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Effect of Organic and Inorganic Fertilizers on Growth, Nutrient Uptake and Yield of Okra (*Abelmoschus esculentus* L. Moench) in Bundelkhand

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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 carried out at Organic Research Farm, Department of Horticulture, Institute of Agricultural Sciences, Bundelkhand University, Karguanji, Jhansi, Uttar Pradesh during the Kharif-2023 with a view to identify the effects of different combinations of organic and inorganic fertilizers and its role in growth, yield and quality of Okra variety Pusa A4. The experiment was laid in Randomized block design with 9 treatments and 3 replications with different combination in RDF and application of organic nutrition. Under this experiment, overall, 9 treatment was taken T0 Control (water spray), T1 (Ash 100%), T2 (MOP 100%), T3 (MOP 50% + Ash 50%), T4 (Presmud 5 t/ha), T6 (Presmud 1.5 t/ha), T7 (MOP 50% + Presmud 50%) and T8 (Presmud 50% + Ash 50%). From the above experimental finding it may be concluded that the treatment T2 (MOP 100%) was found to be best in the terms of growth yield and quality of Okra. The highest net return was found in the T2 (MOP 100%) with (Rs 111378/ha) and the highest B: C ratio was found in the same with 2.11.

Keywords: Okra; presmud; ash; MOP; benefit cost ratio.

1. INTRODUCTION

Okra, scientifically known as Abelmoschus esclentus Moench and popularly known as ladies' fingers or gumbo, is one of the most popular and extensively grown vegetable crops worldwide and is universally recognised as "protective food." It continues to hold its distinguished position among vegetables and is an excellent source of minerals, vitamins, and vegetable protein. The pulp and juice of the okra fruit are edible, have blood purifying properties, stimulate stomach secretion, and have a slight aperient effect. The plants mucilaginous seed pods, which contain soluble fibre, produce the distinctive "goo" or slime when they are boiled. Okra is a member of the Malvaceae family and has chromosome number 2n=130 [1]. Okra is an unclearly parented allopolyploid. Abelmoschus ficulneus, however, is one of the suggested progenitors; A. tuberculatus is a known "diploid" variety of okra. There is disagreement over the exact origins of okra; some claim it originated in West Africa, Ethiopia, South Asia, or Southeast Asia. Ethiopia is where it first originated. 90% of raw okra is made up of water, 2% protein, 7% carbs, and very little fat. Raw okra contains moderate amounts of thiamine (1.2 mg), folate (60 µg), magnesium (57 mg), calcium (52 mg), phosphorus (61 mg), and potassium (299 mg) in a 100-gram reference amount. It is also a rich source of dietary fibre, vitamin C (23 mg), and vitamin K (31.3 µg). Okra possesses beneficial anti-diabetic properties. Pressed from okra seeds, greenish-yellow edible okra oil has a mild flavour and aroma and is rich in unsaturated fats like linoleic and oleic acid. Certain seed varieties have up to 40% oil content. Grown in tropical and subtropical regions across the globe, okra is a significant vegetable crop from an economic standpoint. This crop can be grown both on large commercial farms and as a garden crop. India, Turkey, Iran, Western Africa, Yugoslavia, Bangladesh, Afghanistan, Pakistan, Burma, Japan, Malaysia, Brazil, Ghana, Ethiopia, Cyprus, and the Southern United States are among the countries where it is commercially grown. With 3.5 million tonnes (or 70% of global production) of okra grown on more than 0.35 million hectares of land, India leads the world in this regard. According to FAOSTAT (2020), India leads the world in okra production, accounting for 60% of global okra production. Nigeria and Sudan are next in line. India has 498.12 thousand hectares under cultivation for okra, and in 2021–22, it produced 56.32 metric tonnes. In terms of okra production and area, Gujarat leads West Bengal and Bihar in 2021–22. In Uttar Pradesh, 1.24 thousand hectares are used for production, with 3.67 million tonnes expected to be produced in 2021–22. (Source: NHB, Indian government's Ministry of Agriculture and Farmers Welfare, 2021–2022). Potassium enhances a plant's ability to utilize water efficiently, which is particularly important in water-scarce regions or during drought conditions [2]. Potassium is involved in photosynthesis, a fundamental process for plant growth, as it regulates the opening and closing of stomata, which are tiny openings in leaves that facilitate gas exchange and plays role in providing disease resistance to plant Ma et al., [3] Datnoff et al., [4]. Ashes enhances soil fertility by supplying nutrients like calcium, magnesium, and potassium to soil and supposed to be good reclamation agent for acid soils [5]. It also helps in nutrient recycling and sustainability along with heavy metal remediation [6]. The utilization of ash, presmud (pre-sowing soil moisture), and MOP (Muriate of Potash) is of paramount importance in the production of okra. Ash, when added to the soil, acts as a soil conditioner, raising pH levels and supplying essential micronutrients. This enhances overall soil fertility, ensuring a conducive environment for okra growth. Presmud, on the other hand, ensures adequate moisture levels for germination and early root development, a critical phase in okra cultivation. MOP, rich in potassium, is indispensable for okra. It plays a pivotal role in flower and fruit formation, significantly increasing yield and quality. Potassium also bolsters okra's resilience to environmental stressors like drought and disease. Consequently, the combination of ash, Presmud, and MOP leads to higher okra yields, better fruit quality, and a more robust, disease-resistant crop, contributing to enhanced production and economic returns for farmers. Therefore, the experiment was conducted with aim to determine the effect of organic and inorganic K fertilizers on vegetative growth, nutrient uptake, yield and quality of Okra.

