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Influence of nitrogen and phosphorus levels on yield and economics of high quality protein maize (*Zea mays* L.) To under south Saurashtra agro-climatic zone of Gujarat

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Abstract
An experiment was conducted to assess the influence of nitrogen and phosphorus levels on yield and economics of high quality protein maize (*Zea Mays* L.) to under south saurashtra agro-climatic zone of Gujarat" during summer, 2016 at the Department of Agronomy, College of Agriculture, JAU, Junagadh. Application of 150 kg N + 60 kg P ha^{-1} significantly improved yield *viz.,* grain yield, straw and biological yield, and proved economically profitable dose with highest net return (42910 ha^{-1} and B C ratio (2.41).

Keywords: High quality protein maize, Yield, Nutrient level, Economics

Introduction
Maize (*Zea mays* L.) is an annual plant belongs to the family *Gramineae.* Among the cereals, maize ranks third in total world production of cereal after wheat and rice and it is principal staple food in many countries, particularly in the tropics and subtropics of the word. 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. In India, maize is cultivated on 8.71 million ha with a production of 21.76 million tonnes and productivity of 2498 kg ha^{-1}. Gujarat occupies an area of 0.50 million ha, with production of 0.82 million tonnes and productivity of 1525 kg ha^{-1} (Anon., 2013) [1]. High quality protein maize is a nitrogen exhaustive crop and requires very high dosage of the nutrients. Thus higher yield of 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 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 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 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.

Materials and methods
The field experiment entitled influence of nitrogen and phosphorus levels on yield and economics of high quality protein maize (*Zea Mays* L.) to under south saurashtra agro-climatic zone of Gujara 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^{-1}) and available phosphorus (31.60 kg ha^{-1}) while medium in available potash (245.36 kg ha^{-1}). The experiment comprising of total twelve treatment combinations consisting four levels of nitrogen viz., N_0: Control, N_1: 90 kg N ha^{-1}, N_2: 120 kg N ha^{-1}, N_3: 150 kg N ha^{-1} and three levels of phosphorus viz., P_0: Control, P_1: 45 kg P_2O_5 ha^{-1}, P_2: 60 kg P_2O_5 ha^{-1} 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. Statistical analysis of the individual data of various characters studied in the experiment was carried out using standard statistical procedures as described by Panse and Sukhatme (1985) [7]. Standard error of mean, critical difference (C.D.) at 5 per cent level of probability and coefficient of variance were worked out for the interpretation of the results.

Result and discussion

Effect on yield

Application of nitrogen brought about significant variation in grain, straw and biological yield. Fertilizing the crop with 150 kg N ha^{-1} (N_3) produced remarkably higher grain yield, straw and biological yield. However, it was remain statistically at par with 120 kg ha^{-1} and recorded appreciably higher grain, straw and biological yield. While, significantly the lowest values were recorded under no nitrogen application (N_0).

Application of phosphorus brought about significant variation in grain, straw and biological yield. Fertilizing the crop with 60 kg P_2O_5 ha^{-1} (P_2) produced remarkably higher grain yield, straw yield and biological yield. However, it was found statistically at par with 45 kg P_2O_5 ha^{-1} (P_1) and recorded appreciably higher grain yield, straw yield and biological yield. While, significantly the lowest values were recorded under treatment 0 kg P_2O_5 ha^{-1} (P_0).

Since, yield of the crop is a function of several yield components which are dependent on complementary interaction between vegetative and reproductive growth stages of the crop. As the growth and yield attributes evidently resulted in higher yields under higher nitrogen levels. Significant increase in grain yield, straw yield and biological 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 Kumar (2005) [5]; Kar *et al.,* (2006) [4]; Bindhani (2007) [2]; Jeet *et al.,* (2012) [3] and Om *et al.,* (2014) [6].

Effect on economics

Besides, higher grain and straw yield the net returns clearly indicated that the highest net returns of ₹ 42910 ha^{-1} and BCR 2.41 were accrued with application 150 kg N ha^{-1} (N_3). With regard to phosphorus levels, application of P @ 60 kg P_2O_5 ha^{-1} (P_2) gave highest net returns of ₹ 35227 ha^{-1} and BCR 2.14.

Table 1: Effect of N and P levels on grain and straw yield of high quality protein maize

Treatments	Yield (kg ha^{-1})		
	Grain	Straw	Biological
Nitrogen levels (kg N ha^{-1})			
Control	2419	3556	5975
90	3795	5594	9389
120	3904	6038	9942
150	4201	6194	10395
S.Em.±	134.10	199.78	254.69
C.D. (P = 0.05)	393.31	585.92	746.98
Phosphorus levels (kg P_2O_5 ha^{-1})			
Control	3323	5055	8378
45	3642	5289	8931
60	3774	5694	9468
S.Em.±	116.14	173.01	220.57
C.D. (P = 0.05)	340.62	507.42	646.91
C.V. (%)	11.24	11.21	8.60
Interaction (N×P)	NS	NS	NS

Table 2: Economics of different N and P levels of high quality protein maize

Treatments	Gross return (□ ha^{-1})	Cost of cultivation (□ ha^{-1})	Net return (□ ha^{-1})	B:C ratio
Nitrogen levels (kg N ha^{-1})				
Control	42255	28369	13886	1.49
90	66306	29563	36742	2.24
120	68508	30082	38426	2.28
150	73411	30501	42910	2.41
Phosphorus levels (kg P_2O_5 ha^{-1})				
Control	58219	27890	30329	2.09
45	63568	30150	33418	2.11
60	66074	30847	35227	2.14

Conclusion

On the basis of one year field experimentation, it seems quite logical to conclude that to get higher production and maximum net returns from summer high quality protein maize (cv. HQPM-1) can be secured by fertilizing the crop with 150 kg N ha^{-1}, 60 kg P_2O_5 ha^{-1} and 60 kg K_2O ha^{-1} on medium black clayey soil of south Saurashtra agro-climatic zone of Gujarat.

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