Original Research Article

Response of Organic and Inorganic sources of nutrients on Growth and Yield of Okra (*Abelmoschus esculentus* L. Moench) in Bihar

1.

Abstract

Aims: To assess the effect of integrated and sole applications of organic and inorganic fertilizers on thegrowth, yieldandyieldattributes ofokra in okra- cabbage-bottle gourd crop sequence.

Study design: The experiment consists of seven treatments*viz.*,T_1-100%NPK through inorganic fertilizers (IFs) 120, 60 and 40 Kg N, P_2O_5 and K_2O); T_2-50%NPK through IFs+50%N through farm yard manure (FYM); T_3-50% N through FYM+50% N through vermicompost (VC); T_4-1/3 of N each through FYM + VC + neem cake (NC); T_5-50% N through FYM + PSB + azotobactor; T_6-50% N through FYM+50% N through VC+PSB + azotobactor and T_7-1/3 of N each through FYM + VC + NC +PSB + azotobactor. These seven treatments were replicated thrice in Randomized Block Design.

Place and duration of study: This experiment was conducted at Nalanda College of Horticulture, Noorsarai, Nalanda ((25.269606 °N, 85.457869 °E) Bihar India, during *Kharif*2016 and 2017.

Results: Resultsrevealedthatrecommendeddoseoffertilizer(120:60:40)recordedsignificantlyhighestplantheight (51.45cm, 128.35 cm, and 165.25 cm) at 30, 60 and 90 days after sowing respectively, over rest of the treatment but found at par with T_6-50% N as FYM+50% N as VC+ biofertilizerat 60 and 90DAS. Numberoffruitsperplantandyieldalsodifferedsignificantly.T_1-Recommended dose of fertilizer recorded significantly more number of fruits over T_5, T_6 and T_7, but found at parwith T_2 T_3 and T_4. RDF recorded significantly higher yield over rest of the treatment but was at par with50%NPKthrough IFs+50%NthroughFYM.

Conclusion: On the basis of this two years results, it has been concluded that the best strategy for producing okra in a sustainable manner is integrated use of inorganic fertilizers and manures as T2 (50% NPK through IFs and 50% nitrogen through FYM).

Keywords:Okra,FYM,vermicompost,neemcake,azotobactor, PSB, organic, inorganic, integrated

Introduction

Lady's finger or Okra (*Abelmoschus esculentus* (L.) Moench) is a popular and extensively consumed vegetable that is high in unsaturated fatty acids and essential nutrients. Tightly packed with economic potential, this tropical crop is grown in tropical and subtropical locations worldwide (**Ibitoye and Kolawole, 2022; Udpuay et al., 2024**). Okra is cultivated commercially for the seed pod, which is harvested before it matures and is still tender. Okra has a high amount of bioactive substances like flavonoids and is a rich source of dietary fibers, polysaccharides, minerals (potassium, calcium, phosphorus, and magnesium), and vitamins (as well as vitamins A, K, C, and B_9) (**Romdhane et al., 2020**). However, today's uncontrolled use of synthetic fertilizers and pesticides is degrading the quality of agricultural products. Nonetheless, pesticides are crucial to the production of food. Crops are protected from insects, weeds, fungi, and other pests by the use of pesticides. Pesticides have the potential to be hazardous to humans and, depending on how much and how they are exposed, can have both short-term and long-term health consequences. The exclusive use of inorganic fertilizers in intensive agriculture has proven detrimental due to accelerated soil degradation, including organic matter loss leading to soil acidity, nutrient imbalances, and reduced crop yields. In contrast, nutrients from organic manures are released slowly and remain in the soil longer, ensuring a sustained residual effect. Many countries have adopted the practice of combining organic manures with mineral fertilizers, which has been shown to effectively manage soil fertility. Achieving high and consistent crop yields often involves judicious application of balanced NPK fertilization alongside organic amendments.Considering above, the prudent management of resources and the conservation of soil in intensive cropping systems have become critical areas of agronomic research. Consequently, this study aimed to compare the effects of using organic and inorganic fertilizers alone versus their complementary application on the growth and yield of okra.