2. MATERIALS AND METHODS

The current investigation was carried out in Kharif-2023 at the Karguan ji Organic Research Farm, Jhansi Department of Horticulture, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, U.P. The experimental design employed was a Randomized Block Design (RBD) with three replications and nine treatments. The Fisher and Yates, 6 method was used to statistically analyse the data. The software used for analysis was OPSTAT. The okra variety used was Pusa A4. In the study, the height of randomly chosen plants from each plot was assessed in centimetres using a meter scale. Stem diameter was measured at last harvest stage using meter tape in random selected five plants. Additionally, the number of branches and leaves per plant, emerging from the main shoot, was counted, and the values were averaged. TSS was measured using refractometer. The details of treatments comprised of T_0 (Control-water spray), T_1 (Ash 100%), T_2 (MOP 100%), T_3 (MOP 50% + Ash 50%), T_4 (Presmud 5 t/ha), T_6 (Presmud 1.5 t/ha), T_7 (MOP 50% + Presmud 50%) and T_8 (Presmud 50% + Ash 50%).

3. RESULTS AND DISCUSSION

The height of plant significantly varied among different treatment combinations. The highest plant height (119.11 cm) at harvest was observed in treatment T_2 (MOP 100%) followed by T_8 (Presmud 50% + Ash 50%) with 115.64 cm. Minimum plant height (80.54 cm) was observed in T_0 (control), while the remaining treatments were moderate in their growth habit. It is evident that the stem diameter of plant was influenced by different treatments for growth. There was significant difference present among the treatments applied. It was also found that T_2 (MOP 100%) had maximum thickness for stem diameter (9.07 cm) which was at par with T_8 (Presmud 50% + Ash 50%) having 8.77 cm whereas the minimum thickness for stem diameter was observed in treatment T_0 (Control) with 7.50 cm. The superior stem diameter and plant height, observed in the treatment with 100% MOP (Muriate of Potash) application in okra crops can be attributed to the essential role of potassium. MOP provides a concentrated and readily available source of potassium, which is crucial for cell expansion and structural integrity, resulting in thicker stems and taller plants. In contrast, other treatments involving presumed and ash, whether applied individually or in various combinations, may not supply sufficient or balanced levels of potassium. This potassium deficiency can impede cell enlargement and stem development, leading to reduced stem diameter and height of the plant compared to the MOP-treated group in okra crops. Similar findings were reported by Katrina et al., [7] Samar et al., (2018) in Okra.

Number of branches per plant was also influenced by different treatments showing significant difference present among the treatments applied. It was also found that T_2 (MOP 100%) had highest number of branches per plant (7.05 branches) followed by T_8 (Presmud 50% + Ash 50%) having 6.49 branches whereas the lowest number of branches was observed in treatment T_0 (control) with 5.27 branches. The treatment with 100% MOP (Muriate of Potash) application in okra crops demonstrates a higher number of branches per plant due to the essential role of potassium. MOP provides a concentrated and readily available source of potassium, a vital nutrient that stimulates lateral branching and overall plant growth. In contrast, other treatments involving presmud and ash, whether applied individually or in various combinations, may not supply sufficient or balanced levels of potassium. This potassium deficiency can hinder the development of lateral branches, resulting in fewer branches in okra plants, while the MOP-treated group displays a more robust and branched canopy. Similar findings were reported by Adesida et al [8] Adhikari and Priya [9]in Okra.

