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Research Article

EFFECT OF NITROGEN, FYM AND AZOTOBACTOR ON YIELD AND YIELD ATTRIBUTES OF MAIZE (*Zea mays* L.)

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Abstract: The experiment was conducted at the Soil Science Research Farm of SHUATS – State University, Allahabad, U.P. The design of experiment used was 3x2x2factorial randomized block design having three factors *viz*. three levels of N (60, 90 and 120 kg N ha^{-1}), two levels of FYM (0 and 10 t ha^{-1} FYM) and two Azotobactor levels (0 and 200 g per 10 kg seeds). Application of nitrogen @ 120 kg ha^{-1} gave the maximum cob length (18.00 cm), number of grains cob^{-1} (346.70), test weight (211.79 g) and grain yield (43.03 q ha^{-1}) all these attributes were significantly higher over N1 (90 kg N ha^{-1}) and N0 (60 kg N ha^{-1}). Application of FYM @10 t ha^{-1} recorded the highest cob length (15.81 cm), number of grains cob^{-1} (326.40), test weight (205.57 g) and grain yield (36.34 q ha^{-1}) which was significantly higher over no FYM application. Azotobactor @ 200 g per 10 kg seeds recorded cob length (15.38 cm), number of grains cob^{-1} (323.45), test weight (204.12 g) and grain yield (35.45 q ha^{-1}) these were statistically superior over no seed treatment with Azotobactor. Combined treatment application (T11 = N2+F1+A1) of nitrogen 120 kg ha^{-1}, 10 t FYM ha^{-1} and 200 g Azotobactor ha^{-1} was recorded significantly higher cob length (19.11 cm), number of grains cob^{-1} (362.87), test weight (25.20 g) and grain yield (45.58 q ha^{-1}) these were statistically superior over rest of the treatment combinations.

Keywords: Maize, yield, nitrogen, FYM and Azotobactor

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Introduction

Awareness Maize is cultivated over an area of 177 million tonnes with a production of about 872 million tonnes of grain in the world. USA leads with largest area, followed by Brazil, China, and India. Maize is grown in almost all states of India occupying an area of 8.4 m ha with production and productivity of 21 million tonnes and 3.04 t ha^{-1}, respectively [1]. Maize is a member of family *graminae (poaceae)* sub family panicoideae. Maize is also known as 'Queen of cereals' and fodder maize has been usually considered as poor man's crops and occupying the place in the rich communities due to its multifarious uses as industrial food and feed crops. It is known as an indicator plant for evaluation of Zn deficiency of a soil [2]. Maize rank third in global cereal scenario after wheat and rice, but in India it stands in fourth position followed by rice, wheat and sorghum. The higher yield potential of maize cannot be manifested up to the brim due to several biotic and abiotic factors among which poor nutrient management is the prime one. Being an exhaustive crop especially the improved and hybrids, it responds positively to applied nutrients. Application of nitrogen up to 180 kg ha^{-1} was found to be most beneficial for grain and total biomass production of maize as well as the monetary returns [3]. Maize has high genetic yield potential than other cereal crops. Hence it is called as 'miracle crop' and also being a C4 plant, it is very efficient in converting solar energy in to dry matter. In Indian agriculture, maize assumes a special significance on account of its utilization as food, feed and fodder besides several industrial uses. The organic sources besides supplying NPK also make unavailable sources of elemental nitrogen, bound phosphates, micronutrients and decomposed plant residues into an available form to facilitate to plant to absorb the nutrients. But, it is also the fact that optimum yield level of maize production can't be achieved by using only organic manures because of their low nutrient content.

