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HOW NITROGEN AND PHOSPHORUS INFLUENCE THE PHENOLOGY OF OKRA

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Abstract

Phenology and crop stand are the two important determinants that fix crop growth cycle as well as directly or indirectly affect the crop productivity. In this connection, we carried out a field trial at Horticulture Research Farm of the University of Agriculture, Peshawar during 2010 in order to sort out how N and P influence the phenology of okra using various okra varieties. The experiment was laid out in Randomized complete block design (RCBD) with split plot arrangement. The parameters studied were survival percentage (%), days to flowering, plant height (cm), pod length (cm), and sound seeds pod^{-1} of the okra plants at various levels of nitrogen (N) and phosphorus (P) fertilizers. The different levels of N and P had a significant effect on days to flowering, plant height (cm), and pod length (cm). However, among varieties, maximum days to flowering (39.57) were recorded in Sabz Pari and minimum (36.33) in Arka Anamika; maximum plant height (104.47 cm) in Sabz Pari and minimum (86.86 cm) in Green Star. Among the fertilizer levels, maximum days to flowering (41.11) were recorded in plots of N and P fertilizers applied at rate of 150 and 120 kg ha^{-1}, respectively, while minimum days to flowering (33.11) were there in control plots. Similarly, the tallest plants of height 106.51 cm were observed in N and P treated plots at 150 and 90 kg ha^{-1}, respectively, whereas plant height was least (72.17 cm) in control plots. Pod length was highest i.e., 17.97 cm recorded in N and P combined treated plots at 100 and 120 kg ha^{-1} as compared to the lowest pod length (15.35 cm) in control plots. In light of the results it could be concluded that okra is phonologically vulnerable to different levels of N and P applications in Peshawar region.

Introduction

Okra (*Abelmoschus esculentus* L.) grows best in hot summer with minimum and maximum mean temperature of 18^{o}C (65^{o}F) and 35^{o}C (95^{o}F) respectively and needs a long season with warm nights. Okra planted in late spring may remain vegetative until late summer or early fall (Sadiq *et al.*, 1998). In Khyber Pakhtunkhwa (KPK) it is usually sown from mid March to mid May and in last week of April at the higher elevations. The seeds are sown 0.1 to 0.5 cm deep in rows, which are about 50 to 80 cm apart. Plant to plant distance is kept 20 to 30 cm (Baloch, 1994). Okra is propagated by seeds at the rate of 18-20 kg/ha. The crop should be irrigated every fifth or sixth day during spring and summer when needed. A total of six to eight irrigations are required for okra crop (Rizvi, 1976). The total area in growing season 2008-09 under okra cultivation in Pakistan was 15.081 thousand ha with total production of 114.657 thousand tons in which KPK contributes an area of 2.126 thousand hectare with total production of 18.156 thousand tonnes (Anon., 2009).

The nutrient requirements of crops depend upon soil texture, types of previous vegetation cover, cropping intensity and soil moisture (Denton & Swarup, 1990). Fertilizers are generally applied to improve the crop yield, nutritional quality and aesthetic value of crops (Sikander *et al.*, 2009). Nitrogen and phosphorus elements perform different functions in crops growth and development and none of them can be substituted to act for one another in its special function in the crop, therefore, there is need for fertilizer application in order to obtain optimum yield from cultivated crop (Adepetu, 1986). One of the reasons of low yield in Pakistan is imbalanced fertilizer use; nitrogen 250 kg N and phosphorus 125 kg P_2O_5 ha^{-1} are being used commonly (Akhtar *et al.*, 2010). Nitrogen is the important part of plant parts such as chlorophyll, amino acid, proteins and pigments. It is most essential for vigorous growth branching/tillering, leaf development and enlargement root expansion, high photosynthetic activity and formation of protoplasm. For these reasons, nitrogen increases crop yield and improves quality. Nitrogen fertilizers being used for vegetable production has increased by 21% between 1997 to 2003 (Mubashir *et al.*, 2010). Therefore proper attention must be given to these nutrients while planning a project on plant nutrition (Khalil, 2006). Phosphorus is a key element in the formation of high energy compounds, such as AMP, ADP and ATP (adenosine mono-di- and tripphosphate), contributing to improve yield and quality of crops, playing essential role in photosynthesis and respiration. It is necessary for energy transformation in plant cells, cell division, development of meristem tissue, early root development, tillering and flowering and seed development (Memon, 1996). It improves root growth, hastens seed maturity and increases fruit yield especially when applied in combination with nitrogen (Pandey & Dubey, 1996).

