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Biological Response of Maize (*Zea mays* L.) to Variable Grades of Phosphorus and Planting Geometry

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ABSTRACT

The effect of four phosphorus levels (0, 30, 60 and 90 kg ha^{-1}) and three plant spacing (20, 25 and 30 cm) on maize cultivar-Akber phonology under irrigated conditions was studied during kharif 2001 and 2002. The crop was sown in rows 70 cm spaced having a plot size of 7 x 4 m. The results showed that the plant spacing did not affect the days to silking, leaf number per plant and plant height but the days to maturity were affected significantly. Graded levels of phosphorus did not affect plant height, days to silking and maturity but significantly to flag leaf area. Maximum flag leaf area was recorded at 60 kg P ha^{-1} and minimum at control level (0) of phosphorus.

Key Words: Maize; Phonology; Phosphorus; Plant Spacing

INTRODUCTION

Maize is an important food crop, which possess a remarkable value for human beings. Due to high yield potential, short duration or short maturity period and easy sowing against the other cereals it is gaining popularity. Maize grain is used for the extraction of oil, soap and glycerin. Maize cobs or grains are used as boiled in water or roasted and eaten. Corn stalks are used for making rubber, paper, wallboard, glue and fuel.

Despite the higher potential, the average corn yield in Pakistan is quite low due to improper management, traditional method of cultivation and imbalanced use of fertilizers. In Pakistan, raising of two maize crops in a year are possible by adopting appropriate cultural practices. Fertilizer especially phosphorus application and plant spacing are the important factors contributing to the yield.

Phosphorus plays a key role in energy transfer and thus essential for photosynthesis and other chemico-physiological processes in plants (Wasiullah *et al.*, 1995; Anonymous, 2000). It is inevitable for cell differentiation and development of tissue (Anonymous, 2000). Phosphorus fertilizer application above or below the optimum level affect the crop growth and yield adversely. Variable levels of phosphorus (50, 75, 100, 125 and 150 kg ha^{-1}) at a constant dose of N increased plant height, leaf area index, grain rows per ear, ear length, grain numbers per ear and 1000-grain weight significantly over control and the optimal dose of P appeared to be 125-150 kg ha^{-1}. The higher amounts of starch and protein contents of maize grain were recorded at higher P levels than the lower levels over control (Bakhsh, 1997).

Arya and Singh (2001) from their trial regarding the response of maize to different P rates (0, 13.2, 26.4 and 39.6 kg P ha^{-1}) concluded that leaf area index (3.59), stover yield (6.38 t ha^{-1}), grain yield, plant height and dry matter were obtained at 39.6 kg P ha^{-1}, while the days to 50% flowering was lowest with P 39.6 kg ha^{-1}.

Proper adjustment of plants over the field not only helps maintaining optimum plant population but also enables the plant to utilize land, light and other input resources uniformly and efficiently. So it is imperative to develop such a spacing pattern which may help avoiding excessive crowding and thereby enabling the maize plant to utilize these resources more effectively and efficiently towards increased production.

Thick population results in weak barren plants and results in less grain formation. Increasing plant population per unit area beyond a certain limit results in competition among the plants for sunlight, nutrients moisture and may cause severe lodging.

Pleaslee *et al.* (1971) reported that levels of P accelerated days to silking, however they found phosphorus had little effect on maturity of maize grain. Sherma and Adam (1984) reported the higher leaf number per plant as the distance between plants decreased. Thakur *et al.* (1998) reported the highest corn and ear yields ha^{-1} and net returns/rupee invested at plant spacing of 40 x 20 cm compared to 40 x 10 cm or 60 x 10 or 60 x 20 cm spacings. Plant spacings had significant effect on days to maturity but the effect on days to silking, leaf number per plant and plant height was non-significant. Plant height increased with increased plant spacing (Ali *et al.*, 1998). Mahmood *et al.* (2001) recorded that maximum grain yield per hectare (5.7 t

ha^{-1}) was produced at plant spacing of 20 cm rather 10 or 30 cm and N rate of 180 kg ha^{-1}.

