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Influence of nitrogen and phosphorus on the growth and yield on okra (*Abelmoschus esculentus* L.)

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Abstract

A field experiment was conducted at Horticultural Research Farm, School of Agriculture, ITM University, Gwalior, during summer 2019 to evaluate the effect of nitrogen and phosphorus on growth and yield of lady finger. The experiment was laid out in Randomized Complete Block Design with factorial arrangement having three replications. The treatment consisted of four nitrogen levels viz., 75 kg/ha (N₁), 100 kg/ha (N₂), 125 kg/ha (N₃) and 150 kg/ha (N₄) and three phosphorus levels i.e., 75 kg/ha (P₁), 75 kg/ha (P₂) and 75 kg/ha (P₃). The results of experiment revealed that the different nitrogen and phosphorus levels, both significantly affected the plant height, number of branches per plant, number of leaves per plant, number of nodes on main stem, internodal length and fruit yield per hectare. The treatment combination consisting of application of nitrogen @ 150 kg/ha with combined application of phosphorus @ 100 kg/ha produced significantly maximum plant height (141.99 cm), number of branches per plant (2.85), number of leaves per plant (22.91), number of nodes (19.23 cm), length of internode (8.42 cm) and fruit yield per hectare (17.77) at maximum crop growth stage followed by application of nitrogen @ 150 kg/ha with combined application of phosphorus @ 75 kg/ha as compared to all the remaining treatment combinations. It is concluded that application of optimum level of nitrogen @ 150 kg/ha with combined application of phosphorus @ 100 kg/ha recorded the maximum plant growth and fruit yield of okra.

Keywords: Effect of nitrogen, phosphorus, okra (*Abelmoschus esculentus* L.), fruit yield

Introduction

Okra (*Abelmoschus esculentus* L. (Moench)) commonly known as lady's finger or bhindi, belongs to the family Malvaceae. It is widely adopted vegetable in Indian kitchens and can be grown round the year. The green fruits contain numerous white seeds when immature. The beautiful flowers and upright stature give okra an ornamental value. Dry seeds of okra contain 18- 20 % oil and 20- 30 % crude protein. Okra seeds contain many mono- unsaturated fatty acids viz., oleic and palmitic acid. Okra is a short duration crop and produces fruits continuously for a longer time thus its growth, yield and quality are largely influenced by nutrient management practices.

The yield gap indicates that there is better scope for enhancing the productivity of okra in Madhya Pradesh. Among the various factors influencing successful production of okra, the judicious nutrients application is of vital importance. Fertilizers are generally applied to improve crop yield, nutritional quality (Sikander *et al.*, 2009) [14]. Nitrogen, phosphorus and potash are major nutrients required by plants for their proper growth and development for getting higher yields. Nitrogen and phosphorus perform different functions in crop growth and development and they cannot be substituted by any other factors or element.

Nitrogen is an important constituent of chlorophyll and required for synthesis of protein, nucleic acids and pigments. Nitrogen is needed by plants in large amounts. It is essential element for vigorous growth, branching, leaf development, root expansion, high photosynthetic activity and formation of protoplasm and for these reasons in turn increases crop yield and improves quality. Nitrogen fertilizer use in vegetable cultivation is increased by 21 per cent between 1997 to 2003 (Mubashir *et al.*, 2010) [6]. Several workers have reported linear increase in green pod yield of okra with the application of nitrogen from 56 to 150 kg per hectare.

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Phosphorus is another key element in the formation of high energy compounds such as Adenosine monophosphate, Adenosine diphosphate and Adenosine triphosphate and there by contributing to increased yield and quality of crops. It also plays essential role in photosynthesis and respiration. It is necessary for energy transformation in plant cells, cell division, development of meristematic tissues, early root development, tillering, flowering and seed development (Memon, 1996) ^[5]. Its improved root growth, hastened seed maturity and increases fruit yield especially when applied in combination with nitrogen (Pandey and Dubey, 1996) ^[10].

Materials and Methods

The experiment was carried out at Horticultural Research Farm, School of Agriculture, ITM University, Gwalior, (M.P.) during the *summer* season of 2019. The experiment was conducted in randomize complete block design having Factorial concept with three replications. Different rates of nitrogen and phosphorus allocated to the plots as per treatments. The treatments were four levels of nitrogen levels viz., 75 kg/ha (N₁), 100 kg/ha (N₂), 125 kg/ha (N₃) and 150 kg/ha (N₄) with three phosphorus levels viz., 50 kg/ha (P₁), 75 kg/ha (P₂) and 100 kg/ha (P₃). The gross and net plot size was 3.6 m x 3.6 m and 3.3 m x 3.0 m, respectively. The fertilizers grades were applied as per treatments. The recommended dose of potassium was applied @ 50 kg K₂O/ ha while, nitrogen (N) and phosphorus (P₂O₅) was applied as per the treatments. All the other agronomic practices were applied uniformly to all the treatments.

