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

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I. Introduction

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

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

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

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

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

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

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

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

II. Material and Methods

a) Experimental location and treatment details

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

b) Soil samples collection and treatments imposition

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

c) Determination total nutrient uptake

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

Total plant nutrient uptake was calculated by following the equation:

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

d) Determination Post harvest nutrient status and balance

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

e) Statistical Analysis

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

III. Results and Discussion

a) Nutrient uptake by plants

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

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

b) Post harvest N status and N balance

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

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

c) Available P status after harvest and P balance

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

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

d) Post harvest K status and K balance

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

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

IV. Conclusion

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

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

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Table 1: Physical and chemical proprieties of initial experimental soil

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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