



Original Research Article

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Influence of Integrated Nitrogen Management Practices on Yield Attributes, Yield, Nutrient Uptake and Economics of Hybrid Maize (*Zea mays L.*)

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A field experiment entitled “Influence of Integrated Nitrogen Management Practices on yield attributes and yield of Hybrid Maize (*Zea mays L.*)” was conducted during the pre kharif season of 2015 at experimental field of College of Agriculture, Central Agricultural University, Imphal, Manipur. The experiment was laid-out in Randomized Block Design with 3 replications and consisted 11 treatments. Results indicated that application of 100% RDN + vermicompost 5 t/ha recorded highest number of cobs per plant (2.0), cob length (19.98 cm), cob girth (16. 93 cm), number of grains per cob (510.70) and test weight (277.67 g). Similar trends were observed in case of grain yield (70 q/ha) and stover yield (91.20 q/ha). Significantly higher uptake of nitrogen, phosphorus and potassium were recorded with the application of 100% RDN + vermicompost 5 t/ha (T_7). With regards to economics indices the highest monetary return was associated with the application of 100% RDN + FYM 5 t/ha (T_4).

Introduction

Maize is the third important cereal crop next to the rice and wheat in the world. Maize has been an important cereal crop because of its high production potential compared to any other cereal crop. Since the crop has very high genetic yield potential, it is called as the “queen of cereals”. Maize being a C₄ plant has higher yield potential which also depends on nutrient supplying capacity of the soil. It is grown across a wide range of climatic conditions of the world due its wider adaptability (Amanullah *et al.*, 2007). Maize is

an exhaustive crop and therefore, needs adequate supply of nutrients particularly nitrogen for better growth and yield. Nitrogen is an integral part of chlorophyll, which is the primary absorber of light energy needed for photosynthesis and also impart vigorous vegetative growth, dark green colour to plants. Thus increasing vegetative growth results in higher green fodder production and grain yield. Well decomposed FYM in addition to supplying plant nutrients acts as binding materials and improves the soil physical properties. Manure acts as nutrient reservoir and upon decomposition, produces organic

acids, thereby adsorbed ions are released slowly for the entire growth period leading to higher yield (Kumar *et al.*, 2005). Vermicompost is an excellent base for the establishment of beneficial free living and symbiotic microbes. Application of vermicompost increases the total microbial population of nitrogen fixing bacteria that convert nutrient in soil into plant available form. Hybrid maize is a heavy feeder and is more responsive to applied nutrient. The required amount of nutrient may be supplied through organic manure and inorganic fertilizers to grow it and to maintain soil fertility on a sustained manner (Sarkar *et al.*, 2000). Therefore, it needs fertile soil to express its yield potential. Among the major nutrient, nitrogen is considered to be one of most important nutrient for improving the productivity of hybrid maize. Integrated nutrient management system involves efficient and judicious supply, use and management of all the major components of plant nutrient sources. The integrated supply and use of plant nutrient from chemical fertilizer and organic manures can produce higher crop yield and helps to improve chemical, physical and biological properties of soil with no or minimal deleterious effect on environment. Thus, highest productivity of crops in sustainable manner without deteriorating the soil and other natural resources could be achieved only by applying appropriate combination of different organic manures and inorganic fertilizers (Chandrashekara *et al.*, 2000). Therefore, keeping the above in view, the present investigation entitled "Influence of Integrated Nitrogen Management Practices on yield attributes and Yield of Hybrid Maize (*Zea mays L.*)" was undertaken.

Materials and Methods

A field experiment was conducted at Agronomy Research Farm of College of Agriculture, Central Agricultural University,

Imphal, Manipur during pre *kharif* season of 2015. The experimental site is situated at $24^{\circ} 45'$ N latitude and $93^{\circ} 56'$ E longitudes and at altitude of 790 m above the mean sea level. Representative soil samples were collected at random from the depth of 0-15 cm from several spots of the experimental field before starting the experiment and composited for mechanical and chemical analysis. The data indicated that the soil was clayey in texture having initial pH (5.6) (Glass electrode pH meter, Jackson, 1973) and organic carbon (1.77 %) (Walkley and Black, 1934). The surface soil of the experimental field was found to be medium in available nitrogen (301.0 kg/ha), available phosphorus (20.20 kg/ha) and available potassium (230.54 kg/ha). The field experiment was laid out in randomized block design consisting of 11 treatments each replicated thrice. The treatments were T_1 - 100% recommended dose of nitrogen, T_2 - 75% recommended dose of nitrogen, T_3 - 50% recommended dose of nitrogen, T_4 - 100% recommended dose of nitrogen + FYM @ 5t / ha, T_5 - 75% recommended dose of nitrogen + FYM @ 5t / ha, T_6 - 50% recommended dose of nitrogen + FYM @ 5t / ha, T_7 - 100% recommended dose of nitrogen + Vermicompost @ 5t / ha, T_8 - 75% recommended dose of nitrogen + Vermicompost @ 5t / ha, T_9 - 50% recommended dose of nitrogen + Vermicompost @ 5t / ha, T_{10} - FYM @ 5t / ha, T_{11} - Vermicompost@ 5t / ha. The experimental field was ploughed by a tractor and subsequently harrowed by power tiller to bring the field to a desirable tilth. High yielding hybrid variety PAC 740 was sown on 11 February 2015 using seed rate of 25 kg/ha. The seeds were placed at 3-4 cm depth at a spacing of 60 cm between rows and 20 cm between plants and then covered with thin layer of soil. The FYM and vermicompost was applied 20 days before sowing as per treatment and well incorporated to the soil. Recommended dose of nitrogen (120 kg/ha) as

