Research Paper

ADVANCE RESEARCH JOURNAL OF
CROP IMPROVEMENT
Volume 3 | Issue 2 | December, 2012 | 126-128

Effects of different levels of nitrogen, phosphorus and zinc on yield and yield attributes of maize (*Zea mays* L.)

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ABSTRACT : A field experiment was conducted during the *Rabi* season of the year 2009- 10 at Pulse Research Station, Anand Agricultural University, Model Farm, Vadodara, Gujarat. Results revealed that grain and stover yield (kg ha^{-1}) was found to be significantly higher under application of N_3 (160 kg N ha^{-1}) and N_2 (120 kg N ha^{-1}) over N_1 (80 kg N ha^{-1}). The grain yield showed increase under the levels of N_2 (120 kg N ha^{-1}) and N_3 (160 kg N ha^{-1}) were 11.35 and 18.64 per cent over treatment N_1 (80 kg N ha^{-1}). The grain yield of maize increased steadily with increase in phosphorus levels. Intermediate dose of phosphorus P_2 (60 kg P_2O_5 ha^{-1}) produced significantly higher yield 8.97 per cent as compared to lower dose of P_1 (40 kg P_2O_5 ha^{-1}). The higher dose of P_3 (80 kg P_2O_5 ha^{-1}) increased 10.12 per cent in grain yield over P_1 (40 kg P_2O_5 ha^{-1}). Increased grain yield with application of Z_2 (5 kg Z ha^{-1}) was 10.21 per cent over no application *i.e.* Z_1 (0 kg Z ha^{-1}).

Key Words : Nitrogen, Phosphorus, Zinc, Maize, Yield

How to cite this paper : Raskar, S.S., Sonani, V.V. and Shelke, A.V. (2012). Effects of different levels of nitrogen, phosphorus and zinc on yield and yield attributes of maize (*Zea mays* L.), *Adv. Res. J. Crop Improv.*, **3** (2) : 126-128.

Paper History : Received : 01.09.2012; **Revised :** 24.09.2012; **Accepted :** 10.11.2012

Maize (*Zea mays* L.) the 'queen of cereals', popularly known as corn, is one of the most important cereals of the world, ranking third among the food crop, next to rice and wheat, both in respect of area and production. An increase in the yield of crop can be brought forward either by increasing the area under cultivation or by increasing the productivity per unit area. Since the area is limited, yield level per unit area has to be increased. Maize has been widely cultivated as a rain fed crop in India. Recent studies have shown that maize can be successfully grown during *Rabi* in many part of the country due to evolution of new genotypes. The yield level of maize during *Rabi* season is considerably higher than that of *Kharif* due to its timely water availability and higher fertilizer use efficiencies (Singh, 1974). Nitrogen is the key element in crop growth and is the most limiting nutrient in Indian soil. The paramount importance of nitrogen for increasing the yield has been widely accepted. Nitrogen influences the quality of product by improving the level of protein, succulence and palatability.

Nitrogen plays an important role in synthesis of chlorophyll as well as several amino acids. Corn is heavily consumer of plant nutrient (Bar-Yosef *et. al.*, 1989). Corn responds well to phosphatic fertilizers in almost all the soil types. It plays vital role in plant nutrition. The deficiency of phosphorus in soil severely limits root and shoot growth and thereby affecting the yield. It has been observed that application of phosphorus increases growth and yield, along with dry matter production (Bar-Yosef *et.al.*, 1989). It is associated with several vital physiological, metabolic and biochemical functions such as utilization of sugars and starch, photosynthesis, cell division, fat and albumin formation. Application of micronutrient also plays significant role in improvement of grain yield of maize. Among, micronutrient zinc plays an important role in photosynthesis, nitrogen metabolism and regulates auxin concentration in the plant.

RESEARCH PROCEDURE

A field experiment was conducted at Pulse Research Station, Model Farm, Anand Agricultural University, Vadodara, Gujarat during the *Rabi* season of the year 2009- 10. Soil of the experimental field was sandy loam with pH 7.5. It was very deep and fairly moisture retentive, low in available nitrogen, zinc and organic carbon and high in available phosphorus and potash. Eighteen treatment combinations consisted of three levels of nitrogen (80, 120 and 160 kg N ha^{-1}), three levels of phosphorus (40, 60 and 80 kg P_2O_5 ha^{-1}) and two levels of zinc (0 and 5 kg Z ha^{-1}) were tested in factorial randomized block design with three replications. Furrows were opened manually in each plot 60 cm apart in dry conditions after thorough preparation of land. The full dose of phosphors and zinc and 1/3rd quantity of nitrogen according to treatments were applied at the time of sowing. Remaining 2/3rd quantity of nitrogen was applied in two equal split *i.e.* at knee high stage and at tesseling stage. Eight irrigations were given as when required. The experiment was sown with single cross hybrid maize 'HQPM-1' on 8 Nov 2009 and harvested on 10 March 2010.

