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INFLUENCE OF NITROGEN, PHOSPHORUS AND POTASSIUM ON GROWTH, YIELD AND QUALITY OF OKRA CV. PRABHANI KRANTI UNDER SUB - TROPICAL CONDITION OF MANIPUR

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ABSTRACT

The okra cv. Prabhani Kranti responded well to the application of 80 kg N, 60 kg P_2O_5 and 30 kg K_2O per hectare as evidenced by the increased in plant height, leaf area index, stem thickness, number of nodes and dry weight of the plant and NAR, green fruit yield (156.53, 143.84 and 138.56 q/ha), fruit weight per plant, number of fruit per plant and green fruit length. More number of days was required to achieve 50% flowering and maturity of green fruit at higher dose of nitrogen but phosphorus and potash could not significantly influence on this characters. Significant increase in crude protein content (16.20, 15.07 and 15.21%) of green fruit was associated with 80:30:30 kg NPK/ha. The application of nitrogen and potassium had a negative influence on the crude fibre content of green fruit. From the present study it can be concluded that the application of 80 kg N, 60 kg P_2O_5 and 30 kg K_2O per hectare is the most suitable dose for higher yield and quality of okra under acidic soil condition of Manipur.

INTRODUCTION

Vegetables play a vital role in the improvement of diet of mankind since time immemorial. Compared to cereals, vegetables give three time's higher productivity and profitability. Okra (*Abelmoschus esculentus* L.) belongs to Malvaceae family is one of the oldest cultivated crops, originating from tropical and sub-tropical Africa (Tindal, 1983). Okra is a fast growing annual and its fresh tender fruits are used as vegetable while the roots and stems are used for preparing 'gur' or brown sugar (Chauhan, 1972). The seeds in the fresh edible pods of okra provide vitamins, minerals, calories and amino acid and compares favorably with those in poultry, eggs and soybean (Thompson, 1949; Schipper, 2000). The mucilage of the pod has medicinal properties as an emollient, laxative and expectorant (Muresan and Popescu, 1993). The edible portion of the pod contains approximately water 88, protein 2.1, fat 0.2, carbohydrate 8.0, fibre 1.7 and ash 0.2g per 100g (Tindall, 1983). It is also a rich source of iodine. Thus, okra occupies a prominent position in food and the nutritional security of the country.

Okra is extensively grown in several states of India with a production of 63.46 lakh tones from an area of 5.33 lakh ha including Manipur where it is grown in 120 ha and produces 840 tons. However, the productivity of this crop in the state is very low (7 tons/ha) as compared to the national average of 11.90 tons/ha (Anon., 2015) and thus cannot meet the growing population demand of the state. Lower productivity in the state may be due to unbalance use of fertilizers specially the major nutrients besides other management practices. Hence, there is lot of scope for improving the production and productivity of this crop by judicious fertilizer (NPK) application. These nutrients are specific in function and must be supplied to plants at right time with right quantity. Lack of sufficient amounts of these nutrients will result in poor performance of the crop growth and ultimately lower the yield (Shukla and Naik, 1993).Nitrogen deficiency leads to low production, stunted growth and small yellow leaves (Haque and Jakhro, 1996). Several workers have reported increase in green pod yield of okra with the application of nitrogen (Firoz, 2009 and Choudhary *et al*., 2015).Phosphorus is a key constituent of ATP which has significant role in energy transformation in plants and also in various physiological processes (Shivasankeb *et al*., 1982). Phosphorus helps in nutrients uptake by promoting root growth and thereby ensuring a good pod yield through the increase in total dry matter (Rai, 1982). Phosphorus deficiency results in poor root development, poor pod setting and subsequently reduces yield (Jain *et al*., 1990). Many researchers reported the effect of phosphorus application on green pod yield of okra (Firoz, 2009 and Ahmed and Mohamed 2015).Potassium acts as a chemical for stalk strengthening, protein builder, breathing regulator, disease retarder and increase the plumpness and boldness of seeds but it is not effective without its co-nutrients as nitrogen and phosphorus (Chandra, 1989).