per the treatments was calculated for each plot using urea, along with uniform dose of phosphorus (60 kg/ha) through single super phosphate and potash (40 kg/ha) through muriate of potash were applied to the furrow a day before sowing of the crop at 5-6 cm depth. Half of the nitrogen along with full dose of phosphorus and potash according to the treatment were applied to the respective plots as basal dose and well mixed with soil. The remaining half dose of nitrogen was top dressed into equal splits at knee high stage and tasseling stage. One hand weeding along with interculture and earthing up were done 40 DAS for all the plots to keep the experimental site clean and reduce the crop weed competition. One pre-sowing irrigation was given for uniform germination of the crop. Subsequent irrigation followed at knee height and tasseling stage when top dressing of nitrogen was done. Initial soil analysis of nitrogen, phosphorus and potassium were done as per standard method (Subbiah and Asija, 1956 and Jackson, 1973). The crop was harvested on 22nd June, 2015 from net plot area when the trash turns yellow and grains are hard with less moisture content. The husk was detached from the cobs and sun dried for a week. Thereafter, grains were separated from cobs manually. The grains were then sun dried for safe storage.

Results and Discussion

Effect of integrated nitrogen management practices on yield attributes

The number of cobs per plant increased significantly with combined application of inorganic fertilizer and organic manure. Maximum number of cobs per plant was observed in 100% RDN + vermicompost 5 t/ha (T₇). This increase in number of cobs per plant might be due to the fact that the combine effect of higher level of inorganic nitrogen along with organic source helped the crop in

better nutrition and creation of congenial physical environment for better root growth as well as supply of growth promoting substances (Gibberellin and auxin). Similar finding was also reported by Kumar *et al.*, (2007), and Choudhary and Kumar (2013).

The highest length of cob was recorded with the application of 100% RDN + vermicompost 5 t/ha (T₇). The possible reason could be better absorption of essential nutrients, synthesize phytohormone that promotes the cob length. The benefit of integrated nitrogen management on cob length of maize was also reported by Kumar *et al.*, (2007) and Choudhary and Kumar (2013).

The cob girth increase with combine application of inorganic nitrogen and organic manure at higher dose. Maximum cob girth was recorded in the treatment 100% RDN + vermicompost 5 t/ha (T₇). The results are in accordance with the earlier finding of Ravi *et al.*, (2012).

Significant increase in number of grains per cob was recorded with higher dose of nitrogen combine with organic manure. Maximum number of grains per cob was observed in the treatment 100% RDN + vermicompost 5 t/ha (T₇). Minimum number of grains per cob was recorded in FYM 5 t/ha (T₁₀) where only organic manure was applied. The lesser numbers of grains might be due to inadequate supply of nitrogen from organic source alone which reduced biomass production traits of plant and ultimately reflecting to number of grains per cob. This result is in agreement with the earlier findings of Kumar *et al.*, (2007), Dawadi and Sah (2012) and Kannan *et al.*, (2013).

The test weight increased significantly with higher nitrogen level combined with organic manure. Maximum test weight was observed in treatment 100% RDN + vermicompost 5

t/ha (T_7). The results are in accordance with the finding of Kumar *et al.*, (2007) and Kannan *et al.*, (2013) (Table 1 and 2).

