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EFFECTS OF DIFFERENT LEVELS OF NITROGEN AND PHOSPHORUS ONYIELD ATTRIBUTES AND YIELD OF *KHARIF* MAIZE

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ABSTRACT

A field experiment was conducted during two consecutive *kharif* seasons of 2014 and 2015 to evaluate the effect of different levels of nitrogen (200, 250 and 300 kg ha^{-1}) and phosphorus (40, 60, and 80 kg ha^{-1}) on the yield attributes and yield of maize. The higher values of yield attributes *viz.,* cob length, number of grains cob^{-1} and hundred grain weight were recorded at N applied at 300 kg ha^{-1} and P at 60 kg ha^{-1}, which was however comparable with rest of the levels tried, except on number of grains cob^{-1} by N levels in the second year. Significant interaction was recorded on cob length among N and P levels with highest and lowest values by N_3P_2 (300 kg N + 60 kg P_2O_5 ha^{-1}) and N_1P_3 (200 kg N + 80 kg P_2O_5 ha^{-1}) respectively in the second year of study. During both the years, the highest and lowest grain yields were recorded with application of 300 kg ha^{-1} and 200 kg N ha^{-1} and with P @ 60 kg ha^{-1} and 40 kg ha^{-1} respectively. The combination of 250 kg N and 60 kg P_2O_5 ha^{-1} resulted in higher grain yield of maize during *kharif* season.

KEYWORDS: Maize, nitrogen, phosphorus, yield, yield attributes

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal food crops cultivated both in tropical and temperate regions of the world with the highest production and productivity as compared to rice and wheat. In the world, maize is cultivated in an area of 146 million hectares with a production of 685 million tonnes and an average productivity of 4.7 t ha^{-1}. It is the third most important cereal after rice and wheat for human consumption by contributing to 9 per cent of India's food basket and 5 per cent to World's dietary energy supply (Saikumar *et al.*, 2012). India is the sixth largest producer of maize with 24.27 million tonnes of production from 9.07 million hectares, with a productivity of 2.67 t ha^{-1}. The demand of maize owing to burgeoning growth rate of poultry, livestock, fish and wet and dry milling industries is expected to increase from current level of 21.57 million tonnes to 45 million tonnes by 2030 (Anonymous, 2011).

MATERIAL AND METHODS

Field trial was conducted at College Farm of Agricultural College, Mahanandi campus of Acharya N.G. Ranga Agricultural University, situated at 15.51°N latitude, 78.61°E longitude and at an altitude of 233.5 m above the mean sea level, in the Scarce Rainfall Zone of Andhra Pradesh during *kharif* 2014 and 2015.The soil was sandy loam in texture, neutral in reaction (pH of 7.34), low in organic carbon(0.45%) and available nitrogen (275 kg ha^{-1}), high in available phosphorus (153 kg ha^{-1}) and high in available potassium(670 kg ha^{-1}), during beginning of experimentation.

The trials were laid down in a randomized block design with factorial concept. The treatments consisted of three nitrogen levels (200 kg ha^{-1} (N_1), 250 kg ha^{-1} (N_2) and 300 kg ha^{-1} (N_3)) and three phosphorus levels (40 kg ha^{-1} (P_1), 60 kg ha^{-1} (P_2) and 80 kg ha^{-1} (P_3)).

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The test variety of maize was P-3396 a single cross hybrid. Recommended practices for disease and insect pest control were followed. Nitrogen was applied at graded levels as per the treatments in three splits *i.e.,* one third at basal, one third at knee height stage and the remaining one third at tasseling stage. Entire quantity of P_2O_5 and K_2O (60 kg K_2O ha^{-1}) was applied as a basal dose. The sources of nitrogen, phosphorus and potassium were urea, single super phosphate and muriate of potash respectively. Nitrogen fertilizer was applied by placement at 5 cm away and 5 cm below the seed rows. Five plants were randomly selected per plot for recording of yield components. The yield attributes assessed included number of cobs $plant^{-1}$, cob length, number of grains cob^{-1} and hundred grain weight. At har-vest, the cobs and stover were harvested separately and the cob and stover weight were recorded. The grain from the cobs were shelled and weighed.

The data recorded on hybrid maize for various parameters during the course of investigation were statistically analyzed following the method of analysis of variance for randomized block design with factorial concept. Wherever the treatmental differences were found significant ('F' test), critical difference was worked out at 0.05 probability level and the values are furnished.

RESULTS AND DISCUSSION

Number of cobs $plant^{-1}$

Application of nitrogen and phosphorus has failed to show statistical disparity on number of cobs $plant^{-1}$ in both the years of the study. The number of cobs $plant^{-1}$ is majorly influenced by genetics makeup of the cultivar, but not influenced by the nutrient levels in some of the hybrids. Hence the number of cobs per plant was not altered by nutrient doses. Non significant ef-fect of different phosphorus levels on number of cobs $plant^{-1}$ was also reported by Nsanzabaganwa *et al.* (2014).