Results and Discussion

The result shows that plant height, number of branches per plant, number of leaves per plant, number of nodes on main stem and internodal length was influenced significantly due to different concentrations of nitrogen and phosphorus.

Data regarding these characters are reported in (Table- 1, 2 and 3). Statistical analysis of the data revealed that maximum plant height (141.21 cm), number of branches per plant (2.79), number of leaves per plant (21.48), number of nodes on main stem (18.40) and internodal length (7.20) were recorded when plots treated with the application of nitrogen @ 150 kg/ha (N₄) while, lowest values were observed in plot that received nitrogen @ 75 kg/ha. Similarly, application of phosphorus @ 100 kg/ha gave maximum values of same parameters with the respective of 130.30 cm, 2.51, 20.06, 17.15 and 6.48, respectively.

Statistical analysis of data revealed that interaction effect of nitrogen and phosphorus significantly affected plant growth and fruit yield was found significant. Similarly, in interaction the maximum plant height (141.99), number of branches per plant (2.85), number of leaves per plant (22.91), number of nodes on main stem (19.23) and internodal length (8.42) was recorded from plot receiving nitrogen @ 150 kg/ha combined application with phosphorus @ 100 kg/ha, while minimum values were recorded under the application of nitrogen @ 75 kg/ha with application of phosphorus @ 50 kg/ha.

The increased plant height may be due to higher dose of nitrogen might have enhanced cell division and formation of

more tissues resulting in luxuriant vegetative growth thereby increased plant height. These results were in conformity with Firoz (2009) ^[2] and Khan *et al.* (2010) ^[4]. Significantly highest number of branches & leaves per plant, number of nodes and inter nodal length was recorded when nitrogen was applied at 150 kg per hectare at maximum crop growth stage. This may be due to increased absorption of nitrogen which resulted in increased synthesis of carbohydrates which are utilized in building up of new cells. These results are in accordance with the reports of Shelar *et al.* (2011) ^[13].

Significant increase was observed in growth attributes when nitrogen was applied at the rate of 150 kg per hectare. This increase may be due to highest level of nitrogen, which promoted the axillary buds in to new shoots. Similar variation in number of branches has also been reported by Srivastava *et al.* (2009) ^[16] and Khan *et al.* (2013) ^[3].

Significant increase in growth parameters with the higher level of phosphorus may be due to the phosphorus involvement in energy transformation in plant cells, cell division, development of meristematic tissues, early root development and branching. Many researchers proved the importance of phosphorus in plant vegetative growth with the finding of Muhammad Ajmal *et al.* (2013) ^[7] and Bhende *et al.* (2015) ^[1]. Thus, the increase in nitrogen and phosphorus supply, accelerate synthesis of growth hormones in plants which indirectly exhibited by enhanced grow the plants and their parts. These results were in conformity with the finding of Yadav *et al.* (2016) ^[18] and Narendra *et al.* (2017) ^[8].

Statistical analysis of the data revealed that highest fruit yield (16.59 t/ha) were recorded in plots treated with the application of nitrogen @ 150 kg/ha (N₄) while, lowest values (10.70t/ha) were observed in plot that received nitrogen @ 75 kg/ha. Similarly, application of phosphorus @ 100 kg/ha gave highest fruit yield (14.47 t/ha).

Similarly, data revealed that interaction effect of nitrogen and phosphorus significantly affected fruit yield was found significant. In interaction effect, the highest fruit yield (17.77 t/ha) was recorded from plot receiving nitrogen @ 150 kg/ha combined application with phosphorus @ 100 kg/ha, while lowest value (9.81 t/ha) was recorded under the application of nitrogen @ 75 kg/ha with application of phosphorus @ 50 kg/ha.

Mineral nutrients like nitrogen may exert its influence on flowering initiation by increasing the rate of photosynthesis and export of solute to his sink site. Nitrogen resulted the vegetative growth and have been used also effective in flowering and fruiting characters. On the contrary, it induced earlier flowering and fruiting, this is perhaps due to the fact that nitrogen induced the complete growth phase of okra earlier, resulting in earlier flowering and fruiting.

Use of nitrogen in this investigation favoured the vegetative growth and number of flowers borne was proportionately high. It may be pointed out that relatively large number of auxins and various other substances regulating the lower bud initiation are produced by the foliage and hence applied nitrogen seems to have positive correlation with the number of lowers borne.

Table 1: Influence of effect of nitrogen levels on growth and yield of lady finger.

