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Effect of nitrogen and phosphorus fertilizers on yield attributes and shelling percentage of high quality protein maize (*Zea mays* L.) to under South Saurashtra agroclimatic zone of Gujarat

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Abstract
An experiment was conducted to assess the "effect of nitrogen and phosphorus fertilizers on yield attributes and shelling percentage 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 results revealed that application of 150 kg N/ha significantly higher yield attributes *viz*., number of cobs plant^{-1}, cob length, cob girth, number of grains cob^{-1}, number of rows cob^{-1} and shelling percentage 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 number of cobs plant^{-1}, cob length, cob girth, number of grains cob^{-1} and number of rows cob^{-1} and shelling percent, being remained at par with 45 kg P_2O_5 /ha over control.

Keywords: Quality protein maize, nitrogen and phosphorus

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. 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.

Globally, it is cultivated on more than 160 million hectares (mha) area across 166 countries having wider diversity of soil, climate and management practices. Maize contributes maximum among the food cereal crops *i.e.* 40% annually (>800 million tonnes) in the global food production. Among the maize growing countries, USA is the largest producer and contributes nearly 35% of the total maize produced, followed by China with more than 20% production with same acreage as of USA. Maize is the driver of US food safety with highest productivity (>10 t ha^{-1}) which is double than the global productivity (5.3 t ha^{-1}). Whereas, productivity of India is just half than the world productivity (DMR, 2012) [7].

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^{-1} (Anon., 2013) [1]. In India, it is grown on 8.67 mha area with the production and productivity of 21.75 mt and 2566 kg ha^{-1}, respectively (Anon., 2014) [2].

Materials and Methods
The field experiment entitled the effect of nitrogen and phosphorus fertilizers on yield attributes and shelling percentage of high quality protein maize (*Zea mays* L.) to under South Saurashtra agroclimatic 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 muriatic 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: The data summarized in (Table 1&2) indicated that different levels of nitrogen exhibited their significant influence on yield attributes *viz*., number of cobs $plant^{-1}$, Cob length, cob girth, number of grains cob^{-1}, number of rows cob^{-1} and shelling percentage. Application of 150 kg N ha^{-1} recorded significantly higher yield attributes *viz*., number of cobs $plant^{-1}$ (1.41), cob length (17.44), cob girth (14.78), number of grains cob^{-1} (244.23), number of rows cob^{-1} (14.93) and shelling percentage (77.28%) and remained statistically on the same bar with 120 kg N ha^{-1}. In contrast, significantly the lowest number of cobs $plant^{-1}$ (1.13), cob length (14.22), cob girth (12.11), number of grains cob^{-1} (205.98), number of rows cob^{-1} (13.42) and shelling percentage (67.10%) was recorded under no nitrogen application. In the preceding section, it was emphasized that nitrogen level of 150 and 120 kg N ha^{-1} did cause a significant improvement in overall growth of the crop expressed in terms of plant height, leaf area index, functional leaves, chlorophyll content, stem diameter and dry matter accumulation by virtue of increased photosynthetic efficiency. Thus greater availability of photosynthates, metabolites and nutrients to develop reproductive structures seems to have resulted in increased productive plants, number of grains per cob, number of rows per cob,% barren plant per ha, number of cobs per plant, cob length, cob girth, 100-grains volume, test weigh and shelling% with nitrogen levels of 150 and 120 kg ha^{-1}. The result of the present investigation is in close accordance with the findings of Kumar (2005) [11]; Kar *et al*., (2006) [10]; Bindhani (2007) [3]; Jeet *et al.,* (2012) [9] and Om *et al.*, (2014) [13].

Effect on phosphorus

The perusal of data (Table1&2) revealed that different levels of phosphors exhibited their significant influence on yield attributes *viz*., number cobs $plant^{-1}$, cob length, cob girth, number of grains cob^{-1}, rows cob^{-1} and shelling percentage. Application of 60 kg P_2O_5 ha^{-1} recorded significantly higher yield attributes *viz*., number of cobs $plant^{-1}$ (1.42), cob length (16.58), cob girth (14.17), number of grains cob^{-1} (239.45), number of rows cob^{-1} (14.68) and shelling percentage (74.45%) and remained statistically on the same bar with 45 kg P_2O_5 ha^{-1}. In contrast, significantly the lowest number of cobs $plant^{-1}$ (1.15), cob length (14.83), and cob girth (12.67), number of grains cob^{-1} (209.55), number of rows cob^{-1} (13.43) and shelling percentage (70.79%) was recorded under no phosphors application. In the preceding section, it was emphasized that phosphorus level of 60 and 45 kg P_2O_5 ha^{-1} did cause about significant improvement in overall growth of the crop expressed in terms of plant height, leaf area index, functional leaves, chlorophyll content, stem diameter and dry matter accumulation by virtue of increased photosynthetic efficiency. Thus greater availability of photosynthates, metabolites and nutrients to develop reproductive structures seems to have resulted in increased productive plants, number of grains per cobs, number of rows per cob, per cent barren plant ha^{-1} and number of cobs per plant, cob length, cob girth, 100-grains volume, test weigh and shelling% with their nitrogen levels of phosphorus. The result of the present investigation are in accordance with the findings reported by Mehta *et al.*, (2005) [12]; Choudhary (2005) [4]; Singh *et al*., (2011) [14]; Dibaba *et al*. (2013) [6] and IIMR (2014a) [8].

Table 1: Effect of N and P levels on number of cobs, cob length and cob girth of high quality protein maize.

Treatments	Number of cobs $plant^{-1}$	Cob length (cm)	Cob girth (cm)
Nitrogen levels (kg N ha^{-1})			
Control	1.13	14.22	12.11
90	1.26	15.44	13.00
120	1.38	16.22	13.44
150	1.41	17.44	14.78
S.Em.±	0.05	0.46	0.46
C.D. (P = 0.05)	0.15	1.36	1.34
Phosphorus levels (kg P_2O_5 ha^{-1})			
Control	1.15	14.83	12.67
45	1.33	16.08	13.17
60	1.42	16.58	14.17
S.Em.±	0.04	0.40	0.40
C.D. (P = 0.05)	0.13	1.18	1.16
C.V. (%)	11.90	8.80	10.30
Interaction (N×P)	NS	NS	NS

Table 2: Effect of N and P levels on number of cob grain, grain rows and shelling percentage of high quality protein maize

Treatments	Number of grain cob^{-1}	Number of rows cob^{-1}	Shelling (%)
Nitrogen levels (kg N ha^{-1})			
Control	205.98	13.42	67.10
90	218.07	13.58	70.04
120	233.05	14.11	76.80
150	244.23	14.93	77.28
S.Em.±	6.27	0.37	1.12
C.D. (P = 0.05)	18.40	1.08	3.30
Phosphorus levels (kg P_2O_5 ha^{-1})			
Control	209.55	13.43	70.79
45	227.00	13.93	73.18
60	239.45	14.68	74.45
S.Em.±	5.43	0.32	0.97
C.D. (P = 0.05)	15.94	0.94	2.86
C.V. (%)	8.35	7.91	4.63
Interaction (N×P)	NS	NS	NS

Conclusion

Based on results of one year experimentation, it may be concluded that Application of 150 kg N ha^{-1} recorded significantly higher yield attributes and shelling percentage and remained statistically on the same bar with 120 kg N ha^{-1}. Application of 60 kg P ha^{-1} recorded significantly higher yield attributes and shelling percentage and remained statistically at par with 45 kg P ha^{-1}.

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