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Effect of Nitrogen and Phosphorus on Yield and Yield Attributes of Maize in South Saurashtra, India

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A B S T R A C T

A field experiment was conducted during *kharif* season of 2012 on calcareous soil to study the effect of 4 levels of nitrogen and 3 levels of phosphorus on yield and yield attributes of maize in South Saurastra. N (60, 80, 100 and 120 kg ha^{-1}) and P (40, 50 and 60 kg P_2O_5 ha^{-1}) with twelve treatment combinations tested in factorial randomized block design with three replications. Results indicated that application of 120 kg N ha^{-1} recorded the maximum plant height (165.28 cm), number of cobs per plant (1.49), cob length (17.87 cm), cob girth (15.05 cm), dry matter accumulation (153.09 g $plant^{-1}$), number of grains per cob (283.19), 100 grain weight (26.70 g), grain yield (4905 kg ha^{-1}), stover yield (8478 kg ha^{-1}), biological yield (13382 kg ha^{-1}), net return (39228 ha^{-1}) and BCR (3.14). Application of 60 kg P_2O_5 ha^{-1} recorded the maximum plant height (159.16 cm), number of cobs per plant (1.47), cob length (17.58 cm), cob girth (14.99 cm), dry matter accumulation (146.52 g $plant^{-1}$), number of grains per cob (275.74), 100 grain weight (25.27 g), grain yield (4987 kg ha^{-1}), stover yield (8281 kg ha^{-1}), biological yield (13268 kg ha^{-1}), net return (38967 Rs. ha^{-1}) and BCR (3.03).

Introduction

Maize (*Zea mays* L.) ranks third in total world production after wheat and rice and it is principal staple food in many countries, particularly in the tropics and subtropics. Maize is considered as the "Queen of Cereals". Being a C_4 plant, it is capable to utilize solar radiation more efficiently even at higher radiation intensity. Maize assumes a special significance in Indian agriculture on account of its utilization as food, feed and fodder besides several industrial uses. Among different nutrients, nitrogen is the most commonly deficient nutrient in the soil and gives considerable response in maize crop. It has the quickest and the most pronounced effect on plant growth and development and ultimately on crop yield. Nitrogen is essential constituent of protein and is present in many other compounds of physiological importance in plant metabolism such as nucleotide, phosphatides, alkaloids, enzymes, hormones and vitamins etc. It has best physiological efficiency thus N will help in boosting higher yield. Phosphorus nutrition plays a key role in

plant metabolism. It is most essential for all living creatures for their growth and development. Being involved in various biochemical processes, it ensures transfer and storage of energy as ADP and ATP, permits conversion and transmission of genetic characters, as it is a constituent of RNA and DNA. Therefore, the present study was carried out to find out the effect of N and P dosage on *kharif* maize.

Materials and Methods

A field experiment was conducted during *kharif* season of 2012 at Instructional Farm, Department of Agronomy, College of Agriculture, Junagadh Agricultural University, Junagadh situated at South Saurashtra agroclimatic zone – VII at latitude of 21.51' N ,longitude of 70.49' E and altitude 61.0 m above mean sea level. The soil was medium black, alkaline in reaction (pH 8.0), medium in organic carbon (0.54%), low in available nitrogen (238.0 kg ha^{-1}), medium in available phosphorus (27.50 kg P_2O_5 ha^{-1}) and potassium (236.0 kg K_2O ha^{-1}) content. The experiment comprising twelve treatment combinations consisting four levels of nitrogen viz., 60, 80, 100 and 120 kg N ha^{-1} and three levels of phosphorus viz., 40, 50 and 60 kg P_2O_5 ha^{-1} were tested in a factorial randomized block design with three replications. Fertilizers were applied as per treatment through single super phosphate (SSP) and urea at the time of sowing as basal dose. The rainfall during *kharif* 2012 was 425.0 mm in 25 rainy days.The maize cv. 'GM-6' was sown on 18 July, 2012 using seed rate of 20 kg ha^{-1} with a row spacing of 45 cm and harvested on 7 October, 2012. Four irrigations were applied during growing season. Intercultural operations viz., thinning, hoeing and weeding were followed after 20 days of sowing to maintain recommended spacing and weed control. For weed management atrazine @ 0.5 kg ha^{-1} was applied as pre-emergence to control the weeds in early stages of the crop. Fully mature and develop cobs from randomly selected five plants from each plot were plucked and number of seeds were counted. The average number of cobs and seeds per plants was worked out. After threshing and winnowing the weight of seeds and also stover for each net plot area was recorded in kg per plot and then converted to kg ha^{-1}.

