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A Comparative Study of Spacing and Integrated Nutrient Management on Growth, Yield and Economics of Okra

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was conducted at Horticultural Experimental Farm, B.A.C.A., Anand Agricultural University, Anand in *kharif* during 2022 and 2023. Ensuring balanced plant nutrients and spacing is essential for achieving optimal okra production. Optimal plant density supports uniform and healthy growth by effectively utilizing moisture, nutrients, and light, thereby maximizing okra yield. Single source of nutrients whether chemical fertilizers, organic manures or biofertilizers that cannot improve production, productivity and soil health. Sowing okra at 60 × 30 cm spacing observed better leaf area (433.06 and 568.01 cm^2) and number of nodes per plant (15.57 and 23.46) at 60 and 90 DAS. While, maximum yield per plot (9.20 kg) and yield per hectare (14.19 t) was found in 45 × 30 cm spacing. Application of 25% RDF + 50% RDN through Vermicompost + NPK consortium 1L/ha recorded maximum yield per plot (9.41 kg) and yield per hectare (15.33 t). With respect to treatment combinations, sowing of okra at 60 × 30 cm spacing with application of

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25% RDF + 50% RDN through Vermicompost + NPK consortium 1L/ha recorded the highest leaf area (458.88 and 598.27 cm^2) at 60 and 90 DAS. However, maximum yield per plot (10.45 kg) and yield per hectare (16.13 t) was found in 45 × 30 cm spacing with application of 25% RDF + 50% RDN through Vermicompost + NPK consortium 1L/ha. On economic point of view, maximum net realization (218555.21 ₹/ha) and BCR (2.11) was obtained in 45 × 30 cm spacing with application of 25% RDF + 50% RDN through FYM + NPK consortium 1L/ha.

Keywords: Integrated nutrient management; consortium; spacing; economics; Okra.

1. INTRODUCTION

Okra (*Abelmoschus esculentus* (L.) Moench) is a significant vegetable crop cultivated in our country which belonging to Malvaceae. Originated from Africa, its chromosome number is 2n=130. Achieving high production of okra requires specific care. Various factors can lead to lower yields, including the use of low-yielding varieties, poor plant density, incorrect planting dates, inadequate soil fertility, inappropriate fertilizer use, and infestations of insect pests and weeds. Among these factors, proper plant nutrients and spacing are crucial for optimal okra production [1]. Incorrect spacing can result in overcrowded or sparse populations that reducing yield of okra. Optimal plant density promotes uniform and healthy growth by efficiently utilizing moisture, nutrients and light, leading to maximum. The excessive use of chemical fertilizers poses serious threats to soil health, the environment and human health. Conversely, relying solely on organic fertilizers and biofertilizers is not feasible due to their lower nutrient content, making them better suited as supplements rather than substitutes. Therefore, using a single source of nutrients whether chemical fertilizers, organic manures or biofertilizers that cannot adequately improve production, productivity and soil health. Hence, integrated nutrient management is the best option to maximize returns and ensure sustainable production of okra.

2. MATERIALS AND METHODS

Field experiments were conducted at the Horticultural Experimental Farm, B.A.C.A., Anand Agricultural University, Anand during the second week of July in 2022 and the first week of July in 2023. The experimental field's soil was sandy loam with a 7.36 pH, 0.31% organic matter, 0.24 dSm^{-1} EC, 180.03 kg ha^{-1} available nitrogen, 28.24 kg ha^{-1} available phosphorus and 191.83 kg ha^{-1} available potassium. The experiment was laid out in Randomized Block Design (Factorial) with three replications and fourteen treatment combinations comprising of two levels of spacing (S_1: 60 × 30 cm and S_2: 45 × 30 cm) and seven level of integrated nutrient management *viz.,* F_1: 10 t/ha + 100:50:50 kg/ha (RDF control), F_2: 75% RDF + 25% RDN through FYM, F_3: 75% RDF + 25% RDN through Vermicompost, F_4: 50% RDF + 50% RDN through FYM, F_5: 50% RDF + 50% RDN through Vermicompost, F_6: 25% RDF + 50% RDN through FYM + NPK consortium 1L/ha and F_7: 25% RDF + 50% RDN through Vermicompost + NPK consortium 1L/ha. The nutrient content of the organic manures, were 0.50% nitrogen in FYM and 1.20% nitrogen in vermicompost. Okra cv. Anand Komal was planted in plots measuring 3.6 × 3.0 m. All organic manures, along with half the dose of nitrogen and the full doses of phosphorus and potassium were incorporated into the soil during field preparation. Additionally, biofertilizer was applied according to the treatments, both as a seed treatment and as a drench at 45 DAS.

