Effect of nitrogen and phosphorus fertilizers on nutrient content and uptake of high quality protein maize (*Zea mays* L.) to under South Saurashtra agroclimatic zone of Gujarat

ABSTRACT

An experiment was conducted to assess the "effect of nitrogen and phosphorus fertilizers on nutrient content and uptake of high quality protein maize (*Zea mays* L.) to under South Saurashtra agroclimatic zone of Gujarat" during summer, 2016 at the department of agronomy, college of agriculture, JAU, Junagadh. The experiment comprising of total twelve treatment combinations consisting four levels of nitrogen (Control, 90 kg N ha^{-1}, 120 kg N ha^{-1}, 150 kg N ha^{-1}) and three levels of phosphorus (Control, 45 kg P_2O_5 ha^{-1}, 60 kg P_2O_5 ha^{-1}) laid out in Factorial Randomized Block Design replicated thrice. The results revealed that application of 150 kg N/ha significantly higher nitrogen, phosphorus and potassium content and uptake of grains and straw over control and 90 kg N/ha, while at par with 120 kg N/ha. Result showed that application of 60 kg P_2O_5 /ha significantly higher nitrogen, phosphorus and potassium content and uptake of grains and straw, being remained at par with 45 kg P_2O_5 /ha over control.

Keywords: Quality Protein Maize, Nitrogen and Phosphorus and Potassium

INTRODUCTION

Maize (*Zea mays* L.) is an annual plant belongs to the family *Gramineae.* Maize is considered as the "Queen of cereals". Being a C_4 plant, it is capable to utilize solar radiation more efficiently even at lower radiation intensity. Globally, maize is known as queen of cereals because of its highest genetic yield potential. Maize is the only food cereal crop that can be grown in diverse seasons, ecologies and uses. Beside this maize have many types like normal yellow/white grain, sweet corn, baby corn, popcorn, waxy corn, high amylase corn, high oil corn, quality protein maize, *etc*. Apart from this, maize is an important industrial raw material and provides large opportunity for value addition.

In Indian agriculture, maize assumes a special significance on account of its utilization as food, feed and fodder besides several industrial use. Gujarat occupies an area of 0.50 million ha, with production of 0.82 million tonnes and productivity of 1525 kg/ha (Anon., 2013). In India, it is grown on 8.67 mha area with the production and productivity of 21.75 mt and 2566 kg/ha, respectively (Anon., 2014).

In Gujarat, the important districts growing maize are Dahod, Panchmahal, Vadodara, Sabarkantha, Kheda, Banaskantha, Bharuch, Anand and Dang. The area under maize in the Saurashtra region is almost negligible. It is mainly cultivated in *kharif* season, and due to photo-insensitive crop, it is also grown as *rabi* and summer crop. High quality protein maize is a nitrogen exhaustive crop and

requires very high dosage of the nutrients. Thus higher yield of quality protein maize (QPM) can be obtained through judicious uses of two major nutrients (N and P) as these two nutrients alone contributes 40-60 per cent of the crop make up. Nitrogen is most important for plant growth and development. Nitrogen is an essential constituent of protoplasm and chlorophyll and is associated with the activity of every living cell. Most of the popular/recommended varieties of high quality protein maize (HQPM) are single cross hybrids in which nitrogen stress before flowering reduces leaf area and photosynthesis. Nitrogen stress during flowering stage results in kernel and ear abortion, where as stress during grain filling accelerates leaf sencence, reduces photosynthesis and kernel weight. Thus, for enhancing grain yield of single cross hybrids of high quality protein maize (HQPM), nitrogen fertilization has emerged as a serious matter of concern for maize growing farmers.

Next to nitrogen, phosphorus is of paramount importance for energy transfer in living cells by mean of high energy phosphate bonds of adenosine tri phosphate (ATP). It plays pivotal role in formation, translocation of carbohydrates, fatty acids, glyceroids and other essential intermediate compounds. It also affects protein content of the grain as well as fodder. Potassium activates enzymes that metabolize carbohydrates for the manufacture of amino acids and potassium facilitates cell division and growth by helping to move starches and sugars between plant parts, adds stalk and stem stiffness, increases disease resistance among the others. Potassium regulates many metabolic processes required for growth, fruit and seed development.

