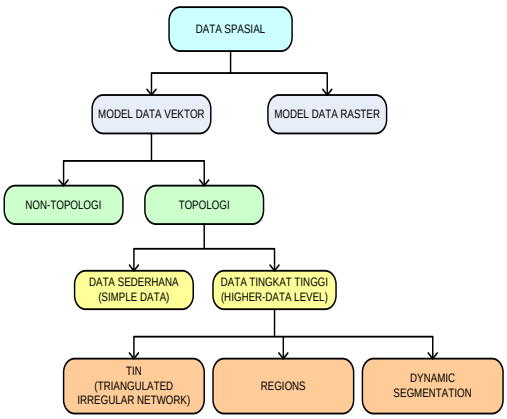

Figure 1: Classification of Spatial Data Models (Gumelar, 2007)

IV. Overlay Method

The analytical method used is the overlay method, where this method requires at least two groups of digital image data in the process. This overlay method is suitable for identifying a large area through digital image visualization. The results of this overlay method can be information that contains data that is a combination of data that is put together, so that the overlay data can be used for the analysis process (Prahasta, 2002). The concept of overlay can be seen in Figure 2.

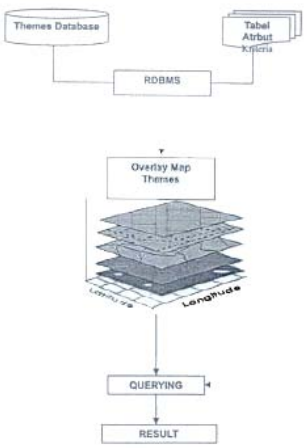

Figure 2: Methods of overlaying spatial data (Prahasta, 2002)

This method helps in data analysis with digital visualization so that it makes decision making needed as needed. For example, information on identifying water catchment areas in an area that requires decisions or policies on the utilization of groundwater in the surrounding area. This research proposes using the method of overlaying spatial data to combine spatial climatological data and spatial data on food production with digital maps of Boyolali district.

V. Data Analysis

Climatological spatial data used are: (1) Rainfall, (2) Temperature, (3) Slope. Rainfall is the average rainfall data in a year in an area, the unit is a millimeter (mm), data is obtained from a rain station. The values for rainfall data are of 3 classes, namely: (1) <1500, (2) 1500-3000, (3)> 3000. Rainfall data representation is in the form of polygons. Geometry data for rainfall data can be seen in Figure 3.

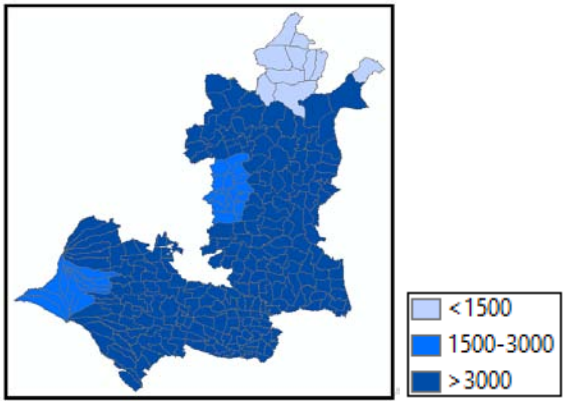

Figure 3: Rainfall Map

Temperature is the temperature of the air in an area. Air temperature is related to the height of an area above sea level so that it affects the temperature of an area. The temperature unit is degrees Celsius. Where the values for temperature data are 3 classes, namely: (1) <23, (2) 23-26, (3)> 26. Temperature data representations are polygons. Geometry data for temperature data can be seen in Figure 4.

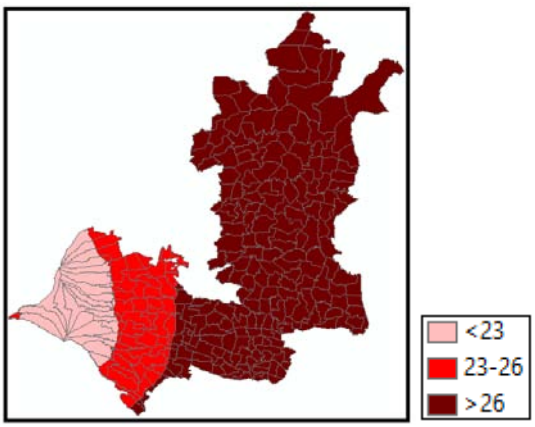

Figure 4: Temperature Data

The slope is the angle formed by the difference in surface height of an area. The slope unit is percent. The values for the slope data are 4, namely: (1) 0-8, (2) 8-15, (3) 15-40, (4)> 40. The slope data representation is in the form of polygons. Geometry data for rainfall data can be seen in Figure 5.

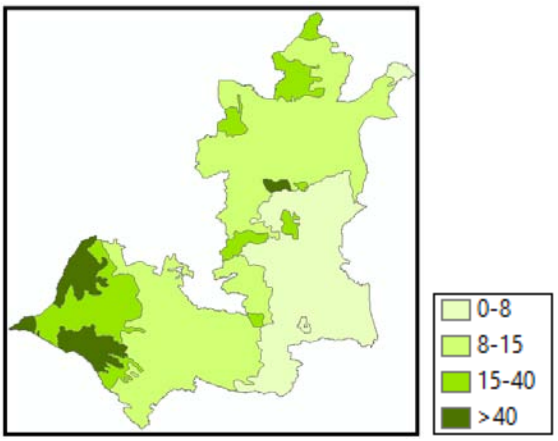

Figure 5: Slope Data

While non-climatological spatial data used are Plant Data. Plant data is the type of plant variety recommended in an area based on the physical characteristics of the area. The values for the tanaman data are 4, namely: (1) Annual Crop Cultivation (plantations), (2) Forestry, Productive Forests, Protected Forests, (3) Agroforestry, (4) Intensification. Representation of plant data is in the form of polygons. Geometry data for plant data can be seen in Figure 6.

