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Research Article

Integrated nutrient management improves maize (*Zea mays* L.) yield in Namsai, Arunachal Pradesh

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ABSTRACT

An experiment was conducted in 2019-20 to study the performance of different integrated nutrient treatments in maize at the Agricultural Research Farm of Arunachal University. Eight (08) different combinations of organic manures and inorganic fertilizers were evaluated in three replications under randomized block design and results were found significant for all characters among these treatments. All treatment exhibited considerable variation in their performance for most of the parameters. Better growth and yield parameters in terms of plant height, number of leaves, days to 50% tasseling, ear length, ear diameter, number of cobs, weight of cobs, number of seeds per cob and grain yield were noticed in all treatments. Among all the treatments, T7 (Cowdung + NPK) enhanced maize yield and nutrient uptake compared to other treatments and hence, this combination may be recommended to farmers of Namsai region.

Keywords: Cowdung, growth, organic manure, yield, *Zea mays*

INTRODUCTION

Maize (*Zea mays* L. 2n= 20), known as "queen of cereals", member of Poaceae family is an important cereal crop and ranks third in production after rice and wheat in India. The average production of maize in India during 2020 was recorded 30.25 mt from an area of 9.2 mha with productivity of 2965 kg/ha (DACNET, 2020). In Arunachal Pradesh, it is grown in an area of 48.1 thousand hectares with annual production of 76 thousand metric tonnes. It has great significance as human food, animal feed and diversified uses for large number of industrial products.

The recent energy crisis, high fertilizer cost and low purchasing power of the farming community have made it necessary to rethink alternative strategies for sustainable agriculture. Maize being an exhaustive crop has very high nutrients demand and its productivity mainly depends upon nutrients management system. Integrated nutrient management (INM) enhances crop yield per unit of applied nutrients by providing a better physical, chemical and microbial environment (Madakemohekar et al., 2013). Continuous application of chemical fertilizer may tend to change the soil pH, disturb beneficial microbial populations, increase pest incidence, and also contribute to the release of greenhouse gases, thereby causing greater public health and environmental concerns.

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Therefore, under this situation, INM can serve as the vehicle for maintaining higher productivity and greater stability for production of crops. The available quantity of animal manure and crop residues cannot meet the country's requirements for crop production. Therefore, maximizing the usage of organic waste and combining it with chemical fertilizers and biofertilizers in the form of integrated manure is the major goal of INM to create a pollution free environment (Selim, 2020). Application of inorganic fertilizers with different sources in different proportions has the potential to boost crop productivity, improve nutrient uptake by plants and maintain soil nutrient status in maize-based cropping systems (Gundlur et al., 2015).

Although various experiments regarding the use of INM in maize have been reported throughout the world but very little information is available regarding their usage and method of application under agroclimatic conditions of Arunachal Pradesh. In Arunachal Pradesh, it is an added advantage that all the households are maintaining livestock (pig, poultry, cattle, goats, etc.) producing sufficient quantity of on-farm manures, which could be efficiently used in the farms. However, one of the major constraints encountered in integrated cultivation of maize is an inadequate knowhow on optimum use of fertilizers. Thus, the present study was carried out to evaluate the effect of various combinations of manure and fertilizers as integrated nutrient management in maize crop to increase the productivity in the study area.

MATERIALS AND METHODS

The study was conducted at the Agricultural Research Farm of Arunachal University of Studies during rabi season of 2019-20. The geographical position of Namsai is between 95°45' to 96°20' East longitudes and 27°30' to 27°55' North latitude. Namsai belongs to tropical climatic condition with an average rainfall of 3500-4000 mm at an average of 156 meters from mean sea level. The temperature ranges from 10ºC-25ºC during winter and 28ºC-40ºC in summer.

The hybrid maize variety Sulabh-25 was used in the experiment. The study consisted of 8 treatments: T1- Cowdung (15 ton ha^{-1}), T2- Poultry manure (10 ton ha^{-1}), T3- NPK (160: 40: 40 kg ha^{-1}), T4- Cowdung + Poultry (5 ton ha^{-1} + 5 ton ha^{-1}), T5-Cowdung + Poultry + NPK (5 ton ha^{-1} + 5 ton ha^{-1} + 140:70:20 kg ha^{-1}), T6- Poultry + NPK (5 ton ha^{-1} + 140:70:20 kg ha^{-1}), T7- Cowdung + NPK (5 ton ha^{-1} + 140:70:20 kg ha^{-1}), T8- Control. In case of T1 and T2, the total quantity of organic manures was applied in 2 equal splits i.e., at basal and at 45 days after planting. In other treatments full dose of organic manures was applied as a single dose as basal application. Phosphorous fertilizer was applied full as basal whereas ½ N and ½ K was applied as basal and ½ N and ½ K at 45 days after planting. The results were analysed using standard statistical procedures of ANOVA.

