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ENHANCING THE PRODUCTIVITY OF HYBRID MAIZE AS INFLUENCED BY INTEGRATED NUTRIENT MANAGEMENT TECHNIQUES

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Abstract

Field experiment was conducted at Farmer's field, Koothampoondi Village, Anthiyur Taluk, Erode District, Tamil Nadu to study the effect of integrated nutrient management on growth, yield and economics of maize. The experiment was laid out in randomized block design with ten treatments replicated thrice by using maize hybrid NK6240. Among the various treatments, the application of 100% Recommended Dose of Fertilizer + vermicompost @ 5 t ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1} (T_9) recorded maximum growth, yield attributes, yield and economics.

Keywords: Maize, Recommended Dose of Fertilizer, vermicompost, vermicompost, seed treatment, *Azospirillum*.

Introduction

Maize (*Zea mays* L.) is the third most important cereal crop next to rice and wheat in the world. Maize has been an important economic cereal crop in indian economy because of its higher production potential and it is an efficient converter of solar energy into dry matter, composed to any other cereal crop and has adaptability to wide range of environment and the crop has very high genetic yield potential. Maize grain contain about 72 percentage starch, 10 percentage protein, 4.85 percentage oil, 5.8 percentage fibre and 3.0 percentage sugar. Maize is otherwise known as **"queen of cereals"** or **"miracle crop"** (Ratuarary *et al.,* 2013). Worldwide maize is grown over an area of 181.38 million hectares with a production of 1073.93 million tonnes and with the productivity of 5.73 t ha^{-1}. In India, maize occupies an area of 9.50 million hectares with a production of 24.50 million tonnes and the productivity of 2.58 ha^{-1} (Foreign Agricultural Service USDA, 2017). In Tamilnadu, it is cultivated in an area with a productivity of 6.5 t ha^{-1} (Annual Maize Report AICRP, 2016).

Maize is an annual C_4 plant has tremendous yield potential and responds well to applied inputs. However, its potential could not be utilized fully due to lack of proper agronomic management practices like nutrient management, season and variety (Sahrawat *et al.,* 2008). The productivity of maize is largely depend on its nutrient management. It is well known that maize is a heavy feeder of nutrients. Maize is used for the production of starch, syrup, acetic and lactic acids, paper and adhesives. Nitrogen, phosphorus and potassium are the key nutrients which greatly influence the yield of crops. Inorganic fertilizers cannot be avoided completely since they are the potential sources of high amount of nutrients in easily available forms. Fertilizer management is one of the most important factors that influence the growth and yield of maize crops (Ghaffari *et al.,* 2011). In addition, integration of organic with inorganic fertilizers improves the maize physiological system and modifies physico-chemical properties for sustaining and maintaining soil productivity. Hence, judicious application of organic with inorganic fertilizers can sustain the soil fertility and productivity (Sindhi *et al.,* 2018). Vermicompost contains considerable amount of plant nutrients in available form to the plants (Pawar and Patil, 2007) and to produce fully stabilize organic soil amendments with low C:N ratio (Ramasamy *et al.,* 2011). *Azospirillum* is an important free living organism that can fix atmospheric nitrogen into the soil ranging from 20 to 30 kg ha^{-1} but also triggers the production of growth substance like auxins, gibberellins and cytokinins. Seed inoculation with Azospirillum increase plant height and yield of maize crop (Kumar *et al.,* 2017). Enriched farmyard manure is the addition of required quantity of phosphorus for the crop to the farmyard manure, it is used to decrease the nutrient losses and to minimize excess use of fertilizers for optimum yield and quality of crop without harming soil and environment (Aswini *et al.,* 2015).

Materials and Methods

Field experiment was conducted at Farmer's field, Koothampoondi Village, Anthiyur Taluk, Erode District, Tamil Nadu to study the effect of integrated nutrient management on growth, yield and economics of maize hybrid NK6240. The experimental soil is clay loam in texture with pH of 8.1. The soil was low in available nitrogen (194.0 kg ha^{-1}), medium in available phosphorus (22.0 kg ha^{-1}) and high in available potassium (260.9 kg ha^{-1}). The experiment was laid out in Randomized Block Design and replicated thrice. There were although ten treatments *viz.,* T_1 – 100% Recommended dose of fertilizer (RDF) 250:75:75 kg NPK ha^{-1}, T_2–75% Recommended dose of fertilizer (RDF) 250:75:75 kg NPK ha^{-1}, T_3–100% Recommended dose of fertilizer (RDF) + Enriched farmyard manure @ 750 kg ha^{-1}, T_4–75% Recommended dose of fertilizer (RDF) + Enriched farmyard manure @ 750 kg ha^{-1}, T_5 – 100% Recommended dose of fertilizer (RDF) + Vermicompost @ 5 t ha^{-1}, T_6–75% Recommended dose of fertilizer (RDF) + Vermicompost @ 5 t ha^{-1}, T_7–100% Recommended dose of fertilizer (RDF) + Enriched farmyard manure @ 750 kg ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1}, T_8–75% Recommended dose of fertilizer (RDF) + Enriched farmyard manure @ 750 kg ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1}, T_9–100% Recommended dose of fertilizer (RDF) + Vermicompost @ 5 t ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 ha^{-1}, T_{10}-75%