Results and Discussion

Effect of nitrogen

Growth parameters, yield attributes and yield of maize viz., plant height, number of cobs per plant, cob length, cob girth, dry matter accumulation, number of grains per cob, 100 grain weight, grain yield, stover yield, biological yield, net return and BCR were significantly influenced by nitrogen application and its levels (Table 4.1 and 4.2). Significantly, the highest values of these growth parameters, yield attribute and yield parameters were observed with application of 120 kg N ha^{-1} and the lowest values were recorded under 60 kg N ha^{-1}. The increase in these components seems to have been brought about by increase in amount of growth and yield attributes substances and naturally occurring phytohormones with an increased nitrogen supply to the plant. Probably the increase in auxin supply with higher levels of nitrogen brought about increase in the dry matter and enhances the plant growth. This improvement might be due to an early and plentiful availability of nitrogen leading to better nutritional environment in the root zone for growth and development. As nitrogen is one of the major essential plant nutrients required for growth. Therefore, increased availability of nitrogen might have increased cell number and cell size leading to better growth in terms of plant growth. Nitrogen is an element of chlorophyll; it harnesses solar

energy and fixes atmospheric CO_2 as carbohydrates and amino acids. Thus, nitrogen application increased dry matter production. The increased supply of nitrogen and their higher uptake by plants might have stimulated the rate of various physiological processes in plant and leads to increased growth parameters, yield attribute and yield. The enhanced growth with nitrogen was also reported by Sofi *et al.*, (2004), Yadav and Pandey (2005), Chillar and Kumar (2006), Kar *et al.*, (2006), Patel *et al.*, (2006), Bindhani *et al.*, (2007), Sahoo and Mahapatra (2007).

Table.1 Effect of nitrogen and phosphorus levels on growth parameters of maize

Treatment	Plant height (cm)	Number of cobs per plant	Cob length (cm)	Cob girth (cm)	Dry matter (g plant^{-1})
Nitrogen (kg N ha^{-1})					
N_1 – 60	128.04	1.19	14.56	12.41	129.83
N_2 – 80	141.30	1.32	15.85	13.40	140.83
N_3 – 100	157.65	1.40	17.22	14.43	149.92
N_4 – 120	165.28	1.49	17.87	15.05	153.09
S.Em. ±	3.45	0.04	0.39	0.32	3.58
CD (P = 0.05)	10.13	0.10	1.16	0.95	10.51
Phosphorus (kg P_2O_5 ha^{-1})					
P_1 – 40	137.38	1.21	15.08	12.55	137.62
P_2 – 50	147.67	1.37	16.47	13.93	146.11
P_3 – 60	159.16	1.47	17.58	14.99	146.52
S.Em. ±	2.99	0.03	0.34	0.28	3.10
CD (P = 0.05)	8.78	0.09	1.00	0.82	NS

Table.2 Effect of nitrogen and phosphorus levels on growth parameters, yield attribute, yield and economics of maize

Treatment	Number of grains per cob	100 grain weight (g)	Grain yield (kg ha^{-1})	Stover yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Net realization (₹ ha^{-1})	BCR
Nitrogen (kg N ha^{-1})							
N_1 – 60	226.70	19.81	4243	6096	10338	31006	2.76
N_2 – 80	250.97	21.86	4691	7016	11707	36148	3.03
N_3 – 100	274.62	25.92	4820	8034	12855	38192	3.11
N_4 – 120	283.19	26.70	4905	8478	13382	39228	3.14
S.Em. ±	4.61	0.62	132	251	268	-	-
CD (P = 0.05)	13.53	1.81	387	736	785	-	-
Phosphorus (kg P_2O_5 ha^{-1})							
P_1 – 40	241.41	21.89	4343	6447	10790	31512	2.71
P_2 – 50	259.46	23.56	4664	7489	12153	35361	2.88
P_3 – 60	275.74	25.27	4987	8281	13268	38967	3.03
S.Em. ±	4.00	0.54	114	217	232	-	-
CD (P = 0.05)	11.72	1.57	335	638	680	-	-

Effect of phosphorus

Growth parameters, yield attribute and yield of maize viz., plant height, number of cobs per plant, cob length, cob girth, number of grains per cob, 100 grain weight, grain yield, stover yield, biological yield, net return and BCR were significantly influenced by phosphorus application and its levels (Table 4.1 and 4.2). Significantly the highest values of these growth parameters, yield attribute and yield parameters were observed with application of 60 kg P_2O_5 ha^{-1} which the lowest values were recorded under 40 kg P_2O_5 ha^{-1}. The improvement in growth parameters with application of 60 kg P_2O_5 ha^{-1} might have resulted in better and timely availability of P for their utilization by plant (Table 4.1 and 4.2). Phosphorus fertilization improves the various metabolic and physiological processes and thus known as "energy currency" which is subsequently used for vegetative and reproductive growth through photo-phosphorylation. In addition to vital metabolic role, P is an important structural component of nucleic acid, phytein, phospholipids and enzymes. An adequate supply of phosphorus early in the life cycle of plant is important in laying down the primordia of its reproductive part. It also increases the initiation of both first and second order rootlets and their development. The extensive root system helps in exploiting the maximum nutrients and water from the soil. Under the present investigation, profound influence of P, a component of fertility management, on crop growth seem to be due to maintaining congenial nutritional environment of plant system on account of their greater availability from soil media. The significant improvement in nutrient status of plant parts (stover) might have resulted in greater synthesis of amino acids, proteins and growth promoting substances, which seems to have enhanced the meristematic activity and increased cell division and their elongation. The enhanced growth with phosphorus was also reported by Patel *et al.*, (2000), Arya and Singh (2001), Mehta (2002), Sahoo and Panda (2001) and Mehta *et al.*, (2005).

On the basis of one year field experimentation, it seems quite logical to conclude that maximum production and net returns from *kharif* maize by the application of nitrogen and phosphorus @ 120 and 60 kg ha^{-1} on calcareous soil under South Saurashtra agro-climatic Zone.

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