Observations on growth, yield and quality parameters were made from five tagged plants. The total number of green pods harvested from these plants was counted during each picking. The number of fruits per plant was calculated by summing the number of pods from all pickings and averaging the total. The weight of all harvested pods from each net plot during each picking was summed and converted into tonnes per hectare. Quality parameters, including mucilage, ascorbic acid and chlorophyll content, were measured at the fourth picking. Five pods per treatment were randomly selected for biochemical parameter observations. The pooled analysis, conducted according to Panse and Sukhatme [2], examined the average effect of various treatments over time.

3. RESULTS AND DISCUSSION

3.1 A Comparative Study of Spacing and Integrated Nutrient Management on Growth

The data pertaining to the effect of spacing was significantly affected with regards to leaf area and number of nodes per plant in pooled analysis (Table 1). The plant growth in terms of maximum leaf area (433.06 and 568.01 cm^2) and number of nodes per plant (15.57 and 23.46) at 60 and 90 DAS were observed maximum with spacing S_1 in pooled analysis. All the growth parameters were recorded minimum under Spacing S_2. The wider spacing gave better results might be due to wider spacing recorded the maximum availability of nutrient as well as less competition for resources that allow more accumulation of photosynthates that directly influenced the leaf area of okra leaves as well as reduces the internodal length by increasing the lateral branches that increased the number of nodes. Similar results were also reported by Morwal and Patel [3] and Gbaraneh [4] in okra.

The data regarding leaf area and number of nodes as influenced by integrated nutrient management was found significant in pooled analysis. Maximum plant growth parameters in terms of leaf area (458.88 and 598.27 cm^2) and number of nodes per plant (16.27 and 24.63) at 60 and 90 DAS was observed with treatment T_7 which was found statistically at par with T_6 and T_1 in pooled data. Whereas, minimum growth parameters were registered in treatment T_4 in pooled data. It might be due to application of inorganic fertilizer and vermicompost with NPK consortium increased the nutrient availability that allow plants to increased vegetative growth by formation of more number of branches that reduce the internodal length that increased the number of nodes as well as increase more cell division and expansion of cell in this treatment which stimulate the growth of plant resulted in higher leaf area. Similar results found by Smriti and Ram [5] and Yadav et al. [6] in okra.

Interaction effect of spacing and integrated nutrient management on number of nodes per plant was found non-significant while, leaf area was observed significant results in pooled result (Fig. 1). Maximum leaf area (461.88 and 603.56 cm^2) at 60 and 90 DAS were observed with S_1T_7 which was at par with S_1T_6, S_2T_7, S_2T_1, S_1T_1, S_1T_5 and S_2T_3 in pooled analysis. While, minimum leaf area (341.58 and 448.45 cm^2) at 60 and 90 DAS were recorded with S_2T_4. It might be due to wider spacing allowed sufficient light and nutrients due to less competition between plants as well as treatment of INM *i.e*. inorganic nutrient, vermicompost and NPK consortium that supply all macro and micro elements and also enhanced their available forms and growth promoting substance which might be increased cell division and expansion resulted in higher leaf area [7]. Similar result was also obtained by Gbaraneh [4] in okra.