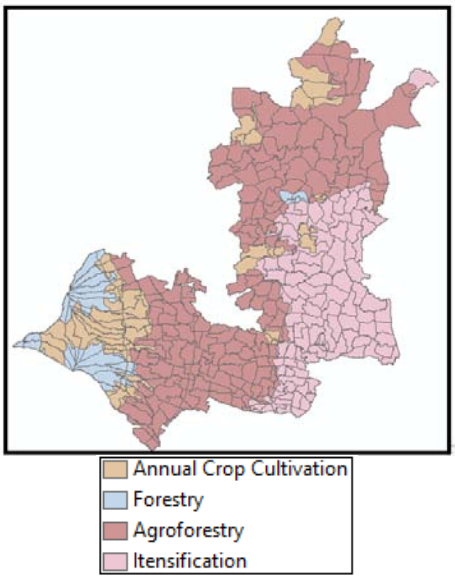

Figure 6: Crop Data

The parameters of the attribute data from the spatial data used can be seen in Table 1.

Table 1: Parameter Attributes

Data	Representation	Deskripsion	Value
Rainfall	Polygon	The average rainfall in a year	<1500
			1500-3000
			>3000
Temperature	Polygon	Temperature of an area	<23
			23-26
			>26
Slope	Polygon	The slope of an area surface	0-8
			8-15
			15-40
			>40
Varieties	Polygon	Varieties of an area	Annual Crop Cultivation
			Forestry
			Itensification
			Agroforestry

VI. Spatial Analysis

Overlaying of rainfall data, temperature data, slope data, plant data and resilience data is then carried out to analyze the data. The results of the overlay of the five data can be seen in Figure 8.

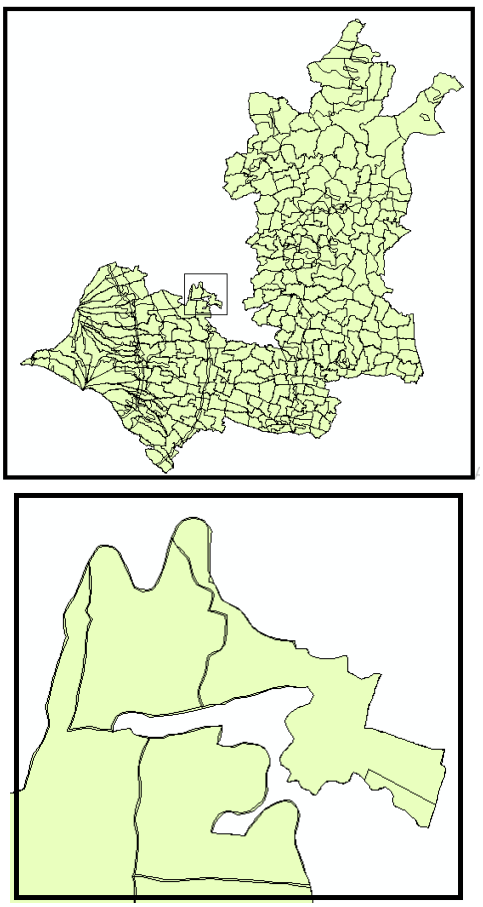

Figure 7: Overlay Map

As for the attributes of the overlay process data can be seen in Table 2. Where the total record data on the overlay attribute is 4205.

Table 2: Overlay attributes

FID	Rainfall	Slope	Temperature	Varieties
2028	>3000	8-15	25-26	Agroforestry
1619	>3000	8-15	25-26	Agroforestry
2803	>3000	8-15	25-26	Agroforestry
2048	>3000	8-15	25-26	Agroforestry
97	>3000	8-15	>26	Agroforestry
…	…	…	…	…

Rainfall, slope and temperature data are the criteria while variety data are the attribute of the destination. Then the analysis process is carried out namely the classification function in data mining on the three attributes using IF. AND. THEN logical expression so that 36 rules are obtained in Table 3.

Table 3: Classification Rules

Rules	Slope	Temperature	Rainfall	Zona
1	0-8	>26	<1500	AX1
2	0-8	>26	1500-3000	AX2
3	0-8	>26	>3000	AX3
4	0-8	23-26	<1500	AY1
5	0-8	23-26	1500-3000	AY2
6	0-8	23-26	>3000	AY3
7	0-8	<23	<1500	AZ1
8	0-8	<23	1500-3000	AZ2
9	0-8	<23	>3000	AZ3
10	8-15	>26	<1500	BX1
11	8-15	>26	1500-3000	BX2
12	8-15	>26	>3000	BX3
13	8-15	23-26	<1500	BY1
14	8-15	23-26	1500-3000	BY2
15	8-15	23-26	>3000	BY3
16	8-15	<23	<1500	BZ1
17	8-15	<23	1500-3000	BZ2
18	8-15	<23	>3000	BZ3
19	15-40	>26	<1500	CX1
20	15-40	>26	1500-3000	CX2
21	15-40	>26	>3000	CX3
22	15-40	23-26	<1500	CY1
23	15-40	23-26	1500-3000	CY2
24	15-40	23-26	>3000	CY3
25	15-40	<23	<1500	CZ1
26	15-40	<23	1500-3000	CZ2
27	15-40	<23	>3000	CZ3
28	>40	>26	<1500	DX1
29	>40	>26	1500-3000	DX2
30	>40	>26	>3000	DX3
31	>40	23-26	<1500	DY1
32	>40	23-26	1500-3000	DY2
33	>40	23-26	>3000	DY3
34	>40	<23	<1500	DZ1
35	>40	<23	1500-3000	DZ2
36	>40	<23	>3000	DZ3

VII. Conclusion

Based on the rules in Table 3 that are applied to the overlay attribute in Table 2, a number of conclusions can be obtained. Forest varieties depend on rainfall data, where the ideal rainfall for forest varieties is rainfall 1500-3000 and> 3000, where land conditions are moist to wet. While agroforestry varieties, annual crop and intensification are strongly affected by land slope. Agroforestry is directed to 8-15% slope or rather steep surface conditions. For annual crops it is recommended to tilt 15-40% or steep surface conditions. As for the slope of the land 0-8% or flat surface conditions are recommended for itensification.