Generally, the soils of Manipur are in the range of low to medium in nitrogen and phosphorus and medium to high in case of potassium, thus, addition of these elements through fertilizers becomes necessary. Okra production system in the state is still predominantly traditional and farmers in Manipur valley have no definite fertilizer recommendation. Keeping the above facts in view, therefore, the present investigation was undertaken with the objective to find out the suitable dose of nitrogen, phosphorus and potassium and provide balance fertilization in okra.

MATERIALS AND METHODS

Experimental site

A field experiment was conducted at the Horticultural Experimental Farm, College of Agriculture, Central Agricultural University, Imphal during 2009 and 2010. The farm is geographically situated at 24° 452 N latitude and 93° 562 E longitude at an altitude of 790 m above mean sea level. The climatic condition of Imphal is sub-tropical where the monsoon normally begins from June and extends up to September and withdraws from October onward.

Representative soil samples from a depth of 0-15 cm were collected at random before stating the experiment and composited for their mechanical and chemical analysis. The soil of the experimental plot was clayey in texture (6.0 % sand, 11.30 % silt and 82.56 % clay) with high organic carbon (1.20%) and available k_2O (430 kg ha^{-1}), medium available N (313.60 $kgha^{-1}$) and low in available P_2O_5 (24.10 kg ha^{-1}). The soil was acidic in reaction (pH 5.4). The methods used for soil analysis are presented in Table 1.

Technical programme

The experiment was laid out in factorial randomized block design with three replication. All possible combinations with 4 levels of nitrogen (0, 40, 80, 120 kg ha^{-1}), 3 levels each of phosphorus (0, 30, 60 kg ha^{-1}) and potassium (0, 30, 60 kg ha^{-1}) were included. There were altogether 36 treatment combinations. The required half dose of nitrogen, full dose of phosphorus and potassium in the form of urea (46% N), single super phosphate (16% P_2O_5) and muriate of potash (60% K_2O) were applied uniformly to each plot one day before sowing and mixed properly with the soil. The remaining half dose of nitrogen was top dressed at 30 days after sowing.

The seed of okra cv. Prabhani Kranti at the rate of 20 $kgha^{-1}$ was sown in 3 cm depth maintaining a spacing of 40 cm between rows and 20 cm between plants. The crop was sown on 10th March of 2009 and 2010. Other recommended package and practices for the crop was given as per the requirement. Various growth and yield parameter were recorded as per standard procedure. The estimation of nitrogen in green fruits was done by the Kjeldhal method (Jackson, 1973). From the nitrogen percentage, crude protein content was estimated by employing the standard factor of 6.25 and expressed in per cent. The crude fibre content in the fresh palatable fruits of okra was analyzed as per the method described by Chopra and Kanwar (1976).

Statistical analysis

All the data pertaining to the present investigation were computed for statistical analysis as per method described by Cochran & Cox (1955) and Gomez & Gomez (1976). The statistical significance of various effects was tested at 5 per cent probability level.

RESULTS AND DISCUSSION

Effect of nitrogen on growth, yield and quality

The effects of N, P and K fertilizers on growth, yield and quality of okra are presented in Table 2 and 3. In general, application of 80 kg N, 60 kg P_2O_5 and 30 kg K_2O ha^{-1}recorded significantly higher growth, green fruit yield and quality of okra as compared to other levels of major nutrients during the experimentation.

