EFFECT OF DIFFERENT COMBINATIONS OF NITROGEN, PHOSPHORUS AND POTASSIUM ON GROWTH AND YIELD OF OKRA (*Abelmoschus esculentus L.)* UNDER RUPANDEHI CONDITION

Swasthani Silwal, Sujata Acharya, Devesh Rai Sangpang, Nabin Chalaune, Jawahar Lal Mandal, Rukmagat Pathak and Puspa Raj Poudel*

Tribhuvan University, Institute of Agriculture and Animal Science, Paklihawa Campus, Siddharthanagar-1, Rupandehi, Lumbini, Nepal

*Corresponding author's email: puspa.poudel@pakc.tu.edu.np

Swasthani Silwal: https://orcid.org/0000-0003-0095-3576

Sujata Acharya: https://orcid.org/0009-0004-4929-8730

Devesh Rai Sangpang: https://orcid.org/0009-0004-4296-7882

Nabin Chalaune: https://orcid.org/0000-0002-9798-440X

Jawahar Lal Mandal: https://orcid.org/0009-0008-3467-283X

Rukmagat Pathak: https://orcid.org/0000-0003-1974-538X

Puspa Raj Poudel: https://orcid.org/0000-0001-7694-4137

ABSTRACT

An experiment on effect of different combinations of nitrogen, phosphorous and potassium on growth and yield of okra (Abelmoschusesculentus L.) var. ArkaAnamika was conducted at Institute of Agriculture and Animal Science (IAAS), Paklihawa, Rupandehi during February 2017 to June 2017. The experiment was laid in Randomized Complete Block Design (RCBD) with seven treatments and three replications. The treatments 220:200:60 NPK Kg ha^{-1} (T_1), 200:180:60 NPK Kg ha^{-1} (T_2), 180:160:40 NPK Kg ha^{-1} (T_3), 160:140:40 NPK Kg ha^{-1} (T_4), 140:120:20 NPK Kg ha^{-1}(T_5), 120:100:20 NPK Kg ha^{-1} (T_6) and Control (T_7)were applied and the growth, yield and yield attributes of okra were studied. The result revealed that there were no significant differences (p=0.05 level by Duncan's Multiple Range Test-DMRT) on plant height, number of leaves, number of branches, fruit length, fruit diameter, average number of fruit per plant and average marketable yield to the effect of different combination of NPK levels. However, the result showed that average marketable yield and total yield was found significant over the control and also the highest total yield (43.21 Mt/ha) was obtained at 160:140:40NPK Kg ha^{-1}

Keywords: Growth, NPK levels, yields.

INTRODUCTION

The extremely varied climate and diverse physiography and condition of Nepal favors the cultivation of wide variation of vegetables that are grown in different seasons and parts of the country. Okra (*Abelmoschus esculentus* L.) is one of the most widely used species of family malvaceae (Naveed *et al.,* 2009). It is primarily grown for its immature pods that can be consumed as fried or boiled vegetables or may be added to salads, soups and stews (Kashif *et al.,*2008). Okra plays a significant role in human nutrition by providing calcium, magnesium, iron, phosphorus, protein, and vitamin A and C including riboflavin as well as high mucilage (Ndaeyo *et al.,* 2005).Okra has been called as "a perfect villagers' vegetables" because of its robust nature, dietary fiber and distinct seed protein balance of lysine and tryptophan, amino acids (Rice *et al.,* 1987).Okra is considered as one of the economically important and popular summer vegetables crop in terai, inner terai and lower hills of Nepal. In Nepal, okra was cultivated in 9584 ha of land with the total production of 110565 Mt and with an average productivity of 11.54 Mt/ha (MOAD, 2020/2021).

Okra requires optimum amount of nutrients such as nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), sodium (Na) and sulphur (S) for optimum yield. Nihort(1985) reported that nitrogen as well as phosphorus plays the important role in fruit, seed, and quality development. Okra gives higher yield with the judicious use of fertilizer and trace elements amendments (Koay & Chua, 1978). These nutrients are specific in function and must be supplied to plants at the right time and at the right quantity. Generally, it is perceived that high amount of fertilizer will increase the yield to the highest level being unaware from the fact that it not only increases the cost of production but also causes severe damage to the fertility of soil in long run (Lal & Mathur, 1988; Joshi & Singh, 2004). So far, most research works are limited only to know the individual effect of nitrogen (Shrestha, 1983) phosphorus and potassium (Bhende *et al.,* 2015 and Pushpavalli *et al.,* 2014) however, the interactive effect of NPK on okra are yet to be studied in Arka Anamika particularly in western part of terai condition in Nepal. There is growing concern on the judicious use of chemical fertilizer on the soil productivity and the environmental pollution. Thus, this study can be effective to find out the appropriate dose of NPK for optimum yield and productivity of okra in western part of terai in Nepal.