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Effect of Age, Size, and Mating Combinations in *Trichomalopsis Uziae*, A Pteromalid Ecto-Pupal Parasitoid of the Tachinid Fly, *Exorista Bombycis*, Onits Reproductive Performance

By J. B. Narendra Kumar & D. Manjunath
University of Mysore

Abstract- Preliminary laboratory studies have indicated that the pteromalid ecto-pupal parasitoid, *Trichomalopsis uziae* Sureshan & Narendra Kumar, has been reported to possess immense potential to serve as a biological control agent of the tachinid fly, *Exorista bombycis* (Louis), which inflicts a cocoon yield reduction of 10-20% in the southern states of India. The present laboratory investigations aims at generating information on the impact of age (0-10 days at 1 day apart in age) and size (big and small) of the parasitoid in addition to mating combinations (sib, conspecific, and random) on its reproductive performance when the pupae of *E. bombycis* were parasitized.

Keywords: brood allocation; developmental duration; hymenoptera; parasitism; progeny production; pteromalidae; sex ratio.

GJSFR-D Classification: FOR Code: 070302

Strictly as per the compliance and regulations of:

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J. B. Narendra Kumar [α] & D. Manjunath [σ]

Abstract- Preliminary laboratory studies have indicated that the pteromalid ecto-pupal parasitoid, *Trichomalopsis uziae* Sureshan & Narendra Kumar, has been reported to possess immense potential to serve as a biological control agent of the tachinid fly, *Exorista bombycis* (Louis), which inflicts a cocoon yield reduction of 10-20% in the southern states of India. The present laboratory investigations aims at generating information on the impact of age (0-10 days at 1 day apart in age) and size (big and small) of the parasitoid in addition to mating combinations (sib, conspecific, and random) on its reproductive performance when the pupae of *E. bombycis* were parasitized.

The results revealed that age of *T. uziae* had an influence on rate of parasitism, brood allocation, progeny production, and sex ratio that decreased significantly with the parasitoid age. With regard to parasitoid size, big females showed significantly superior reproductive efficiency when compared with their small counterparts. In size-related mating combinations, all the reproductive parameters were significantly higher with big females irrespective of size of males they mated with. Among sib, conspecific, and random mating combinations, the latter led to substantially superior reproductive performance. The findings of the investigation have been discussed to explore the possibilities of undertaking mass production of *T. uziae* on *E. bombycis.*

Keywords: brood allocation; developmental duration; hymenoptera; parasitism; progeny production; pteromalidae; sex ratio.

I. Introduction

Contraryto the general thinking that tachinid flies have been relentless in their attack of in sectpests of various crops, thus lending a helping hand in man's relentless fight against such pests, there are a few tachinid flies reported to be causing problem in the raising of silkworm larvae by sericulture farmers as they parasitize these larvae which results in considerable reduction in the production of cocoons/raw silk. These include (i) the Japanese uzi fly, *Crossocosmia sericariae* (Randani) (ii) the hime or black uzi fly, *Ctenophorocera pavida* (Meigen) (iii) the tasar uzi fly, *Blepharipa zebina* Walker, and (iv) the Indian uzi fly, *Exorista bombycis* (Louis) (Sengupta et al. 1990).The parasitism of larvae of the mulberry silkworm, *Bombyx mori* L. (Lepidoptera: Bombycidae), by *E. bombycis*is estimated to cause a cocoon yield reduction of 10-20%in the premier silk producing states of the Indian sub-continent namely Karnataka, Andhra Pradesh, and Tamil Nadu (Narayanaswamy and Devaiah 1998). It is an accidentally introduced pest from the State of West Bengal (India), where it existed for centuries, in to the state of Karnataka way back in 1980.Since then, the fly pest menace has continued unabated in these south-Indian states warranting the sericulture entomologists to make concerted efforts to develop strategies, chiefly non-chemical, to obviate the economic loss. Such strategies also include an IPM package comprising an adult exclusion to render silkworms inaccessible to the fly by confining silkworms to a nylon net/wire mesh enclosure, a chemotrap (uzitrap) to attract and kill both sexes of fly, an ovicide (uzicide) to kill eggs laid by the fly on silkworms, an eulophid ecto-parasitoid (*Nesolynx thymus* Girault) to parasitize pupae of the fly, and killing of the fly maggots and pupae by packing silkworm rearing residue in polythene bags (Dandin and Giridhar 2010; Narendra Kumar et al. 2017).

E. bombycis is reported to have long list of parasitoids (as many as 21) (larval, larvi-pupal, and pupal) which also includes the newly reported ecto-pupal parasitoid namely *Trichomalopsis uziae* Sureshan & Narendra Kumar (Hymenoptera: Pteromalidae). (Narayanaswamy and Devaiah 1998; Narendra Kumar and Manjunath 2018). Of these, only a few, *viz*. *N. thymus* (Aruna 2007), *Trichopria* sp. (Veena 2008), and *Tetrastichus howardi* (Olliff) (Gangadhar 2009) have been studied for various biological aspects. Preliminary laboratory investigations have indicated that *T. uziae* possess immense potential to serve as a biocontrol agent of *E. bombycis.* However, in-depth studies are yet to be undertaken on various biological aspects of the parasitoid in order to understand whether the parasitoid could be used alongside *N. thymus* as a biocontrol agent. The contemplation of such an idea assumes great significance in the backdrop of the statement of

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Bellows and Fisher (1999) and Gordh et al.(1999) that increased dependence on a single biological control agent for containing any pest is not a good proposition. In addition, keeping in view the increased sensitivity of *B. mori* to most chemical agents, exploitation of biocontrol agent(s), especially parasitoids and predators (if any), would undoubtedly assume great significance and go a long way in the management of *E. bombycis*.