Treatment	Plant height (cm)	Number of branches per plant	Number of leaves per plant	Number of nodes on main stem	Length of internode (cm)	Fruit yield per hectare (t/ha)
N ₁	106.61	1.80	16.70	13.43	5.15	10.70
N ₂	123.39	2.34	18.71	16.25	5.67	12.73
N ₃	131.95	2.59	19.95	17.23	6.14	14.52
N ₄	141.21	2.79	21.48	18.40	7.20	16.59
S. Em±	1.2	0.04	0.14	0.23	0.16	0.11
CD	3.53	0.12	0.42	0.68	0.47	0.32

Thus, it is clear that yield of pod in tonnes per hectare was the maximum at 150 kg N/ha due to the highest values of yield attributing characters. Patton *et al.* (2002) ^[11] and Shanke *et al.* (2003) ^[12] in different regions also indicated similar increase in pod yield attributing characters at higher levels of nitrogen probably due to the fact that higher nitrogen stimulated the assimilation of carbohydrates and proteins which in turn enhanced cell division and formation of more tissues resulting in luxuriant vegetative growth and more photosynthetic area and thus the taller plants. This increased the photosynthetic area and favourable physiological activities under higher nitrogen levels since to have resulted in more production and translocation of photosynthesis in plants, which subsequently accelerated the formation of more number of large size fruits. These results were in conformity with the finding of Yadav *et al.* (2016) ^[18] and Narendra *et al.* (2017) ^[8].

Phosphorus is also one of the important nutrients required by plants for proper growth and development for getting higher yield. It is an important constituent of nuclear proteins and enzymes. The application of phosphorus as used present investigation influenced significantly the growth attributes like plant height, spread of plant, diameter of stem and number of leaves per plant. Each increase in the level of phosphorus on 50 to 100 kg/ha increased the amount of these attributes correspondingly. The highest value of these attributes was recorded with 100 kg P₂O₅/ha. For the formation of nucleic acid, nucleoprotein and lecithin which are present in almost all the living cells, phosphorus is essential. Particularly all phosphorus is absorbed by the plant in the form of phosphorus. Similar to our results, Patton *et al.* (2002) ^[11] also observed significant effect on vegetative growth, flowering and yield. Singh (2001) ^[15], reported that phosphorus fertilization significantly increased yield attributes and pod yield. These findings confirm the present results.

Table 2: Influence of effect of phosphorus levels on growth and yield of lady finger

Treatment	Plant height (cm)	Number of branches per plant	Number of leaves per plant	Number of nodes on main stem	Length of internode (cm)	Fruit yield per hectare (t/ha)
P ₁	121.97	2.26	18.52	15.59	5.64	12.73
P ₂	125.11	2.37	19.05	16.25	6.00	13.71
P ₃	130.3	2.51	20.06	17.15	6.48	14.47
S. Em±	1.04	0.04	0.13	0.20	0.14	0.09
CD	3.06	0.11	0.37	0.59	0.41	0.28

This was also due to the beneficial effect at optimum level of phosphorus i.e. 100 kg/ ha, which might be due to the stimulating effect of phosphorus on plant processes, viz. cell division and root elongation in meristematic tissues and constituent of ADP and ATP in plant, which plays an important role in energy storage. With increase in photosynthetic products, coupled with efficient translocation,

plant produced more pods/ plant. The significant increase fruit yields appeared to be on account of beneficial effects of nitrogen and phosphorus on growth and yield attributes which finally reflected in higher fruit yield of okra. These results were in conformity with the finding of Yadav *et al.* (2016) ^[18] and Narendra *et al.* (2017) ^[8].

Table 3: Influence of effect of between nitrogen and phosphorus on growth and yield of lady finger

Treatment	Plant height (cm)	Number of branches per plant	Number of leaves per plant	Number of nodes on main stem	Length of internode (cm)	Fruit yield per hectare (t/ha)
N ₁ P ₁	99.98	1.56	15.53	11.54	4.56	9.81
N ₁ P ₂	104.27	1.72	16.99	13.47	5.23	10.66
N ₁ P ₃	115.57	2.13	17.58	15.28	5.65	11.63
N ₂ P ₁	117.38	2.22	18.08	16.06	5.66	12.26
N ₂ P ₂	125.12	2.37	18.61	16.15	5.68	12.87
N ₂ P ₃	127.68	2.43	19.43	16.54	5.68	13.07
N ₃ P ₁	130.39	2.52	19.74	16.91	6.10	13.36
N ₃ P ₂	129.51	2.61	19.81	17.24	6.14	14.78
N ₃ P ₃	135.97	2.64	20.31	17.54	6.19	15.42
N ₄ P ₁	140.11	2.75	20.74	17.83	6.24	15.48
N ₄ P ₂	141.52	2.78	20.78	18.15	6.96	16.52
N ₄ P ₃	141.99	2.85	22.91	19.23	8.42	17.77
S. Em±	2.08	0.07	0.25	0.40	0.28	0.19
CD	6.11	0.21	0.73	1.19	0.82	0.55

Conclusion

The significant improvement in the fruit yields of okra with the application of nitrogen appears to be cumulative effect of greater uptake and translocation of nitrogen during reproductive and fruiting stage. Based upon this experiment it is concluded that application of higher level of nitrogen at the rate of 150 kg/ ha combined application with phosphorus at the rate of 100 kg/ ha recorded the maximum growth and grain yield of okra.

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