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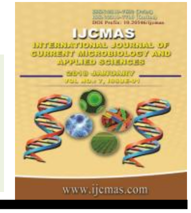

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Effect of Different Nitrogen and Phosphorus Levels on Growth and Yield of Maize during *Kharif* Season

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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 growth and yield of maize. The growth parameters of maize *viz*., plant height, leaf area index and dry matter production were considerably influenced by nitrogen and phosphorus levels at 30, 90 DAS and at harvest in the first year and only by nitrogen levels at all the stages on dry matter production and on LAI at 90 DAS in the second year. Interaction was not significant except at 90 DAS on plant height and at harvest, on dry matter production in the first year. During both the years, the highest and lowest grain and stover yields were recorded with N level of 300 kg ha^{-1} and 200 kg ha^{-1} and with P level of 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 yield of maize during *kharif* season.

Introduction

Wheat, rice and maize are the most important cereal crops in the world but maize is the most popular due to its high yielding, ease of processing, readily digested and costs less than other cereals (Jaliya *et al.*, 2008). Maize as a major source of carbohydrate is used as food, in livestock diet and in alcohol production. Maize has immense potential in the tropics and yield of up to 7500 kg ha^{-1} can be obtained if the crop is properly managed. Unfortunately, yields are still generally below 5000 kg ha^{-1} (FAO, 2007) and this had caused inadequacy of maize for its numerous usages. Yield differences between temperate and tropical areas have been attributed to low nutrient status of tropical soils especially nitrogen, phosphorus and potassium resulting from the practice of slash and burn farming system with excessive leaching of the soil nutrients. The low fertility status of most tropical soils hindered maize production as maize has a strong exhausting effect on the soil. Luxuriant growth resulting from fertilizer application leads to larger dry matter production owing to better utilization of solar radiation and nutrients (Saeed *et al.*, 2001). Conflicting results about the benefits and adverse effects of fertilizer have however been found in literature. Ayoola and Adeniyan (2006) had reported that the use of inorganic fertilizer has not been helpful under intensive agriculture because it is often associated with reduced yield, nutrient imbalance, leaching and pollution of groundwater. In view of inconsistency in the fertilizer and increasing cost of production associated with its usage, field trials were conducted in 2014 and 2015 to determine the appropriate N and P rate that will produce the optimum yield in maize.

Materials 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* seasons of 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}), medium 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 included 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)). 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 high stage and the remaining one third at tasseling stage. Entire quantity of P_2O_5 as per the treatments 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. The split dose of 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 determination of growth parameters. The growth parameters assessed included plant height (cm), leaf area index (LAI) and total dry matter (kg ha^{-1}). At harvest, the cobs and stover were harvested and weighed separately. The cobs and stover were dried and re-weighed. The grain on 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. Treatmental differences that were non-significant are denoted as NS.

Results and Discussion

Plant height

Among the nitrogen levels, application of nitrogen at 300 kg ha^{-1} (N_3) produced taller plants, which were on par with that of 250 kg N ha^{-1} (N_2) at all the stages of crop growth except at 30 DAS during the first year (Table. 1). Improvement in plant height with each successive increment of nitrogen might be attributed to the fact that nitrogen is an integral part of proteins, the building blocks of plant and it also helps in maintaining higher auxin level which might have resulted in better plant height. Similar findings were reported by Dawadi and Sah (2012) and Nsanzabaganwa *et al.,* (2014).

Among the phosphorus levels, application of 60 kg P_2O_5 ha^{-1} (P_2) produced taller plants in the first year and 80 kg P_2O_5 ha^{-1} (P_3) in the second year. Improvement in plant height with higher phosphorus levels over and above 40 kg P_2O_5 ha^{-1} (P_2) might be attributed to the fact that phosphorus is a constituent of nucleic acids, phospholipids, coenzymes and most importantly ATP. It activates coenzymes for amino acid production used in protein synthesis which might have resulted in better plant height. Similar results were obtained by Gemechu (2011).

With regard to interaction, increase in levels of nitrogen in combination with increased phosphorus levels resulted in taller plants *i.e* N_3P_3 (300 kg N + 80 kg P_2O_5 ha^{-1}) at 30 DAS and N_2P_2 (250 kg N + 60 kg P_2O_5 ha^{-1}) at 90 DAS. The increase in plant height in the presence of adequate nutrients might be due to rapid cell division and cell elongation which might have stimulated the growth. Significant interaction between nitrogen and phosphorus levels with respect to plant height was in conformity with the works of Baffoe (2014).