MaterialsandMethods

Experimental Site and Soil

This experiment was carried out in the *kharif*of 2016–2017 at the Research Farm of Nalanda College of Horticulture Noorsarai (25.269606 °N, 85.457869 °E) in Nalanda, Bihar. Nalanda College of Horticulture falls under Zone III (B) of Bihar (Middle Gangetic Plain of India).Okra is one of the mandates of Nalanda College of Horticulture, Noorsarai (NCOH), Nalanda Bihar. The soil in the experimental plot was a clay loam with available N, P, and K contents of 262 kg, 14.60 kg, and 142 kg ha^{-1}, respectively, with a pH of 7.47, 0.21 EC (dSm^{-1}), and 0.62 % soil organic carbon. The Walkley and Black method [**Walkley and Black 1934**] was used to determine organic matter, while the glass electrode pH meter method [**Jackson, 1973**] was used to measure the pH of the soil (1:2.5 soil: water). The Olsen method [**Olsen et al., 1954**] was used to determine available P, and the semi-micro Kjeldahl method [**Bremner and Mulvaney 1982**] was used to determine the level of total N. After extraction with 1 N NH4OAc at pH 7, the exchangeable K was measured using a flame photometer [**Knudsen et al., 1982**]. The available S was calculated by extracting soil samples with a CaCl2 solution (0.15%) and then measuring the turbidity using a spectrophotometer [Williams and Steinbergs, 1959].

Experimental Details

The experiment consists of seven treatments *viz.*,T_1-100%NPK through inorganic fertilizers (IFs) 120:60 and 40 Kg N: P_2O_5 and K_2Oha^{-1}); T_2-50%NPK through IFs+50%N through farm yard manure (FYM); T_3-50% N through FYM+50% N through vermicompost (VC); T_4-1/3 of N each through FYM + VC + Neemcake (NC); T_5-50% N through FYM + PSB + azotobacter; T_6-50% N through FYM+50% N through VC;+PSB + azotobacter and T_7-1/3 of N each through FYM + VC + NC+PSB + azotobacter. Vermicompost (having 1.21%N, 0.61**%** $P_2O_5$and 0.91**%** K_2O) and farm yard manure (having 0.45%N, 0.23**%** P_2O_5and0.42**%**K_2O) were produced at college's farm and neem cake were purchased from the market (having 4.91%N, 1.0**%** P_2O_5 and 1.21**%** K_2O). These seven treatments were replicated thrice in Randomized Block Design (RBD) having 15 square meters plot size. Among inorganic sources, urea, diamonium phosphate (DAP) and muriate of potash (MOP) were used while, well rotten farm yard manure (FYM), vermicompost (VC), neem cake (NC) and biofertilizers (15 ml per plot of 15 m^2) namely azotobacter and PSB were applied as per treatments.

Agronomic practices

Recommended agronomical package of practices were followed excluding fertilizers and manures. Organic fertilizers were applied infield 10 days before sowing. It was uniformly spread in the plots and incorporated into the soil manually. Irrigation was given as per crop demand. Weeding was done manually at 25 days after sowing. Harvesting of matured fruit started as they attain maturity in each experimental plot on treatment basis, and observations such as plant height, number of branches and number of fruits, fruit weight per plot and yield per hectare were measured. After harvesting, soil samples were taken from each plot for routine laboratory analysis. Soil pH and EC (described by **Chopra and Kanwar, 1982**), organic carbon determined by Walkley and Black's rapid titration method (**Jackson, 1973**). The determination of available nitrogen was done by alkaline permanganate method (**Subbiah and Asija, 1956**), available phosphorus by Olsen's (1954) method (as described Houba*et al.,* 1988), and potassium by flame photometer described by Jackson(1973). The data collected on different aspect of experimentation, were analyzed with the analysis of variance technique given by Gomez and Gomez (1984). Economics of the treatments had been calculated on the local market price of the crop produce and the materials used.T_1-100%NPK through inorganic fertilizers (IFs) 120, 60 and 40 Kg N, P_2O_5 and K_2O); T_2-50%NPK through IFs+50%N through farm yard manure (FYM); T_3-50% N through

FYM+50% N through vermicompost (VC); T_4-1/3 of N each through FYM + VC + neem cake (NC); T_5-50% N through FYM + PSB + azotobacter; T_6-50% N through FYM+50% N through VC+PSB + azotobacter and T_7-1/3 of N each through FYM + VC + NC +PSB + azotobacter.

Results and Discussion

Plant growth

The effect of fertility levels was noticed on various growth parameters. Plantheight(Table1)differedsignificantlyduetodifferentfertilizertreatments.Amongallthetreatments,T_1-100%NPK through inorganic fertilizersrecorded highest plant height(51.45, 128.35 and 165.25 cm)at30,60and90daysaftersowingrespectivelyandwassignificantly tallerthan rest of the treatmentsexcept T_6(110.15 and 150.10 cm) at 60 and 90daysaftersowing.At60and 90 daysaftersowingT_1recordedsignificantlytallplant over all the treatments. This may be attributed to the fastsupplyandavailabilityofnutrientsofmineral fertilizers applied in split doses thatcausedmorevegetativegrowth.These findings are in close agreement with those of Sachan*et al.*,(2017).There were no significant difference were found in numberofbranches. However, highestnumber of branches were recordedinT_1 (3.70, 6.70 and 7.70) at 30, 60 and 90 daysaftersowing respectively.Although, it was observed that the number of branches varied from plant to plant within the plot, regardless of changes in fertilizer doses.ApositiveeffectoforganicfertilizeronvegetativegrowthwasreportedbyKumar *et al.*, (2022).