Recommended dose of fertilizer (RDF) + Vermicompost @ 5 t ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1}. The recommended seed rate of 15 kg ha^{-1} hybrid Maize was adopted. Two seeds $hole^{-1}$ were dibbled at a depth of 4 cm with a spacing of 60 cm × 20 cm. The recommended fertilizers schedule of 250:75:75 N, P_2O_5 and K_2O kg ha^{-1} were applied as per fertilizer schedule. The entire dose of phosphorus and potassium were applied basally. A half dose of nitrogen was applied basally and the remaining half doses of nitrogen were applied as two splits (top dressing) on 25 and 45 days after sowing. Vermicompost was applied basally @ 5 t ha^{-1} and enriched FYM also applied basally @ 750 kg ha^{-1}. The observations on growth, yield were recorded. The economics were worked out based on the prevailing market price.

Result and Discussion

Growth characters

Growth characters of maize were significantly influenced by the integrated nutrient management practice (Table 1). the maximum plant height (269.56 cm), leaf area index (6.18) and dry matter production (11240 kg ha^{-1}) wrer observed in the treatment 100% Recommended Dose of Fertilizer + vermicompost @ 5 t ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1} (T_9). Application NPK with organic manure increased the growth characters, as many researchers state that vermicompost involved in the synthesis of certain phytohormone and vitamins and more chlorophyll. Leaf area index is an indicator of photosynthetic capacity and translocation. It also supply balanced amount of nutrients to stimulate growth and promote root growth resulting in taller plant. A similar result of finding was in concomitance with Lazcano *et al.* (2011), Nagavani and Subbian (2014) and Verma *et al.* (2018). Application of *Azospirillum* increased the germination percentage, plant height, leaf area index and dry matter production by fixing atmospheric nitrogen and solubilizing nutrients and it secretes growth promoting hormones like auxins, gibberllins, cytokinins etc., to enhance the shoot and root growth of the crop and it is eco-friendly in nature. These results are accordance with the findings of Tetarwal *et al.* (2012) and Iwuagwu *et al.* (2013).

Yield attributes and yield

Application of organic and inorganic fertilizer markedly increased the yield attributes and yield (table 2). The maximum cob length (26.75 cm), cob diameter (6.90 cm), 100 grain weight (26.43 g), number of grains cob^{-1} (484) grain yield (6898 kg ha^{-1}) and stover (9430 kg ha^{-1}) were significantly registered with application of 100% recommended dose of fertilizer + vermicompost @ 5 t ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1} (T_9). The increased yield components due to the application of 100% recommended dose of fertilizer resulted in higher nutrient uptake by increasing nutrient availability. These findings were in agreement with reports of Gul *et al.* (2015). It has been emphasized that NPK fertilizer play a vital role in improving three major aspects of yield determination *i.e.,* formation of vegetative structure for nutrient absorption, photosynthesis and strong sink length through development of reproductive structure. The influence of NPK level in both of these characters mediated through increased photosynthesis efficiency and nutrient accumulation have ultimately led to production of higher biological yield under this application. The observed result are in close conformity with findings of Deewan *et al.* (2017). Application of inorganic fertilizer would lead to an increased yield due to the readily available and mineralized nutrients present in inorganic fertilizers along with constant release of nutrients by organic fertilizers. This was in concurrence with Canatoy (2018).

The application of vermicompost @ 5 t ha^{-1} along with organic fertilizer increased the length of the cob, cob diameter and number of grains cob^{-1}. The present result were in accordance with the findings of Shadab Niazi *et al.* (2017). Combined application of inorganic fertilizer with vermicompost gave higher grain yield because vermicompost act as a nutrient reservoir and upon decomposition produces organic acids, there by absorbed ions are released slowly for the entire growth period leading to higher yield. Similar findings were reported by Rayees and Wani (2017). The combined use of *Azospirillum* with NPK fertilizer increased yield components *viz.,* cob length, cob diameter, and number of grains cob^{-1} and 100 grain weight. The uses of biological fertilizers significantly reduced the consumption of chemical fertilizers and reduced the adverse environmental effect and increased the grain yield. The result also confirmed with the reports of Shirkhani and Nasrolahzadesh (2016).

