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Influence of Planting Densities and Nitrogen Levels on Yield of *rabi* Maize

K Revathi, M Sree Rekha, N Venkata Lakshmi and P Prasuna Rani
Department of Agronomy, Agricultural College, Bapatla 522 101, Andhra Pradesh

ABSTRACT

A field experiment was conducted during *rabi* 2014-2015 at Agricultural College Farm, Bapatla, to study the influence of planting densities and nitrogen levels on yield of *rabi* maize. The experiment was laid out in a split plot design and replicated thrice. The results revealed that planting density of M_2 (83,333 plants ha^{-1}) and S_8 (300 kg N ha^{-1}+ 0.5% $ZnSO_4$ as foliar spray at tasseling) recorded highest kernel yield which was on par with M_1 (1,00,000 plants ha^{-1}) and S_8 (300 kg N ha^{-1}+ 0.5% $ZnSO_4$ as foliar spray at tasseling). Foliar application of $ZnSO_4$ along with nitrogen at tasseling influenced yield attributes, kernel and stover yield significantly. The interaction between planting densities and nitrogen levels was found to be non significant.

Key words : Maize, Nitrogen levels, Planting densities, Zinc foliar spray.

Maize is one of the major cereal crop that occupies third position among the cereals after rice and wheat, as it is representing 24 % of total cereal production in the world. Being a C_4 plant, maize is capable of utilizing solar radiation more efficiently compared to other cereals. It contains about 70 to 75 % starch, 8 to 12 % protein, 3 to 8 % oil and carbohydrates 1 to 3 %. It is cultivated as a food and feed crop under varying soil topography, seasons and management practices throughout the country (Singh *et al*., 2007). Maize in India, is grown in 8.7 M.ha with an annual production of 22.5 M.t. In Andhra Pradesh, it is cultivated in 4.07 lakh ha area during *rabi* season (Directorate of Maize Research, 2012-2013). It is widely cultivated as a rainfed crop during *kharif* season but due to evolution of new genotypes it can be grown successfully as *rabi* season crop, harvesting bumper yields and also the yield of *rabi* crop is higher compared to *kharif* crop (Tank *et al*., 2006).

MATERIAL AND METHODS

The experiment was conducted during *rabi* 2014 at Agricultural College Farm, Bapatla, Andhra Pradesh. The experimental site is situated at 80^0 25' E longitude, 15^0 54' N latitude and at an altitude of 5.49 m and 7 km away from Bay of Bengal. The experimental soil was sandy loam in texture, slightly alkaline in reaction (pH 6.6), medium in organic carbon (0.52%), low in available nitrogen (206 kg ha^{-1}), medium in available phosphorus (24.1 kg ha^{-1}), high in potassium (301.5 kg ha^{-1}) and low in zinc (0.3 ppm). The mean maximum and mean minimum temperatures were 30.0 ^{0}C and 18.3 ^{0}C during the crop growth period. The experiment was laid out in a split plot design with three main treatments and eight sub treatments replicated thrice. The treatments consisted of three planting densities *viz.,* M_1: 50 cm x 20 cm (1,00,000 plants ha^{-1}), M_2 : 60 cm x 20 cm (83,333 plants ha^{-1}) and M_3 :75 cm x 20 cm (66,666 plants ha^{-1}) as main plots and eight nitrogen levels *viz.,* S_1 (120 kg N ha^{-1}), S_2 (180kg N ha^{-1}) S_3 (240 kg N ha^{-1}) S_4 (300kg N ha^{-1}), S_5 (120 kg N ha^{-1} + 0.5% $ZnSO_4$ as foliar spray at tasseling), S_6 (180 kg N ha^{-1} + 0.5% $ZnSO_4$ as foliar spray at tasseling), S_7 (240 kg N ha^{-1} + 0.5% $ZnSO_4$ as foliar spray at tasseling) and S_8 (300 kg N ha^{-1} + 0.5% $ZnSO_4$ as foliar spray at tasseling) as subplots.