When the use of a biocontrol agent, such as a parasitoid, is contemplated in a pest control program, what becomes the pre-requisite is its mass production. Such an effort is invariably preceded by investigations on the factors influencing the parasitoid performance subsequent to its release in the field. Such factors include (a) host-associated factors (age, size, quality, density, etc.), (b) parasitoid-associated factors (age, size, density, mating status, super-parasitism, multiple parasitism, etc.), and(c) environment-governed factors (chiefly physical) (temperature, relative humidity, solar radiation, etc.) (Singh and Thangavelu 1996; Traynor and Mayhew 2005; He and Wang 2006; Aruna 2007; Veena 2008; Hu et al.2012; Iqbalet al. 2016; Broski and King 2017; Narendra Kumar and Manjunath 2018; Narendra Kumar et al. 2018). Further, the interplay of some or all of these factors would decide the fitness of the progeny individuals and their efficiency in containing the pest problem. Fitness is exclusively associated with parasitoid size which assumes great significance, especially when it relates to female. Therefore, what one needs to understand is 'bigger the female better would be its fitness' by way of possessing the desirable traits of a biocontrol agent, such as being more fecund, long lived, efficient in host searching and parasitism, higher temperature tolerance and so on (Godfray 1994; Petersen and Hardy 1996; West et al. 1996; Gao et al. 2016). It is, therefore, necessary to undertake detailed investigations on these aspects so that information generated thereof would be useful for developing protocol(s) for mass production of parasitoids. In the backdrop of this, an attempt has been made in the current investigation to record the impact of age, size, and mating combinations on the reproductive performance of *T. uziae* that could be of considerable value in the direction of working out a protocol for mass production of the parasitoid.

II. Material and Methods

a) Procurement of parasitoid adults and host pupae

The investigations were undertaken in the laboratory at 23-28° C and 70-80% RH. The adult females of the parasitoid (*T. uziae*) (0-10 day-old) were chosen from the laboratory culture maintained on the pupae of *E. bombycis*. The pupae of *E. bombycis* (3 day-old) were procured by collecting the post-parasitic maggots that were emerging from the cocoons of *B. mori* subjected to transaction (sale by open auction) by the sericulture farmers in the Cocoon Markets located in Karnataka and allowing them to pupate in the laboratory. For parasitoid size-related studies, the size of parasitoid adults (males and females) was decided based on measurement of the cold-exposed (at 4° C for 2-3 min) individuals using a stage micrometer under a light microscope at 50 X and ensuring that there was a significant difference in size of the adults of the respective sexes.

b) Effect of female age on the reproductive performance of T. uziae

The impact of *T. uziae* female age on reproductive performanceof the parasitoid was recorded by allowing 1 to 10 day-old females to parasitize 3 day-old pupae of *E. bombycis* for a period of 5 days at a parasitoid-host ratio of 1:5 in glass test tubes the mouth of which plugged with cotton. Aqueous honey 30% smeared with a camel hairbrush on an elongated stripe of paraffin wax-coated paper hung from top in test tube served as the parasitoid adult diet. After the stipulated duration of parasitism, the parasitoid females were removed from test tubes. The host pupae in test tubes were observed and data were recorded on rate of parasitism (%), parasitoid developmental duration (days), brood allocation (numbers of parasitoid adults emerging/host), progeny production (total numbers of parasitoid adults emerging from parasitized hosts), and progeny sex ratio (females/male).

c) Effect of female size on the reproductive performance of T. uziae

Size-related reproductive ability of *T. uziae* was studied by exposing 3 day-old *E. Bombycis* pupae to big and small females of the parasitoid at a parasitoid-host ratio of 1:5 for 5 days. Aqueous honey 30% was provided as parasitoid adult diet during the period of oviposition. Observations on rate parasitism, developmental duration, brood allocation, progeny production, and sex ratio were recorded. Data on these parameters were also collected to understand the reproductive performance of the progeny individuals, as influenced by female size in parent generation, by allowing the randomly chosen females to oviposit on the pupae of *E. bombycis*(3 day-old) at a parasitoid-host ratio of 1:5 for 5 days.

d) Effect of size-related mating combinations on the reproductive performance of T. uziae

To understand the impact of mating among the big and small sized parasitoid adults, the following mating combinations were set up: a) big female x big male, b) big female x small male, c) small female x big male, and d) small female x small male. Each of the mated females was offered 5*E. bombycis* pupae (3 day-old) for parasitism for 5 days. Aqueous honey 30% was provided as parasitoid adult diet during the period of oviposition. Results on rate parasitism, developmental

duration, brood allocation, progeny production, and progeny sex ratio were recorded.

e) *Effect of sib, conspecific, and random mating on the reproductive performance of T. uziae*

With regardto studies on these aspects, the following mating combinations were set up: a) sib mating (mating between brothers and sisters), b) conspecific mating (mating between sons and daughters of two mothers) c) random mating (mating between sons and daughters of several mothers). In each mating combination, each of the mated females was offered 5 pupae of *E. bombycis*(3 day-old)for parasitism for 5 days. Aqueous honey 30% was provided as parasitoid adult diet during the period of oviposition. Results on rate of parasitism, developmental duration, brood allocation, progeny production, and progeny sex ratio were documented.