Yieldattributesandyield

With the adequate nutrient application the nutrient supplying capacity of soil to plants increases. It is obvious from the data that the various organic and inorganic treatments markedly influenced the yield attributing characters of Okra. The highest number of fruits (Table 2)was found in T_1 (6.95 and 20.25) at 60 and 90daysaftersowing respectively,whichwassignificantlyhigheroverT$_7$(having 4.75 fruits per plant)andfoundatparwithrestoftheorganictreatments at 60 daysaftersowing.While, at90 days after sowing T_1 become significantoverT_3-50%NasFYM+50%NasVC,T_4-1/3of Neach through FYM+VC+NC, T_5-50% NthroughFYM+biofertilizersandT_7-T4+biofertilizersbutfoundatparwithT_2-50%NPKasMF+50%NasFYM.Thefruityield per hectare also recorded highest in T_1 (245 q ha^{-1})which was statistically at par with T_2-50%NPKasIfs+50%NasFYM(216.80 q ha^{-1}). Yield recorded in the organictreatmentsweresignificantly lower than the T_1 and are at par with each other.The application of organic manure may have led to a slow release of nutrients, which could have resulted in reduced plant growth (Kaur *et al*, 2021). The increase in yield in T_2 (50% NPK as IFs + 50% N as FYM) can be attributed to the solubilization of plant nutrients from the added FYM, which enhanced the uptake of NPK(Pawar et al., 2020). In this experiment also Fig. 1 clearly indicated that the T_6 having 100 % organic sources found statistically at par with integrated sources of nutrients in terms of plant height, number of fruit at 90 days after sowing and finally yield of okra. Additionally, FYM likely improved the soil's nutrient status and water-holding capacity. The importance of organic manuring in promoting sustainable agriculture is well recognized (Sagar *et al*, 2018).

Economics

Economic studies have also been performed (Table 2) which was found highly variable due to different fertilizers and manure sources. Cost of organic manures estimated more as compared to inorganic sources of fertilizers, consequently cost of cultivation in organically treated plots observed relatively high. Results revealed that highest gross return (lakh ha^{-1}), net return (lakh ha^{-1}) and B:C ratio was recorded in T_1-100 % inorganic fertilizer sources (Rs. 1.97, Rs. 1.57 and 3.99 respectively, followed by T_2-50%NPK through inorganic fertilizer +50%N through FYM (Rs. 1.73, Rs. 1.29 and 2.88). Among 100% organics, T_6-50% N through FYM and 50% N through VC +biofertilizers (PSB and azotobactor) recorded highest gross return (Rs 1.48 lakh ha^{-1}), net return (0.92lakh ha^{-1}) and benefit: cost ratio (1.65). Since all of the manures utilized in this experiment were bought from the local market, the lowest cost of inorganic fertilizers relative to organic manures may have contributed to the highest net return, which was seen in T_1 and T_2. The reason for the low B:C ratio in organically treated plots is the higher cost of organic manures bought from the nearby market and the similar selling price of products produced organically compared to those produced in inorganically treated plots.

Conclusion

The findings showed that, of all the treatments examined, 50% NPK through IFs and 50% nitrogen through FYM exhibited vegetative growth, yield attributes, and okra yield statistically comparable to 100% IFs. Thus, it has been concluded that the best strategy for producing okra in a sustainable manner is integrated use of inorganic fertilizers and manures as T2 (50% NPK through IFs and 50% nitrogen through FYM). Although this study has only lasted two years, but Fig. 1 suggests that okra may performed best when grown entirely organically in the long run as observed in T_6.