Efficacy of organic sources to meet the nutrient requirement of crop is not as assured as mineral fertilizers, but the combined use of chemical fertilizers along with various organic sources is improve soil quality and higher crop productivity on long- term basis. Highest productivity of crops in sustainable manner without adversely affecting the soil and other natural resources could be achieved only by applying appropriate combination of different organic manures and inorganic fertilizers [4]. Nitrogen is a vitally important for plant nutrient. Nitrogen is essential constituent of protein and is present in many other compounds of great physiological importance in plant metabolism. Nitrogen is called a basic constituent of life. Nitrogen also produces vigorous vegetative growth and imparts dark green colour to plant and it increase early growth of maize. Nitrogen governs the utilization of potassium, phosphorus and other elements in maize crop. The quantity required of these nutrients particularly nitrogen depends on the preclearing vegetation, organic matter content, tillage method and light intensity. FYM (farm yard manure) helps to improve and conserve the fertility of soil. FYM imparts dark color to the soil and thereby help to maintain the temperature of soil. The activity and population of beneficial soil organisms increased on application of FYM in soil. FYM is one of the oldest manure used by the farmer is growing crops because of its early availability and presence of almost all the nutrient required by plant. Azotobactor represents the main group of heterotrophic, non symbiotic, gram negative, free living nitrogen N-fixing bacteria. They are capable of fixing an average 20 kg N/ha/year. The genus Azotobactor includes 6 species, with *A. chrococcum* most commonly inhabiting in various soils all over the world [5]. Azotobactor fix nitrogen and also produces thiamine, riboflavin, indole acetic acid and gibberellins.

When Azotobactor is applied to seeds, seed germination is improved to a considerable extent; it also controls plant diseases due to above substances produced by Azotobactor. The exact mode of action by which Azotobactor enhances plant growth is not yet fully understood. Three possible mechanisms have been proposed: N2 fixation; delivering combined nitrogen to the plant; the production of phytohormone like substances that alter plant growth and morphology, and bacterial nitrate reduction, which increases nitrogen accumulation in inoculated plants [6]. Azotobactor can be used as a Bio fertilizers for most non leguminous annual and perennial crops for the nutrition of nitrogen rice, cotton, sugarcane are some examples. Azotobactor act in temperate zone soils having pH 6.5-8.0. It fixes the nitrogen @ 5-20 kg N ha^{-1}/year in the soil. Seed treatment, seedling dipping and soil application methods are used for Azotobactor application. For seed treatment 200 g Azotobactor used for 10 kg seed. For seedling dipping prepare the suspension of required number of inoculants in water in the ratio of 1: 10 and applied 3- 5 kg Azotobactor inoculums mix with 5 tonne FYM for one-hectare soil application. Keeping these things, the present investigation "Effect of Nitrogen, FYM and Azotobactor on Yield and Yield Attributes of Maize (*Zea mays* L.)" was taken during kharif, 2016.

Materials and Method

The experiment was conducted at the Soil Science Research Farm of SHUATS – State University, Allahabad, U.P. The soil of experimental area filled in order of Inceptisol. The climatic conditions of Allahabad are subtropical climate receiving the mean annual rainfall of about 1100 mm, major rain received from July to end of September. However, occasional precipitation is also not uncommon during winter; the winter months are cold while summer months are very hot and dry. The minimum temperature during the crop season is around 26^{0}C and the maximum is 38.04^{0}C. The humidity varies between 41.00% and 98.00%. The design of experiment used was 3x2x2factorial randomized block design having three factors viz. three levels of N (60, 90 and 120 kg N ha^{-1}), two levels of FYM (0 and 10 t ha^{-1} FYM) and two Azotobactor levels (0 and 200 g per 10 kg seeds). P_2O_5 and K_2O were applied as per recommendation @ 60 kg ha^{-1} each in all plots uniformly. The source of Nitrogen, Phosphorus, Potassium, FYM and Azotobactor was Urea, SSP, MOP, FYM and Azotobactor respectively. Basal dose of fertilizer was applied in plots according to treatment. Azotobactor treated seeds were sown on well prepared beds in shallow furrows, at the depth of 5cm, row to row distance was maintained at 50 cm and plant to plant distance was 20 cm, during the course of experiment, observations were recorded as mean values of the data. All other agronomic practices were followed as per package of practices of maize for this region. Length of cob was recorded at maturity of crop. For these three plants randomly selected from each plot and tagged for observation. Length of cob in centimetre recorded from shoot tip to end point of cob. Number of grain per cob under different treatments recorded after harvest of crop. For these three cobs randomly selected from each plot and tagged for observation, mean value used for calculation. One thousand healthy seeds were counted from the seeds of each plot and weighed. The crop plants from each plot harvested and put for sun drying. After the cobs and plants properly dried, threshing was done manually and seeds obtained were weighed on single pan physical balance. The grain yield from the net plot area recorded in g $plot^{-1}$ and converted into q ha^{-1}. The data recorded during the course of investigation were subjected to statistical analysis by analysis of variance (ANOVA) technique [7]. The significant and non-significant of treatment effect was judged with the help of 'F' (variance ratio) test. The significant differences between treatments mean were tested against the critical difference at 5% level for testing the hypothesis.