Cob length

Application of N at 300 kg ha^{-1} recorded longer cobs, which were on par with that of 250 kg and 200 kg N ha^{-1} . Phosphorus applied at the rate of 60 kg ha^{-1} recorded the cobs, which were the length of which was on par with that of 80 kg and 40 kg P_2O_5 ha^{-1}. The smaller cobs were recorded with the application of nitrogen at 200 kg ha^{-1} and phosphorus at 40 kg ha^{-1}, during both the years (Table. 1).

Nitrogen and phosphorus exerted a significant influence on cob length during the second year of study. Application of 300 kg N + 60 kg $P_2O_5ha^{-1}$ (N_3P_2) recorded highest cob length, which was however on par with 300 kg N + 80 kg $P_2O_5ha^{-1}$ (N_3P_3), 250 kg N + 80 kg $P_2O_5ha^{-1}$ (N_2P_3), 200 kg N + 40 kg $P_2O_5ha^{-1}$ (N_1P_1) and 200 kg N + 60 kg $P_2O_5ha^{-1}$ (N_1P_2) treatments. The treatment, 200 kg N + 80 kg $P_2O_5ha^{-1}$ (N_1P_3) recorded significantly lower cob length, which was however on par with all the remaining treatments except with 300 kg N + 60 kg $P_2O_5ha^{-1}$ (N_3P_2), 300 kg N + 80 kg $P_2O_5ha^{-1}$ (N_3P_3) and 250 kg N + 60 kg $P_2O_5ha^{-1}$ (N_2P_2).

Among the nitrogen levels tried, crop fertilized with 300 kg ha^{-1}(N_3) produced the longest cobs than the lower levels, however the difference is not significant with lower doses of nitrogen. The increase in the size of the cob might be due to the fact that positive effect of nitrogen on plant height, LAI, nutrient uptake and increased translocation of photosynthates from source to sink. The results are in accordance with the findings of Om *et al.* (2014).

Phosphorus levels did not result in any effect on the cob length of maize. Similar results of no response of phosphorus on cob length were reported by Nsanzabaganwa *et al.*, (2014).

Number of grains cob^{-1}

Higher number of grains cob^{-1} was recorded with the application of nitrogen @ 300 kg ha^{-1} (N_3) during the first year which was however on par with other rates of nitrogen application. Similarly during second year significantly higher number of grains cob^{-1} were recorded with the application of 300 kg N ha^{-1} (N_3) which was on par with 250 kg N ha^{-1} (N_2). Significantly lowest number of grains cob^{-1} was recorded with the application of 200 kg N ha^{-1} (N_1) which was however on par with 250 kg N ha^{-1} (N_2).

The higher number of grains cob^{-1} were recorded with the application of phosphorus at 60 kg ha^{-1} (P_2) which was statistically on par with other phosphorus levels. The interaction of nitrogen and phosphorus levels did not result in any significant variation in number of grains cob^{-1}.

Each successive increase in nitrogen level resulted in corresponding increase in the number of grains cob^{-1} which was found to be higher with application of300 kg N ha^{-1}(N_3), while the lowest number of grains cob^{-1} was resulted with application of 200 kg N ha^{-1}(N_1). This might be because of better pollination under higher nitrogen levels, reduced barrenness and helping to maintain the sink capacity resulting in well filled kernels in cob and kernel number. These results corroborate with the findings of Zakkam *et al.*,(2012) and Asif *et al.*, (2013).Phosphorus has no effect on number of grains cob^{-1}. Similar results were reported by Nsanzabaganwa *et al.,* (2014).

Hundred grain weight

The higher hundred grain weight was registered with 300 kg N ha^{-1}, which was however on par with other doses of nitrogen tried. The lowest hundred kernel weight was associated with 200 kg N ha^{-1}.Phosphorus applied at the rate of 80 kg ha^{-1} recorded higher hundred grain weight weight was recorded with the application of 40 kg P_2O_5ha^{-1}.Hundred grain weight recorded with the application of 300 kg N ha^{-1}and80 kg P_2O_5ha^{-1}was statistically at par to that of remaining levels. The higher hundred grain weight under higher nutrient level might be due to synergistic effect of externally added nutrients and higher biomass production coupled with increased sink capacity. Sekhar *et al.,* (2012) and Zakkam *et al.,* (2012) also reported similar results.

Table.1 Yield attributes of maize as influenced by different nitrogen and phosphorus levels during *kharif* season.

Treatments	Number of cobs plant^{-1}		Cob length (cm)		Number of grains cob^{-1}		Hundred grain weight (g)	
	2014	2015	2014	2015	2014	2015	2014	2015
Nitrogen levels (kg N ha^{-1})								
200 (N1)	1	1	15.9	15.2	464	469	28.6	30.9
250 (N2)	1	1	16.1	15.4	481	492	29.7	31.7
300 (N3)	1	1	16.5	15.7	500	509	30.2	31.8
SEm±	0.02	0.02	0.28	0.28	10.5	10.3	0.50	0.66
CD (P=0.05%)	NS	NS	NS	NS	NS	31	NS	NS
Phosphorus levels (kg P_2O_5 ha^{-1})								
40 (P1)	1	1	16.3	15.1	478	471	29.1	30.8
60 (P2)	1	1	16.4	15.7	485	501	29.5	31.3
80 (P3)	1	1	15.8	15.4	481	497	29.9	32.3
SEm±	0.02	0.02	0.28	0.28	10.5	10.3	0.50	0.66
CD (P=0.05%)	NS	NS	NS	NS	NS	NS	NS	NS
Interaction								
SEm±	0.03	0.03	0.49	0.48	18.3	17.8	0.86	1.14
CD (P=0.05%)	NS	NS	NS	1.4	NS	NS	NS	NS