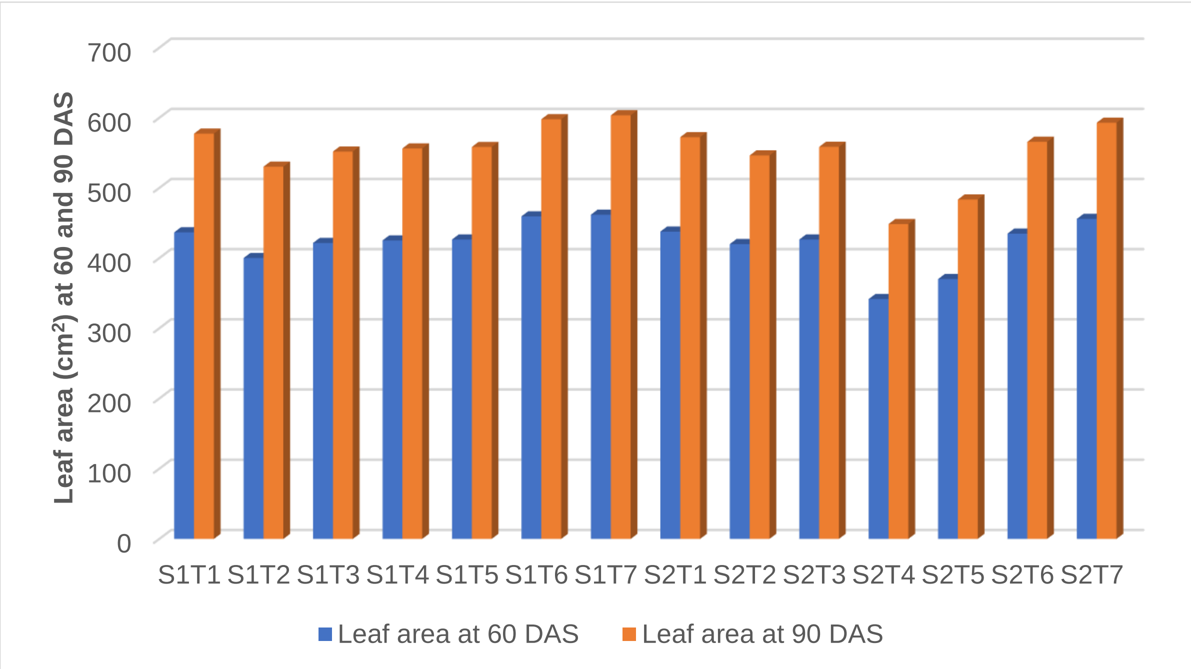

Fig. 1. A comparative study of spacing and integrated nutrient management on leaf area of okra at 60and 90 DAS

Table 1. A comparative study of spacing and integrated nutrient management on growth of okra (Two years pooled data)

Application of INM (T)	Leaf area (cm^2)						Number of nodes per plant					
	60 DAS			90 DAS			60 DAS			90 DAS		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	436.75	437.73	437.24	577.52	572.39	574.95	16.03	15.40	15.72	24.20	23.07	23.63
T_2	400.10	419.97	410.03	530.31	546.37	538.34	15.23	14.60	14.92	22.83	21.93	22.38
T_3	421.59	426.46	424.03	551.89	558.65	555.27	15.50	14.97	15.23	23.43	22.60	23.02
T_4	425.14	341.58	383.36	556.33	448.45	502.39	14.53	13.80	14.17	21.83	20.50	21.17
T_5	426.50	370.11	398.30	558.42	483.56	520.99	14.80	14.07	14.43	22.20	20.97	21.58
T_6	459.45	434.88	447.16	598.02	565.79	581.90	16.30	15.63	15.97	24.57	23.67	24.12
T_7	461.88	455.88	458.88	603.56	592.98	598.27	16.57	15.97	16.27	25.17	24.10	24.63
Mean	433.06	412.37		568.01	538.31		15.57	14.92		23.46	22.40	
	S	**T**	**S × T**	**S**	**T**	**S × T**	**S**	**T**	**S × T**	**S**	**T**	**S × T**
S. Em.±	4.71	8.81	12.46	6.73	12.59	17.80	0.15	0.28	0.39	0.24	0.45	0.63
C. D at 5 %	13.37	25.01	35.37	19.11	35.74	50.55	0.42	0.79	NS	0.68	1.27	NS

3.2 A Comparative Study of Spacing and Integrated Nutrient Management on Yield of Okra

The data regarding day to 50% flowering and day to first picking as influenced by spacing was found non-significant in pooled analysis but found significant on yield in pooled analysis (Table 2). The plants gave higher yield per plot (9.20 kg), yield per hectare (14.19 t) with spacing S_2 in pooled analysis. Maximum yield parameters were found in closer spacing might be due to maximum plant population per unit area was obtained in closer spacing which resulted into maximum yield per hectare. Similar results were also found by Khanal et al. [1], Padhiyar et al. [8] and Vashi et al. [9] in okra.