The observations on all the experiments were based on 10 replications. The accrued data were analyzed by one-way ANOVA (Version 21) followed by DMRT for understanding whether or not the results were significantly different from each other at 1 or 5% among the treatments as per the methods outlined by Snedecor and Cochran (1979).

III. Results

a) *Effect of female age on the reproductive performance of T. uziae*

When the parasitoid females of 0-10 day-old, at a space of 1 day in their age, were allowed to parasitize *E. bombycis* (3 day-old), the rate of parasitism was highest by 1 day-old female (96.00± 4.00%) and least by 7 and 8 day-old females (48.00± 4.90%) with variation in the mean values among the treatments being highly significant. The parasitoid developmental duration was longest for the progenies of 8 day-old female (12.80±0.20 days) and shortest for those of 1, 2, 5, and 6 day-old females (12.20±0.20 days) with mean results being comparable. While the 10 day-old female allocated a minimum brood of 9.00±1.00 numbers, the zero day-old one (newly emerged and mated) allocated a maximum brood of 37.33±0.59 numbers. The comparison of mean data among the treatments revealed a significant variation. With regard to progeny production, the mean value was greatest for zero day-old female (164.40 ±15.66numbers) and least for 10 day-old female (22.60 ±1.60 numbers) with mean results among the treatments revealing highly significant variation. Looking at the progeny sex ratio, it was highest for zero day-old female (5.42±0.48 females/male) and least for 10 day-old female (1.90 ±0.25 females/male) with mean values differing significantly (Table 1).

b) *Effect of female size on the reproductive performance of T. uziae*

The mean results for rate of parasitism by small and big parasitoid females were 60.00±5.96 and 72.00±6.80%, respectively with a highly significant variation (P≤0.01).The time spent for completion of parasitoid progeny development was almost identical from small(12.70±0.21 days) and big (12.50±0.17days) parent females. While the small female allocated a brood of 25.12±1.79 numbers, the big one did so with 33.36±2.09 broods that were significantly higher in number. Insofar as the progeny production was concerned, it was significantly greater in numbers for big female (120.50±14.17) as compared to small female (77.10±10.19) with progenies sex ratios being 6.08±0.51 and 3.60±0.21, respectively (Table 2).

c) *Effect of size-related mating combinations on the reproductive performance of T. uziae*

Of the 4 mating combinations, the rate of parasitism was highest with big female x big male (88.00±8.00%) which was *at par* with big female x small male (84.00±7.48%). The mean results scored for these mating combinations were significantly higher (P≤0.01) than those obtained for mating combinations of small female x big male (68.00±10.20%) and small female x small male (64.00±4.00%) with the mean values for these mating combinations being comparable with each other. The time taken by the parasitoid for completion of its development was nearly identical for mating combinations of small female x big male(12.00±0.00 days) as well as big female x big male and small female x small male (12.60±0.24 days). With regard to brood allocation, it was least with small female x small male (22.48±0.88numbers) and highest and significantly superior with big female x small male (33.56±3.11numbers) which was no different from mating combination involving big female x big male (32.72±2.85numbers). The parasitoid produced a progeny which was maximum and significantly higher with big female x big male (154.40±25.80numbers), which was *at par* with mating between big female x small male (145.40±24.50numbers), when compared with small female x small male (71.80±4.60numbers). The mean sex ratio(females/male) for progenies produced by the above mating combinations was significantly superior with big female x big male (6.09±0.20)when compared with rest of the mating combinations where the mean sex ratio scored for big female x small male (4.23±0.62) was significantly higher than that for small female x big male (2.88±0.17) and small female x small male (2.81±0.22) with the results for the latter mating combinations being comparable (Table 3).

d) *Effect of sib, conspecific, and random matings on the reproductive performance of T. uziae*

The results onimpact of mating among the progenies of a single mother (sib mating), of two

mothers (say A & B) (conspecific mating), and of several mothers (random mating) were documented by setting up the mating combinations as follows: a) sib mating, b) female progeny of mother A x male progeny of mother B, c) female progeny of mother B x male progeny of mother A, and d) random mating. It was observed that mean values registered for rate of parasitism for the treatments a, b, c, and d were 72.00±7.42, 84.00±5.81, 82.00±6.29, and 90.00±4.47, respectively, with the values differing significantly except the mating involving conspecifics that had nearly identical performance. With regard to parasitoid developmental duration, the mean data for the treatments were 12.50±0.17, 12.20±0.13, 12.50±0.17, and 12.50±0.17days and the values were comparable. Considering brood allocation, the results scored for the above treatments except sib mating (29.24±1.11) were significantly greater and comparable (33.75±1.74 for Fem A x Male B; 34.09±1.21 for Fem B x Male A; 37.81±1.39 numbers for random mating). Taking in to consideration of the progeny production, the mean results for the above treatments stood at 105.50±12.06, 148.70±11.44, 142.00±13.99, and 171.70±12.35 with conspecifics being comparable in performance and sibs to be inferior and random ones to be significantly superior. The corresponding sex ratios for progenies of these mating combinations were 3.33±0.21, 4.17±0.31, 4.47±0.35, and 5.50±0.34 with the latter (random mating) being significantly superior (Table 4).

