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Effect of Different Levels of Nitrogen and Potassium on Ascorbic Acid, Crude protein and Crude fibre content of Okra (*Abelmoschus esculentus* L.)

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ABSTRACT

A field experiment was conducted during kharif, 2011 on a sandy loam soil (Alfisol) at Student's Farm, College of Agriculture, Rajendranagar, Hyderabad with a view to study the effect of levels of nitrogen (0, 60, 120 and 180 kg N ha^{-1}) and potassium (0, 30, 60 and 90 kg K ha^{-1}) on pod yield and quality of okra. Randomized Block Design (RBD) with factorial concept was followed. The pod yield of okra was significantly increased with nitrogen, potassium and their interactions. Among the different interactions (N×K), the highest yield (126.17 q ha^{-1}) was recorded by combined application of 180 kg N ha^{-1} + 90 kg K_2O ha^{-1} (N_3K_3) which was on par with 180 kg N ha^{-1} + potassium 60 kg K_2O ha^{-1} (N_3K_2). With regard to quality parameters of okra the results revealed that increasing levels of nitrogen and potassium increased the ascorbic acid and crude protein content and the values ranged from 13.68 to 18.87 mg 100 g^{-1} and 14.09 to 19.29%, respectively. But the results of crude fibre content revealed that increased levels of nitrogen (0 to 180 kg N ha^{-1}) caused the decrease in crude fibre content (13.36 to 11.06%) whereas increase in potassium levels caused increase in crude fibre content (11.28 to 13.21%). The interaction effect of nitrogen and potassium did not show significant effect on quality parameters of okra. Nitrogen use efficiency was found to be higher (38) at N_2K_2 (120 kg N ha^{-1} + 60 kg K_2O ha^{-1}) level.

Key words: *Nitrogen, Potassium, Yield, Quality, Okra*

INTRODUCTION

Okra is one of the most important vegetable crops grown throughout the year which is having nutritional value with respect to vitamin A, B and C, proteins and minerals. It also has medicinal and industrial importance. Fully matured fruits and stems containing crude fibre are used in paper industry. In India, *Okra* is cultivated in 0.43 million hectares producing 4.54 million tonnes with a productivity of 10.4 t ha^{-1} [2].

Nitrogen is the first limiting nutrient in okra production that greatly influences crop growth and pod yield. The Indian soils are generally deficient in organic matter thus unable to release N at a rate required to maintain adequate N supply to the growing plant.

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Nitrogen is an essential constituent of various metabolically active compounds like amino acids, proteins, nucleic acids, pyrimidines, flavines, purines, nucleoproteins, enzymes, alkaloids etc[9]. Therefore, application of nitrogen in the form of fertilizers becomes indispensable to meet the N needs of the crop. Potassium is another important plant nutrient that plays a vital role in enzyme activation, water regulations, translocaton of assimilates, photosynthesis and protein synthesis. It counteracts harmful effects of excess nitrogen in plants. The response of crop to potassium increases significantly in the presence of nitrogen[15].

Hence, keeping in view the significance of N and K on productivity of okra, an experiment was conducted to study the effect of levels of nitrogen and potassium on yield and quality of okra grown on an Alfisol.

MATERIALS AND METHODS

A field experiment was conducted on a sandy loam soil (*Alfisol)* at Student's Farm, College of Agriculture, Rajendranagar, Hyderabad during *kharif* season 2011. The experiment was laid out in randomized block design with factorial concept consisting of sixteen treatment combinations with four levels each of nitrogen (N_0-0, N_1-60, N_2-120 and N_3-180 kg N ha^{-1}), potassium (K_0-0, K_1-30, K_2-60 and K_3-90 kg K_2O ha^{-1}). Nitrogen and potassium were applied in the form of urea and muriate of potash, in 3 splits as per treatment combinations. A basal dose of 60 kg P_2O_5 ha^{-1} was applied in the form of single super phosphate to all the treatment plots.