RESULTS AND DISCUSSION

Growth of maize was evaluated in respect of plant height (cm) at 50 days after planting (DAP), number of leaves per plant at 50 DAP, days taken to 50% tasseling, ear length (cm), ear diameter (cm), number of cobs per plant, weight of cobs (g) per plant and per plot (dry weight), number of seeds per cob (g) and grain yield (kg/plot) (Table 1).

Plant height was recorded at 50 days after planting (DAP). The results showed significant variation in plant height. In an average the highest plant height (tallest) was recorded in T4 (155.4 cm), while minimum (dwarf) plant height was observed in T3 (122.7 cm). For all the growth parameters T7 (Cowdung + NPK) showed the most favourable and commendatory treatment except in the case of plant height. The highest plant height in treatment T4 (Cowdung + Poultry Manure) over inorganic fertilizer treatments might be due to improvement of soil conditions by application of organic manures and are helpful in balancing nutrient availability which enhanced the plant growth (Gyewali et al., 2020).

Table 1: Growth and yield attributes of maize crop in response to various organic and inorganic fertilizers combination

Treatments	Plant height (cm) at 50 DAP	No. of leaves per plant at 50 DAP	Days taken to 50% tasseling	Ear length (cm)	Ear diameter (cm)	Number of cobs per plant	Dry weight of cobs per plant (g)	Number of seeds per plot	Grain yield per plant (kg)	Grain yield per plot (kg)
T1 (Cowdung)	151.39	26.55	53.67	11.75	10.89	7.33	91.91	174.27	4.06	65.67
T2 (Poultry Manure)	139.39	28.93	57.67	12.47	11.48	8.67	78.96	152.73	3.32	72.00
T3 (NPK)	122.77	27.73	61.00	14.65	13.24	7.67	97.71	237.92	4.17	71.67
T4 (Cowdung + Poultry)	155.43	28.61	56.67	13.36	12.03	5.67	83.59	234.85	3.75	79.33
T5 (Cowdung + Poultry + NPK)	128.40	29.57	57.67	13.58	12.12	6.00	77.87	211.28	4.18	80.33
T6 (Poultry + NPK)	148.11	28.50	57.67	13.75	12.31	5.67	87.19	286.92	3.98	79.33
T7 (Cowdung + NPK)	146.07	31.48	48.67	16.42	13.82	9.00	134.36	289.88	4.48	81.33
T8 (Control)	131.20	24.50	57.67	12.08	11.78	5.00	65.46	193.80	2.80	59.67
C.D.	N/A	3.61	5.47	N/A	N/A	N/A	N/A	N/A	N/A	N/A
SE(m)	12.99	1.18	1.79	1.42	0.63	1.71	15.15	36.12	0.69	7.12
SE(d)	18.36	1.67	2.53	2.01	0.89	2.42	21.42	51.09	0.98	10.07
C.V.	16.03	7.23	5.49	18.24	8.92	43.17	29.27	28.10	29.98	16.74

The data revealed significant difference among treatments on number of leaves per plant. The highest number of leaves per plant was recorded in T7 (31.4) while minimum (24.5) was observed in the control treatment. It is well established that the addition of organic manures along with inorganic fertilizers enhances the organic matter of the soil and availability of other plant nutrients (Brar et al., 2015). For this reason, the number of leaves per plant was significantly increased in cowdung and NPK treated plots.

The days taken to 50% tasseling were significantly different among the treatments. T7 (Cowdung + NPK) showed minimum days to 50% tasseling i.e., 48 days and T3 (NPK) showed the maximum days to 50% tasseling i.e., 61 days. Number of days taken to reach the stage of 50% tasseling was significantly affected by the integration of different organic and inorganic sources. T7 recorded the minimum number of days to 50% tasseling compared to other treatments which may be due to the abundant availability of NPK application that hastened the tasseling to the rapid growth and development of maize could be attributed to absorption of more quantities of available nutrients. Similar results were reported by Khadtare et al. (2006).

Ear length of maize in plots treated with cowdung and NPK fertilizers recorded the longest length with 16.4 cm. The shortest length was observed in those plots treated with only cowdung. Similarly, the maximum Ear diameter (13.8 cm) was observed in T7 (Cowdung + NPK) and minimum (10.8 cm) was observed in T1 (Cowdung). The maximum ear length and diameter in cowdung and NPK fertilizer treatments can be attributed to positive effects of organic manure and inorganic fertilizer on ear development in maize.