Economics

Among the different nutrient management practices, application of 100% recommended dose of fertilizer + vermicompost @ 5 t ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1} (T_9) recorded the higher gross return (Rs. 1,15,432 ha^{-1}) and net return (Rs.73,546 ha^{-1}). The additional cost of vermicompost was compensated by the additional cob yield of maize. We found that the net return was highest in the vermicompost application. Application of cattle manure vermicomposting harvested greater grain yield which led to a higher output and it generated more economic benefits. The result was in accordance with the findings of Nurudeen *et al.* (2015) and Guo *et al.* (2016). The least net return ha^{-1} and return $rupee^{-1}$ were recorded in treatment (T_2).

Conclusion

Based on the results of the experiment carried out at Koothampoondi village, Erode district, it can be concluded that application of 100% recommended dose of fertilizer + vermicompost @ 5 t ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1} (T_9) registered the higher values for most of the parameters like growth, yield attributes, grain yield and economics of hybrid maize. Hence, this practices is considered to a suitable to maize farmers for realizing better yield, return and also improve soil fertility.

Table 1: Effect of integrated nutrient management practices on growth characters of hybrid maize

Treatments	Plant height (cm)			Leaf area index		DMP (kg hg^{-1})		
	30 DAS	60 DAS	Harvest	30 DAS	60 DAS	30 DAS	60 DAS	Harvest
T_1 – 100% RDF (250:75:75 kg NPK ha^{-1})	63.82	150.35	168.23	1.56	4.04	3285	5469	7857
T_2 – 75% RDF (250:75:75 kg NPK ha^{-1})	55.12	138.49	155.59	1.32	3.83	2978	4960	7439
T_3 – 100% RDF + EFYM @ 750 kg ha^{-1}	74.57	175.15	192.37	1.99	4.65	3822	6208	8693
T_4 – 75% RDF + EFYM @ 750 kg ha^{-1}	68.59	161.00	180.11	1.78	4.30	3516	5847	8272
T_5 – 100% RDF + Vermicompost @ 5 t ha^{-1}	83.58	198.62	219.42	2.53	5.21	4379	6970	9523
T_6 – 75% RDF + Vermicompost @ 5 t ha^{-1}	79.39	186.26	206.65	2.21	4.89	4156	6524	9112
T_7 – 100% RDF + EFYM @ 750 kg ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1}	92.68	221.70	243.14	3.04	5.72	4860	7814	10392
T_8 – 75% RDF + EFYM @ 750 kg ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1}	87.93	210.32	230.09	2.82	5.47	4643	7398	9968
T_9 – 100% RDF + Vermicompost @ 5 t ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1}	104.70	242.54	269.56	3.53	6.18	5349	8495	11240
T_{10}– 75% RDF + Vermicompost @ 5 t ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1}	98.94	230.75	255.78	3.31	5.94	5067	8117	10813
S.Ed	1.16	3.66	4.03	0.05	0.10	89.78	143.98	184.31
CD (P = 0.05)	2.43	7.71	8.46	0.10	0.20	179.56	287.96	368.63

Table 2: Effect of integrated nutrient management practices on yield attributes, yield and economics of hybrid maize

Treatments	Cob length (cm)	Cob diameter (cm)	Number of grains cob^{-1}	Test Weight (g)	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Gross income (kg ha^{-1})	Net income (kg ha^{-1})
T_1 – 100% RDF (250:75:75 kg NPK ha^{-1})	16.40	3.79	304	26.05	3024	6020	48,356	15,760.34
T_2 – 75% RDF (250:75:75 kg NPK ha^{-1})	14.57	3.22	279	25.98	2740	5660	44,020	12,501.38
T_3 – 100% RDF + EFYM @ 750 kg ha^{-1}	19.84	4.34	351	26.12	3968	6860	62,412	27,526.96
T_4 – 75% RDF + EFYM @ 750 kg ha^{-1}	17.93	4.08	329	26.09	3576	6480	56,544	23,262.26
T_5 – 100% RDF + Vermicompost @ 5 t ha^{-1}	22.19	5.21	396	26.24	4900	7760	76,360	37,150.59
T_6 – 75% RDF + Vermicompost @ 5 t ha^{-1}	20.95	4.72	373	26.16	4439	7330	69,476	32,869.88
T_7 – 100% RDF + EFYM @ 750 kg ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1}	24.14	6.06	440	26.32	5890	8640	91,100	54,302.06
T_8 – 75% RDF + EFYM @ 750 kg ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1}	23.22	5.69	419	26.26	5385	8210	83,600	48,902.72
T_9 – 100% RDF + Vermicompost @ 5 t ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1}	26.75	6.90	484	26.43	6898	9430	1,15,432	73,546.56
T_{10}– 75% RDF + Vermicompost @ 5 t ha^{-1} + seed treatment (*Azospirillum*) @ 600 g ha^{-1} + soil application (*Azospirillum*) @ 2000 g ha^{-1}	25.37	6.32	462	26.37	6377	9080	1,08,438	67,001.61
S.Ed	0.43	0.11	8.19	NS	109.41	159.27		
CD (P = 0.05)	0.91	0.22	16.39	NS	218.83	318.54		

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