The data regarding day to 50% flowering and day to first picking as influenced by spacing were found non-significant in pooled analysis but found significant on yield per plot and yield per hectare in pooled analysis. The plants yield parameters in terms of yield per plot (9.41 kg) and yield per hectare (15.33 t) were found maximum with treatment T_7. However, minimum yield parameters were observed with treatment T_4. Maximum yield parameters were observed under treatment T_7 might be due to increased availability of sufficient amount of nutrients present in soil and favour uptake of nutrient to increase metabolism, synthesis of carbohydrates and greater vegetative growth and pod yield per plant. Similar result was also found by Gurjar et al. [10], Magar et al. [11] and Narwariya et al. [12] in okra.

The data regarding days to 50% flowering and day to first picking as influence by interaction effect of spacing and INM were found non-significant but found significant on yield per plot and yield per hectare in pooled data (Fig. 2). Yield per plot (10.45 kg) and yield per hectare (16.13 t) were observed maximum in S_2T_7. It might be due to the combined effect of closer spacing that increased plant population as well as INM treatments supply all macro and micro nutrients to plants which ultimately enhanced the pod yield per hectare. These results were also found by Norman et al. [13], Khanal et al. [1], Vashi et al. [10], Magar et al. [11] and Narwariya et al. [12] in okra.

3.3 A Comparative Study of Spacing and Integrated Nutrient Management on economics of Okra Cultivation

The data regarding to cost of cultivation for different treatments depicted in Table 3. Maximum gross realization 3,22,600 ₹ per hectare was obtained in S_2T_7 while, maximum net realization 218555.21 ₹ per hectare and BCR of 2.11 was obtained in S_2T_6 (Fig. 3). However, minimum cost of treatment 15140.75 ₹ per hectare and total cost of cultivation 91202.02 ₹ per hectare were observed in treatment S_1T_2.

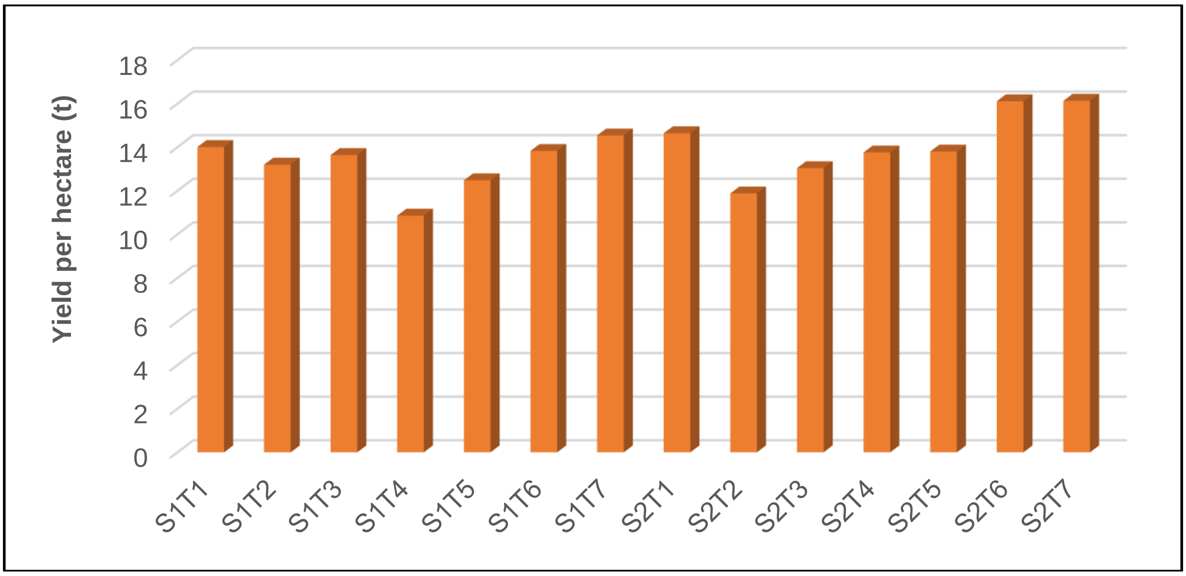

Fig. 2. A comparative study of spacing and integrated nutrient management on okra yield per hectare

Table 2. A comparative study of spacing and integrated nutrient management on yield of okra (Two years pooled data)