Interaction between N and P levels on cob length of maize during 2015

	P_1	P_2	P_3	Mean
N_1	15.6	15.7	14.2	15.2
N_2	14.8	14.9	16.4	15.4
N_3	14.9	16.6	15.5	15.7
Mean	15.1	15.7	15.4	

Yield:

During the first year, application of 300 kg N ha^{-1} resulted in highest grain yield, which was statistically superior to that of 250 kg and 200 kg N ha^{-1} . During the second year nitrogen applied at the rate of 300 kg ha^{-1} resulted in highest grain yield, which was statistically on par with that of 250 kg N ha^{-1}. Lower kernel yield was associated with 200 kg N ha^{-1} during both the years.

Maize supplied with 60 kg P_2O_5 ha^{-1} resulted in higher grain yield, which was however statistically on par with application of 80 kg P_2O_5 ha^{-1}. Significantly lowest grain yield was obtained in the treatment supplied with 40 kg P_2O_5 ha^{-1} in the first year. Similar trend was observed during the second year but all the three phosphorus levels recorded statistically on par values of grain yield.

Higher nitrogen dose of 300 kg ha^{-1} resulted in the higher grain yield, whereas the lowest grain yield was obtained in 200 kg N ha^{-1}. This might be due to favourable effect at higher nitrogen level leading to better crop growth and increase in yield attributes which was reflected in grain yield of maize. In physiological terms, the grain yield of maize was largely governed by source and sink relationships as it is directly related to nitrogen. These results are in accordance with the findings of Sekhar *et al.* (2012), Zakkam *et al.* (2012), Nsanzabaganwa *et al.* (2014) and Om *et al.* (2014).

Grain yield of maize increased significantly up to 60 kg $P_2O_5ha^{-1}$. Further increase in P from 60 to 80 kg $P_2O_5ha^{-1}$, failed to record statistical significance. Increase in grain yield up to certain level of phosphorus was directly related to the vegetative and reproductive growth phases of the crop and attributes to complex phenomenon of phosphorus utilization in plant metabolism. Similar results were obtained by Araei and Mojaddam (2014) and Nsanzabaganwa *et al.*(2014).

Highest grain yield of maize was recorded with N_2P_2 (250 kg N + 60 kg $P_2O_5ha^{-1}$) which was statistically superior over lower levels of N and P, while on par with the higher levels. The balanced nitrogen and phosphorus levels might have helped in efficient absorption and utilization of other required plant nutrients which ultimately increased the grain yield. Similar results were obtained by Abera *et al.*(2009) and Nepalia and Singh (2009).

Stover yield of maize increased significantly with increase in nitrogen levels from 200 to 300 kg N ha^{-1}. Increased stover yield with increase in nitrogen level could be attributed to adequate nutrient supply, which in turn improved growth parameters like plant height, leaf area index and dry matter production which resulted in higher stover yield. These results are agreement with the findings of Om *et al.* (2014).

Stover yield of maize increased significantly up to 60 kg $P_2O_5ha^{-1}$. Further increase in P from 60 to 80 kg $P_2O_5ha^{-1}$, decreased the stover yield. Higher straw yield at medium phosphorus level could be attributed to adequate and balanced nutrient supply over higher and lower levels. Similar results were obtained by Araei and Mojaddam (2014) and Nsanzabaganwa *et al.* (2014).

Table.2 Grain and stover yield of maize as influenced by nitrogen and phosphorus levels during *kharif* season

Treatments	Grain yield (kg ha^{-1})		Stover yield (kg ha^{-1})	
	2014	2015	2014	2015
Nitrogen levels (kg N ha^{-1})				
200 (N1)	6885	8170	7997	10951
250 (N2)	7832	9116	8961	12186
300 (N3)	8231	9146	9277	12517
SEm±	124.4	125.5	252.9	402.3
CD (P=0.05%)	373	376	758	1206
Phosphorus levels (kg P_2O_5 ha^{-1})				
40 (P1)	7271	8714	8491	12003
60 (P2)	7983	8936	9387	13240
80 (P3)	7693	8781	8357	11844
SEm±	124.4	125.5	252.9	402.3
CD (P=0.05%)	373	NS	758	1206
Interaction				
SEm±	215.4	217.3	438.0	696.8
CD (P=0.05%)	NS	651	NS	NS

Interaction between N and P levels on grain yield of maize during 2015.

	P_1	P_2	P_3	Mean
N_1	8071	8319	8120	8170
N_2	8986	9307	9055	9116
N_3	9087	9183	9169	9146
Mean	8714	8936	8781	

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