Effect of integrated nitrogen management practices on yield

The grain yield was significantly affected by the application of nitrogen at higher dose along with organic manure. Application of 100% RDN + vermicompost 5 t/ha (T_7). The soil sample analyzed before the start of the experiment also showed that the available nitrogen status of soil in the experiment site was in medium range (301.00 kg/ha). Application of nitrogen combined with organic manure, therefore, provided better nutrition to maize which resulted in higher grain yield. Increase in grain yield with the application of nitrogen combined with organic manure may also be attributed to better growth

of plant as expressed in terms of plant height, fresh weight and dry weight of plant and LAI which were favorably affected by inorganic and organic fertilization. Thus, the improvement in growth resulted in significant increase in yield attributes like number of cobs per plant, grains per cob, cob length and cob girth and test weight which ultimately contributed to higher grain yield. This findings are also supported by Nanjappa *et al.*, (2001), Kumar *et al.*, (2007), Dadarwal *et al.*, (2009), Tahir *et al.*, (2011), Shilpasree *et al.*, (2012), Kannan *et al.*, (2013) and Kumar (2014).

Stover yield increased significantly with the application of nitrogen and organic manure. The higher stover yield was associated with the application of 100% RDN + vermicompost 5 t/ha (T_7). This finding confirms the earlier report of Kumar *et al.*, (2007) and Meena *et al.*, (2007).

Table.1 Number of cobs/plant, cob length (cm) and cob girth (cm) of hybrid maize as influenced by integrated nitrogen management

Treatment	No. of cobs/plant	Cob length (cm)	Cob girth (cm)	No. of grains/cob	Test weight(g)
T₁- 100% RDN	1.80	16.98	15.45	490.33	260.77
T₂- 75% RDN	1.34	13.22	14.29	471.03	250.13
T₃- 50% RDN	1.13	11.08	13.95	450.77	239.47
T₄- 100% RDN+ FYM 5t/ha	1.93	18.77	16.74	504.12	274.67
T₅- 75% RDN + FYM 5t/ha	1.67	15.30	15.00	485.13	258.63
T₆- 50% RDN + FYM 5t/ha	1.27	12.97	14.15	465.07	248.87
T₇- 100% RDN + Vermicompost 5t/ha	2.00	19.98	16.93	510.70	277.67
T₈- 75% RDN + Vermicompost 5t/ha	1.73	16.00	15.05	488.53	259.27
T₉- 50% RDN + Vermicompost 5t/ha	1.33	13.10	14.27	468.03	249.03
T₁₀- FYM 5t/ha	1.00	9.07	12.80	435.37	229.80
T₁₁- Vermicompost 5t/ha	1.00	9.23	13.00	440.03	233.67
S.Ed(\pm)	0.05	0.85	0.59	3.73	2.48
CD (p=0.05)	0.10	1.77	1.24	7.78	5.16

Table.2 Number of grains per cob and test weight (g) of hybrid maize as influenced by integrated nitrogen management

Treatment	No. of grains/cob	Test weight (g)
T1- 100% RDN	490.33	260.77
T2- 75% RDN	471.03	250.13
T3- 50% RDN	450.77	239.47
T4- 100% RDN+ FYM 5t/ha	504.12	274.67
T5- 75% RDN + FYM 5t/ha	485.13	258.63
T6- 50% RDN + FYM 5t/ha	465.07	248.87
T7- 100% RDN + Vermicompost 5t/ha	510.70	277.67
T8- 75% RDN + Vermicompost 5t/ha	488.53	259.27
T9- 50% RDN + Vermicompost 5t/ha	468.03	249.03
T10- FYM 5t/ha	435.37	229.80
T11- Vermicompost 5t/ha	440.03	233.67
S.Ed(\pm)	3.73	2.48
CD (p=0.05)	7.78	5.16

Table.3 Nitrogen, phosphorus and potassium uptake (kg/ha) as influenced by integrated nitrogen management

Treatment	Uptake (kg/ha)		
	Nitrogen	Phosphorus	Potassium
T₁- 100 % RDN	123.87	23.30	138.98
T₂- 75 % RDN	115.77	20.54	133.98
T₃- 50 % RDN	104.30	17.17	101.39
T₄- 100 % RDN + FYM 5 t/ha	129.50	24.83	140.98
T₅- 75 % RDN + FYM 5 t/ha	121.60	21.33	135.53
T₆- 50 % RDN + FYM 5 t/ha	110.53	18.87	109.90
T₇- 100 % RDN + Vermicompost 5 t/ha	131.37	25.46	142.70
T₈- 75 % RDN + Vermicompost 5 t/ha	122.97	22.84	137.98
T₉- 50 % RDN + Vermicompost 5 t/ha	114.77	19.66	122.53
T₁₀- FYM 5 t/ha	96.67	12.33	85.23
T₁₁- Vermicompost 5 t/ha	97.97	13.35	92.75
S.Ed(\pm)	2.56	1.34	5.72
CD (p=0.05)	5.34	2.80	11.95

Table.4 Influence of integrated nitrogen management on economics of hybrid maize production