Application of INM (T)	Days to 50% flowering			Days to first picking			Yield per plot (kg)			Yield per hectare (t)		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
T_1	45.33	46.33	45.83	50.17	49.83	50.00	8.07	9.49	8.78	14.01	14.64	14.33
T_2	47.00	47.17	47.08	50.50	51.00	50.75	7.61	7.70	7.65	13.20	11.88	12.54
T_3	46.33	46.83	46.58	50.50	50.17	50.33	7.85	8.45	8.15	13.64	13.04	13.34
T_4	47.67	48.17	47.92	51.00	51.67	51.33	6.26	8.91	7.58	10.86	13.76	12.31
T_5	47.50	47.83	47.67	50.83	51.00	50.92	7.19	8.94	8.06	12.48	13.80	13.14
T_6	44.50	45.00	44.75	49.50	50.00	49.75	7.97	10.44	9.21	13.83	16.11	14.97
T_7	44.83	44.33	44.08	49.17	49.33	49.25	8.37	10.45	9.41	14.54	16.13	15.33
Mean	46.02	46.52		50.24	50.43		7.62	9.20		13.22	14.19	
	S	T	S × T	S	T	S × T	S	T	S × T	S	T	S × T
S. Em.±	0.57	1.07	1.51	0.67	1.26	1.78	0.14	0.27	0.38	0.23	0.43	0.61
C. D at 5 %	NS	NS	NS	NS	NS	NS	0.40	0.76	1.07	0.65	1.22	1.72

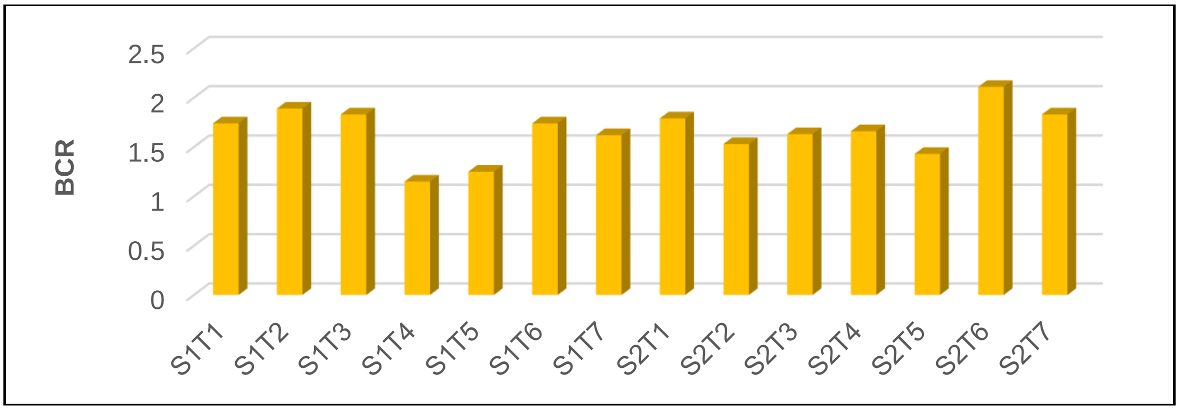

Fig. 3. A comparative study of spacing and integrated nutrient management on benefit: cost ratio of okra cultivation

Table 3. A comparative study of spacing and integrated nutrient management on economics of okra cultivation (Two years pooled data)

Treatment combination	Yield (kg/ha)	Gross realization (₹/ha)	Treatment cost (₹/ha)	Total cost of cultivation (₹/ha)	Net realization (₹/ha)	BCR
S_1T_1	14010	280200	24117.00	102153.04	178046.96	1.74
S_1T_2	13200	264000	15140.75	91202.02	172797.99	1.89
S_1T_3	13640	272800	19342.75	96328.46	176471.55	1.83
S_1T_4	10860	217200	23054.00	100856.18	116343.82	1.15
S_1T_5	12480	249600	31450.50	111099.91	138500.09	1.25
S_1T_6	13830	276600	23119.75	100936.40	175663.61	1.74
S_1T_7	14540	290800	31516.25	111180.13	179619.88	1.62
S_2T_1	14640	292800	26317.00	104837.04	187962.96	1.79
S_2T_2	11880	237600	17340.75	93886.02	143713.99	1.53
S_2T_3	13040	260800	21542.75	99012.46	161787.55	1.63
S_2T_4	13760	275200	25254.00	103540.18	171659.82	1.66
S_2T_5	13800	276000	33650.50	113783.91	162216.09	1.43
S_2T_6	16110	322200	25339.75	103644.80	218555.21	2.11
S_2T_7	16130	322600	33736.25	113888.53	208711.48	1.83