MATERIALS AND METHODS

The experiment was conducted at Samundri (Faisalabad) during kharif 2001 and 2002. Three plant spacing (20, 25 and 30 cm spaced) and four phosphorus levels (0, 30, 60 and 90 kg ha^{-1} using RCBD with split plot arrangements replicated thrice were studied. All the agronomic operations like weeding, intra-culture, etc. were kept constant for all the treatments for uniform growth. During this experiment data were recorded on plant height, leaf number per plant, flag leaf area, days to maturity and silking.

Ten plants were randomly selected from each treatment and the number of green leaves was counted and plant height was measured excluding tassel. Days to silking and maturity were recorded by counting the number of days from sowing till plants produced their 50% silk and from sowing till 80% of the plants become fully maturity. Leaf area was calculated firstly recording length and width of the flag leaf and then multiplying the product of length x width by a factor 0.70. The data recorded were analyzed by M-stat package of technology for split plot arrangement in RCBD. The analysis of variance and F-test were used to know whether the effect of the two factors and their interactions are significant or not LSD was used to compare the treatment means.

RESULTS AND DISCUSSION

Plant height. Phosphorus levels, plant spacing and their interaction had no significant effects on plant height. But plant height increased with increase in plant spacing 20 to 30 cm. Plants spaced 30 cm apart attained maximum plant height of 176 cm, while the shortest plants of 169 cm were noted in plots planted 20 cm apart. Phosphorus level of 90 kg ha^{-1} gave the tallest plants i.e. 178 cm as compared to 30 kg P_2O_5 ha^{-1} (171 cm). Similar results were obtained by Arya and Singh (2001) and Bakhsh (1997) who reported that plant height increased with increased level of phosphorus. But the results are not in line with Sherma and Adam (1984) who recorded more plant height in dense population.

Green leaf number plant^{-1}. Plant spacing and phosphorus levels and their interaction had no significant effects on green leaf number per plant (Table II). The maximum green leaf number per plant noted was 13 from plant spaced 30 cm apart but minimum of 12 leaves were counted from plants spaced 20 cm. These results are in conformity to Ali *et al.* (1998) who reported that both the plant spacing and phosphorus levels did not affect significantly the green leaf number per plant.

Table I. Plant height (cm) of maize as affected by P levels and plant spacing

P levels (kg ha^{-1})	Plant spacing (cm)			Mean
	20	25	30	
0	176	174	175	175
30	168	172	174	171
60	171	173	179	174
90	174	180	175	178
Mean	174	175	176	

Mean followed by different letters are significantly different at 5% level of probability

Table II. Green leaf number plant^{-1} as affected by P levels and plant spacing

P levels (kg ha^{-1})	Plant spacing (cm)			Mean
	20	25	30	
0	12	12	13	12
30	12	12	13	12
60	12	12	13	12
90	12	12	13	12
Mean	12	12	13	

Mean followed by different letters are significantly different at 5% level of probability

Table III. Flag leaf area of maize as affected by P levels and plant spacing

P levels (kg ha^{-1})	Plant spacing (cm)			Mean
	20	25	30	
0	19.69	23.91	20.74	21.45 b
30	23.05	22.86	29.72	25.21 a
60	25.36	30.71	26.16	27.41 a
90	24.11	22.86	26.75	24.57 ab
Mean	23.05	25.09	25.48	

LSD 5% = 5.55

Flag leaf area. Table III shows that phosphorus levels had significant effect on flag leaf area where as the effect of plant spacing and the interaction between the two factors were non-significant. The flag leaf area was maximum (27.41 cm^2) at phosphorus level of 60 cm kg ha^{-1} while minimum of 21.45 cm was recorded in plots where no phosphorus was applied. These results are in conformity to Bakhsh (1997) and Nawab *et al.* (1997) who reported that the FLA increased significantly by P levels.

