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Response of Nitrogen, Phosphorus and Potassium Levels on Growth and Yield of Okra [*Abelmoschus esculentus* (L.) Moench] *cv.* Arka Anamika

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ABSTRACT

A field experiment was conducted during summer (zaid) 2015 at Department of Horticulture, MJRP College of Agriculture & Research, MJRP University Jaipur (Rajasthan). The experiment consisted of eight treatments. Results of field experiment revealed that the minimum days (39.73) required to opening flower from sowing were recorded under application of 90 kg N + 60 kg P_2O_5 + 60 K_2O ha^{-1}, followed by application of 90 kg Nitrogen ha^{-1} (41.22 days), whereas the maximum days (44.21) were noted under absolute control. Whereas, Plant height was recorded the maximum under application of 90 kg N + 60 kg P_2O_5 + 60 K_2O ha^{-1}, after 40 days (28.10 cm), 60 days (75.40 cm) and 80 days (106 cm) and seed germination (91.96 %). Amongst fruit characters the maximum length of fruits (13.93 cm), diameter of fruits (2.6 cm), fruit yield $plant^{-1}$ (258.18 g) and number of fruits $plant^{-1}$ (30.54) were recorded under application of 90 kg N + 60 kg P_2O_5 + 60 kg K_2O ha^{-1}. The maximum yield (172.12 q ha^{-1}) was obtained under application of 90 kg N + 60 kg P_2O_5 + 60 K_2O ha^{-1} followed by application of 90 kg N +60 P_2O_5 ha^{-1} (163.12 q ha^{-1}) and the maximum number of seeds $fruit^{-1}$ was recorded (56.46) under application of 90 kg N + 60 kg P_2O_5 + 60 K_2O ha^{-1}. Application of 90 kg N + 60 kg P_2O_5 + 60 K_2O ha^{-1} recorded significantly higher net returns (123084.10 Rs ha^{-1}) and B: C ratio (2.13) which was found statistically superior over other treatments.

Key words: *Okra, Nutrients, Growth characters, Fruit characters, Fruit yield and B: C ratio.*

INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is an annual vegetable crop grown in the tropical and sub tropical parts of the world. It is originated from Abyssinian center of origin. It belongs to family *Malvaceae*. In the northern plains of India, it is grown mainly in two seasons *i.e.* rainy and summer. It is now cultivated throughout the country in different agro-climatic regions. During raining season, plants grow tall, vigorous and bear a large number of fruits, which contributes to the higher yield per unit area over the summer season crop.

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In India total area under okra crop is 507.0 thousand hectare which produces 5853.0 thousand tonnes with average productivity 11.5 tonnes per hectare[1] in our country. The major okra growing states are West Bengal, Bihar, Gujrat, Odisha, Jharkhand and Andhra Pradesh. In Rajasthan, okra occupies 4.02 thousand hectare area having an annual production of 12.88 thousand tonnes with average productivity of 3.95 tonnes per hectare[1].

Okra produces fruit for a long time and needs a balanced and sufficient supply of nutrients for higher yield and better quality. Indiscriminate use of inorganic fertilizers has resulted in decreased nutrients uptake, poor quality of vegetables and deterioration of soil health[2]. Vegetables and vegetable based cropping system show that vegetable crops are well responsive to nutrient supply through organic manures and chemical fertilizers[3]. It is well proved that growth, yield and quality of plants are greatly influenced by availability of a wide range of nutrients in the soil. Nitrogen is an essential macronutrient which has great significance in growth, development and metabolism of plants. Phosphorus is a constituent of nucleic acid, phospholipids and several enzymes which are of great importance in the transformation of energy within the plant system, metabolism and also in respiration in plants[4]. It has beneficial effect on root development, growth and also hastens maturity as well as improves quality of crop produce[5].

Potassium is one of the three major nutrient elements (N, P and K) required by plants. Potassium imparts vigour and disease resistance to the plant and plays an important role in crop productivity[6]. Plant health at field is also responsible for lower productivity and need to look for other means in production system management which could help in achieving high yield and productivity. Therefore, present investigation lay to find out optimum levels of NPK for growth and yield of okra and to measure the economics of the various treatments.