Table 1: Effect of Organic and inorganic nutrient application on Plant height and number of branches of Okra						
Treatments	**Plant height**			**No of branches**		
	30DAS	**60DAS**	**90DAS**	**30DAS**	**60DAS**	**90DAS**
T_1-100%NPK through inorganic fertilizers (IFs)	51.45	128.35	165.25	3.70	6.70	7.70
T_2-50%NPK through IFs+50%N through farm yard manure (FYM)	41.80	108.65	143.30	2.50	6.50	6.55
T_3-50% N through FYM+50% N through vermicompost (VC)	42.40	108.55	134.35	2.95	6.40	7.05
T_4-1/3 of N each through FYM + VC + neem cake (NC)	42.45	105.75	132.35	2.75	6.45	7.00
T_5-50% N through FYM + PSB + azotobactor	38.75	102.65	130.10	2.80	5.80	6.70
T_6-50% N through FYM+50% N through VC+PSB + azotobactor	41.35	110.15	150.10	2.50	5.90	6.80
T_7-1/3 of N each through FYM + VC + NC +PSB + azotobactor.	39.70	108.40	131.60	2.85	5.85	6.60
SEm±	2.65	6.00	10.00	0.45	0.90	0.80
C D (P= 0.05)	5.75	13.05	21.75	0.95	1.95	1.75

Table 2. Effect of Organic and inorganic nutrient application on number of fruits, yield and economics						
Treatments	**Number of fruits per plant**		**Yield (q ha^{-1})**	**Gross return**	**Net return**	**Benefit: cost Ratio**
	60DAS	**90DAS**				
T_1-100%NPK through inorganic fertilizers (IFs)	6.95	20.25	245.85	1.97	1.57	3.99
T_2-50%NPK through IFs+50%N through farm yard manure (FYM)	5.80	19.35	216.80	1.73	1.29	2.88
T_3-50% N through FYM+50% N through vermicompost (VC)	5.85	16.50	179.65	1.44	0.91	1.72
T_4-1/3 of N each through FYM + VC + neem cake (NC)	5.80	15.45	166.25	1.33	0.82	1.58
T_5-50% N through FYM + PSB + azotobactor	5.00	11.65	114.85	0.92	0.47	1.04
T_6-50% N through FYM+50% N through VC+PSB + azotobactor	6.05	16.70	184.95	1.48	0.92	1.65
T_7-1/3 of N each through FYM + VC + NC +PSB + azotobactor.	4.75	15.30	166.60	1.33	0.79	1.44
SEm±	0.80	1.70	25.65			
C D (P= 0.05)	1.75	3.65	55.90			

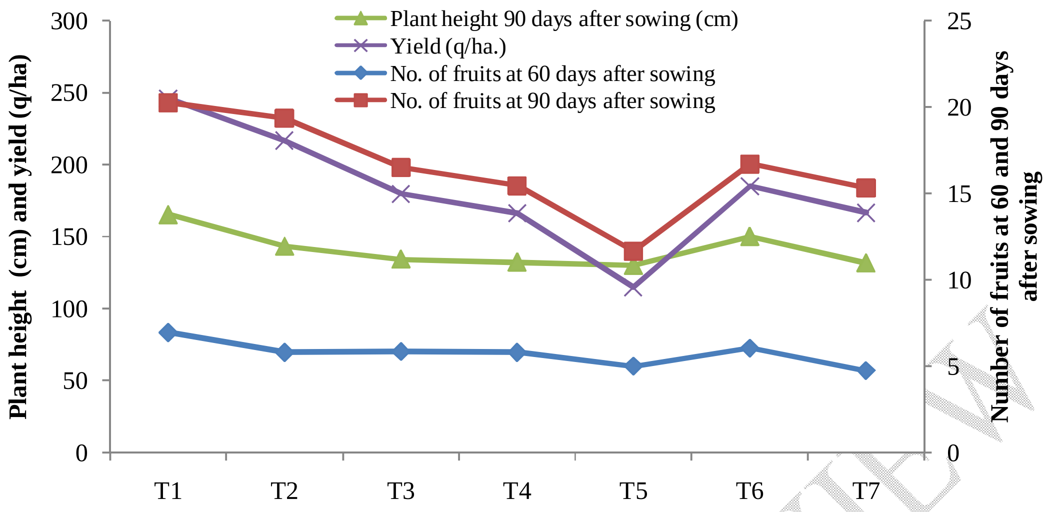

Fig.1 Graphical representation of response of organic and inorganic sources of nutrients on growth and yield of okra.

References

Bairwa HL, Mahawer LN, Shukla AK, Kaushik RA, Mathur SR. Response of integrated nutrient management on growth, yield and quality of okra. Indian J. Agril. Sci.; 2009: 79(5):381-384.

Bremner JM, Mulvaney CS (1982) Nitrogen-total. In: Page AL, Miller RH, Keeney DR (eds) Methods of soil analysis: part 2. American Society of Agronomy, Inc., Madison, pp 595–624

Chopra SL and Kanwar JS. 1982. Analytical Agricultural Chemistry,Kalyani Publishers, New Delhi.

Houba VJG, Vanderlee JJ, NovoZamsky I and Walinga I. 1988. Soilanalysis procedure, part 5, Wageningen Agric. University, TheNetherlands.