The experimental soil is sandy loam in texture, slightly alkaline (pH 7.8) in reaction, non saline (0.23 dS m^{-1}), low in organic carbon (0.48 per cent) and available N (226.8 kg ha^{-1}), medium in available P_2O_5 (38.63 kg ha^{-1}) and K_2O (278.5 kg ha^{-1}). *Okra* fruits were picked in the morning hours when they are still tender. A total of 15 pickings were taken and yield was recorded. Fresh okra pods were analyzed for their quality in terms of ascorbic acid content where as Crude protein and Crude fibre contents were analyzed on dry weight basis by following standard procedures. Ascorbic acid (vitamin C) content of okra fruit was analyzed by dichlorophenol indophenol dye method and expressed in mg 100 g^{-1} [11] . Fibre content of the okra fruit was estimated as per the procedure outlined[10]. Crude protein content was calculated by multiplying per cent nitrogen in fruits with a factor 6.25. Nitrogen use efficiency[5] was calculated by using the following formula:

$$\text{NUE} = \frac{\text{Difference in pod yield (kg) between the treatments}}{\text{Difference in added N fertilizer (kg)}}$$

RESULTS AND DISCUSSION

1. Pod yield: The levels of nitrogen, potassium and their interactions had significant effect on pod yield of okra (Table 1). The pod yield increased to an extent of 24.18 (60 kg N ha^{-1}), 50.19 (120 kg N ha^{-1}) and 68.21 per cent (180 kg N ha^{-1}) as compared to control. Similarly, K application increased the pod yield by 14.55, 37.28 and 45.09 per cent at 30, 60 and 90 kg K_2O ha^{-1}, respectively over no K application.

Among the interactions, N_3K_3 has recorded the higher pod yield (126.17 q ha^{-1}) but it was on par with the yield recorded at N_3K_2 (124.83 q ha^{-1}) and the yield at N_2K_3 (112.63 q ha^{-1}) was on par with N_2K_2 (109.27 q ha^{-1}) significantly superior over other interactions. Yield attributes like number of flowers, number of pods per plant, size and weight of pods are governed by nitrogen[1]. Potassium also influenced the yield due to the direct or indirect involvement of potassium in major plant processes such as photosynthesis, respiration, enzyme activation and metabolism of carbohydrates[4 &13]. The increase in yield by the combined application of nitrogen and potassium may be attributed due to efficient functioning of photosynthetic surface and increased accumulation of photosynthates[16].

2. Quality of okra:

The data on quality parameters are given in table 2. Increasing levels of nitrogen and potassium not only increased pod yield but also the quality parameters like ascorbic acid and crude protein content of okra. Ascorbic acid content values ranged from 13.68 to 18.87 mg 100 g^{-1}. This might be due to increase in uptake of nutrients by nitrogen which had promoted ascorbic acid content[3]. Similar increase in ascorbic acid content was recorded by Tomar and Singhal[17]. The positive influence of potassium was due to the close relationship between carbohydrates metabolism and formation of ascorbic acid[6]. Similarly crude protein content vales ranged from 14.09 to 19.29%. This is attributed due to enhanced absorption from soil of added N and its direct participation in protein synthesis[14]. The positive influence on crude protein content due to potassium was noticed by Rani *et al*[12].

Crude fibre content was significantly influenced by levels of nitrogen and potassium (Table 2). Increase in applied nitrogen from N_0 to N_3 decreased the crude fibre per cent significantly from 13.36 to 11.06. Among the potassium levels, K_3 recorded significantly highest crude fibre per cent (13.21%) followed by K_2, K_1 and K_0. The decrease in crude fibre content was due to the increase in succulence by the increased application of nitrogen[7] and increased by the levels of potassium due to the involvement of K in strenthening the thickness of the cell wall. Similar decrease in crude fibre content with increased levels of nitrogen was obtained by Irene[3]. The interaction effect of nitrogen and potassium did not show significant effect on quality parameters of okra.