IV. Discussion

When a constant number of *E. bombycis* pupae (5 in number) was offered to*T. uziae* females of varying ages from zero to 10 days, at a space of 1 day in their age, brood allocation, progeny production, and sex ratio decreased with parasitoid parent female age. The mean values for these parameters declined sharply at an age of 5 days where the decrease amounts to nearly 1.70-folds for brood allocation and 2-folds for progeny production as well as sex ratio when compared with corresponding results at a parasitoid age of zero day. The further decrease in mean results for these parameters at a parasitoid age of 10 days *vis-à-vis* zero day was of the order of nearly 4, 7, and 3-folds, all of which were appreciably inferior even when compared with those at a parasitoid age of 5 days. It's also worth mentioning that rate of parasitism at a parasitoid age of 10 days too was found diminished by 1.70-folds. The above findings, therefore, clearly demonstrated that parasitoid female age had a substantial impact on the reproductive parameters, except developmental duration. The substantial decrease in brood allocation, progeny production, and sex ratio, at least at parasitoid female ages of 5 and 10 days in comparison with zero day, as has been considered for discussion here, could be attributed to oosorption/ovisorption, a phenomenon/condition where matured eggs in ovary getting absorbed whenever there is a longer time lag between egg production and availability of host for oviposition (Flanders 1942; Doutt 1959; King 1963). The reason for substantial reduction in progeny sex ratio was due to production of more numbers of male progenies relative to female progenies as parasitoid females in general allocate more numbers of male brood to a host when they are older and less numbers when they are younger and *vice-versa* for female brood (Broski and King 2017).

The information available with regard to impact of parasitoid age on biological parameters of pteromalid parasitoids, more so of *Trichomalopsis* spp., is rather scanty. Nonetheless, Singh and Thangavelu (1996) studied the age-specific survival and fecundity, intrinsicrate of population increase, and sex ratio in the case of *Trichomalopsis apanteloctena* Crawford, a pupal parasitoid of the tachinid fly, *B. zebina*, parasitizing the tropical tasar silkworm, *Antheraea mylitta* Drury, underlaboratory conditions. It was revealed that the numbers of progeny produced by the parasitoid and the sex ratio did not vary significantly with maternal age when the parasitoid developed on the pupae of *B. zebina*. Hu et al. (2012) working with *Pachycrepoideus vindemmiae* (Rondani) recorded a decrease in off spring male percentage with female age. Likewise, parasitoid female age-related reproductive strategy has been observed in *Anisopteromalus calandrae* (Howard) (Choi et al. 2001; Choi and Ryoo 2002; Ji et al. 2004; Zilch et al. 2017). In a recent study, Broski and King (2017) noticed the impact of female age on reproductive performance in *Spalangia endius* (Walker).

It is a well-known fact that a parasitoid female exhibits a great deal of fluctuation in egg production and egg deposition during her life time. Considerably fewer eggs are laid on the first day of life than on the following days, showing a peak of egg deposition on a couple of days; the number diminishing gradually towards the end of her life. With the egg number varying greatly, often the number of eggs laid would be more than that of progeny emerging as a large number of young larvae on most occasions dying as a consequence of competition for food (resources), especially under the conditions of super parasitism (Merwe 1943; van Dijken and Waage 1987; van Alphen and Jervis 1996; Aruna 2007; Gonzalez et al. 2007; Kraft and Nouhuys 2013). Enhanced fecundity was realized in younger female parasitoids than older ones (Guang and Oloo 1990; Iqbalet al. 2016). As far as sex ratio is concerned, in younger parasitoids female-biased sex ratio and in older ones male-biased sex ratio has been realized (Simser and Coppel 1980; Laetemia et al. 1995). With increasing age, an ovipositing female may receive depleted sperm numbers and hence produce more male progeny towards the end of her reproductive period (King 2000; Santolamazza-carbone et al. 2007).

Ininsects, including parasitoids, bodysize is found positively correlated with fitness of their life-history traits (Leather 1988; Odeet al. 1996; Cloutier et al. 2000; Ji et al. 2004; He and Wang 2006). Larger females may have greater longevity (Visser 1994; Ueno 1999; He and Wang 2006; Aruna 2007; Veena 2008), higher fecundity (Visser 1994; He and Wang 2006; Aruna 2007; Veena 2008), superiordispersal and host searching ability (Visser 1994; Ellers et al. 1998; He and Wang 2006), greater oviposition success (Ueno 1999; Gao et al. 2016), and an innate capacity for increase (Cloutier et al. 2000), thus clearly supporting our understanding that 'bigger the better'. Especially, in hymenopteran parasitoids, "adult size-fitness hypothesis" shows that large sized individuals (especially females) possess more physiological and behavioral advantages, such as ability to search and attack large and high quality hosts, lifetime fecundity, longevity and mating success, even the outcome of numerous parasitoid-host interactions, than small sized congeners (Wylie 1966; Godfray 1994; Petersen and Hardy 1996; West et al. 1996; Ji et al. 2004; Gao et al. 2016).Therefore, it is a foregone conclusion that adult size is known to have effect even on some of the behavioral traits, such as mating, host searching, host acceptance, sex allocation and other parameters, viz. longevity, fecundity, progeny production, offspring adult size and so on.

Our attempts to document the reproductive efficiency of *T. uziae*as influenced by its sizeled us to understand that rate of parasitism, brood allocation, progeny production, and sex ratio to befargreater for mating combinations involving big female irrespective of size of male she mated with as against small female of the parasitoid. When the effect of parasitoid size based on mean data for females of both sizes were quantified and compared, the superiority of big female was to the tune of nearly 1.20, 1.30, 1.60, and 1.70 times, respectively for the above parameters. For superior performance of big parasitoid female, the female progeny numbers proved instrumental and males had no role whatsoever as their numbers remained almost similar for mating combinations comprising females of both the sizes. From these observations, what one could conceive is that parasitoid female gained advantage in terms of reproductive capability by virtue of being bigger, irrespective of size of the male it mated with, thus falling in line with the glorifying statement that 'bigger the better' to indicate that bigger parasitoid females are bestowed with superiority in terms of longevity, temperature tolerance, dispersal, parasitism rate, progeny production and so on (Cloutier et al. 2000; King 2002; Eliopoulos et al.2005; He and Wang 2006; Sagarra et al.2002). Therefore, production of parasitoid females of bigger size undoubtedly assumes supreme importance when one contemplates the idea of undertaking their mass production for inundative release of parasitoids in field under biological control programs of crop pests. Nevertheless, the role of host-related factors, especially host size and host quality, need to be coupled with parasitoid female size while undertaking mass production program.