Ibitoye DO, Kolawole AO. Farmers' Appraisal on Okra [Abelmoschus esculentus (L.)] Production and Phenotypic Characterization: A Synergistic Approach for Improvement. Front Plant Sci. 2022 Mar 24;13:787577. doi: 10.3389/fpls.2022.787577. PMID: 35401647; PMCID: PMC8988028.

Jackson ML (1973) Soil chemical analysis. Prentice Hall of India Pvt. Ltd., New Delhi, pp 69–182

Kaur K, Singh N, Maurya V, Sharma A, Kumar R. Integrated Nutrient Management in Okra [*Abelmoschus esculentus* (L.) Moench]using Bio-fertilizers, Biological Forum – An International Journal 2021;13(4): 116-122

Kumar A, Choudhary A.S, Shani Raj, Ghode N, Kumar A. Effect of nutrient management on yield parameters of okra, International Journal of Agriculture and Plant Science. 2022; 4(1): 30-34

Mishra TD, Singh SK, Chaurasia SNS, Kemaria P and Singh TB. Effect of vermicompost and bio fertilizers on okra (Abelmoschus esculentus (L.) Moench) under graded dose of nitrogen and phosphorus. New Agriculturist. 2009; 20(1-2):9-13

Olsen SR, Cole CU, Watanabe FS, Dean LA (1954) Estimation of available phosphorus in soil by extraction with sodium bicarbonate. Circular No. 939, USDA, Washington

Pawar R, Kumar A, Sepehya S, Singh SP. Yield and Nutrient Uptake by Okra (Abelmoschus esculentus L.) as influenced by Integrated Nutrient Management, Int.J.Curr.Microbiol.App.Sci, Special Issue 2020; 11: 2128-2137

Romdhane MH, Chahdoura H, Barros L, Dias MI, Carvalho Gomes Corrêa R, Morales P, Ciudad-Mulero MFH, Flamini GCFR, Majdoub H, Ferreira ICFR. Chemical Composition, Nutritional Value, and Biological Evaluation of Tunisian Okra Pods (*Abelmoschus esculentus* L. Moench). Molecules. 2020 Oct 15;25(20):4739. doi: 10.3390/molecules25204739. PMID: 33076530; PMCID: PMC7587556.

Sachan S, Singh D, Kasera S, Mishra S, Tripathi Y, Mishra V, and Singh R. Integrated Nutrient Management (INM) in Okra (Abelmoschus esculentus (L.) Moench) for Better Growth and Higher Yield, Journal of Pharmacognosy and Phytochemistry2017; 6(5): 1854-1856

Sagar V, and Bala S. Effect of Integrated Nutrient Management on growth and quality characters of Okra (Abelmoschus esculentus (L.) Moench cultivar Kashi Mohini (VRO-3)", Chem Sci Rev Lett.2018;7(28), 1005-1011

Singh S, Sekhon H. S, Harpreeth, K. Effect of farmyard manure, vermicompost and chemical nutrients on growth and yields of chickpea (Cicer arietinum L.). Int. J. Agric. Res., 2012; 7 (2) : 93 – 99

Singh VB, and Tiwari AK. Effect of integrated nutrient management (INM) on physico-chemical properties of soil, available content and nutrient uptake by okra (Abelmoschus esculentus). International Journal of Current Microbiology and Applied Sciences. 2019; 8: 130-37.

Subbiah BV and Asija CL. 1956. A rapid procedure for the estimationof available nitrogen in soil. Current Sci. 25: 258-260

Tripathy P, Maity TK. Impact of Integrated nutrient management on fruit quality and yield of okra hybrids. Crop Research Hisar.; 2009; 37(1/3):101-106

Udpuay S, Hayat Ullah, Himanshu SK,Tisarum R,Praseartkul P et al., Effects of microbial biofertilizer on growth, physio-biochemical traits, fruit yield, and water productivity of okra under drought stress, Biocatalysis and Agricultural Biotechnology 2024; 58; 103125, ISSN 1878-8181, https://doi.org/10.1016/j.bcab.2024.103125.

Vishwajith, Devakumar N. Effect of Organic Nutrient Management on Growth and Yield of Okra (Abelmoschus esculentus L.) Mysore J. Agric. Sci., 2018. 52 (3) : 519-528

Walkey AJ, Black AI. Estimation of organic carbon by chromic acid titration method. J Soil Sci 1934; 25:259–260

Williams CH, Steinbergs A. Soil sulphur fractions as chemical indices of available sulphur in some Australian soils. Aust J Agric Res.1959; 10:340–352