Leaf Area Index

Significantly higher LAI was recorded with the application of 300 kg N ha^{-1} (N_3) followed by 250 kg N ha^{-1} (N_2), whereas the lowest LAI was obtained with 200 kg N ha^{-1} (N_1) (Table. 2). Increase in LAI with application of nitrogen at higher levels might be due to adequate dose and timely application which could have facilitated luxurious uptake of nitrogen, triggering the foliage emergence. The positive effect of nitrogen on LAI in terms of more leaf elongation and less leaf senescence leading to production of larger leaves and improved photosynthetic capacity of the plants was also quoted by Nsanzabaganwa *et al.*, (2014) and Thimmappa *et al.*, (2014).

With regard to phosphorus, application of 60 kg ha^{-1} (P_2) resulted in higher LAI, which was comparable to 80 kg ha^{-1} (P_3) and was significantly superior to 40 kg ha^{-1} (P_1). This was due to availability of adequate phosphorus at higher levels of application which encouraged leaf expansion and growth. Similar observations were also recorded by Gemechu (2011) and Araei and Mojaddam (2014). The interaction was not significant with respect to LAI during both the years of study.

Table.1 Plant height (cm) of maize at different growth stages during *kharif* season

Treatments	Plant height							
	30 DAS		60 DAS		90 DAS		At Harvest	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Nitrogen levels (kg N ha^{-1})								
N_1	106.2	94.5	268.8	257.6	276.2	269.2	276.8	269.4
N_2	111.8	96.4	269.9	260.9	277.7	272.0	277.8	272.4
N_3	117.9	99.1	274.1	261.2	281.6	271.7	281.6	273.5
SEm±	1.10	1.56	2.16	2.83	1.69	3.71	2.34	4.21
CD (P = 0.05)	3.30	NS	NS	NS	5.1	NS	NS	NS
Phosphorus levels (kg P_2O_5 ha^{-1})								
P_1	108.6	95.8	270.4	257.6	273.6	271.7	276.0	271.9
P_2	115.9	97.3	271.6	263.2	279.7	268.4	279.9	269.9
P_3	111.4	96.9	270.5	259.0	279.0	272.9	279.4	274.6
SEm±	1.10	1.56	2.16	2.83	1.69	3.71	2.34	4.21
CD (P = 0.05)	3.30	NS	NS	NS	5.1	NS	NS	NS
Interaction								
SEm±	1.91	2.70	3.73	4.91	2.94	6.43	4.05	7.30
CD (P = 0.05)	5.72	NS	NS	NS	8.8	NS	NS	NS

Interaction between N and P levels on plant height of maize at 30 DAS during 2014

	P_1	**P_2**	**P_3**	**Mean**
N_1	105.7	108.4	104.3	106.2
N_2	110.5	118.5	106.4	111.8
N_3	109.5	120.9	123.3	117.9
Mean	108.6	115.9	111.4	

Interaction between N and P levels on plant height of maize at 90 DAS during 2014

	P_1	**P_2**	**P_3**	**Mean**
N_1	269.9	279.8	278.8	276.2
N_2	273.9	283.1	277.2	277.7
N_3	280.9	282.8	281.1	281.6
Mean	274.9	281.9	279.0	

Table.2 Leaf area index of maize at different growth stages during *kharif* season

Treatments	Leaf area index							
	30 DAS		60 DAS		90 DAS		At Harvest	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Nitrogen levels (kg N ha^{-1})								
N_1	2.26	1.38	4.26	4.33	4.27	4.36	4.26	3.12
N_2	2.36	1.63	4.65	4.42	4.75	4.65	4.64	3.22
N_3	2.47	1.89	4.80	4.45	5.08	4.75	5.03	3.24
SEm±	0.08	0.24	0.234	0.212	0.205	0.119	0.195	0.127
CD (P = 0.05%)	NS	NS	NS	NS	0.51	0.35	0.58	NS
Phosphorus levels (kg P_2O_5 ha^{-1})								
P_1	2.31	1.59	4.01	4.05	4.10	4.32	4.02	3.16
P_2	2.42	1.68	4.56	4.46	4.76	4.49	4.70	3.20
P_3	2.36	1.62	4.34	4.16	4.69	4.36	4.64	3.24
SEm±	0.08	0.24	0.234	0.212	0.205	0.119	0.195	0.127
CD (P = 0.05%)	NS	NS	NS	NS	0.61	NS	0.58	NS
Interaction								
SEm±	0.13	0.41	0.405	0.367	0.355	0.205	0.355	0.221
CD (P = 0.05%)	NS	NS	NS	NS	NS	NS	NS	NS