Treatments	Cost of cultivation (Rs/ha)	Gross income (Rs/ha)	Net return (Rs/ha)	B:C Ratio
T₁-100% RDN	32,979	111,535	78,556	2.38
T₂- 75% RDN	32,261	81,037	48,775	1.51
T₃-50% RDN	31,544	56,860	25,315	0.80
T₄-100%RDN+FYM 5 t/ha	42,979	146,272	103,292	2.40
T₅-75%RDN+FYM 5 t/ha	42,261	108,563	66,301	1.56
T₆-50%RDN+FYM 5 t/ha	41,544	77,263	35,718	0.85
T₇-100%RDN+Vermicompost 5 t/ha	107,979	149,120	41,140	0.38
T₈- 75%RDN+ Vermicompost 5 t/ha	107,261	112,720	5,458	0.05
T₉-50%RDN+ Vermicompost 5 t/ha	106,544	79,803	-26,741	-0.25
T₁₀- FYM 5 t/ha	32,950	43,730	10,780	0.32
T₁₁- Vermicompost 5 t/ha	97,950	45,203	-52,747	-0.53

Effect of integrated nitrogen management practices on nutrient uptake

Different nitrogen management practices showed significant effect on the nitrogen, phosphorus and potassium uptake by the hybrid maize. The highest nitrogen, phosphorus and potassium uptake (131.37, 25.46 and 142.70 kg/ha) were associated with the application of 100 % RDN + vermicompost 5 t/ha (T₇).The increase in nitrogen, phosphorus and potassium uptake might be due to adequate and balance availability of nutrients in soil which resulted in higher dry matter production as revealed in increased fresh weight and dry weight of plant. The minimal uptake of major nutrients was recorded in FYM 5 t/ha (T₁₀). These results confirm the earlier findings of Nanjapp *et al.*, (2001) and Datta *et al.*, (2003) (Table 3).

Effect of integrated nitrogen management practices on economics of hybrid maize production

The acceptance of innovated technology by the farmers ultimately depends on the economics involved in the production. Among the different indicators of monetary efficiency in any production system, the economics in terms of net returns and benefit cost ratio has a greater

impact on the utility and acceptance of the technology. The price of inputs and farm produce change from time to time and place to place. Accordingly to agronomic management practices crop production also will be vary from one farmer fields to another farmer fields (Table 4).

In the present study, the highest cost of cultivation was noticed with the application of 100% RDN + vermicompost 5 t/ha (Rs 107,979 /ha) followed by the application of 75% RDN + vermicompost 5 t/ha (Rs 107,261/ha). Higher cost of cultivation was mainly due to the higher cost of vermicompost. Similar results of higher cost of cultivation are well documented by Kumar *et al.*, (2007), Sujatha *et al.*, (2008) and Choudhary *et al.*, (2013) in hybrid maize.

Remarkably higher gross returns was obtained with the application of 100% RDN + vermicompost 5 t/ha (Rs 149,120/ha) which was closely followed by the treatment 100% RDN + FYM 5 t/ha (Rs 146,272/ha). The higher gross returns in this treatment are mainly attributed to higher grain and stover yield. Similarly, economic benefit of integrated nutrient management in maize was also reported by Negi *et al.*, (1992). Through higher gross return was associated with 100% RDN +

vermicompost 5 t/ha however, maximum net return and B: C ratio was recorded in the treatment 100% RDN + FYM 5 t/ha (T₄). The reason for higher economic benefit in this treatment (T₄) is due to lower cost of FYM as compared to vermicompost with the grain and stover yield remaining at par to one another (T₄ and T₇) Similar results of higher net returns were recorded by studies carried out by Pathak *et al.*, (2002), Saha and Mondal (2006), Sharma and Kumar (2009) and Jat *et al.*, (2013) in hybrid maize also clearly indicated that higher monetary return was obtained with integration of inorganic and organic nutrient management.

The net return and B: C ratio recorded negative value in the treatment with either vermicompost alone (T₁₁) or 50 % RDN + vermicompost 5 t/ha (T₉). This may be attributed to lower yield and higher cost of the input (vermicompost) which in turn resulted in lower monetary return.

On the basis of results obtained from the present investigation it could be concluded that the hybrid maize variety “PAC 740” responded well to the application of either 100 % RDN + vermicompost 5 t/ha or 100% RDN + FYM 5 t/ha. However, from the economic point of view, the highest monetary benefit in terms of net return and B: C ratio was associated with the application of 100 % RDN + FYM 5 t/ha. Further, higher monetary return could be achieved in the treatment with 100 % RDN + vermicompost 5 t/ha, if the farmer produce vermicompost in the farm itself to reduce the cost of this input.

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