Maize hybrid, Lakshmi-2277 was sown during 2nd week of November 2014. Thinning and gap filling was done at 15 DAS by keeping one seedling per hill^{-1}. Entire dose of phosphorus was applied as basal dose through single super phosphate and nitrogen was applied as per treatments in three equal splits through urea as basal, at 30 DAS and at 60 DAS. Potassium was applied twice, as basal and at 60 DAS through muriate of potash,while 0.5% $ZnSO_4$ was applied as foliar spray at tasseling as per the treatments.

RESULTS AND DISCUSSION

Yield attributes

Among yield components of maize, no. of cobs plant^{-1}, cob length (cm) and number of kernels cob^{-1} were significantly influenced by planting densities and nitrogen levels while 100-grain weight was not significantly influenced by planting densities but influenced by nitrogen levels. Interaction between them was found to be non significant (Table 1).

Lower planting density of 66,666 plants ha^{-1} recorded maximum number of cobs plant^{-1}, cob length and number of kernels cob^{-1} than 83,333 plants ha^{-1} and 1,00,000 plants ha^{-1}. Greater competition between plants for resources like nutrients, solar energy and soil water might have suppressed the performance of individual plants with higher plant density as reported by Wasnik *et al*. (2012).

Number of cobs plant^{-1}, kernels rows cob^{-1} and kernels cob^{-1} recorded were significantly highest with S_8 (300 kg N ha^{-1}+ 0.5% $ZnSO_4$ as foliar spray at tasseling) which was on a par with S_4 (300 kg N ha^{-1}) but significantly superior to other levels of nitrogen with or without zinc. Significantly highest cob length and 100- kernel weight was recorded with S_8 (300 kg N ha^{-1}+ 0.5% $ZnSO_4$ as foliar spray) which was on a par with S_4 (300 kg N ha^{-1}) and S_7 (240 kg N ha^{-1}+ 0.5% $ZnSO_4$ as foliar spray at tasseling). This might be due to better absorption of N and Zn through foliage and their synergistic effect improved the yield parameters of maize. These results are in accordance with Tank *et al*. (2006). Test weight was not statistically influenced by planting densities. However, numerically test weight recorded with 66,666 plants ha^{-1} was high followed by 83,333 plants ha^{-1} and 1,00,000 plants ha^{-1}. Low kernel weight at high plant density might be due to availability of less photosynthates for kernel development because of high inter specific competition resulting in reduction of grain weight as reported by Zamir *et al*. (2011). Higher test weight was obtained with 300 kg N ha^{-1} + 0.5% $ZnSO_4$ as foliar spray which was on a par with 240 kg N ha^{-1}+ 0.5% $ZnSO_4$ as foliar spray and significantly superior to other levels. Increase in test weight might be due to better absorption of zinc through foliage and availability of nitrogen and their synergistic effect might have helped in better grain filling and hence higher 100-kernel weight. These results are in conformity with Aruna *et al*. (2006) and Paramasivan *et al*. (2011).

Kernel and stover yield

Planting densities and nitrogen levels significantly influenced the kernel and stover yields of maize and their interaction was found to be non significant (Table 1). Maximum kernel yield of 4767 kg ha^{-1} was recorded with M_2 (83,333 plants ha^{-1}) and stover yield of 6120 kg ha^{-1} was recorded with M_1 (1,00,000 plants ha^{-1}). Significantly highest kernel and stover yields of maize was recorded with S_8 (300 kg N ha^{-1}+ 0.5% $ZnSO_4$ as foliar spray at tassseling) which was on a par with only nitrogen S_4 (300 kg N ha^{-1}) and significantly superior to other levels. This indicates that decline in yield components was more compensated with increase in plant density per unit area and adequate availability of nutrients and moisture. Similar results were reported by Gollar and Patil (2000).The increase in kernel yield at higher N levels together with Zn as foliar spray is due to better uptake of nutrients and zinc applied at tasseling. The results obtained are in consonance with the findings of Sekhar *et al*. (2012). Maximum stover yield of maize at higher plant densities might be due to variation in the crop stand per unit area. These results are in agreement with Zamir *et al*. (2011). As zinc plays a role in metabolism of plant as an activator of enzymes which in turn directly or indirectly affect the synthesis of carbohydrates, soil application of NPK coupled with $ZnSO_4$ as foliar spraying at tasseling influenced the stover yield of maize. These findings are in agreement with Tyagi *et al*. (1998).