MATERIALS AND METHODS

The field experiment entitled the effect of nitrogen and phosphorus fertilizers on nutrient content and uptake of high quality protein maize (*Zea mays* L.) to under South Saurashtra agro-climatic zone of Gujarat was conducted during summer 2016 at Instructional Farm, Department of Agronomy, Junagadh Agricultural University, Junagadh (Gujarat), which is situated in South Saurashtra Agro-climatic region of Gujarat state and enjoys a typically subtropical climate characterized by fairly cold and dry winter, hot and dry summer as well as warm and moderately humid monsoon. This is situated at 221.50 N latitude and 70.50 E longitudes with an altitude of 60 m above the mean sea level. The soil was clayey in texture and slightly alkaline in reaction with pH 7.9 and EC 0.38 dS m^{-1}. The soil was low in available nitrogen (241.00 kg/ha) and available phosphorus (31.60 kg/ha) while medium in available potash (245.36 kg/ha). The experiment comprising of total twelve treatment combinations consisting four levels of nitrogen viz., N_0: Control, N_1: 90 kg N/ha, N_2: 120 kg N/ha, N_3: 150 kg N/ha and three levels of phosphorus viz., P_0: Control, P_1: 45 kg P_2O_5/ha, P_2: 60 kg P_2O_5 /ha laid out in Factorial Randomized Block Design replicated thrice. The crop was sown in 60 cm × 20 cm spacing with seed rate of 25 kg/ha. The variety HQPM-1 was shown on 10th February and all other recommended practices were adopted according to as per needed of crop requirement. As per treatment nitrogen, phosphorus and potassium were applied through urea, DAP and muriate of potash respectively. One half of nitrogen and full dose of phosphorus and potassium were applied as basal. The remaining dose of nitrogen was top dressed at knee high stage. All the data were subjected to statistical analysis by adopting appropriate method of analysis of variance as described

by Cochran and Cox (1967). Wherever, the F value was found significant at 5 per cent level of probability, the Critical Difference (CD) value was computed for comparing treatment means. The crop was harvested at physiological maturity stage on 16 May, 2016.

RESULTS AND DISCUSSION

Effect on nitrogen

An appraisal of data (Table 1 to 4) showed that different levels of nitrogen imparted their significant influence on nitrogen, phosphorus and potassium content and uptake of grains and straw. Application of 150 kg N/ha recorded significantly the higher nitrogen, phosphorus and potassium content of grains (1.77, 0.59 and 0.57 %) and straw (0.84, 0.25 and 1.06 %) and nitrogen, phosphorus and potassium uptake of grains (74.39, 24.69 and 24.27 $kg\ ha^{-1}$) and straw (52.33, 15.71 and 66.28 $kg\ ha^{-1}$) remained statistically at par with 120 kg N/ha over 90 kg N/ha and control. The nutrient uptake is a function of yield and nutrient concentration in plant. Thus, significant improvement in uptake of NPK might be attributed to their concentration in grain and straw and associated with higher grain and straw yield. This might also be attributed to better availability of nutrients in the soil under these treatments. The results of present investigation are in close agreements with the finding of Banerjee *et al.,* (2003), Kar *et al.,* (2006), Worku *et al.,* (2007), Ram *et al.,* (2009), Singh *et al.,* (2011), Choudhary *et al.,* (2013) in quality protein maize (QPM). Result showed that application of nitrogen 150 kg/ha recorded significantly the higher grain yield (4201 kg/ha), straw yield (6194 kg/ha) and biological yield (10395 kg/ha) and remained statistically at par with 120 kg N/ha (Fig.1). Significantly, the lowest grain yield, straw yield and biological yield was recorded under no nitrogen application. Significant increase in grain yield and straw yield under nitrogen levels appears to be on account of their influence on dry matter production and indirectly on increase in plant height, number of leaves, leaf area index, stem thickness and possibly a result of higher uptake of nutrients. The findings are in close agreement with the results obtained by Bindhani (2007), Jeet *et al.,* (2012) and Om *et al.,* (2014).