MATERIALS AND METHODS

The experiment was conducted at Horticulture field, Institute of Agriculture and Animal Science (IAAS), Paklihawa, Rupandehi (Nepal) during February 2017 to June 2017. This site is located 4 km south west from Bhairahawa. The altitude of this site is about 256 meters above sea level (masl) with 27^0 30 '0" North latitude and 83^0 27' 0" East longitudes. The site lies in the tropical humid climatic zone.Vegetable based cropping pattern was followed since last five years in the research plot. The major cropping patterns were broccoli-okra-fallow and cauliflower-cucurbits-fallow. The experiment was set in Randomized Complete Blocked Design (RCBD) with three replications and seven treatments. The experiment was conducted during spring-summer season .There were seven treatment combinations viz, T_1= 220:200:60 NPK Kg ha^{-1} ,T_2=200:180:60 NPK Kg ha^{-1} , T_3= 180:160:40 NPK Kg ha^{-1} ,T4= 160:140:40 NPK Kg ha^{-1} ,T_5= 140:120:20 NPK Kg ha^{-1} ,T_6= 120:100:20 NPK Kg ha^{-1}andT_7= FYM (Control) which were allocated using the rules of randomization in each replication. ArkaAnamika (open pollinated variety) was selected for sowing at different combination of NPK levels. The individual plot area was 2.4 m² (2m×1.2m). In each plot there were four rows having four plants in each row.

The priming of the seed was done for 24 hours in normal water. Seeding was done at 50 cm row to row and 30cm plant to plant distance as recommended by Ministry of Agriculture and Livestock Development (MoALD),Nepal (Agriculture Information and communication Center (AICC, 2071). Seeds were sown on by dibbling 2-3 seeds per hill on the prepared plots. One seedling per hill was maintained by thinning the remaining seedlings. As per the treatment plan half dose of nitrogen and full dose of phosphorous and potassium was broadcasted during the land preparation. Remaining, nitrogen was applied in two split doses i.e. 30 and 60 days after sowing (DAS) respectively. Farm yard manure (FYM) was also applied during initial land preparation in each plot.

Among the sixteen plants in each plot, five plants inside the border row were randomly selected and tagged as the sample plant for data collection. The morphological characters of tagged plants were recorded at every ten days interval starting from thirty five days after sowing and up to final harvest. Plant height (cm) was measured from the base of the plant

to the highest growing point of the plant with the help of measuring tape. Number of green, photosynthetically active leaves per sample was counted and recorded at ten days interval up to final harvesting. Primary branches were counted on selected five plants and were measured at ten days interval up to final harvesting. Number of nodes at final harvest of each sampled plants was counted. Similarly, the total number of fruits harvested during crop period was divided by total plant population to obtain number of fruits per plant. Fruit length of each selected plant was recorded at every harvest and their average was taken to determine average fruit length. Likewise, fruit diameter was measured with the help of Vernier calipers from the random selection of five fruits in each plot. Also, the average fruit yield was taken by random selection of five fruits of total harvest in each plot. The total yield from each plot was recorded from first harvesting to final harvesting to determine the yield per plot.

All the data on vegetative, reproductive and yield attributes were entered using Microsoft Excel. Analysis of variance (ANOVA), Duncan's Multiple Range Test (DMRT) and Least Significant Difference (LSD) tests were conducted using the MSTAT software.

RESULTS AND DISCUSSION

Plant height

The table 1 shows the effect of different levels of NPK on plant height at different days after sowing (DAS). It revealed that the incremental nature of plant height with increase in the level of NPK was in agreement with the findings of Gloria *et al.* (2017) who reported that increasing level of NPK fertilizer increases the plant height in okra. It was found that at 35 DAS, maximum plant height of 11.61cm was observed in 160:140:40 NPK Kg ha^{-1},which is significantly different than the control group i.e. 8.633 cm,but it is not significantly different than rest of the six treatments (p. 0.05 level b DMRT).

Table 1. Effect of different levels of NPK on Plant height of okra at Paklihawa, Rupandehi during 2017