Seed crop growing in vegetable seed production requires environmental conditions that are very different from those for the harvest of the market-use vegetable crop. For example, ambient temperature, photoperiod, length of growing season and precipitation amount and distribution may vary for the optimum production of market-use and seed crops (Naik, 1994). Therefore, keeping in view the importance of nitrogen and phosphorus on phenology a nd growth of okra, a field research was conducted to study the effect of various levels of N and P on okra with the objectives to find out the optimum level of N and P for best crop performance and to assess the response of the routine okra varieties.

Materials and Methods

A field trial to study how nitrogen and phosphorus influence the phenology of okra was conducted at Horticulture Research Farm Malakandher, Khyber Pakhtunkhwa (KPK) Agricultural University Peshawar, during the year 2010. Urea and SSP (Single

Superphosphate) were used as a source of nitrogen and phosphorus, respectively. Subsequent irrigation was applied as required by the crop. Hoeing and weeding were done regularly. The experiment was designed RCBD with split plot arrangement replicated three times. The treatments were in two factors i.e. Factor A being okra varieties including Sabz Pari, Arka Anamika and Green Star and Factor B being different combinations of N and P including 0-0, 100-60, 100-90, 100-120, 150-60, 150-90, and 150 kg N-120 kg P ha^{-1}. Okra varieties (Factor A) were assigned to main plots and N-P combinations (Factor B) to the sub plots. A composite soil sample 15-20 cm deep was collected from experimental plot before fertilizer application and was analyzed in Soil Science laboratory, Agricultural University Peshawar (Table 1).

The data was recorded on survival percentage, days to flowering, plant height (cm), pod length (cm), and sound seeds pod^{-1}. The survival percentage was recorded with the help of formula:

$$\text{Survival percentage} = \frac{\text{Total number of plants survived} \times 100}{\text{Total number of germinated seeds}}$$

Table 1. Soil chemistry of the experimental field.

S. No.	Soil Characteristic	Content
1.	Electric conductivity	0.1ds /m
2.	Organic matter	15.7%
3.	Nitrogen (N)	1.00 mg kg^{-1}
4.	P_2O_5	0.085 mg kg^{-1}
5.	K_2O	69.26 mg kg^{-1}
6.	pH	8.2
7.	Iron (Fe)	5.61 mg kg^{-1}
8.	Copper (Cu)	3.46 mg kg^{-1}
9.	Zinc (Zn)	2.39 mg kg^{-1}
10.	Manganese (Mn)	6.22 mg kg^{-1}

The two middle rows were selected and their days from sowing to flowering were recorded and average days taken to flowering were calculated. The plant height of randomly selected 5 plants was recorded with the help of measuring tape and average plant height was calculated. The pods were harvested at maturity and pod length of the randomly selected 5 pods was measured with the help of a measuring tape and average pod length was calculated. The number of sound seeds was counted and diseased and damage seeds were removed and then the average of sound seeds per pod was calculated. The data recorded for each trait were individually subjected to the ANOVA Technique by using MSTATC computer software and significant means were separated by using Fisher's LSD test (Steel & Torrie, 1980).

Results and Discussion

Survival percentage (%): Statistical analysis of data showed that varieties, application of nitrogenous and phosphate fertilizers and their interaction had non significant effects on okra survival percentage (Table 2).