Harvest index was not influenced by planting densities and nitrogen levels. However, numerically highest harvest index of 46 per cent was obtained with 83,333 plants ha^{-1} followed by 66,666 plants ha^{-1} and 1,00,000 plants ha^{-1}. Application of 300 kg N ha^{-1}+ 0.5% $ZnSO_4$ as foliar spray at tasseling recorded numerically higher harvest index followed by other nitrogen levels.

It can be concluded that *rabi* maize grown with a planting density of 83,333 plants ha^{-1} and application of N @ 300 kg ha^{-1} with 0.5% $ZnSO_4$ as foliar spray at tasseling resulted in maximum kernel yield.

Table 1. Yield attributes and yield of *rabi* maize as influenced by planting densities and nitrogen levels.

Treatments	No. of cobs plant^{-1}	Cob length (cm)	No. of kernels cob^{-1}	100-Kernel weight (g)	Kernel yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Harvest index (%)
Main plots (Planting densities)							
M_1: 50 cm x 20 cm (1,00,000 plants ha^{-1})	0.99	14.0	308.7	23.3	4586	6120	42.2
M_2 : 60 cm x 20 cm (83,333 plants ha^{-1})	1.02	14.4	374.8	24.0	4767	5095	48.1
M_3 :75 cm x 20 cm (66,666 plants ha^{-1})	1.03	15.6	422.4	25.0	4081	4698	46.0
S.Em ±	0.005	0.30	9.03	0.43	131.7	137.3	1.33
CD (P=0.05)	0.01	1.1	35.4	NS	517	539	NS
CV(%)	2.21	10.1	12.0	8.3	14.4	12.6	14.3
Sub-plots (Nitrogen and zinc treatments)							
S_1:120 kg N ha^{-1}	0.93	12.9	309.1	22.1	3240	4033	43.5
S_2:180 kg N ha^{-1}	1.00	14.0	339.8	22.7	3923	4841	44.5
S_3:240 kg N ha^{-1}	1.00	14.6	377.1	23.9	4635	5646	45.0
S_4:300 kg N ha^{-1}	1.07	16.0	433.1	24.9	5578	6291	46.4
S_5: 120 kg N ha^{-1}+0.5% $ZnSO_4$ foliar spray at tasseling	0.98	13.3	318.3	23.6	3427	4301	44.5
S_6: 180 kg N ha^{-1}+0.5% $ZnSO_4$ foliar spray at tasseling	1.00	14.5	342.2	24.1	4203	5144	45.1
S_7: 240 kg N ha^{-1}+0.5% $ZnSO_4$ foliar spray at tasseling	1.02	15.7	379.3	25.3	5002	5697	47.1
S_8:300 kg N ha^{-1}+0.5% $ZnSO_4$ foliar spray at tasseling	1.09	16.6	450.0	26.5	5816	6478	47.6
S.Em ±	0.028	0.60	12.93	0.86	146.4	209.9	1.84
CD (P=0.05)	0.07	1.7	36.9	2.4	417	599	NS
CV(%)	8.24	12.3	10.5	10.8	16.0	11.8	12.2
Interaction							
Planting densities at same nitrogen levels							
S.Em ±	0.045	1.03	22.82	1.47	409.0	366.8	3.27
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS
Nitrogen levels at same or different planting densities							
S.Em ±	0.048	1.05	22.40	1.51	414.0	363.7	3.19
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

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