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RESPONSE OF MAIZE (*Zea mays*) TO GRADED LEVELS OF NITROGEN AND PHOSPHORUS DURING *RABI*

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ABSTRACT

A field experiment was conducted for three consecutive years (2010-11, 2011-12 and 2012-13) on sandy clay loam soils at RARS farm, Tirupati during *rabi* season to study the response of maize to the graded levels of nitrogen and phosphorus. The experiment consisted of twelve treatments with four nitrogen levels i.e. 100, 150, 200 and 250 kg N ha^{-1} and three levels of phosphorus i.e. 30, 60 and 90 kg P_2O_5 ha^{-1}. The experiment was laid out in randomized block design with factorial concept and replicated thrice. Application of nitrogen @ 250 kg ha^{-1} had recorded the highest grain yield which was significantly superior over N_{100} and N_{150} kg ha^{-1} however it is on a par with N_{200} kg ha^{-1}. The grain yield of maize did not influenced significantly by different levels of phosphorus. However, application of nitrogen @ 200 kg ha^{-1} in combination with 30 kg P_2O_5 ha^{-1} recorded statistically non measurable grain yield. The other parameters such as plant height and yield attributes such as cob length and test weight followed the same trend. Nitrogen requirement for *rabi* maize was found to be 200 kg ha^{-1} with application of phosphorus @ 30 kg ha^{-1} that would be optimum for realizing optimum yield.

KEYWORDS: Maize, nitrogen and phosphorus levels, yield attributes and kernel yield.

INTRODUCTION

Maize (*Zea mays* L.) is an important cereal food crop of the world with the highest production and productivity as compared to rice and wheat. It is the third most important cereal after rice and wheat as human food, contributing to 9 per cent of India's food basket and 5 per cent to World's dietary energy supply (Saikumar *et al.*, 2012). Maize production has increased more than 12 times from a mere 1.73 million tons in 1950-51 to 21.57 million tons in 2011-12 and currently maize is grown on 9.3 million hectares with production of 24.2 million tons and with a productivity of 2602 kg ha^{-1} in India (FAO STAT, 2014). In Andhra Pradesh (13 districts), it is cultivated in an area of 1.2 lakh hectares with a production of 6.65 lakh tons and productivity of 5546 kg ha^{-1}.

Demand of maize grain for 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 (DMR, 2011).To meet the growing demand, enhancement of maize yield in coming years across all the growing locations in India is the big challenge. There is little scope for horizontal expansion of this crop. The challenge of achieving higher productivity of maize can be realized only through nutrient management. Hence, an attempt was made to study the response of maize to graded levels of N and P during *rabi*.

MATERIAL AND METHODS

A field experiment was conducted on sandy clay loam soil of Regional Agricultural Research Station, Tirupati consecutively for three years during *rabi* 2010-11, 2011-12 and 2012-13 respectively. The experimental field had a pH of 7.8, EC of 0.15 dSm^{-1}, low available nitrogen (172 kg ha^{-1}) medium available phosphorus (32 P_2O_5 kg ha^{-1}) and available potassium (221 K_2O kg ha^{-1}). A total rainfall of 15.50 mm and 37.20 mm and 296mm was received during 2010-11, 2011-12 and 12-13 respectively. (Table 1). The experiment was laid out in randomized block design with factorial concept and replicated thrice. The twelve treatments consisted of four nitrogen levels i.e. 100, 150, 200 and 250 kg N ha^{-1} and three levels of phosphorus i.e. 30, 60 and 90 kg ha^{-1}. Hybrid from M/s Kaveri Seeds (Kaveri) was used during all the years of study. The field was well prepared with the help of tractor drawn cultivator twice and rotavator once to get fine tilth. Later ridges and furrows were made with ridgemar at a spacing of 60 cm. Seeds were sown at intra row spacing of 20 cm. Nitrogen was applied in four

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Table 1. Weather parameters (means) recorded during *rabi* 2010-11, 2011-12 and 2012-13

Date	Temperature		Relative Humidity		Sunshine hours	Rainfall (mm)	No. of rainy days	Evaporation (mm)
	Max	Min	I	II				
2010-11	32.56	17.98	85.01	43.73	7.95	15.50	2	5.40
2011-12	33.17	19.00	81.85	41.66	7.90	37.20	2	5.08
2012-13	30.60	18.00	88.00	51.20	7.00	296.00	9	3.90

Table 2. Plant and yield attributes of maize as influenced by different levels of nitrogen and phosphorus during rabi 2010-11