Days to flowering: The data related to days to flowering were significantly affected by varieties, various levels of nitrogen and phosphorus and their interaction. According to the mean values of the experimental results maximum days to flowering (39.57) were recorded in variety sabz pari followed by 37.52 in green star and minimum 36.33 in arka anamika. Results of various levels of N and P showed that maximum days to flowering (41.11) were recorded in treatment of 150 kg N and 120 kg P ha^{-1} and minimum days to flowering (33.11) were recorded in control plots. However, the interaction between varieties and various levels of N and P, maximum days to flowering (41.33) were recorded in variety sabz pari having received N and P at the rate of 100 and 120 kg ha^{-1}, with minimum days to flowering (31) arka anamika in control plots. The difference in days to flowering might be due to the genetic variation among the varieties because all the cultural practices were kept uniform for all the varieties. The early flowering may be attributed to the genetic make up of the cultivar (Amjad *et al*., 2001). Regarding the nitrogen fertilizer treatments, the higher doses of N delayed blooming. This may be due to the fact that excessive supply of N promotes luxuriant and succulent vegetative growth dominating the reproductive phase. As P enhances development of reproductive parts stimulates blooming and fruit setting, therefore minimum days to flowering were recorded in plot fertilized with lowest dose of N (100 kg ha^{-1}) combined with phosphorus and potassium (Khan *et al*., 2000). The results are in line with that of Gill *et al*., (1974) who reported that number of days to flowering was reduced by P and increased by N in sweet pepper (Table 3).

Table 2. Effect of N and P fertilizers on survival percentage of okra varieties

Fertilizer: Nitrogen + Phosphorus (kg ha^{-1})	Okra varieties			Mean
	Sabz pari	Arka anamika	Green star	
0N+0P	93.67	96.26	94.91	94.95
100N+60P	94.02	96.34	92.51	94.29
100N+90P	94.71	91.61	94.41	93.58
100N+120P	94.11	91.97	95.29	93.79
150N+60P	95.15	95.21	93.49	94.61
150N+90P	93.03	93.61	96.19	94.28
150N+120P	94.97	93.35	94.46	94.26
Mean	**94.24**	**94.05**	**94.46**	

COV = 5.25%

Table 3. Effect of N and P fertilizers on days to flowering of okra varieties.

Fertilizer: Nitrogen + Phosphorus (kg ha^{-1})	Okra varieties			Mean
	Sabz pari	Arka anamika	Green star	
0N+0P	36.67 d-f	31.00 h	31.67 h	33.11 e
100N+60P	40.00 a-c	32.33 gh	35.00 fg	35.78 d
100N+90P	37.67 b-f	36.00 ef	37.33 c-f	37.00 cd
100N+120P	41.33 a	35.67 ef	39.00 a-e	38.67 bc
150N+60P	40.00 a-c	41.00 ab	39.67 a-d	40.22 ab
150N+90P	40.33 a-c	37.33 c-f	38.67 a-e	38.78 b
150N+120P	41.00 a	41.00 ab	41.33 a	41.11 a
Mean	**39.57 a**	**36.33 b**	**37.52 ab**	

LSD value for varieties = 2.2823, various levels of fertilizers = 1.7148; COV = 4.74%

LSD value for interaction = 2.97

Means followed by the same letter are not significantly different using LSD test at 5% level of probability

Plant height (cm): Analysis of data showed that varieties and various levels of nitrogen and phosphorus had a significant effect on plant height whereas their interaction effect was non significant. The experimental results revealed that maximum plant height (104.47 cm) was recorded in variety sabz pari, followed by plant height (100.79 cm**)** in variety arka anamika, while minimum plant height (86.86 cm) was recorded in variety green star, while results of various levels of N and P revealed that maximum plant height (106.51 cm) was recorded in treatment of N and P at rate of 150 and 90 kg ha^{-1} while minimum plant height (72.17 cm) was recorded in control plots The higher dose of N might have enhanced cell division and formation of more tissues resulting in luxuriant vegetative growth and thereby increased plant height (Firoz, 2009). Minimum plant height (72.18 cm) in control may be due to its poor nutritional status which resulted in retarded growth and reduced pant height. The results resemble with that of Sarnaik *et al*., (1986) who obtained maximum plant height with application of 120 kg N + 60 kg P ha^{-1}. Similar results were also obtained by Gondane and Bhatia (1995) who reported that NPK fertilizer significantly increased plant height. Majanbu *et al*., (1985) also observed that plant height was enhanced by N fertilizer upto 100 kg N /ha (Table 4).

