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OPTIMIZATION OF NPK WITH ZINC FERTILIZER ON YIELD, YIELD ATTRIBUTES AND NUTRIENTS UPTAKE OF HYBRID MAIZE

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Abstract

Maize (*Zea mays* L.) is one of the most important cereal crops in the world agricultural economy, both as food for human beings and feed for animal. Among the plant nutrients, macro nutrients such as nitrogen, phosphorous and potassium play a crucial role in deciding the maize growth and yield. The response of crops to macronutrients varies widely from place to place, depending upon the fertility level of soil and other environmental conditions. A field experiment was conducted to study the optimization of NPK with zinc fertilizer on yield, yield attributes and nutrients uptake of hybrid maize in sandy loam soil of Vanniyarpalayam village belongs to Vadalapakkam series (*Typic Rhodustalf*), low in organic carbon, low in available N, low in available P and medium in available K. Field experiment was conducted with seven treatments *viz.*, T_1- 50% RDF, T_2- 100% RDF, T_3- 150% RDF, T_4- 150% RDF + $ZnSO_4$ @ 25 kg ha^{-1}, T_5- 150% RDF + $ZnSO_4$ @ 25 kg ha^{-1} + Neem cake @ 200 kg ha^{-1}, T_6- 150% RDF + $ZnSO_4$ @ 25 kg ha^{-1} + *Azotobacter* @ 2 kg ha^{-1}, T_7- 150% RDF + $ZnSO_4$ @ 25 kg ha^{-1} + Neem cake @ 200 kg ha^{-1} + *Azotobacter* @ 2 kg ha^{-1}. The experiment was carried out in Randomized Block Design (RBD) with four replications and tested with maize var. Dhanvi-166 as test crop. The results of the study indicated that the application of 150 % recommended dose of fertilizer, zinc sulphate @ 25 kg ha^{-1} and neem cake @ 200 kg ha^{-1} along with azotobacter @ 2 kg ha^{-1} was significantly registered the maximum grain yield of 620.48 kg ha^{-1} and Stover yield is 8951.91kg ha^{-1}. Lowest grain yield, Stover yield and nutrient uptake is was noticed in 50 % recommended dose of fertilizer treatment.

Key words: Nitrogen, Phosphorus, Potassium, Zinc sulphate, Neem cake, Azotobacter and Maize.

Introduction

Maize (*Zea mays* L.) is an important crop among the cereals in India. It is also known as "Queen of Cereals". It is one of the important food, fodder, industrial and table purpose crop and fetches very good price in the market. Maize is an exhaustic nature and requires balanced supply of major plant nutrients on most of the soils. It responds well to various agronomic practices and has capacity for bulk production, in short span of 90-110 days. It can be successfully grown in area receiving an annual rainfall of 60mm provided it should be well distributed throughout the growth period. It may tolerate an annual rainfall of 250-400 mm. India is the sixth largest producer of maize with 22.36 million tonnes of production from 9.40 million hectares, with a productivity of 2.4 t ha^{-1} (ASG, 2016). In Tamil Nadu, maize is cultivated in an area of 0.20 million hectares with a production of 0.24 million tonnes and productivity of 1189 kg ha^{-1} (crop report, 2017). Among the inorganic nutrients, nitrogen, phosphorus and potassium play important role in the growth and development of crop plants. Nitrogen is indispensable for increasing crop production as a constituent of protoplasm and chlorophyll and is associated with the activity of every living cell. Similarly, phosphorus also plays an important role in energy storage and transfer in the plant system. In addition, phosphorus is an important constituent of nucleic acids, phytins, phospholipids and enzymes. Potassium plays an important role in the maintenance of cellular organizations by regulating permeability of cell membranes and keeping the protoplasm in a proper degree of hydration. It activates the enzyme in protein and carbohydrate metabolism and translocation of carbohydrates and imparts resistance to plants against fungal and bacterial diseases. Several

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workers have reported the beneficial effects of NPK fertilization on productivity of maize (Rajanna *et al.,* 2006). Zinc is now been reported as the third most important limiting nutrient element in crop production after N and P. application of zinc fertilizers in soils is highly economic and profitable. Among the micronutrients, zinc is predominant in almost all types of soils. (Anonymous, 2004). Integrated use of organic and inorganic fertilizers not only recorded significantly greater root-shoot dry matter but also accelerated their yield compared to inorganic fertilizer application (Ghosh *et al.,* 2003). The aim of the research was to determine the effect of *Azotobacter chroococcum* on the microbiological activity in the rhizosphere and on the grain yield of maize hybrids grown in the system of organic production. Azotobacter bacteria utilize atmospheric nitrogen gas for their cell protein synthesis. This cell protein is then mineralized in soil after the death of *Azotobacter* cells thereby contributing towards the nitrogen availability of the crop plants. *Azotobacter* sp. is sensitive to high salts and temperature (Tchan and New, 1998).