MATERIALS AND METHODS

The present study was conducted during the *zaid* season, 2015 at MJRP College of Agriculture and Research, Achrol, Jaipur (Rajasthan). Jaipur is situated at 26.92^0 N North latitude, 75.82^0 E East longitudes and an altitude of 427 meters above mean sea level. This region falls under agro climatic zone- III A (Semi-Arid eastern Plain) of the state. The soil of experimental site was clay loam in texture, slightly alkaline in reaction, low in available nitrogen, medium in available phosphorus and potassium. The experiment was conducted in "Randomized Block Design" replicated three times. Okra cv. Arka Anamika planted at spacing of 45 X 30 cm (P-P x R-R). Detail of treatments with their symbols given in Table 1.

The recommended dose of NPK was applied through Urea, SSP and MOP, respectively. The recommended dose of NPK for okra crop was 90:60:60 kg ha^{-1}, respectively. For each fertilizer treatment combination, the NPK dose was calculated and applied timely. Full dose of phosphorus and potassium and half dose of nitrogen are applied as basal dose just before sowing and rest half dose of nitrogen was applied in two splits i.e. 30 and 45 days after sowing. Five randomly selected plants were tagged from each plot and tagged permanently and observations were recorded on this plant during entire study.

The number of seedlings emerged in the two middle rows of each net plot was observed at 5 days interval till it become constant (up to 15 days) and counted as seed germination (%). The plant height to the plants was measured from ground surface to the growing point at 40, 60 and 80 days after sowing with the help of meter scale. When flowers appeared the days of flowering counted from the sowing in tagged/selected plants in each plot. Length of fruits was recorded from the base to the tip of the fruit with help of scale and mean value expressed in centimetre. Diameter was measured at successive pickings with the help of "vernier calliper" and mean value expressed in

centimetre. Total numbers of fruits picked from all selected plants were recorded and average number of fruits per plant was calculated. The total numbers of pickings were counted from first harvesting to last harvestings.

Number of days was counted between first to last harvesting from the selected plants. The same fruits after recording length were weighed for their weight with the help of a balance and later on their average was calculated. The mean weight of fruits harvested from five tagged plants was used to calculate the yield per plot on the basis of plant population per plot. The mean weight of fruits harvested from five tagged plants was used to calculate the yield per hectare on the basis of plant population per hectares. The number of seed count from all selected fruits was recorded and average number of seeds per fruit was calculated. In order to find out the benefit: cost ratio the net profit from individual treatment was divided by their respective cost of cultivation, which included cost of treatment also.

The experimental data were statistically analyzed for analysis of variance and test at significance through the procedure described by Fisher[7] and critical difference for treatment comparison worked out where the "F" test was used to find significant at 5 per cent level of significance.

RESULTS AND DISCUSSION:

Growth Parameters

The data on average per cent seed germination during the *zaid* season have been presented in table 2. The data indicated that maximum germination percentage (91.24 %) was recorded in treatment T_7, followed by treatment T_4 (84.57) and minimum in treatment T_0 (64.11). The treatment T_7 increased the higher seed germination by 29.73 per cent over control, but it was statistically at par with the treatment T_4, T_5 and T_6. Foliar spray treatments didn't affect the mean germination percentage in *zaid* season. These observations are in line with the earlier findings of that of Adepoju[8].

The application of nutrients either alone or in combination brought perceptible variation in plant height at 40 days after sowing (Table-2). The maximum plant height (28.10 cm) was obtained with the treatment T_7 and minimum plant height (18.32 cm) in treatment T_0. It increased the plant height significantly as compared to the control treatments. A similar trend in plant height was recorded at 60 and 80 days after sowing. It is clear from the data (Table-2) that, days taken to first flowering marginally reduced with the application of nutrients either alone or in combination. However, these were failed to bring about statistically significant variation over control. Among all the treatments, minimum 39.73 days taken to first flowering were recorded under the treatment T_7 and maximum 44. 21 days taken were under the treatment T_0. The fruit is a capsule 5-20 cm long containing numerous green or dark brown to black seeds[9]. The increased growth by the use of nitrogen, phosphorus and potassium may be explained on the basis of the established facts that the phosphorous is known to play an important role in photosynthesis. It is a constituent of nucleo-protein which is responsible for growth, thus the fact that phosphorus promotes the growth is understandable[10]. Singh *et al*.[11] reported that the plant height and leaf area of okra were increased significantly with the application of 140 kg nitrogen ha^{-1} and 100 kg phosphorus ha^{-1}.