RESEARCH ANALYSIS AND REASONING

A significant increase in growth and yield attributes *viz.*, plant height, cob length, number of grain rows/cob, grain yield/cob and shelling percentage was obtained with increase in nitrogen levels from 80 to 120 kg N ha^{-1}. Further increase in nitrogen levels beyond 120 kg N ha^{-1} did not bring any significant increase in these parameters. The number of cobs/plant and test weight were also increased with each increase in nitrogen levels up to 160 kg N ha^{-1}. However, there was no significant difference between two consecutive levels of nitrogen. The grain and stover yields were also significantly influenced by nitrogen applications. Application of 120 and 160 kg N ha^{-1} were at par and produced significantly higher grain and stover yields as compared to 80 kg N ha^{-1}. The mean grain yield recorded under application of 120 and 160 kg N ha^{-1} were 5209 and 5550 kg ha^{-1} which accounted for 11.35 and 18.64 per cent increase over 80 kg N ha^{-1}. These findings are in accordance with the results observed by Arya and Singh (2000), Shivay *et al.* (2002), Patel *et al.* (2006), Sepat and Kumar (2007) and Kumar (2009).

There was a significant effect of phosphorus on growth and yield attributes of maize (Table 1). All the characters like plant height, cob length, grain yield/cob, shelling percentage and test weight increased significantly with increase in phosphorus levels up to 60 kg P_2O_5 ha^{-1}, whereas number of grains row/cob increased significantly up 80 kg P_2O_5 ha^{-1}. Increasing levels of phosphorus increased the grain and stover yield

Table 1: Growth and yield attributes as well as grain and stover yield of maize as influenced by nitrogen, phosphorus and zinc levels

Treatments	Plant height (cm)	Number of cobs plant^{-1}	Cob length (cm)	Number of grain rows cob^{-1}	Grain yield cob^{-1} (g)	Test weight (100 grains) (g)	Shelling (%)	Number of barren plants net plot^{-1}	Grain yield, (kg ha^{-1})	Stover yield, (kg ha^{-1})	Harvest index (%)
Nitrogen levels (kg ha^{-1})											
80	172.59	1.08	12.69	12.57	73.40	24.53	70.34	4.33	4678	6959	39.95
120	191.42	1.13	13.38	13.10	81.04	24.95	72.63	3.83	5209	7628	40.37
160	191.50	1.19	13.52	13.41	83.54	25.64	73.57	3.72	5550	7742	41.32
S.E. ±	2.313	0.024	0.125	0.128	1.925	0.280	0.530	0.125	142.4	122.8	0.83
C.D. (P=0.05)	6.639	0.068	0.358	0.368	5.525	0.804	1.523	0.358	408.7	352.5	NS
Phosphorus levels (kg ha^{-1})											
40	179.60	1.08	12.87	12.52	74.96	24.39	70.79	4.33	4838	7137	39.99
60	186.52	1.17	13.27	13.09	80.78	25.11	72.79	3.94	5272	7568	40.82
80	189.40	1.16	13.46	13.47	82.23	25.63	72.96	3.61	5328	7625	40.84
S.E. ±	2.313	0.024	0.125	0.128	1.925	0.280	0.530	0.125	142.4	122.8	0.83
C.D. (P=0.05)	6.639	0.068	0.358	0.368	5.525	0.804	1.523	0.358	408.7	352.5	NS
Zinc levels (kg ha^{-1})											
0	182.0	1.10	12.94	12.84	76.96	24.70	71.28	4.11	4896	7165	40.34
5	138.3	1.16	13.46	13.21	81.69	25.38	73.08	3.81	5396	7721	40.76
S.E. ±	1.89	0.019	0.102	0.105	1.571	0.229	0.433	0.102	116.2	100.2	0.689
C.D. (P=0.05)	5.42	0.055	0.292	0.301	4.511	0.656	1.243	0.292	333.7	287.8	NS
C.V.%	5.30	8.85	4.01	4.18	10.29	4.74	3.12	13.35	11.74	7.00	8.71

NS=Non-significant

significantly. Application of 60 and 80 kg P_2O_5 ha^{-1} were at par and produced significantly higher grain yield than that of 40 kg P_2O_5 ha^{-1}. The mean grain yield recorded under application of 60 and 80 kg P_2O_5 ha^{-1} were 5272 and 5328 kg ha^{-1} which accounted for 8.97 and 10.13 per cent increase over 80 kg P_2O_5 ha^{-1}. This increase in grain yield with increase in phosphorus levels may be attributed probably to the development of extensive root system, which enabled the plants to absorb more nutrient from the soil depth and might have growth of plant enhanced photosynthetic activities. The positive effect of phosphorus levels on grain yield and yield attributes have also been reported by Kumpawat and Rathore (1995) and Patel *et al.* (2000).

Zinc application significantly influenced all the attributes of maize (Table 1). The plant height, cob length, test weight, number of grain rows/cob, shelling percentage and grain yield/cob were significantly higher in 5 kg Z ha^{-1} as compared to control. It also significantly increased grain and stover yields as compared to control. The per cent increased was to the tune of 10.21 in case of grain and 7.76 in case of stover yield. The grain and stover yields increased owing to zinc application which takes part in metabolism of plant as an activator of several enzymes and in turn may directly or indirectly affect the synthesis of carbohydrate and protein. Arya and Singh (2000) also reported an increase in the grain and stover yield.

In light of the results obtained from this investigation, it can be concluded that for securing maximum seed yield and net profit, it is advisable to apply 120 kg N ha^{-1} and 60 kg P_2O_5 ha^{-1} in addition to 5 kg Z ha^{-1} to *Rabi* maize crop var. HQPM-1 under middle Gujarat Agro-climatic conditions.

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