Materials and Methods

A field experiment was conducted to study the optimization of NPK with zinc fertilizer on yield attributes and nutrients uptake of hybrid maize sandy loam soil. The initial soil of the experimental site had a pH–6.0 and EC-0.40 dSm^{-1}. The soil was low in available N (182 kg ha^{-1}), P (9.3 kg ha^{-1}) and medium in available K (235 kg ha^{-1}) respectively. The low status of DTPA-Zn is 1.05 mg kg^{-1}. The treatment imposed *viz.*, T_1- 50% RDF, T_2- 100% RDF, T_3 - 150% RDF, T_4- 150% RDF + $ZnSO_4$ @ 25 kg ha^{-1}, T_5- 150% RDF + $ZnSO_4$ @ 25 kg ha^{-1} + Neem cake @ 200 kg ha^{-1}, T_6- 150% RDF + $ZnSO_4$ @ 25 kg ha^{-1} + *Azotobacter* @ 2 kg ha^{-1}, T_7- 150% RDF + $ZnSO_4$ @ 25 kg ha^{-1} + Neem cake @ 200 kg ha^{-1} + *Azotobacter* @ 2 kg ha^{-1}. The experiment was laid out in Randomized Block Design (RBD) with four replications using maize var. Dhanvi-166 as test crop. A fertilizer dose of 135: 62.5: 50 kg of nitrogen, phosphorus and potassium per hectare for maize was applied as urea, single super phosphate and muriate of potash, respectively. Entire N, P_2O_5 and K_2O were applied as basal. A required quantity of zinc sulphate @ 25 kg ha^{-1} was also applied as basal as per the treatment schedule. Composted neem cake @ 200 kg ha^{-1} were applied basally and well incorporated into the soil as per the treatment schedule. The bio fertilizer namely *Azotobacter* @ 2 kg ha^{-1} was applied to all the experimental plots. The yield and yield attributes *viz.*, cob weight, cob length, cob girth, grain yield and Stover yield were recorded. Nutrient uptake of nitrogen, phosphorus, potassium and zinc was registered at 30, 60 DAS and harvest stage of maize.

Result and Discussion

Yield attributes

The yield attributes such as cob weight, cob length, cob girth, number of grains per cob, hundred seed weight, grain and Stover yield were significantly influenced by various treatments. The maximum cob weight (212.5 g), longest cob (25.51 cm) and maximum cob girth (13.74 cm) were obtained from the treatment with 150% recommended dose of fertilizer, zinc sulphate @ 25 kg ha^{-1}, neem cake @ 200 kg ha^{-1} along with *azotobacter* @ 2 kg ha^{-1} followed by the treatment with 150% recommended dose of fertilizer, zinc sulphate @ 25 kg ha^{-1} plus neem cake @ 200 kg ha^{-1} treatment. The different levels (50%, 100% and 150%) of recommended dose fertilizer alone treatments gave the lower values of yield attributes than the other combination treatments Table 2. Significantly higher grain and Stover yields (7620.48 and 8951.91 kg ha^{-1}) were recorded with the application of 150 % recommended dose of fertilizer, zinc sulphate @ 25 kg ha^{-1}, neem cake @ 200 kg ha^{-1} along with azotobacter @ 2 kg ha^{-1}. The application of 150 % recommended dose of fertilizer, zinc sulphate @ 25 kg ha^{-1} along with neem cake @ 200 kg ha^{-1} resulted in the next highest grain and Stover yields (7442.15 and 8651.66 kg ha^{-1}) respectively. The increased in grain yield of maize might be due to the highest growth attributes in maize

Table 1: Effect of macro and micro nutrient fertilizers with organic sources of nutrients of maize on cob weight (g), cob length (cm), cob girth (cm), grain yield (kg) and stover yield (kg)

Treatments	Cob weight (g)	Cob length (cm)	Cob girth (cm)	Grain yield	Stover yield
T_1	150.03	16.35	7.14	5578.64	6526.48
T_2	161.40	17.98	7.60	6048 .22	6986.00
T_3	175.10	20.46	8.84	6487.84	7464.63
T_4	190.92	21.13	11.26	6809.42	7902.74
T_5	211.60	25.35	13.46	7442.15	8651.66
T_6	200.10	21.57	11.60	7018.44	8192.35
T_7	212.5	25.51	13.74	7620.48	8951.91
SEd	5.08	0.23	0.16	134.34	178.38
CD (p=0.050)	11.18	0.51	0.36	295.55	392.45

Table 2: Effect of macro and micro nutrient fertilizers with organic sources of nutrients on nitrogen (kg ha^{-1}), phosphorus (kg ha^{-1}), potassium (kg ha^{-1}) and zinc (kg ha^{-1}) uptake in maize