Treatments N:P:K level (Kg/ha)	35DAS	45DAS	75DAS	105DAS	135DAS
220:200:60(T1)	11.08^{a}	19.33^{ab}	57.53^{ab}	94.53^{ab}	146.4^{a}
200: 180:60(T2)	10.47^{a}	22.87^{a}	64^{a}	108.1^{ab}	140.2^{a}
180:160:40(T3)	11.39^{a}	22.33^{ab}	64.27^{a}	113.4^{a}	140.9^{a}
160:140:40(T4)	11.61^{a}	22.23^{ab}	64.13^{a}	110.8^{a}	133.9^{ab}
140:120:20(T5)	10.43^{a}	20.1^{ab}	61.87^{ab}	104.7^{ab}	142.3^{a}
120:100:20(T6)	10^{ab}	20.77^{ab}	65.4^{a}	101.5^{ab}	137.7^{a}
Control(T7)	8.633^{b}	18.7^{b}	51^{b}	80.67^{b}	117.5^{b}
Sem±	0.5782	1.2926	3.7856	9.1657	5.9876
LSD (P=0.05)	1.782	3.983	11.66	28.24	18.45
CV%	9.52	10.71	10.72	15.57	7.57
Grand Mean	10.517	20.905	61.171	101.962	136.981

Treatments means followed by common letter (s) within column are not significant among each other based on DMRT at 5% level of significance. Abbreviations DAS=Days after sowing, SEM= Standard Error of Mean, LSD = Least Significance Difference and CV = Coefficient of Variation

Number of branches

The table 2 shows the effect of different levels of NPK on number of branches per plant. The result indicates that there is no significant effect of NPK levels on the no. of branches in okra. This result is in contradiction with the findings of Gloria *et al.* (2017).

Table 2. Effect of different levels of NPK on number of branches of okra at Paklihawa, Rupandehi during 2017

Treatments N:P:K level (Kg/ha)	Branch no. at 45DAS	Branch no. at 55 DAS	Branch no. at 65 DAS	Branch no. at 95 DAS	Branch no. at 125 DAS
220:200:60(T1)	1.133^{a}	1.6^{ab}	1.933^{abc}	3.4^{a}	5.067^{a}
200: 180:60(T2)	0.8^{ab}	1.467^{ab}	1.467^{c}	3^{ab}	4.867^{ab}
180:160:40 (T3)	0.7333^{ab}	1.8^{a}	2^{abc}	2.533^{b}	3.8^{bc}
160:140:40(T4)	0.9333^{ab}	1.4^{ab}	2.067^{ab}	2.933^{ab}	4.733^{ab}
140:120:20 (T5)	0.7333^{ab}	1.667^{ab}	2.2^{a}	2.867^{ab}	4.533^{ab}
120:100:20(T6)	0.6667^{ab}	1.4^{ab}	1.867^{abc}	2.333^{b}	4^{abc}
Control(T7)	0.4667^{b}	1.2^{b}	1.533^{bc}	2.733^{ab}	3.133^{c}
Sem ±	0.1788	0.1656	0.1888	0.2549	0.3552
LSD (P=0.05)	0.5512	0.5094	0.5819	0.7856	1.094
CV%	39.65	19.06	17.52	15.61	14.29
Grand Mean	0.781	1.505	1.867	2.829	4.305

Treatments means followed by common letter (s) within column are not significant among each other based on DMRT at 5% level of significance. Abbreviations DAS=Days after sowing, SEM= Standard Error of Mean, LSD = Least Significance Difference and CV = Coefficient of Variation

Number of leaves

The table 3 shows the effect of different levels of NPK on number of leaves of okra. Number of leaves was found to be non-significant among all treatments at all DAS. However, the highest no. of leaves was observed in 220:200:60 NPK $Kgha^{-1}$having the highest dose of nitrogen past 65 DAS up to final harvest this is because nitrogen seems to increase vegetative growth which resulted in formation of new leaves (Bin-Ishaq, 2009 &Ghoneim, 2000).

Table 3. Effect of different levels of NPK on number of leaves of okra at Paklihawa, Rupandehi during 2017

Treatments N:P:K level (Kg/ha)	35DAS	45DAS	55DAS	65DAS	95DAS	125DAS
220:200:60(T1)	6.8^{a}	11.4^{a}	20.87^{a}	31.87^{a}	60.47^{a}	42.73^{a}
200: 180:60(T2)	6.467^{a}	11.07^{a}	19.33^{a}	30.87^{a}	55.8^{ab}	35.67^{a}
180:160:40 (T3)	7.467^{a}	11.6^{a}	21.6^{a}	31.6^{a}	55.33^{ab}	31.4^{ab}
160:140:40(T4)	6.867^{a}	11.8^{a}	20.67^{a}	30.13^{a}	53.73^{ab}	35.27^{ab}

140:120:20 (T5)	6.4[a]	10.8[a]	20.2[a]	31.4[a]	60.07[a]	38.87[a]
120:100:20(T6)	6.867[a]	10.6[a]	20.33[a]	30.53[a]	47.6[ab]	30.67[ab]
Control(T7)	6.333[a]	10.53[a]	19.53[a]	28.2[a]	41.47[b]	20.13[b]
Sem±	0.42	0.7809	1.656	2.4502	5.6579	5.0024
LSD (P=0.05)	1.294	2.406	5.103	7.55	17.43	15.41
CV%	10.79	12.17	14.09	13.84	18.32	25.84
Grand Mean	6.743	11.114	20.362	30.657	53.495	33.533