Effect of phosphorus

An examination of data (Table 1to 4) mentioned that various levels of phosphorus exerted their significant influence on nitrogen, phosphorus and potassium content of grains and straw. Application of 60 kg N/ha recorded significantly the higher nitrogen, phosphorus and potassium content of grains (1.76, 0.58 and 0.57 %) and straw (0.80, 0.25 and 1.06 %) and nitrogen, phosphorus and potassium uptake of grains (66.53, 22.31 and 22.13 $kg\ ha^{-1}$) and straw (46.27, 14.31 and 60.29 kg ha^{-1}), remained statistically at par with 45 kg N/ha over control. Higher photosynthetic activity in plant as evident from increase in biomass accumulation at successive duration and plant height reveals higher availability of metabolites from shoot to root. This might have promoted growth of root as well as their functional activity resulting in higher extraction of nutrients from soil environment to aerial parts. The nutrient uptake is a function of yield and nutrient concentration in plant. Thus, significant improvement in uptake of NPK might be

attributed to their concentration in grain and straw and associated with higher grain and straw yield. This might also be attributed to better availability of nutrients in the soil under these treatments. The results of present investigation are in close conformity with the finding of Mehta *et al.,* (2005), Ram *et al.,* (2009), IIMR (2012e), Jena *et al*. (2013) and Suthar *et al.,* (2013). Result that various levels of phosphorus manifested their significant influence on grain yield and straw yield. Application of 60 kg P_2O_5 ha^{-1} recorded significantly higher of grain yield (3774 kg ha^{-1}), straw yield (5694 kg/ha) and biological yield (9469 kg/ha) and remained statistically at par with 45 kg P_2O_5/ha. Where, no application of phosphorus produced significantly the lowest grain, straw and biological yields (Fig.1). The findings are in close agreement with the results obtained by Bindhani (2007), Dibaba *et al*., (2013) and Om *et al.,* (2014).

CONCLUSIONS

On the basis of one year field experimentation, it may be concluded that to application 150 kg N/ha and 60 kg P_2O_5/ha recorded significant higher nitrogen, phosphorus and potassium content and uptake of grains and straw, remained statistically at par with 120 kg N/ha and 45 kg kg P_2O_5/ha over lowest level.

Table: 1 Effect of N and P levels on N, P and K content in grain of high quality protein maize

Treatments	N content (%)	P content (%)	K content (%)
Nitrogen levels (kg N ha^{-1})			
Control	1.65	0.46	0.48
90	1.67	0.54	0.50
120	1.71	0.55	0.53
150	1.77	0.59	0.57
S.Em.±	0.03	0.01	0.01
C.D. (P = 0.05)	0.09	0.03	0.04
Phosphorus levels (kg P_2O_5 ha^{-1})			
Control	1.62	0.48	0.45
45	1.72	0.55	0.54
60	1.76	0.58	0.57

S.Em.±	0.03	0.01	0.01
C.D. (P = 0.05)	0.08	0.03	0.04
C.V. (%)	5.27	6.54	8.17
Interaction (N×P)	NS	NS	NS

Table: 2 Effect of N and P levels on N, P and K content in straw of high quality protein maize

Treatments	**N content (%)**	**P content (%)**	**K content (%)**
Nitrogen levels (kg N ha^{-1})			
Control	0.66	0.22	1.01
90	0.75	0.23	1.05
120	0.81	0.24	1.05
150	0.84	0.25	1.06
S.Em. ±	0.02	0.01	0.03
C.D. (P = 0.05)	0.05	NS	NS
Phosphorus levels (kg P_2O_5 ha^{-1})			
Control	0.74	0.22	1.03
45	0.76	0.24	1.04
60	0.80	0.25	1.06
S.Em. ±	0.01	0.01	0.03
C.D. (P = 0.05)	0.04	NS	NS
C.V. (%)	6.12	11.64	9.53