Treatments	Nitrogen (kg ha^{-1})			Phosphorus (kg ha^{-1})			Potassium (kg ha^{-1})			Zinc (g ha^{-1})		
	30 DAS	60 DAS	Harvest stage	30 DAS	60 DAS	Harvest stage	30 DAS	60 DAS	Harvest stage	30 DAS	60 DAS	Harvest stage
T_1	108.85	127.52	142.12	52.88	54.65	56.48	100.02	145.84	174.25	75.17	96.68	100.61
T_2	116.68	136.71	153.68	54.88	58.28	62.19	107.74	154.66	185.47	92.41	120.76	133.07
T_3	127.45	147.18	166.43	57.23	62.41	68.80	114.46	164.88	196.56	110.77	144.52	164.13
T_4	136.96	163.36	180.52	59.90	66.37	74.53	123.96	175.84	207.97	127.46	168.36	195.56
T_5	150.88	188.94	206.84	60.78	71.98	83.48	140.30	192.26	227.93	151.91	197.26	238.27
T_6	142.22	170.24	189.21	56.25	68.82	77.95	129.12	181.95	215.16	133.34	173.48	206.91
T_7	156.63	195.45	216.24	61.36	74.28	86.75	146.55	198.68	235.72	158.62	201.48	244.81
SEd	3.43	3.84	4.78	0.55	1.30	1.91	0.55	3.68	4.38	4.46	6.98	8.39
CD (p=0.050)	7.56	8.45	10.52	1.22	2.86	4.21	1.22	8.11	9.64	9.82	15.36	18.47

and enhanced level of nutrients applied to the crop. The different levels (50 %, 100% and 150%) of recommended dose fertilizer alone treatments recorded the lower grain and Stover yield than the other combination treatment Table 2. Grain yield in maize showed positive relationship with increase in potash levels statistically higher value of yield attributes with cob length cob girth, single cob weight and biological yield in maize. The results are in agreement with the Ullasa *et al.,* (2017) Raghavendra *et al.,* (2018) and Hussain *et al.,* (2019). Significantly higher values of most of the above mentioned parameters were recorded under application of *azotobacter* combination treatment. Inoculation of azotobacter increased the biomass (straw yield) production which may have favorably contributed for the grain weight. Hence the grain weight registered was higher in the *azotobacter*. This could be owing to better growth of plant in terms of dry matter accumulation under inoculation of azotobacter. The present results are in accordance with those reported by Tetarwal *et al.,* (2011), Baral and Adhikari (2013), Tomar *et al.,* (2017) and Panchal *et al.,* (2018).

Nutrient uptake

The uptake of N, P, K and Zn was significantly influenced by the application of various levels (50 %, 100% and 150% RDF) of recommended dose of fertilizer, zinc sulphate along with azotobacter and neem cake. Among the various treatments, the combined application 150% recommended dose of fertilizer, zinc sulphate @ 25 kg ha^{-1}, neem cake @ 200 kg ha^{-1} along with *azotobacter* @ 2 kg ha^{-1} recorded the highest N uptake. The values were 156.63 kg ha^{-1} at 30 DAS, 195.45 kg ha^{-1} at 60 DAS, 216.24 kg ha^{-1} in grain and 58.65 kg ha^{-1} in Stover. With respect to phosphorous uptake the maximum phosphorous noticed in same treatment and values were 61.36, 74.28, 86.75 and 24.55 kg ha^{-1} in 30 DAS, 60 DAS, Stover and grain respectively. Regarding maximum potassium uptake noticed in treatment T_7 (150% RDF + $ZnSo_4$ @ 25 kg ha^{-1} + Neem cake @ 20 kg ha^{-1} + *azotobacter* @ 2 kg ha^{-1}). The values were 146.55, 198.68, 235.72 and 67.56 kg ha^{-1} at 30 DAS, 60 DAS, Stover and grain respectively. The various levels (50 %, 100% and 150%) of recommended dose fertilizer alone treatments gave the lowest uptake of nitrogen, phosphorus, potassium and zinc than the other combined application treatments Table 1. The nutrient uptake in plants is a function of growth and availability of nutrients. Higher the availability of nutrients in soil better is the nutrient uptake and plant growth. The nitrogen, phosphorus and potassium uptake by maize increased with the advancement of decomposition process of different forms of neem cake. Maize has high demand for N as indicated by the high N uptake compared to P across all treatments. The high uptake of N is linked to the high demand for protein production being utilized in crop development (vegetative and reproductive stages) while P is mostly required to boost early root development resulting in uptake of other soil nutrients for plant growth and development. The uptake trend for K study confirms that maize has higher requirement of K after nitrogen. Compared to organic fertilizer like neem cake and azotobacter to inorganic fertilizer, studies showed that organic neem cake treated treatments shows significantly higher NPK uptake may be due to more balanced available nutrient for plant uptake. Similar findings are reported by Lehmann, (2006) and Garba and Oyinlola (2014). Nutrient uptake of NPK and Zn by grain significantly influenced by azotobacter treatment. These results were in conformity with these of Abdelmuniem and Madhavi (2016).

Conclusion

The results of the study showed that for increased yield and yield attributes and nutrient uptake by maize in sandy loam soil, application of 150% recommended dose of fertilizer, zinc sulphate @ 25 kg ha^{-1}, neem cake @

200 kg ha^{-1} along with *azotobacter* @ 2 kg ha^{-1} was identified as best treatment combination to recommend to the farmer's of Cuddalore district to realize the maximum net profit in maize yield.

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