Days to silking. Phosphorus levels and plant spacing had no significant effect on silking (Table IV). However, the effect of their interaction on silking was significant. Maximum 64 days to silking were recorded for plot that received no P while minimum days to silking were observed in plots that received the highest dose of 90 kg P ha^{-1}. There was a gradual decrease in days to silking with increasing P levels. These results are in consonance with the findings of Mahmood *et al.* (2001) who reported that high level of P enhanced DS in contrast the findings of Gill and Maan (1963) who reported that fertilizer showed no effect on silking.

Days to maturity. Plant spacing had no significant effect on maturity (Table V), however, P level and the interaction between the two factors showed no effect. Maximum DM (days to maturity) (98) were recorded from plants spaced 20 cm apart while the minimum days to maturity (94) were recorded for the widest plant spacing of 30 cm. Minimum days were taken by the widest plant spacing to reach the maturity as compared to the harvest. The results are in conformity with those reported by Pleaslee *et al.* (1971) who observed that P levels had non-significant effect on days to maturity. Contrarily, Ali *et al.* (1998) confirmed that P levels had significant effect on days to maturity.

Table IV. Days to silking of maize as affected by P level and plant spacing

P levels (kg ha^{-1})	Plant spacing (cm)			Mean
	20	**25**	**30**	
0	63 a	63 ab	63 a	63
30	62 abc	61 bc	61 abc	62
60	62 abc	60 c	60 bc	61
90	60 c	60 c	59 c	60
Mean	62	61	61	

LSD 5% = 1.79

Table V. Days to maturity of maize as affected by P levels and plant spacing

P levels (kg ha^{-1})	Plant spacing (cm)			Mean
	20	**25**	**30**	
0	100	96	95	97
30	99	95	94	96
60	96	94	94	95
90	97	95	94	
Mean	98 a	95 b	94 b	

LSD 5% = 1.69

REFERENCES

Ali, A., 1998. Effect of nitrogen and magnesium on growth, yield and quality of hybrid maize (*Zea mays*. L.). *M.Sc. Thesis*, Department of Agronomy, University of Agriculture Faisalabad–Pakistan

Anonymous, 2000. *Fertilizers and their use*. FAO, International Fertilizer Industry Association, Rome

Arya, K.C. and S.N. Singh, 2001. Productivity of maize (*Zea mays* L.) as influenced by different levels of phosphorus, zinc and irrigation. *Indian J. Agric. Sci*., 71: 57–9

Bakhsh, M.A.A.H.A., 1997. Effect of different levels of phosphorus on growth, yield and quality of two genotypes of maize (*Zea mays* L.). *M.Sc. Thesis*, Department of Agronomy, University of Agricul;ture Faisalabad–Pakistan

Gill, M.S. and M.A. Maan, 1963. Effect of different fertilizers on yield of maize grain. *Pakistan J. Agric. Res*., 1: 163–9

Mahmood, T., M. Maqsood, T.H. Awan and R. Sarwar, 2001. Effect of different levels of N and intra–row plant spacing on yield and yield components. *Pakistan J. Agric. Sci*., 38: 48–9

Nawab, K., M. Hatam, B.A. Khan, K. Rasul and M. Mansoor, 1999. Study of some morphological characters in maize as affected by time of weeding and plant spacing. *Sarhad J. Agric*., 15: 21–4

Plearee, D.E., J.L. Ranged and W.G. Buncan, 1971. Grain filling period of corn influenced by P_2O_5 and K_2O and time of planting. *Agron. J*., 63: 561–3

Sherma, E. and A. Adam, 1984. Effect of planting densities on yield. *Indian J. Agron*., 15: 58–61

Takur, D.R., O.M. Prakash, P.C. Kharwara, S.K. Bhalla and O. Prakash, 1998. Effect of nitrogen and plant spacing on yield and nitrogen uptake and economics in baby corn (*Zea mays*). *Indian J. Agron*., 43: 668–71

Wasiullah, M.J.K. Khattak and J.K. Khattak, 1995. Effect of methods of NPK fertilizer application on maize crop. II. Effect on uptake of P and K. *Sarhad J. Agric*., 11: 161–3

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