Fageria *et al*.[12] reported that application of 75 kg N ha^{-1} increased the number of fruits per plant, fruit length and fruit diameter of okra. Fayaz *et al*.[13] obtained the maximum plant height, number of pods $plant^{-1}$ and pod yield of okra with the combined application of 120 kg N + 90 kg P_2O_5 + 60 kg K_2O ha^{-1} at S.K.N. college of Agriculture, Jobner. Significant increase in the growth of okra was observed after the application of N and or NPK[14]. Yadav *et al*.[15] reported that the maximum plant height and branches per plant of okra was recorded with application of 90 kg N ha^{-1} through urea, FYM, poultry manure and vermicompost over control.

Yield Components and Yield

It is clear from the data (Table -3) that nutrients application increased fruit diameter as compared to control. The maximum fruit diameter (2.61 cm) was recorded with the application of T_7, which was found significantly higher among all the treatments including control and increase fruit diameter by 47.89 per cent over control. It is apparent from the data (Table -3) that, there was a significant effect of Nitrogen, Phosphorus and Potassium either alone or combination brought on length of fruits. The mean maximum fruit length was obtained T_7 (13.93 cm). The treatment T_7 represented a significant increase in length of fruits over control however, it was at par with each other.

The significant variation was observed in the number of fruits per plant due to various treatments (Table- 3). The mean maximum number of fruits plant^{-1} (30.59) were recorded under the treatment T_7 and minimum number of fruits per plant (20.31) was obtained in treatment T_0 (control). The treatments T_5, T_4, T_6, and T_1, also exhibited significantly higher number of fruits than that of control. The treatment T_7 recorded 33.60 per cent higher number of fruits per plant than the control. There was significant variation in weight of fruits per plant due to various treatments (Table- 3).The maximum weight of green fruits per plant (258.18 g) was recorded in T_7, and the minimum (210.80 g) was recorded in control. The treatment T_7 recorded 18.35 per cent average weight of fruits plant^{-1} higher than the control. However, it was found at par with the treatment T_4 and T_5.

There was significant variation in the number of pickings due to different treatments. The mean values of number of pickings under different treatments presented in Table- 4 revealed that maximum number of pickings (18.76) was observed in the treatments T_7 and minimum numbers of pickings (14.23) was found in control. The treatments T_4, T_5, T_6, and T_3 showed higher number of pickings than the control but it was statistically at par with the treatment T_4 and T_5. The treatment T_7 recorded 24.14 per cent number of pickings higher than the control.

A perusal of data presented in (Table -4) clearly indicates that a significant variation was found due to the application of Nitrogen, Phosphorus and Potassium either alone or in combination (N+P+K) on duration of pickings. The maximum duration of picking (34.32 days) was found under the treatment T_7, and the minimum duration of picking (23.13) was found under the treatment T_0 (control). The treatment T_7 recorded 32.60 per cent duration of picking (days) higher than the control.

It is clear from the data (Table- 4) that effect of Nitrogen, Phosphorus and potassium application showed significant variation regarding yield per plot among the treatments over control. The maximum yield per plot was recorded (18.07 kg) with the treatment T_7 which was followed by T_5 and the minimum yield per plot was recorded (14.76 kg ha^{-1}) in treatment T_0. Increase in the higher yield in T_7 was by 18.31 per cent over control and was statistically at par with the treatment T_5 and T_4.

It is clear from the data (Table- 4) effect of Nitrogen, Phosphorus and potassium application showed significant variation regarding yield per hectare among the treatments than control. The maximum yield ha^{-1} was recorded (172.12 q ha^{-1}) with the treatment T_7 which was followed by T_4, T_5 and T_6 and the minimum yield of fruit hectare^{-1} was recorded (140.53 q ha^{-1}) in control. The treatment T_7 Increased the higher yield by 18.35 per cent over control, however, it was found at par with the treatment T_4 and T_5. Yadav *et al*.[15] reported that the application of 90 kg N ha^{-1} through urea, poultry manure, FYM and vermicompost significantly increased number of fruits, fruit length, girth of fruit and total yield of okra as compared to control.