Table.3 Dry matter production (kg ha^{-1}) of maize at different growth stages during *kharif* season

Treatments	Dry matter production							
	30 DAS		60 DAS		90 DAS		At Harvest	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Nitrogen levels (kg N ha^{-1})								
N_1	942	725	7823	6507	13882	16026	15093	21139
N_2	1002	751	8756	7959	14793	16555	16320	21306
N_3	1164	902	9392	8387	15508	17361	17521	22330
SEm±	50.6	58.2	296.3	209.9	382.8	411.7	375.7	363.2
CD (P = 0.05%)	152	175	888	629	1148	1235	1127	1082
Phosphorus levels (kg P_2O_5 ha^{-1})								
P_1	1019	805	7944	7715	14762	16255	15859	21659
P_2	1105	889	8712	7994	14958	16445	16958	22701
P_3	1061	837	8438	7744	15950	16325	17103	22116
SEm±	50.6	58.2	296.3	209.9	382.8	411.7	375.7	834.3
CD (P = 0.05%)	NS	NS	NS	NS	1148	NS	1127	NS
Interaction								
SEm±	87.7	102.5	513.3	363.6	663.1	713.0	650.7	1445.0
CD (P = 0.05%)	NS	NS	NS	NS	NS	NS	1952	NS

Interaction between N and P levels on dry matter production of maize during 2014

	P_1	**P_2**	**P_3**	**Mean**
N_1	13236	16173	14968	14793
N_2	14163	16172	17725	16020
N_3	17178	18528	15957	17221
Mean	14859	16958	16217	

Table.4 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})				
N_1	6885	8170	7997	10951
N_2	7832	9116	8961	12186
N_3	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})				
P_1	7271	8714	8491	12003
P_2	7983	8936	9387	13240
P_3	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	

Dry matter production

Among the nitrogen levels tried, 300 kg (N_3) and 250 kg ha^{-1} (N_2) produced significantly higher dry matter accumulation than that of 200 kg ha^{-1} (N_1) (Table. 3). This indicated the positive effect of nitrogen in boosting the crop growth. Shivay and Singh (2000) observed that application of nitrogen increased plant height by increasing leaf size resulting in more and larger photosynthetic apparatus consequently influencing dry matter production. LAI and leaf greenness determine the capture and use of solar radiation by maize plant, there by affecting the conversion rate of available radiation to dry matter accumulation. These findings are in conformity with the results of Nsanzabaganwa *et al.,* (2014) and Om *et al.,* (2014).

Application of phosphorus at 60 kg ha^{-1} (P_2) resulted in higher dry matter, which was comparable to 80 kg ha^{-1} (P_3) and significantly superior to 40 kg ha^{-1} (P_1). It seems the reason is increase in leaf area, photosynthesis improvement resulting in higher dry matter. Araei and Mojaddam (2014) also recorded the highest dry weight and leaf area of maize by applying 60 kg P ha^{-1} over 0 and 90 kg P_2O_5 ha^{-1}.

Interaction existed at the harvest stage of maize crop and the dry matter accumulation increased significantly by enhancing the fertility level up to N_3P_2 (300 kg N + 60 kg P_2O_5 ha^{-1}), however this was significantly superior over N_3P_3 (300 kg N + 80 kg P_2O_5 ha^{-1}). Higher LAI paved the way for higher dry matter production. Similar observations were recorded by Gul *et al.,* (2015) and Massey and Gaur (2016).

Yield

During the first year, application of 300 kg N ha^{-1} (N_3) resulted in higher grain yield, which was statistically superior to that of 250 kg (N_2) and 200 kg N ha^{-1} (N_1). The lowest grain yield was associated with 200 kg N ha^{-1} (N_1). During the second year nitrogen applied at 300 kg ha^{-1} (N_3) resulted in highest grain yield, which was statistically on par with that of 250 kg N ha^{-1} (N_2). The lowest grain yield was associated with 200 kg N ha^{-1} (N_1) (Table. 4). 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 kernel 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 Nsanzabaganwa *et al.,* (2014), Om *et al.,* (2014) and Thimmappa *et al.,* (2014).

Maize supplied with 60 kg P_2O_5 ha^{-1} (P_2) resulted in higher grain yield, which was however statistically on par with 80 kg P_2O_5 ha^{-1} (P_3). Significantly lowest grain yield was obtained with 40 kg P_2O_5 ha^{-1} (P_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.