Interaction (N×P)	NS	NS	NS

Table: 3 Effect of N and P levels on N, P and K uptake by grain of high quality protein maize

Treatments	N uptake (kg ha^{-1})	P uptake (kg ha^{-1})	K uptake (kg ha^{-1})
Nitrogen levels (kg N ha^{-1})			
Control	40.56	11.32	12.34
90	63.47	20.43	19.02
120	66.66	22.43	22.21
150	74.39	24.69	24.27
S.Em. ±	2.66	0.84	0.84
C.D. (P = 0.05)	7.79	2.45	2.45
Phosphorus levels (kg P_2O_5 ha^{-1})			
Control	54.50	16.42	15.83
45	62.79	20.43	20.42
60	66.53	22.31	22.13
S.Em. ±	2.30	0.72	0.72
C.D. (P = 0.05)	6.75	2.12	2.12
C.V. (%)	13.01	12.71	12.88
Interaction (N×P)	NS	NS	NS

Table: 4 Effect of N and P levels on N, P and K uptake by straw of high quality protein maize

Treatments	N uptake (kg ha^{-1})	P uptake (kg ha^{-1})	K uptake (kg ha^{-1})
Nitrogen levels (kg N ha^{-1})			
Control	23.92	7.91	36.08
90	42.89	12.90	58.49
120	48.97	14.89	63.13
150	52.33	15.71	66.28
S.Em. ±	1.75	0.53	1.98
C.D. (P = 0.05)	5.12	1.56	5.80
Phosphorus levels (kg P_2O_5 ha^{-1})			
Control	37.99	11.30	52.43
45	41.83	12.96	55.27
60	46.27	14.31	60.29
S.Em. ±	1.51	0.46	1.71
C.D. (P = 0.05)	4.44	1.35	5.03
C.V. (%)	12.47	12.38	10.60
Interaction (N×P)	NS	NS	NS

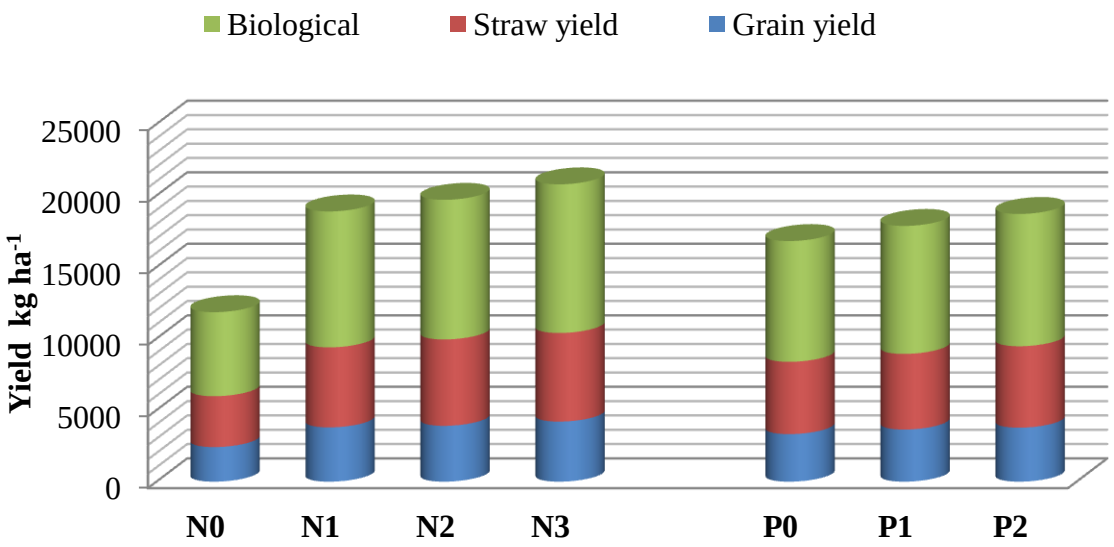

Fig. 1. Effect of N and P levels on grain, straw and biological yield of high quality protein maize.

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