Among the levels of nitrogen, application of 80 kg ha^{-1} increased significantly all the growth characters like plant height, leaf area index (LAI), stem thickness, number of nodes, dry matter accumulation and Net Assimilation Rate (NAR). This increased in growth with adequate availability of nitrogen from fertilizer is due to the fact that nitrogen being the major constituent of proteins, enzymes, hormones, vitamins and chlorophyll played a significant role in stimulating the meristematic growth through protoplasmic biosynthesis. Such benefits of nitrogen in growth of okra confirms the earlier report of Mohan and Batra (2000), Vimala and Natarajan (2002), Shanke *et al*. (2003), Ansari and Sukhraj (2010). More number of days was required to achieve 50% flowering as well as maturity of green fruits at higher dose of nitrogen. This may be due to the fact that adequate supply of nitrogen promotes luxuriant and succulent vegetative growth dominating the reproductive phase. Similar report of higher dose of nitrogen favouring vegetative growth, delaying the flowering and maturity of green fruit is also confirmed by Haque and Jakhro (1996) and Prabhu *et al*. (2006). Thus, the improvement in growth with the addition of nitrogen favoured more number of fruits and increase the size of the fruit which ultimately contributed to higher green fruit yield (156.53 q ha^{-1}). The increase in green fruit yield with the application of 80 kg N ha^{-1} over control was to the tune of 41 per cent. Such a positive yield response to application of nitrogen is obvious when it is deficient in the growing medium. This result is in agreement with the findings of Khan *et al*. (2000), Singh *et al*. (2008) and Brar and Singh (2016) in okra. The crude protein

Table 1: Methods used in mechanical and chemical analysis of soil

Sl. No.	Particulars	Method adopted
1.	Texture	International Pipette method (Piper, 1966).
2.	pH	1: 2.5 soil water suspension glass electrode pH meter (Jackson, 1973).
3.	Organic carbon	Walkley and Black's method (Piper, 1966).
4.	Available N ($kgha^{-1}$)	Alkaline permanganate method (Subbiah and Asija, 1956).
5.	Available P_2O_5 (kg ha^{-1})	Bray and Kurtz method (Jackson, 1973).
6.	Available K_2O ($kgha^{-1}$)	Flame photometric method (Jackson, 1973).

Table 2: Influence of NPK on growth characters of okra (90 DAS) pooled mean of 2 years

Treatment	Plant height (cm)	LAI	Stem thickness (cm)	No. of nodes/plant	Dry weight of plant (g)	NAR (mg m^{-2} day^{-1})
Levels of N (kg N/ha)						
Control	44.58	1.06	1.27	10.62	14.88	23.49
40	56.93	1.24	1.38	12.86	20.20	27.30
80	75.66	1.51	1.53	15.45	27.39	31.91
120	76.38	1.57	1.56	16.40	28.60	32.64
$CD_{0.05}$	2.94	0.09	0.09	1.07	1.95	1.99
Levels of P (kg P_2O_5/ha)						
Control	58.67	1.28	1.38	12.95	20.83	27.23
30	62.14	1.35	1.45	13.82	22.75	29.63
60	69.40	1.40	1.48	14.73	24.73	29.61
$CD_{0.05}$	2.55	0.08	0.05	0.93	1.69	1.73
Levels of K (kg K_2O/ha)						
Control	61.24	1.25	1.40	13.43	21.33	27.19
30	63.39	1.39	1.44	13.90	23.15	29.04
60	65.53	1.40	1.46	14.17	23.83	30.26
$CD_{0.05}$	2.55	0.08	0.05	NS	1.69	1.73

Table 3 : Influence of NPK on yield attributes, yield and quality of okra (pooled mean of 2 years)