The number of cobs per plant were significantly influenced by treatments. The highest number of cobs per plant (9 cobs) was observed in T7 (Cowdung + NPK) whereas the minimum number of cobs per plant (5) was

found in T8 (Control). Number of cobs had positive relationship with number of seed per cob. Among the organic manures, better performance of T7 might be due to the continued supply of N until the reproductive stage of the crop growth as a result of faster decomposition by making more availability of the nutrients. This is in consonance with the findings of Kannan et al. (2013).

The highest cobs weight per plant (134.3 g) was found in T7 (Cowdung + NPK) while lowest weight of cobs per plant (65.4 g) was found in T8 (Control). This is probably due to greater availability of nutrients as reported by De Grazia et al. (2003) after conducting a field trial at Catede Horticulture and Agriculture Institute, Argentina. The highest number of seeds per plot (289.8 seeds) was found in T7 (Cowdung + NPK) followed by 286 seeds in T6 (Poultry + NPK) while the lowest (152.7 seeds) was observed in T2 (Poultry manure). This can be attributed to the positive effects of fertilizer, especially N fertilizer in promoting growth and yield in crops.

The highest grain yield per plant (4.48 kg) was found in T7 (Cowdung + NPK) while the lowest (2.8 kg) was found in T8 (Control). The grain yield per plot (81 kg) was highest in T7 (Cowdung + NPK) followed by 80 kg in T5 (Cowdung + Poultry + NPK), 79 kg in T4 (Cowdung + Poultry) and T6 (Poultry + NPK). Total grain yield per plot had significant positive correlation with number of leaves, days taken to 50% tasseling, ear length, ear diameter, number of cobs per plant and weight of cobs (Table 2).

Application of nitrogen either through inorganic or organic sources positively influenced the grain weight and number of grains per cob, which in turn increased the weight of grains per cob. Significantly the higher weight of grains per cob might be due to steady supply of nutrients throughout the growing period of the crop. Cowdung was found to be the important component leading to maximum grain yield. The positive response of crop to cowdung is due to the presence of higher quantity of phosphorus and secondary nutrients. The plants with ample phosphorus might have showed the highest meristematic activity which resulted in an increase in the number of leaves and seed setting percentage per plant. Similar opinion was expressed by Gosavi et al. (2006). The higher yield attributes obtained from the application of cowdung with NPK fertilizers might be attributed to the stimulating effect of cattle

Table 2: Correlation matrix of growth and yield attributes in comparison with treatments

	PH	NOP	DT	EL	ED	NCP	WCP	NSC	GYP	GYPP
PH	1									
NOP	0.64	1								
DT	-0.88	-0.45	1							
EL	0.73	0.40	-0.38	1						
ED	0.63	0.45	0.23	0.96	1					
NCP	0.54	0.49	-0.44	0.33	0.28	1				
WCP	0.87	0.45	-0.70	0.82	0.72	0.63	1			
NSC	0.52	0.36	-0.27	0.79	0.77	-0.14	0.59	1		
GYP	0.90	0.46	-0.76	0.83	0.71	0.55	0.99	0.64	1	
GYPP	0.30	-0.07	-0.00	0.79	0.71	0.12	0.56	0.63	0.55	1

PH - Plant height at 50 DAP; NOP – Number of leaves per plant at 50 DAP; DT – Days taken to 50% tasseling; EL – Ear length; ED – Ear Diameter; NCP – Numbers of cobs per plant; WCP – Weight of cobs per plot; NSC – Numbers of seeds per cob; GYP – Grain yield per plant; GYPP – Grain yield per plot

manure that supplies nutrients required for better yield of plant. Recent study indicated that different nitrogen doses influenced the growth and yield of maize in Namsai, Arunachal Pradesh (Singh & Manpoong, 2022). The combined application of cattle manure and NPK fertilizer increased the maize growth, which might have been due to the balance availability of nutrients to the plants that resulted in a favourable soil environment. These favourable conditions increased the nutrient availability and water holding capacity of the soil resulting in enhanced growth and yield of maize (Rashid et al., 2013).

CONCLUSION

The study clearly indicated that cowdung and NPK fertilizers significantly improved the performance of maize crop in Namsai. Therefore, it is recommended that resource poor farmers in the study area should utilize integrated application of cowdung with NPK fertilizers for increasing the yield of maize. Through the experiment, it can be concluded that integrated nutrient treatment i.e., T7 (Cowdung + NPK) have shown the best performance with respect to growth and yield parameters. This indicates that maize responds well to integrated nutrient management in the plains of Namsai district, Arunachal Pradesh.

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