Firoz[16] reported that the highest yield (16.73 t/ha) was obtained after the application of 100 kg N/ha which was statistically identical to 120 kg N/ha. He also obtained the highest yield (15.77 t/ha) from 120 kg P_2O_5/ha. Philip *et al.*,[17] reported that spacing of 90 × 30 cm and application of NPK fertilizers 150 kg/ha (22.5 kg N, 22.5 kg P_2O_5 and 22.5 kg

K_2O_5) gave the highest yield of okra. Sajid *et al*.[18] reported that maximum number of pods plant^{-1} and maximum seed yield in okra were reported in plots having received both 150 kg N ha^{-1} and 90 kg P ha^{-1}. Sharma *et al*.[19] reported that highest yield of okra was recorded in the treatment comprising 100 per cent recommended NPK + vermicompost @ 10 t ha^{-1}. Significant increase in the yield of okra was observed after the application of N and or NPK[14].

It is evident from the data (Table 4) that all the applied treatments significantly increased B: C ratio as compared to control (1.83). It is explicitly clear that application of increasing doses of N + P fertilizers brought about significant increase in B : C ratio. Significantly, the highest B: C ratio (2.13) was obtained with application of 90 kg N kg + 60 kg P_2O_5 + 60 kg K_2O ha^{-1} which was higher by 14.08 per cent, over the control (1.83). Sharma *et al*.[20] recorded that application of 5 tonnes vermicompost ha^{-1} resulted significantly higher values of yield attributes, fruit yield (69.2 ha^{-1}) and B:C ratio (2.11) with net returns of rupees 35614 ha^{-1} in okra crop.

Table 1: Detail of treatments with their symbols

S. No.	Symbols	Treatments (kg/ha)
1.	T_0	Control
2.	T_1	N (90)
3.	T_2	P (60)
4.	T_3	K (60)
5.	T_4	N+P (90+60)
6.	T_5	N+K (90+60)
7.	T_6	P+K (60+60)
8.	T_7	N+P+K (90+60+60)

Table 2: Effect of nitrogen, phosphorus and potassium on growth parameters of okra

Treatments	Germination %	Plant height (cm)			Days taken to flowering
		40 DAS	60 DAS	80 DAS	
T_0	64.11	18.32	50.78	67.33	44.21
T_1	71.82	22.21	57.98	85.97	41.22
T_2	72.94	19.80	52.73	77.10	42.54
T_3	71.18	19.91	52.62	77.29	42.48
T_4	86.89	24.39	66.10	97.57	41.27
T_5	80.82	25.43	66.76	93.97	41.60
T_6	84.30	23.82	65.91	92.23	42.93
T_7	91.24	28.10	75.40	106.00	39.73
CD (P=0.05)	**11.01**	**6.69**	**6.30**	**6.14**	**3.81**

Table 3: Effect of nitrogen, phosphorus and potassium on fruit characteristics of okra

Treatments	Fruit diameter (cm)	Fruit length (cm)	No. of fruits per plant	Av. wt. of fruits plant^{-1}
T_0	1.36	12.00	20.31	210.80
T_1	1.29	13.73	25.86	227.10
T_2	1.48	13.67	24.29	221.80
T_3	1.49	13.87	23.44	215.91
T_4	1.90	13.87	28.44	244.71
T_5	2.36	13.87	28.67	242.11
T_6	1.79	13.83	26.53	233.57
T_7	2.61	13.93	30.59	258.18
CD (P=0.05)	**0.21**	**3.53**	**1.72**	**22.63**

Table 4: Effect of nitrogen, phosphorus and potassium on yield characteristics and B:C of okra

Treatments	No. of pickings	Duration of pickings (days)	Yield per plot (kg)	Yield per ha (q)	B : C ratio
T_0	14.23	23.13	14.76	140.53	1.83
T_1	16.32	27.65	15.86	151.39	1.99
T_2	15.81	25.71	15.40	146.70	1.82
T_3	15.69	26.17	15.11	143.94	1.81
T_4	17.79	30.65	17.12	163.12	2.06
T_5	17.45	30.63	16.95	161.40	2.08
T_6	16.29	29.40	16.39	156.15	1.90
T_7	18.76	34.32	18.07	172.12	2.13
CD (P=0.05)	**1.63**	**2.90**	**1.58**	**13.7**	**-**

CONCLUSION

On the basis of the results emanated from present investigation conducted during summer (*Zaid*) 2015, it can be concluded that application of NPK (90+60+60) kg ha^{-1} may be applied in okra to achieve higher fruit yield ha^{-1}, net returns and B : C ratio. However this result varies according to soil and climatic condition and therefore requires further experimentation.

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