4. CONCLUSION

From the two years field study, it can be concluded that sowing of okra at 60 × 30 cm spacing with application of 25% RDF + 50% RDN through Vermicompost + NPK consortium 1L/ha recorded the leaf area and number of nodes per plant. However, maximum yield was found in 45 × 30 cm spacing with application of 25% RDF + 50% RDN through Vermicompost + NPK consortium 1L/ha, while quality parameter was not affected significantly. On economic point of view**,** maximum net realization ₹ 218555.21 per hectare and BCR of 2.11 was obtained in 45 × 30 cm spacing with application of 25% RDF + 50% RDN through FYM + NPK consortium_1L/ha.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Khanal S, Dutta JP, Yadav RK, Pant KN, Shrestha A, Joshi P. Response of okra [*Abelmoschus Esculentus* (L.) Moench] to

nitrogen dose and spacing on growth and yield under mulch condition, Chitwan, Nepal. Journal of International Water, Air & Soil conservation Society 2020;4(1):40-44.

2. Panse VG, Sukhatme PV. Statistical methods for Agricultural workers. 4th ed., ICAR, New Delhi; 1985.
3. Morwal BR, Patel MC. Growth and yield of okra (*Abelmoschus esculentus* L.) as affected by date of sowing and spacing under North Gujarat condition. Journal of Krishi Vigyan. 2017;6(1):93-96.
4. Gbaraneh LD. Effect of plant spacing and harvest interval on the growth, fruit quality and yield of okra (*Abelmoschus esculentus* L.) in port Hartcourt, Nigeria. International Journal of Earth Science. 2018; 4(4):18-28.
5. Smriti S, Ram RB. Effect of organic, inorganic and bio-fertilizers on biochemical aspects of "Kashi Pragati" a standard cultivar of okra [*Abelmoschus esculentus* (L.) Moench]. Journal of Entomology and Zoology Studies. 2018;6(4):262-264.
6. Yadav SL, Topno SE, Bahadur V, Prasad VM, Kerketta A. Effect of different organic manure and inorganic fertilizer on growth, yield and quality of okra (*Abelmoschus esculentus* L.). International Journal of Environment and Climate Change. 2023; 13(8):1990-1997.
7. Edwards CA, Arancon NQ and Sherman R. Vermiculture technology: earthworms, organic wastes, and environmental management. CRC press, Boca Raton, Florida; 2011.
8. Padhiyar D, Kanzaria DR, Senjaliya HJ, Vasava HV. Effect of different sowing time and planting distance on pod yield and quality of okra. The Pharma Innovation Journal. 2023;12(7):3155-3158.
9. Vashi JM, Patel AI, Intwala CG. Effect of different time of sowing and planting geometry on off season okra (*Abelmoschus esculentus* L.). The Pharma Innovation Journal. 2023;12(8):2227-2234.
10. Gurjar RPS, Goyal AK, Kishor S, Singh A. Response of integrated nutrient management on growth, yield and benefit: cost ratio of Okra [*Abelmoschus esculentus* (L.) Moench]. In Biological Forum–An International Journal. 2022;14 (2):1269-1272.
11. Magar SK, Poudel B, Dhungana R, Rawal S, Thapa S, Bhusal KK, Malla S. Effect of integrated nutrient management on growth, yield and soil nutrient status in okra (Abelmoschus esculentus) cv. Arka Anamika. Archives of Agriculture and Environmental Science. 2023;8(1):49-54.
12. Narwariya R, Sharma A, Pal RK, Dahiya P. Effect of organic and inorganic manures on growth and yield of okra (*Abelmoschus esculentus* L. Moench) cv. Arka Anamika. International Journal of Plant & Soil Science. 2023;35(22):285-288.
13. Norman JE, Quee DD, Kamanda PJ, Samura AE. Influence of plant spacing on insect population, growth and yield of okra in Sierra Leone. American Journal of Entomology. 2019;3(2):49-55.

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