Results and Discussion

Effect of Nitrogen

The results showed that nitrogen levels influenced the performance of maize significantly [Table-3]. Application of nitrogen @ 120 kg ha^{-1} gave the maximum cob length (18.00 cm), number of grains cob^{-1} (346.70), test weight (211.79 g) and grain yield (43.03 q ha^{-1}) all these attributes were significantly higher over N1 (90 kg N ha^{-1}) and N0 (60 kg N ha^{-1}). Amongst nutrients, nitrogen is considered to be a vitally important plant nutrient. It is necessary for chlorophyll synthesis and as a part of the chlorophyll molecule, which is the primary absorber of light energy needed for photosynthesis. Due to lack of N and chlorophyll crop will not utilize sunlight as an energy source to carry on essential function such as nutrient uptake. It is a component of vitamins and energy systems in plants. Nitrogen is an essential component of amino acids, which form plant proteins. Besides these, it is also a constituent of certain organic compounds of physiological importance [8, 9]. Greater assimilating surface at reproductive development stage results in better grain formation because of adequate production of metabolites and their translocation towards grain as evident from nutrient concentration and their uptake might have resulted in increased weight of individual grain and expressed in terms test weight. Since grain weight per cob as dependent on number of grains per cob and weight of individual grain, thus highest grain yield @ 120 kg N ha^{-1} could be ascended to the improvement of these parameters. The results of present investigation indicating positive response of various yield parameters to higher level of N fertilization corroborates findings of several researchers [10, 11].

Table-1 *Details of manure, bio fertilizers and fertilizers given per plot (2 x 2 m²).*

Treatment	Dose	Source (%)	Quantity of fertilizer applied (g plot-1)
Nitrogen	60 kg N ha^{-1} 90 kg N ha^{-1} 120 kg N ha^{-1}	Urea (46%N) Urea (46%N) Urea (46%N)	52.17 g $plot^{-1}$ 78.25 g $plot^{-1}$ 104.34 g $plot^{-1}$
Phosphorus	60 kg P_2O_5 ha^{-1}	SSP (16%P_2O_5)	150 g $plot^{-1}$
Potassium	60 kg K_2O ha^{-1}	MOP (60%K_2O)	40 g $plot^{-1}$
Azotobactor	200 gm10 kg^{-1} seed		2 g $plot^{-1}$
Farm yard manure (FYM)	0 t FYM ha^{-1} 10 t FYM ha^{-1}	Nitrogen (0.50%) Phosphorus(0.25%) Potassium (0.50%)	0kg $plot^{-1}$ 4kg $plot^{-1}$

Effect of FYM

Application of FYM significantly increased the yield attributes and yield of maize [Table-3]. Application of FYM @10 t ha^{-1} recorded the highest cob length (15.81 cm), number of grains cob^{-1} (326.40), test weight (205.57 g) and grain yield (36.34 q ha-1) which was significantly higher over no FYM application. The advantage of FYM is quite obvious, as this provide a steady supply of nutrients leading better growth of plants. Moreover, the increased availability of P and K in addition to other plant nutrients released by the FYM might have contributed in enhancing the yield-attributes. The positive impact of availability of individual plant nutrients and humic substances from FYM and balanced supplement of nitrogen through inorganic fertilizers might have induced cell division, expansion of cell wall, meristematic activity, photosynthetic efficiency and regulation of water intake into the cells, resulting in the enhancement of yield parameters and yield of maize [12, 13].

Effect of Azotobactor

Seed treatment with Azotobactor significantly increased he yield attributes and yield of maize as compared to without seed treatment [Table-3]. Treatment of seeds with Azotobactor @ 200 g per 10 kg seeds recorded cob length (15.38 cm), number of grains cob^{-1} (323.45), test weight (204.12 g) and grain yield (35.45 q ha^{-1}) these were statistically superior over no seed treatment with Azotobactor. Beneficial effects of Azotobacter inoculation could be attributed to their multiple action for synthesise growth promoting substances, antifungal and antibiotics which might have been utilized by the plants in synthesis of protein, carbohydrates, starch and other assimilates, thereby improving growth of plant. It has been well emphasized that Azotobactor inoculation played vital role in improving three major aspects of yield determination *i.e.*, formation of vegetative structure for higher photosynthesis, strong sink strength through development of reproductive structure and production of assimilates to fill economically important sink [14, 15].