Treatment Levels of N (kg N/ha)	Days taken to 50% flowering	Days taken to fruit maturity	No. of fruits/ plant	Green fruits weight/ plant (g)	Green fruit length (cm)	Green fruit yield (q/ha)	Crude protein (%)	Crude fibre (%)
Control	53.71	5.7	10.77	81.41	12.06	92.5	12.85	13.97
40	55.19	6.04	12.89	106.7	13.04	121.24	14.6	13.43
80	55.95	6.53	15.6	137.74	14.31	156.53	16.2	12.46
120	57.23	6.8	16.08	139.16	14.32	158.13	16.49	12.28
$CD_{0.05}$	2.4	0.4	0.92	6.02	0.95	6.78	0.77	0.55
Levels of P (kg P_2O_5/ha)								
Control	54.92	6.14	12.52	106.3	12.91	120.79	14.5	12.87
30	55.53	6.24	13.91	115.88	13.39	131.67	15.07	12.99
60	56.1	6.43	15.07	126.58	13.99	143.84	15.54	13.24
$CD_{0.05}$	NS	NS	0.79	5.21	0.82	5.87	0.65	NS
Levels of K (kg K_2O/ha)								
Control	54.21	6.18	12.48	107.09	12.89	121.69	14.36	13.38
30	55.67	6.29	14.24	119.74	13.65	136.06	15.21	13.09
60	56.67	6.32	14.79	121.93	13.75	138.56	15.55	12.64
$CD_{0.05}$	NS	NS	0.79	5.21	0.82	5.87	0.66	0.48

content (16.20 %) of green fruit was significantly influenced by the application of 80 kg nitrogen. This is because of the added nitrogen has a direct participation in protein synthesis. The positive effect of nitrogen on crude protein content has been reported earlier in okra by Arora *et al.* (1985) and Feleafel and Ghoneim (2005). Added nitrogen had a negative influence on the crude fibre content in the present study. Decrease crude fibre content due to increased nitrogen application has been observed earlier in okra (Vethamoni, 1988).

Effect of phosphorus on growth, yield and quality

The plant height, dry weight of the plant, number of fruits, green fruit weight and fruit yield increased with every increase in the level of phosphorus up to 60 kg ha^{-1}. However, the significant increase in LAI, stem thickness, No. of nodes, NAR, fruit length and crude protein content recorded up to 30 kg P_2O_5 ha^{-1}but it failed to elucidate any significant effect on crude fibre content of green fruit. The significant improvement in growth and yield of okra might be due to better development of root system as phosphorus is a constituent of cell nucleus and functions in cell division as energy supplier, which in turn is important in water and nutrient uptake from soil. The 16 per cent increase in yield as compared to control might have resulted from adequate supply of phosphorus from the fertilizer which was low in the growing medium. Further, the better growth performance with the application of phosphorus resulted in more number of fruits and weight of the fruit which ultimately contributed to higher fruit yield (143.84 q ha^{-1}). This result is in agreement with the findings of Firoz (2009), Ahmed and Mohamed (2015) and Choudhary *et al.* (2015) in okra. The crude protein content (15.07 %) of green fruit was significantly enhanced by the application of phosphorus up to 30 kg ha^{-1}. This might be because of the added phosphorus having direct role in protein synthesis. The positive effect of phosphorus on crude protein content has been reported earlier in okra by Naik and Srinivas (1992).

Effect of potassium on growth, yield and quality

Successive increase in level of potassium up to 30 kg ha^{-1} resulted in significant increase of plant height, LAI, stem thickness, dry weight of the plant and NAR. However, different level of potassium up to 60 kg ha^{-1} could not significantly influence the number of nodes, days taken to 50 % flowering and fruit maturity. The better growth of the crop with adequate supply of potassium resulted in significant increase in the number of fruits, fruit weight and length and ultimately resulted in higher fruit yield (136.06 q ha^{-1}). Further, increase in level of potassium to 60 kg ha^{-1} could not show significant increase in green fruit yield which may be attributed to higher initial availability of potassium in the soil. These findings are also observed by Syrial and Rajan (1992), Kolawole *et al*. (2008), Thakur *et al*. (2015) and Thriveni *et al*. (2015). The crude protein content of green fruit (15.21%) was significantly increased by the application of potassium up to 30 $kgha^{-1}$. This might be because of applied potassium which could have activated the enzyme relating to protein synthesis. The positive effect of potassium on crude protein content has been reported earlier in okra by Farag and Damrany. (1994). The crude fibre content decrease with every increase in level of potassium up to 60 kg ha^{-1}. The negative influence of potassium application on crude fibre content has been reported earlier by Mani and Ramanathan (1981).

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