3. Nitrogen use efficiency:

Research findings revealed that the nitrogen use efficiency in terms of kg Pod per kg applied nitrogen was influenced by different levels of potassium. The nitrogen use efficiency varied from 40 to 60 per cent in different crops[8] with a global average of 50 per cent. Increase in nitrogen use efficiency is the consequence of enhanced uptake of N. with increase in levels of potassium, there was significant increase in N and K uptake.

The synergistic effect of N x K on increase in NUE was used as one of the measures to identify the best combination of N and K. The values of NUE are given in table 3. The highest NUE (38) was recorded with N_2K_2 level and decrease in NUE was recorded with highest levels of N viz., N_3K_3 (22.6) and N_3K_2 (26.0).

Though the pod yield recorded at N_3K_3 level was high, keeping in view of the improvement in nitrogen use efficiency (NUE), it can be suggested that application of 120 kg N ha^{-1} combined with 60 kg K_2O ha^{-1} i.e., N_2K_2 is optimum for better productivity which also reduces the cost on fertilizers.

Table 1: Effect of levels of nitrogen, potassium and their interactions on pod yield (q ha^{-1}) of okra

Levels	**Pod yield (q ha^{-1})**				
	K_0	K_1	K_2	K_3	**Mean**
N_0	50.56	57.47	73.37	81.45	**65.71**
N_1	66.26	77.48	86.52	96.16	**81.60**
N_2	80.18	92.68	109.27	112.63	**98.69**
N_3	90.01	101.13	124.83	126.17	**110.53**
Mean	**71.75**	**82.19**	**98.50**	**104.10**	
	S.Ed±		CD (0.05)		
N	1.48		3.02		
K	1.48		3.02		
N×K	2.95		6.03		

Table 2: Effect of levels of nitrogen, potassium and their interactions on quality parameters of okra

Levels	Ascorbic acid (mg 100 gm^{-1})					Crude protein (%)					Crude fibre (%)				
	K_0	K_1	K_2	K_3	**Mean**	K_0	K_1	K_2	K_3	**Mean**	K_0	K_1	K_2	K_3	**Mean**
N_0	13.68	14.71	15.52	16.31	**15.06**	14.09	14.67	15.19	15.83	**14.94**	12.17	12.95	13.85	14.47	**13.36**
N_1	14.53	15.98	16.65	17.66	**16.21**	15.14	15.53	16.40	17.91	**16.25**	11.75	12.45	13.15	13.41	**12.69**
N_2	16.06	16.75	17.61	18.24	**17.16**	16.27	16.86	17.86	18.28	**17.32**	11.05	11.65	12.35	13.05	**12.03**
N_3	16.48	17.82	18.46	18.87	**17.91**	17.31	18.23	18.78	19.29	**18.40**	10.15	10.80	11.40	11.92	**11.06**
Mean	**15.19**	**16.32**	**17.06**	**17.77**		**15.70**	**16.32**	**17.06**	**17.83**		**11.28**	**11.96**	**12.69**	**13.21**	
	S.Ed±		CD (0.05)			S.Ed±		CD (0.05)			S.Ed±		CD (0.05)		
N	0.32		0.66			0.20		0.40			0.18		0.36		
K	0.32		0.66			0.20		0.40			0.18		0.36		
N×K	0.65		N.S.			0.40		N.S.			0.35		N.S.		

Table 3: Interaction effect of nitrogen and potassium on Nitrogen use efficiency (NUE)

NUE (Kg pod per kg N applied)					
Levels	**K_0**	**K_{30}**	**K_{60}**	**K_{90}**	**MEAN**
N_{60}	26.2	33.3	22.0	24.5	**26.5**
N_{120}	23.2	25.3	38.0	27.5	**28.5**
N_{180}	16.4	14.1	26.0	22.6	**19.8**
MEAN	**21.9**	**24.2**	**28.6**	**24.9**	

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