The findings on reproductive efficiency of *T. uziae* based on whether mating was between brothers and sisters (sib mating), sons and daughters of two mothers (conspecific mating), or sons and daughters of several mothers (random mating), were on following lines: random mating > conspecific mating > sib mating. Be it an insect or any other animal, including human beings, it's a universal phenomenon that mating among sibs leads to reduction in vigor among progenies and expression of certain genetic defects. As against this, in the case of random mating the progenies would be vigorous and almost devoid of defective gene expression. In the case of mating among progenies of two different mothers, the progenies are likely to be 'mediocre' in vigor and expression of defective genes. In keeping fine tune with the fundamental principle governing the breeding in plants or animals, the parasitoid in question(*T. uziae*) followed this principle with utmost discipline. Interestingly, it was evident to note at this juncture that random breeding provided an opportunity not only to enhance the progeny production but also to boost the production of female progenies that would directly contribute to the efficiency of mass production of the parasitoid. Further, the relatively reduced numbers of males in random mating in comparison to the remaining two types of breeding (sib and conspecific) wouldn't be a constraint in view of the fact that the males oftener sort to multiple mating (polygamy) so that even a few of them would be adequate enough to inseminate several females.

Based on our awareness of literature on the above aspect pertaining to parasitoids belonging to the genus *Trichomalopsis* in particular and family Pteromalidae in general, it appears that efforts by researchers are yet to be spared. However, just to quote some instances where the parasitoids from other families too followed the fundamental principles governing mating among individuals of close or distant relatives have been drawn from the reports of Aruna (2007) and Veena and Manjunath (2015) working on *N. thymus*(Eulophidae) and *Trichopria* sp. (Diapriidae), respectively.

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Table 1: Reproductive performance of *Trichomalopsis uziae* as influenced by its age when *Exorista bombycis* was parasitized

Age of parasitoid female (Days)	Per cent parasitism@	Dev. duration (days)	Progeny production (No.)			Brood allocation (No.)			Sex ratio (♀♀/♂)
			Male	Female	Total	Male	Female	Total	
0	88.00 ±8.00^{a}	12.40 ±0.24	26.80 ±4.09^{a}	137.60 ±11.83^{a}	164.40 ±15.66^{a}	5.95 ±0.48^{ab}	31.37 ±0.55^{a}	37.33 ±0.59^{a}	5.42 ±0.48^{a}
1	96.00 ±4.00^{a}	12.20 ±0.20	23.20 ±2.75^{abc}	119.80 ±5.88^{ab}	143.00 ±8.19^{a}	4.79 ±0.45^{bc}	24.93 ±0.33^{b}	29.72 ±0.68^{bc}	5.36 ±0.43^{a}
2	84.00 ±9.80^{a}	12.20 ±0.20	28.00 ±6.47^{a}	123.60 ±20.76^{ab}	149.60 ±26.27^{a}	6.27 ±0.92^{ab}	28.75 ±2.64^{ab}	35.01 ±3.40^{ab}	4.83 ±0.49^{ab}
3	80.00 ±8.94^{ab}	12.60 ±0.24	28.00 ±4.01^{a}	113.40 ±20.51^{ab}	141.40 ±24.24^{a}	6.67 ±0.50^{ab}	26.36 ±2.36^{ab}	33.03 ±2.67^{abc}	3.98 ±0.30^{b}
4	80.00 ±8.94^{ab}	12.40 ±0.24	24.60 ±1.81^{ab}	101.40 ±10.08^{b}	125.60 ±10.88^{a}	6.27 ±0.33^{ab}	27.30 ±2.16^{ab}	32.21 ±3.05^{abc}	4.18 ±0.43^{b}
5	76.00 ±4.00^{ab}	12.20 ±0.20	22.80 ±2.67^{abc}	60.80 ±3.29^{c}	83.60 ±5.79^{b}	6.40 ±0.72^{ab}	16.12 ±0.92^{c}	22.52 ±1.40^{de}	2.75 ±0.17^{c}
6	60.00 ±6.32^{bc}	12.20 ±0.20	14.20 ±1.66^{cd}	38.20 ±3.92^{cd}	52.40 ±5.35^{bc}	4.78 ±0.45^{bc}	12.90 ±0.94^{c}	17.68 ±1.29^{e}	2.74 ±0.19^{c}
7	48.00 ±10.20^{c}	12.40 ±0.24	18.00 ±3.15^{abcd}	37.40 ±6.05^{cd}	55.40 ±8.64^{bc}	8.02 ±1.03^{a}	17.78 ±3.59^{c}	25.80 ±4.57^{cd}	2.16 ±0.22^{c}
8	48.00 ±4.90^{c}	12.80 ±0.20	15.40 ±1.69^{bcd}	35.00 ±4.72^{cd}	50.40 ±5.82^{bc}	6.90 ±0.61^{a}	14.10 ±1.73^{c}	21.00 ±2.15^{de}	2.05 ±0.23^{c}
9	52.00 ±4.90^{c}	12.40 ±0.24	9.20 ±1.07^{d}	18.00 ±1.76^{d}	27.20 ±2.52^{c}	3.73 ±0.66^{c}	7.17 ±1.09^{d}	10.90 ±1.68^{f}	2.03 ±0.26^{c}
10	52.00 ±4.90^{c}	12.80 ±0.20	8.20 ±1.24^{d}	14.40 ±0.40^{d}	22.60 ±1.60^{c}	3.23 ±0.49^{c}	5.77 ±0.62^{d}	9.00 ±1.00^{f}	1.90 ±0.25^{c}
F value	6.090 **	NS	5.238 **	19.804 **	16.573 **	5.053 **	23.661 **	16.416 **	17.315 **

