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Response of Maize (*Zea Mays* L.) to Planting Densities and Nitrogen Levels Under Late *Rabi* Conditions

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ABSTRACT

A field experiment was conducted during *rabi* season of 2010-11 on clay loam soils of Agricultural College Farm, Bapatla to study the response of maize (*Zea mays* L.) to planting densities and nitrogen levels under late *rabi* conditions. Increasing planting density from 66666 plants ha^{-1} to 133333 plants ha^{-1} reduced the yield attributes and yield of maize. Among nitrogen levels tried, application of 240 kg N ha^{-1} resulted in increased growth, yield attributes and yield of maize. The interaction was found non significant for all the parameters with the exception of cob length, grain weight cob^{-1} and nutrient uptake.

Key words : Growth, Maize, Nitrogen levels, Planting densities, Yield.

Maize is globally the top ranking cereal in potential grain productivity. It is considered as a 'Queen of cereals'. It has a tremendous potentiality in ensuring sustainability and food security in India. Low yield of maize is due to many constraints but among them, imbalanced use of fertilizers and lack of optimal crop stand are the factors of prime importance which intensely and repeatedly impact the resource availability. In India maize is grown in area of 12.24 lakh hectares with an annual production of 4.43 Mt during *rabi*. In Andhra Pradesh, it is cultivated in an area of 2.81 lakh hectares (www.indiastat.com) during *rabi* season. The possibility of *rabi* maize can provide a major breakthrough for rapid increase in production and productivity, as yields are much higher as compared to *kharif*.

Very often the sowing of maize gets delayed due to late harvest of preceding crops and also frequent heavy rains due to cyclonic activity that occur in the months of October and November. The optimum plant population and nitrogen requirement of *rabi* maize may be different from that of rainy season because they differ considerably with respect to length of growing season, prevailing weather conditions and productivity. Pertaining to planting densities and nitrogen management, much of research work is available. But, such information under delayed conditions is quite scarce. Therefore, the present investigation was undertaken to study the response of maize to planting densities and nitrogen levels under late *rabi* conditions.

MATERIAL AND METHODS

A field experiment was conducted at Agricultural College Farm, Bapatla during *rabi* 2010-11 under irrigated condition. The soil of the experimental site was clay loam in texture, slightly alkaline in reaction with pH -7.8, low in organic carbon (0.4 %), low in available nitrogen (157 kg N ha^{-1}), medium in available phosphorus (25 kg P_2O_5 ha^{-1}) and potassium(184 kg K_2O ha^{-1}). The treatments comprised of two factors; three planting densities (**S_1**: 66666 plants ha^{-1}, **S_2**: 88888 plants ha^{-1} and **S_3**: 133333 plants ha^{-1}) and four nitrogen levels (**N_1 -** 120kg ha^{-1}, **N_2** -160 kg ha^{-1}, **N_3 -** 200kg ha^{-1} and **N_4 -** 240 kg ha^{-1}**)** arranged in a randomized block design with factorial concept and were replicated thrice. Maize hybrid 30 V 92 used as test variety and sown on 03.01.11 and harvested on 24.04.11. A total of 137 mm rainfall was received during the experimentation. The mean monthly maximum and minimum temperatures ranged from 29.3^0 to 34.7^0 C and 15.2^0 to 26.1^0 C, respectively during the crop growth period. Bold and healthy seeds were hand dibbled into the soil @ one seed per hill at 3 different spacings of 75 cm x 20 cm, 75 cm x 15 cm and 75 cm x 10 cm to obtain required planting densities of 66666, 88888 and 133333 plants ha^{-1}. Gap filling was done to maintain required plant population. Nitrogen was applied in the form of urea (46 % N) as per the treatments in 3 splits i.e. ¼ at the time of sowing, ½ at knee high stage and ¼ at tasseling stage. A common dose of 60 kg P_2O_5 and 50 kg K_2O ha^{-1} was applied in the form of single

Table 1. Growth parameters and nitrogen uptake by maize as influenced by planting densities and nitrogen levels

Treatments	Plant height at harvest (cm)	Drymatter accumulation at harvest (kg ha^{-1})	Days to 50 % tasseling	Days to 50 % silking	Per cent Barrenness (%)	Nitrogen uptake (kg ha^{-1})	
						Grain	Stover
Planting densities (plants ha^{-1})							
S_1- 66666	256	13555	56	61	3.13	78.7	29.8
S_2-88888	251	14907	57	63	3.66	52.3	36.4
S_3-133333	250	17873	58	64	4.49	66.3	43.4
SEm±	4	474	0.3	0.2	0.11	2.0	1.0
CD (0.05)	NS	1389	1.0	0.6	0.34	5.9	3.1
Nitrogen levels (kg ha^{-1})							
N_1- 120	238	11544	60	65	5.88	36.2	21.7
N_2- 160	251	14370	57	63	4.42	55.5	30.4
N_3- 200	254	16607	56	62	2.71	73.4	38.9
N_4- 240	265	19259	54	60	2.03	97.9	55.0
SEm±	5	547	0.3	0.2	0.13	2.3	1.2
CD (0.05)	13	1604	1.0	0.7	0.39	6.8	3.6
Interaction (S x N)							
SEm±	8	948	0.6	0.4	0.23	4.0	2.1
CD (0.05)	NS	NS	NS	NS	NS	13.9	7.5