Pod length (cm): The ANOVA of the data showed that pod length was significantly affected by various levels of N and P; while varieties and the interaction between varieties and various levels of N and P had non significant effect on pod length. Longest pods (17.97 cm) were recorded in N and P treatments at the rate of 100 and 120 kg ha^{-1} and shortest pods (15.35 cm) were there in control plots. Pod length is a tone character for economic yield which depends upon various factors such as genetic makeup of the cultivars and their response to prevailing environmental conditions. This reflects that more the fertilizer dose better will be pod length (Anjum & Amjad, 1999). The results resemble to those of Arora *et al*., (1991) and Naik & Srinivas, (1992) who reported that pod length in okra was significantly improved by application of N and P. Similar results were obtained by Singh (1979) (Table 5).

Sound seeds pod^{-1}: Statistical analysis of data showed that varieties, various levels of nitrogen and phosphorus and their interaction had non significant effect on sound seeds per pod (Table 6).

Table 4. Effect of N and P fertilizers on plant height (cm) of okra varieties.

Fertilizer: Nitrogen + Phosphorus (kg ha^{-1})	Okra varieties			Mean
	Sabz pari	Arka anamika	Green star	
0N+0P	81.47	69.33	65.73	72.18 b
100N+60P	110.00	103.47	87.00	100.16 a
100N+90P	110.73	108.47	79.00	99.40 a
100N+120P	108.27	108.73	92.27	103.09 a
150N+60P	107.67	104.00	93.40	101.69 a
150N+90P	111.73	112.47	95.33	106.51 a
150N+120P	101.47	99.07	95.33	98.62 a
Mean	**104.48 a**	**100.80 a**	**86.87 b**	

LSD value for varieties = 9.8767, various levels of fertilizers = 9.8636; COV = 10.59%

Means followed by the same letter are not significantly different using LSD test at 5% level of probability

Table 5. Effect of N and P fertilizers on pod length (cm) of okra varieties.

Fertilizer: Nitrogen + Phosphorus (kg ha^{-1})	Okra varieties			Mean
	Sabz pari	Arka anamika	Green star	
0N+0P	15.60	15.38	15.01	15.35 b
100N+60P	18.24	17.64	17.48	17.79 a
100N+90P	17.37	17.73	17.84	17.64 a
100N+120P	16.90	17.23	19.78	17.97 a
150N+60P	16.96	18.18	17.42	17.52 a
150N+90P	17.95	18.61	17.29	17.95 a
150N+120P	18.46	17.43	18.00	17.96 a
Mean	**17.36**	**17.46**	**17.55**	

LSD for various levels of fertilizers = 1.2297; COV = 7.37%

Means followed by the same letter are not significantly different using LSD test at 5% level of probability

Table 6. Effect of N and P fertilizers on sound seeds pod^{-1} of okra varieties.

Fertilizer: Nitrogen + Phosphorus (kg ha^{-1})	Okra varieties			Mean
	Sabz pari	Arka anamika	Green star	
0N+0P	48.73	47.60	45.13	47.16
100N+60P	50.80	45.20	45.40	47.13
100N+90P	42.13	53.20	47.93	47.76
100N+120P	51.93	48.93	43.40	48.09
150N+60P	56.73	52.20	45.87	51.60
150N+90P	46.67	48.80	43.27	46.24
150N+120P	50.80	51.93	49.93	50.89
Mean	**49.69**	**49.70**	**45.85**	

COV = 12.15%

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