Treatments means followed by common letter (s) within column are not significant among each other based on DMRT at 5% level of significance. Abbreviations DAS=Days after sowing, SEM= Standard Error of Mean, LSD = Least Significance Difference and CV = Coefficient of Variation

Fruit characteristics and yield

Data regarding number of fruits per plant gave significant results for the different levels of NPK and the mean values of the treatments differed statistically from each other(Table 4). The maximum number of fruits was observed in 160:140:40 NPK Kg ha^{-1} (43.7) which has significant effect on number of fruits per plant than control, NPK level of 120:100:20 Kg ha^{-1}, NPK level of 180:160:40 Kg ha^{-1}. This implies that the highest level of NPK doesn't gives the maximum no. of fruits/plant which is because the high level of nitrogen cause longer vegetative phase reducing the reproductive phase (Tremblay, 1989).

Moniruzzaman *et al.* (2007) found that fruit diameter is one of the important criteria which is associated with the yield of okra. Pod size; bigger pods and longer pods are mostly preferred and gains high market value in the market. The application of different levels of NPK showed significant effect on fruit diameter. Result indicated that maximum fruit diameter (1.633 cm) was obtained from the application of 180:160:40 NPK level which is significantly higher than control. However, the application of different levels of NPK showed no significant differences on the length of fruits per plant.

The result of average marketable yield of okra shows non- significant result among all the treatments, whereas it is found to be significant over the control. The highest yield (40.64 Mt/ha) was recorded in 160:140:40 NPK Kg ha^{-1} followed by 180:160:40 NPK Kg ha^{-1} (39.03 Mt/ha) and the least in control (27.18 Mt/ha). Similarly, the result of the total fruit yield of okra is shown as being influenced by different combinations of NPK levels (Table 4). The highest yield (43.21 Mt/Ha) was obtained from 160:140:40 NPK Kg ha^{-1} which was significantly different than the control but non-significant among the rest of the five treatments. The differences of the yield among the different levels of NPK were attributable to the differences in the numbers of fruits per plant. As, the numbers of fruits were higher in the plant treated with 160:140:40 NPK Kg ha^{-1}, the fruit yield was also higher in those plants. The combined effect of NPK level for the increase of yield of okra in the experiment was found consistent with the findings of Ahmed and Tullock-Reid (1986) and Philip *et al.* (2010).

Table 4: Effect of different levels of NPK on average fruit diameter and fruit length of okra at Paklihawa, Rupandehi during 2017

Treatments N:P:K level (Kg/ha)	Average no of fruits/plant	Average Fruit diameter	Average Fruit length	Average Marketable Yield(Mt./ha)	Total Yield(Mt./ha)
220:200:60(T1)	41.27^{ab}	1.515^{b}	13.13^{a}	36.59^{a}	40.01^{a}
200: 180:60(T2)	41.73^{ab}	1.527^{b}	13.64^{a}	38.34^{a}	41.71^{a}
180:160:40(T3)	41.17^{b}	1.633^{a}	12.97^{a}	39.03^{a}	41.44^{a}
160:140:40(T4)	43.7^{a}	1.504^{b}	13.48^{a}	40.64^{a}	43.21^{a}
140:120:20(T5)	41.17^{ab}	1.52^{b}	13.49^{a}	37.98^{a}	40.91^{a}
120:100:20(T6)	39.57^{b}	1.518^{b}	13.24^{a}	36.82^{a}	39.53^{a}
Control(T7)	32.1^{c}	1.467^{b}	13.11^{a}	27.18^{b}	29.4^{b}
Sem±	2.0084	0.0244	0.251	1.9299	2.3874
LSD (P=0.05)	2.521	0.07956	0.7734	5.946	7.356
CV%	8.66	2.77	3.27	9.12	10.48
Grand Mean	40.157	1.526	13.295	36.653	39.459

Treatments means followed by common letter (s) within column are not significant among each other based on DMRT at 5% level of significance. Abbreviations DAS=Days after sowing, SEM= Standard Error of Mean, LSD = Least Significance Difference and CV = Coefficient of Variation

CONCLUSION

Thus, based on the overall performance of treatments on completion of the research work on effect of different level of NPK in growth and yield of okra, it was found that in treatment of 220:200:60 NPK Kg ha^{-1} showed higher vegetative growth. Although, highest yield of okra was obtained at 160:140:40 NPK Kg ha^{-1}, the result has shown that the use of NPK levels of 120:100:20Kg ha^{-1}for okra cultivation is likely to be appropriate under Paklihawa and similar agro domain of Rupandehi and Terai condition than the use of higher dose of NPK levels.

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