Grain yield of maize increased significantly up to 60 kg P_2O_5 ha^{-1}. Further increase in P from 60 to 80 kg P_2O_5 ha^{-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_5 ha^{-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 Jaliya *et al.,* (2008) and Abera *et al.,* (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_5 ha^{-1}. Further increase in P from 60 to 80 kg P_2O_5 ha^{-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).

Combination of 250 kg N and 60 kg P_2O_5 ha^{-1} was found to be advantageous in getting the higher values of growth parameters and the yield of maize during *kharif* season.

References

Abera, T., Feyisa, D and Friesen, D. K. 2009. Effects of Crop Rotation and N-P Fertilizer Rate on Grain Yield and Related Characteristics of Maize and Soil Fertility at Bako, Western Oromia, Ethiopia. *East African Journal of Sciences.* 3 (1): 70-79.

Araei, M and Mojaddam, M. 2014. The effect of different levels of phosphorus from triple super phosphate chemical fertilizers and biological phosphate fertilizer (fertile 2) on physiological growth parameters of corn (*sc*704) in Ahvaz weather conditions. *International Journal of Plant, Animal and Environmental Sciences.* 4: 625-632.

Ayoola, O. T. and Adeniyan, O. N. 2006. Influence of poultry manure on yield and yield components of crops under different cropping systems in South west Nigeria. *African Journal of Biotechnology*. 5:1386-1392.

Baffoe, M. J. N. 2014. Effect of different rates of nitrogen and phosphorus fertilizer on maize grain protein content. M.Sc. thesis submitted to the University of Ghana Legon, Accra, Ghana.

Dawadi, D. R and Sah, S. K. 2012. Growth and yield of hybrid maize (*Zea mays* L.) in relation to planting density and nitrogen levels during winter season in Nepal. *Tropical Agricultural Research.* 23 (3): 218-227.

FAO. (2007). Food and Agriculture Organisation yearbook Volume 60.

Gemechu, G. A. 2011. Influence of nitrogen and phosphorus fertilizers on seed yield and quality of maize (*Zea mays* L.) at Bedele, South-Western Ethiopia. M. Sc thesis submitted to the Department of Plant Sciences, School of Graduate

Studies, Haramaya University, Ethiopia.

Gul, S., Khan, M. H., Khanday, B. A and Sabeena Nabi. 2015. Effect of sowing methods and NPK levels on growth and yield of rainfed maize (*Zea mays* L.) Hindawi Publishing Corporation, *Scientifica.* 1-6.

Jaliya, A. M., Falaki, A. M., Mahmud, M Sani, Y. A. 2008. Effects of sowing date and NPK fertilizer rate on yield and yield components of quality protein maize (*Zea mays* L.). *Journal of Agriculture and Biological Sciences.* 2:23-29.

Massey, J. X and Gaur, B. L. 2006. Effect of plant population and fertility levels on growth and NPK uptake by sweet corn (*Zea mays* L.) cultivars. *Annals of Agricultural Research (New series)*. 27 (4): 365-368.

Nsanzabaganwa, E., Das, T. K and Rana, D. S. 2014. Nitrogen and phosphorus effects on the growth, phenology, heat and nutrients accumulation and yield of winter maize (*Zea mays*) in Western Indo-Gangetic Plains. *Indian Journal of Agricultural Sciences*. 84 (5): 661-664.

Om, H., Singh, S. P., Singh, J. K., Singh, R. N., Ansari, M. A., Meena, R. L and Yadav, B. 2014. Productivity, nitrogen balance and economics of winter maize (*Zea mays*) as influenced by QPM cultivars and nitrogen levels. *Indian Journal of Agricultural Sciences*. 84 (2): 306-308.

Saeed, I. M., Abbasi, R and Kazim, M. 2001. Response of maize (*Zea mays*) to nitrogen and phosphorus fertilization under agro-climatic condition of Rawalokol, Jammu and Kaslim and Kashmir. *Pakistan Journal of Biological Sciences.* 4: 949-952.

Shivay, Y. S and Singh, R. P. 2000. Growth, yield attributes, yield and nutrient uptake of maize (*Zea mays* L.) as influenced by cropping systems and nitrogen levels. *Annals of Agricultural Research.* 21 (4): 494-498.

Sridhar, M. K. C and Adeoye, G. O. 2003. Organo-mineral fertilizer from urban wastes. *The Field.* 68:91-111.

Thimmappa, V., Reddy, M. S., Reddy, U. V. B and Reddy, S. T. 2014. Effect of nitrogen levels and plant densities on growth parameters, yield attributes and yield of *kharif* maize (*Zea mays* L.). *Crop Research*. 47 (1, 2 & 3): 29-32.

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