Treatment	Plant height (cm)	Cob length (cm)	Cob girth (cm)	100 seed wt. (g)	No. of seeds / cob (g)	Seed yield (kg ha^{-1})
Nitrogen level (kg ha^{-1})						
100	183.6	15.2	13.4	18.0	471	3588
150	220.4	17.0	13.8	18.9	555	4120
200	255.6	17.9	14.5	20.3	582	4565
250	275.4	18.2	14.9	20.5	633	4787
C.D. at 0.05 level	15.8	1.6	0.9	NS	93	343
Phosphorus level (kg ha^{-1})						
30	230.0	16.3	13.6	18.1	534	4104
60	234.6	17.3	14.2	20.0	554	4253
90	236.0	17.7	14.6	20.2	593	4439
C.D. at 0.05 level	NS	NS	NS	NS	NS	NS

Table 3. Plant and yield attributes of maize as influenced by different levels of nitrogen and phosphorus during *rabi* 2011-12

Treatment	Plant height (cm)	Cob length (cm)	Cob girth (cm)	100 seed wt. (g)	No. of seeds / cob (g)	Kernel yield (kg ha^{-1})
Nitrogen level (kg ha^{-1})						
100	204	20.4	14.9	22.8	307	5009
150	214	20.6	15.7	24.6	326	5584
200	222	21.1	16.1	24.8	340	5841
250	223	21.2	16.3	25.7	341	6016
C.D. at 0.05 level	13.1	NS	0.53	NS	15.6	406
Phosphorus level (kg ha^{-1})						
30	211	20.8	15.5	24.2	321	5334
60	218	20.6	15.8	24.8	330	5713
90	220	21.0	16.0	24.5	334	5790
C.D. at 0.05 level	NS	NS	NS	NS	NS	352

equal splits. One fourth dose at the time of sowing, remaining three doses at 25-30, 45-50 and 60-65 days after sowing (DAS) and phosphorus fertilizers were applied basally as per the treatments and a common recommended dose of potassium (60 kg K_2O ha^{-1}) was also applied at the time of sowing uniformly for the entire experimental field. Atrazine @ 2.0 kg ha^{-1} was sprayed immediately after sowing of maize seeds as pre-emergence herbicide in order to control weeds in the initial stages. Prophylactic measures were taken in maize crop as and when required. Initial and final soil samples were taken for analysis of various physico-chemical properties. The data on growth and yield attributes *viz*., cob length, number of kernels per cob, test weight, kernel and stalk yield and uptake of nitrogen and phosphorus were recorded and subjected to statistical analysis as per Panse and Sukhatme (1978).

Methodology adapted:

a) Treatments:

Nitrogen levels (kg ha^{-1})	Phosphorus levels (kg ha^{-1})
N_1: 100	P_1: 30
N_2: 150	P_2: 60
N_3: 200	P_3 : 90
N_4: 250	

A common dose of 60 kg K_2O ha^{-1} was applied uniformly to all treatments.

a) Replications : Three

b) Design : Randomized Block Design with factorial concept

c) Spacing : 60 cm x 20 cm

d) Hybrid : Pinnacle

f) Irrigation : as and when required

g) Plot size : 5.4 m x 5.0 m

f) Duration : Three seasons

RESULTS AND DISCUSSION

All the weather parameters were congenial for realizing higher productivity of maize during the three consecutive years (Table 1). Maximum temperature during these seasons ranged from 30.60°C to 33.17°C. Sunshine hours ranged from 7 to 7.95 hours. Evaporation ranged from 3.9 to 5.4 mm per day.

Table 4. Yield of maize in kg ha^{-1} as influenced by different levels of nitrogen and phosphorus during *rabi* 2011-12

N levels (kg ha^{-1})	P levels (kg ha^{-1})			
	30	60	90	Mean
100	5130	4303	5592	5009
150	5409	5453	5889	5584
200	5258	**6606**	5659	5841
250	5538	6491	6020	6016
Mean	5334	5713	5790	