Interaction effect

The results showed that the interaction between nitrogen fertilizer in conjunction with FYM and Azotobactor were significant[Table-2]. Combined treatment application (T11 = N2+F1+A1) of nitrogen 120 kg ha^{-1}, 10 t FYM ha^{-1} and 200 g Azotobactor ha^{-1} was recorded significantly higher cob length (19.11 cm), Table-2 *Interaction effect of different treatment combination on length of cob, number of grains/ cob, test weight and yield of Maize Zea mays L.) Var. hybrid MM-2255*

Treatment combination		Length of cob (cm)	Number of seed /cob	Test weight (g)	Grain yield (qha^{-1})
T_0	(T_0=N_0+F_0+A_0)	10.90	298.87	191.14	23.95
T_1	(T_1=N_0+F_1+A_0)	11.61	294.27	192.80	25.91
T_2	(T_2=N_0+F_0+A_1)	12.43	297.80	197.03	26.84
T_3	(T_3=N_0+F_1+A_1)	13.31	300.93	199.13	29.27
T_4	(T_4=N_1+F_0+A_0)	14.01	309.00	201.21	31.12
T_5	(T_5=N_1+F_1+A_0)	14.91	315.13	202.82	33.57
T_6	(T_6=N_1+F_0+A_1)	15.88	325.67	204.48	35.99
T_7	(T_7=N_1+F_1+A_1)	16.51	329.93	206.61	38.05
T_8	(T_8=N_2+F_0+A_0)	18.37	345.13	212.85	43.99
T_9	(T_9=N_2+F_1+A_0)	16.87	337.60	208.16	40.29
T_{10}	(T_{10}=N_2+F_0+A_1)	17.65	341.20	210.96	42.27
T_{11}	(T_{11}=N_2+F_1+A_1)	19.11	362.87	215.20	45.58
Interaction (N x Fx A)	F – test	S	S	S	S
	S. Ed. (±)	0.25	4.80	0.42	0.42
	C. D. at 5%	0.52	9.75	0.86	0.86

Table-3 *Effect of different factor of nitrogen, FYM, Azotobacter fertilizers on yield attributes and yield of maize (Zea mays L.) Var. hybrid MM-2255*

Factor		Length of cob (cm)	Number of grains/cob	Test weight (g)	Grain yield (q ha^{-1})
Nitrogen(N)					
N_0	50 % Nitrogen as urea	12.06	297.97	195.03	26.49
N_1	75% Nitrogen as urea	15.33	319.93	203.78	34.69
N_2	100% Nitrogen as urea	18	346.7	211.79	43.03
	F – test	S	S	S	S
	S. Ed. (±)	0.1	1.96	0.17	0.17
	CD at 5%	0.21	3.98	0.35	0.35
FYM, (F)					
F_0	0% [FYM]	14.44	316.67	201.5	33.14
F_1	100%[FYM]	15.81	326.4	205.57	36.34
	F – test	S	NS	S	S
	S. Ed. (±)	0.08	1.6	0.14	0.14
	CD at 5%	0.17	3.25	0.29	0.29
Bio fertilizer (A)					
A_0	0% [Azotobacter]	14.87	319.61	202.95	34.03
A_1	100% [Azotobacter]	15.38	323.45	204.12	35.45
	F- test	S	S	S	S
	S. Ed. (±)	0.1	1.96	0.17	0.17
	CD at 5%	0.21	3.98	0.35	0.35

number of grains cob-1 (362.87), test weight (25.20 g) and grain yield (45.58 q ha-1) these were statistically superior over rest of the treatment combinations. Similar findings were also reported [16, 17].

Conclusion

From the present investigation it can be concluded that application of 120 kg N ha-1 along with 10 t FYM ha-1 and seed inoculation with Azotobacter increase the yield attributes and yield of maize significantly.

Application of research: This research is very useful for Integrated Nutrient Management in maize in a sustainable manner and maintains the soil health on long term basis.

Research Category: Nutrient Management

Abbreviations:
FYM- Farm Yard Manure
ANOVA-Analysis of Variance

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