@ - Based on 5 host pupae provided for parasitism; values given in the Table are the means of 10 replications (Mean ± SE)
Mean values followed by the same superscript in columns are not significantly different from each other
*** P≤0.01; NS-Non-significant.*

Table 2: Reproductive performance of *Trichomalopsis uziae* as impacted by its size when *Exorista bombycis* was parasitized

Parasitoid size#	Per cent parasitism@	Dev. duration (days)	Progeny production (No.)			Brood allocation (No.)			Sex ratio (♀/♂)
			Male	Female	Total	Male	Female	Total	
Small	60.00 ±5.96	12.70 ±0.21	16.70 ±1.99	60.40 ±8.44	77.10 ±10.19	5.53 ±0.44	19.58 ±1.46	25.12 ±1.79	3.60 ±0.21
Big	72.00 ±6.80	12.50 ±0.17	17.10 ±1.72	103.10 ±12.91	120.50 ±14.17	4.98 ±0.53	28.38 ±1.72	33.36 ±2.09	6.08 ±0.51
t value	3.78**	NS	NS	7.665**	6.13**	NS	15.27**	8.970**	20.008**

#- Body length: 0.67±0.02 mm (small) and 0.82±0.01 mm (big) with measurements differing significantly
@ - Based on 5 host pupae provided for parasitism
Values given in the Table are the means of 10 replications (Mean ± SE)
Mean values followed by the same superscript in columns are not significantly different from each other
*** P≤0.01; NS- Non-significant.*

Table 3: Effect of size-related mating combinations on the reproductive efficiency of *Trichomalopsis uziae* on *Exorista bombycis*

Mating combination	Per cent parasitism @	Dev. duration (days)	Progeny production (No.)			Brood allocation (No.)			Sex ratio (♀/♂)
			Male	Female	Total	Male	Female	Total	
Big F x Big M	88.00 ±8.00^{a}	12.60 ±0.24	21.60 ±3.47	132.80 ±22.37^{a}	154.40 ±25.80^{a}	4.78 ±0.45^{b}	29.19 ±3.05^{a}	32.72 ± 2.85^{a}	6.09 ± 0.20^{a}
Big F x Small M	84.00 ±7.48^{a}	12.40 ±0.24	28.40 ±5.07	117.00 ±20.71^{a}	145.40 ±24.50^{a}	6.66 ±0.82^{a}	26.89 ±2.76^{a}	33.56 ± 3.11^{a}	4.23 ± 0.62^{b}
Small F x Big M	68.00 ±10.20^{b}	12.00 ±0.00	19.80 ±2.31	57.00 ±7.55^{b}	76.80 ±9.71^{b}	5.95 ±0.22^{ab}	17.17 ±1.35^{b}	23.12 ± 1.50^{b}	2.88 ± 0.17^{c}
Small F x Small M	64.00 ±4.00^{b}	12.60 ±0.24	19.20 ±1.88	52.60 ±3.01^{b}	71.80 ±4.60^{b}	6.00 ±0.48^{ab}	16.48 ±0.54^{b}	22.48 ± 0.88^{b}	2.81 ± 0.22^{c}
F value	3.98**	NS	NS	6.763**	5.568**	2.127 *	8.996 **	6.896**	18.912**

@ - Based on 5 host pupae provided for parasitism; values given in the Table are the means of 10 replications (Mean ± SE)
Mean values followed by the same superscript in columns are not significantly different from each other
*** P≤0.01; * P≤0.05; NS- Non-significant.*

Table 4: Impact of sib, conspecific, and random mating on the reproductive efficiency of *Trichomalopsis uziae* on *Exorista bombycis*

Mating combination	Per cent parasitism@	Dev. duration	Progeny production (No.)			Brood allocation (No.)			Sex ratio (♀♀/♂)
			Male	Female	Total	Male	Female	Total	
Sib mating	**72.00 ±7.42^{c}**	**12.50 ±0.17**	**24.30 ±2.50**	**81.20 ±9.83^{c}**	**105.50 ±12.06^{c}**	**6.89 ±0.43**	**22.35 ±0.91^{c}**	**29.24 ±1.11^{b}**	**3.33 ±0.21^{c}**
Conspecific mating Fem-A x Male-B	84.00 ±5.81^{b}	12.20 ±0.13	29.20 ±2.45	119.50 ±9.72^{b}	148.70 ±11.44^{b}	6.63 ±0.37	27.12 ±1.59^{b}	33.75 ±1.74^{a}	4.17 ±0.31^{bc}
Fem-B x Male-A	82.00 ±6.29^{b}	12.50 ±0.17	26.30 ±2.53	115.70 ±12.15^{b}	142.00 ±13.99^{b}	6.43 ±0.42	27.66 ±1.10^{b}	34.09 ±1.21^{a}	4.47 ±0.35^{b}
Random mating	90.00 ±4.47^{a}	12.50 ±0.17	26.90 ±2.29	144.80 ±10.67^{a}	171.70 ±12.35^{a}	6.06 ±0.39	31.85 ±1.17^{a}	37.81 ±1.39^{a}	5.50 ±0.34^{a}
F value	3.943*	NS	NS	6.041**	4.822**	NS	10.176**	6.431**	8.362**
df	2, 27	2, 27	2, 27	2, 27	2, 27	2, 27	2, 27	2, 27	2, 27

@ - Based on 5 host pupae provided for parasitism
Fem-A x Male B: female of mother A x male of mother B; fem B x male A: female of mother B x male of mother A
Values given in the Table are the means of 10 replications (Mean ± SE)
Mean values followed by the same superscript in columns are not significantly different from each other
*** P≤0.01; * P≤0.05; NS- Non-significant.*

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Fellows/Associates of Science Frontier Research Council

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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.

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.

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

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