During *rabi* 2010-11, plant height of maize was significantly influenced by different levels of nitrogen. The tallest plant height (275.4 cm) was recorded with 250 kg N ha^{-1}. The shortest plants were recorded with lowest level of N (183.6 cm). Phosphorus levels did not show any influence on plant height. There was no interaction effect between N and P levels on plant height. Cob length was significantly influenced by N levels. The largest cobs were recorded with 250 kg N ha^{-1} which was significantly superior over cobs recorded at lowest N level (100 kg ha^{-1}), however it was on a par with 150 and 200 kg N ha^{-1}. Cob girth was also highest with 250 kg N ha^{-1} which was significantly superior over lowest N level (100 and 150 kg ha^{-1}), however it was on a par with 200 kg N ha^{-1}. Neither P levels nor interaction with N levels were found significant on cob girth. Test weight of maize grains were not influenced by N, P levels and their interaction. Among nitrogen levels, the highest seed yield was recorded with application of N @ 250 Kg ha^{-1}. However, it is comparable with application of N @ 200 kg ha^{-1}. Progressive increment in seed yield was recorded with increasing levels of nitrogen from 100 to 250 kg ha^{-1}. The yield differences were not significant with respect to phosphorus application. Enhanced levels of nutrient supply exerted a significant and positive influence on the kernel yield of maize. Graded levels of N have profound influence on the kernel yield of maize. Nitrogen is a critical input in agriculture and is a powerful tool for increasing the grain yield in cereals. Maize has maximum nitrogen use efficiency of about 50 per cent, but under poor management, its efficiency varies from 30 – 40 per cent (Patel *et al.,* 2006). Among the major nutrients, P ranked next to N in its importance because of its vital

Table 5. Plant and yield attributes of maize as influenced by different levels of nitrogen and phosphorus during *rabi* 2012-13

Treatment	Plant height (cm)	Cob length (cm)	Cob girth (cm)	100 seed wt. (g)	No. of seeds/ cob (g)	Seed yield (kg ha^{-1})
Nitrogen level (kg ha^{-1})						
100	210.8	19.4	15.83	27.6	451	5053
150	225.4	20.0	16.03	27.9	509	6007
200	234.6	20.6	16.06	28.0	514	6609
250	235.6	20.8	16.41	29.2	540	6911
C.D. at 0.05 level	12.1	0.69	NS	NS	46.7	594
Phosphorus level (kg ha^{-1})						
30	225.9	20.2	16.09	28.1	513	6155
60	230.6	20.2	16.14	28.5	504	6206
90	223.3	20.1	16.02	28.0	493	6074
C.D. at 0.05 level	NS	NS	NS	NS	NS	NS

Table 6. Yield of maize (kg ha^{-1}) as influenced by nitrogen levels and phosphorus levels (Pooled data of 2010-11, 2011-12 and 2012-13)

Treatment	2010-11	2011-12	2012-13	Pooled
Years				
2010-11	-	-	-	4265
2011-12	-	-	-	5612
2012-13	-	-	-	6145
CD (0.05)				218
Nitrogen level (kg ha^{-1})				
100	3588	5009	5053	4549
150	4120	5584	6007	5237
200	4565	5841	6609	5672
250	4787	6016	6911	5905
CD (0.05)	343	406	594	252
Phosphorus level (kg ha^{-1})				
30	4104	5334	6155	5197
60	4253	5713	6206	5390
90	4439	5790	6074	5434
CD (0.05)	NS	352	NS	NS
N x P	NS	Sig.	NS	NS

role in major life processes and its availability to the growing crop in required levels is of very important. Application of phosphorous in a balanced proportion with other essential nutrients has produced higher yields and ensured more profit to the farmers (Manimaran and Poonkodi, 2009). Similar trend was recorded in all the three consecutive years except during 2011-12 where in interaction of N with P levels was found to be significant. Interaction effects showed that application of N @ 200 kg ha^{-1} along with P_2O_5 @ 60 kg ha^{-1} recorded highest seed yield (6606 kg ha^{-1}).

The pooled data of 2010-11, 2011-12 and 2012-13 also revealed that significant differences in yield were observed among nitrogen levels (Table 6). The response was significant up to 200 kg ha^{-1} which recorded seed yield of 5672 kg ha^{-1}. Highest level of nitrogen i.e. 250 kg N ha^{-1} recorded seed yield of 5905 kg ha^{-1} but was on par with 200 kg N ha^{-1} (5672 kg ha^{-1}). Significant differences were not observed among phosphorus levels tested. Tyagi *et al.* (1998) observed an increase in grain yield of maize from 61 to 137 per cent with increased levels of N application from 75 to 250 kg ha^{-1} over that of no nitrogen on sandy loam soils of Hissar, Haryana. Patel *et al.* (2006) also reported that with increasing levels of N from 75 to175 kg ha^{-1} also improved all the yield attributes and grain yield of maize in alfisols of Anand, Gujarat. Increased dry matter production with increased nitrogen application coupled with P increased biomass as reported by Wadsworth (2002). Thus greater availability of photosynthates, metabolites and nutrients to develop reproductive structures seems to have resulted in increased dry weight of grain. Enhanced levels of nitrogen supply exerted a significant and positive influence on the kernel yield of maize.

CONCLUSION

Results revealed that nitrogen requirement for *rabi* maize was found to be 200 kg ha^{-1} with application of phosphorus @ 30 kg ha^{-1} would be optimum for realizing profitable grain yield in maize.

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