superphosphate (16 % P_2O_5) and muriate of potash (60 % K_2O) respectively, at the time of sowing. Two handweedings were given during entire crop growth period at 15 and 30 DAS. Total of five irrigations were given during the entire crop growth period. Chlorpyriphos @ 1.5 mL per litre of water was sprayed twice at 15 and 30 DAS to protect the crop from the incidence of leaf eating caterpillar and whorl application of Carbofuran granules was done to protect the crop against stem borer. Nitrogen content in the plant sample was estimated by the modified Microkjeldahl method (Piper, 1966).

RESULTS AND DISCUSSION

Effect of planting densities

Interestingly, plant densities did not affect the plant height significantly, as taller plants were produced at lower planting density (66666 plants ha^{-1}) than higher planting densities of 88888 and 133333 plants ha^{-1}. The competition for light and space due to less intra-row spacing might have compensated by wider inter-row spacing. Drymatter accumulation and per cent barren plants increased with increase in planting densities and the highest values of these parameters were recorded at higher planting density of 133333 plants ha^{-1} (S_3) than S_2 and S_1. These results are in accordance with the findings of Suryavanshi *et al*., (2009).

Yield attributes of maize viz., grains per cob, test weight and shelling percentage were significantly higher at lower planting density (S_1) than S_2 and S_3 which might be due to reduced competition for various growth resources especially moisture and nutrients. The yield of maize was significantly superior at lower planting density (S_1) which might be due to cumulative effect of increased yield parameters. Stover yield produced by the planting density of 133333 plants ha^{-1} was significantly higher and resulted in lower harvest index than 88888 and 66666 plants ha^{-1}. These results are in conformity with the findings of Kumar and Bangarwa (1997), and Reddy *et al*., (2010).

Effect of nitrogen levels

The maximum plant height recorded with application of 240 kg N ha^{-1} might be due to cell division and cell elongation as promoted by nitrogen. Drymatter accumulation increased significantly and barrenness decreased with each successive increase in nitrogen levels from 120 to 240 kg N ha^{-1}. Adequate supply of nitrogen might have helped the maize plants to increase their growth which inturn

Table 2. Yield attributes and yield of maize as influenced by planting densities and nitrogen levels

Treatments	Coblength (cm)	No. of grains cob^{-1}	Grain weight cob^{-1} (g)	100 grain weight (g)	Shelling percentage (%)	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest Index (%)
Planting densities (plants ha^{-1})								
S_1- 66666	17.8	500.8	132.4	25.4	80.9	6519	7013	48.0
S_2-88888	16.6	439.0	107.2	23.2	78.3	5370	8463	38.8
S_3-133333	15.6	360.0	81.7	22.2	77.5	6009	9348	38.5
SEm±	0.2	13.0	1.4	0.2	0.7	250	216	1.5
CD (0.05)	0.6	38.2	4.1	0.8	2.2	734	632	4.4
Nitrogen levels (kg ha^{-1})								
N_1- 120	15.4	367.0	89.4	21.0	75.6	4163	5959	41.2
N_2- 160	16.3	415.4	98.2	22.9	78.1	5448	7657	4.6
N_3- 200	16.8	445.0	111.1	24.3	79.6	6431	8887	42.0
N_4- 240	18.1	505.7	129.9	26.0	82.4	7821	10595	42.3
SEm±	0.2	15.1	1.6	0.3	0.9	289	249	1.7
CD (0.05)	0.7	44.1	4.7	0.9	2.6	847	729	NS
Interaction (S x N)								
SEm±	0.4	26.1	2.8	0.5	1.5	501	431	3.0
CD (0.05)	1.5	NS	9.7	NS	NS	NS	NS	NS

putforth more photosynthetic surface, thus contributed to more drymatter accumulation Yield parameters viz., grains per cob, test weight and shelling percentage were significantly higher with application of 240 kg N ha^{-1}. A significant enhancement in yield and nitrogen uptake was observed with successive increase in nitrogen level from 120 to 240 kg N ha^{-1}. These results are in line with the findings of Vadivel *et al.*, (2001) and Singh *et al.*, (2006)

Interaction effect

The interaction effect of planting densities and nitrogen levels was found significant only in case of cob length, grain weight per cob and nitrogen uptake. Application of 240 kg N ha^{-1} at lower planting density of 66666 plants ha^{-1} resulted in significantly more cob length and grain weight cob^{-1} over all other treatment combinations. Nitrogen uptake by stover at planting density of 133333 plants ha^{-1} with 240 kg N ha $^{-1}$ was significantly superior to all other treatment combinations. Whereas, in case of grain, significantly higher nitrogen uptake was recoded with lower plant population of 66666 plants ha^{-1} at 240 kg N ha^{-1}.

Overall, the results showed that sowing of maize at a planting density of 66666 plants ha^{-1} was found optimum with a linear response upto 240 kg N ha^{-1} during late *rabi* conditions.

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