Days to first flowering showed significant difference present among the treatments applied. It was also found that T_2 (MOP 100%) was earliest for days to first flowering (38.67 days) followed by T_8 (Presmud 50% + Ash 50%) having 40.94 days whereas the maximum number of days to first flowering was observed in treatment T_0 (control) with 46.63 days. It was also found that among all treatments, T_2 (MOP 100%) had minimum number of days to 50% flowering (41.90 days) at par with T_8 (Presmud 50% + Ash 50%) having 40.93 days whereas the maximum number of days to 50% flowering was observed in treatment T_0 (control) with 49.03 days. It was also found that among all treatments, T_2 (MOP 100%) had minimum number of days to first pod setting (45.60 days) at par with T_8 (Presmud 50% + Ash 50%) having 46.23 days whereas the maximum number of days to first pod setting was observed in treatment T_0 (control) with 53.87 days. Days to first pod picking showed significant difference present among the treatments applied. It was also found that among all treatments, T_2 (MOP 100%) had minimum number of days to first pod picking (59.95 days) at par with T_8 (Presmud 50% + Ash 50%) having 60.00 days whereas the maximum number of days to first pod picking was observed in treatment T_0 (control) with 67.82 days. The early flowering followed by early pod maturation in the treatment with 100% MOP (Muriate of Potash) application in okra crops can be attributed to the pivotal role of potassium in fruit development. MOP offers a concentrated and readily available source of potassium, a key nutrient essential for cell enlargement and fruit ripening processes. In contrast, other treatments involving presmud and ash, whether applied individually or in various combinations, may not provide sufficient or balanced levels of potassium. This potassium deficiency can lead to delayed pod maturation, while the MOP-treated group experiences accelerated fruit ripening, resulting in the observed earliness in pod maturation in the okra crop. Similar findings were reported by Kumar et al., [10] in Okra.

The number of pods per plant indicated a substantial variation between the treatments used. It was also found that among various treatments applied, T_2 (MOP 100%) had highest number of number of pods per plant (21.08 pods) at par with T_8 (Presmud 50% + Ash 50%) having 20.66 pods whereas the lowest number of number of pods per plant was observed in treatment T_0 (control) with 11.57 pods. The treatment with 100% MOP (Muriate of Potash) application in okra crops exhibits a higher number of pods per plant due to the pivotal role of potassium. MOP provides a concentrated and readily available source of potassium, a crucial nutrient for flower and fruit development. Potassium influences flower formation, pollination, and overall reproductive processes, leading to increased pod production. In contrast, other treatments involving presmud and ash, whether applied individually or in various combinations, may not supply adequate or balanced levels of potassium, leading to reduced pod formation. The MOP-treated group benefits from enhanced pod development, resulting in a greater number of pods per plant in the okra crop. Similar findings were reported by Samar et al., (2018); Adhikari and Piya [9] Adesida et al., [8] in Okra.

It was also found that among various treatments applied, T_2 (MOP 100%) had longest average pod length (19.85 cm) at par with T_8 (Presmud 50% + Ash 50%) having 19.25 cm whereas the shortest average pod length was observed in treatment T_0 (control) with 14.75 cm. It was also found that among various treatments applied, T_2 (MOP 100%) had maximum thickness for pod diameter (7.07 cm) followed by T_8 (Presmud 50% + Ash 50%) having 6.54 cm whereas the minimum thickness for pod diameter was observed in treatment T_0 (control) with 4.49 cm. It was also found that among various treatments applied, T_2 (MOP 100%) had maximum pod weight (27.95 g) followed by T_8 (Presmud 50% + Ash 50%) having 24.10 g whereas the minimum pod weight was observed in treatment T_0 (control) with 17.22 g.

The treatment with 100% MOP (Muriate of Potash) application in okra crops results in better pod dimension and weight due to the critical role of potassium in fruit development. MOP offers a concentrated and readily available source of potassium, a key nutrient essential for cell expansion, water uptake, and fruit filling. In contrast, other treatments involving presmud and ash, whether applied individually or in various combinations, may not provide sufficient or balanced levels of potassium. This potassium deficiency can limit the capacity of pods to absorb water and nutrients, leading to reduced fruit weight. The MOP-treated group benefits from improved pod growth, resulting in heavier and more substantial pods in the okra crop.

Table 1. Effect of organic and inorganic K fertilizers on growth and earliness parameters of Okra

Treatment Details		Plant height (cm) [at harvest]	Stem diameter (cm)	No of branches per plant	Days to first flowering	Days to 50% flowering	Days to first pod setting	Days to first pod picking
T_0	Control	80.54	7.50	5.27	46.63	49.03	53.87	67.82
T_1	Ash 100%	90.67	7.92	5.50	42.31	45.90	47.51	64.69
T_2	MOP 100%	119.11	9.07	7.05	38.67	41.90	45.60	59.95
T_3	MOP 50% + Ash 50%	99.28	8.51	5.35	46.49	44.53	49.18	63.32
T_4	Presmud 5 t/ha	113.76	8.60	6.22	44.30	47.89	50.60	66.55
T_5	Presmud 2.5 t/ha	108.44	8.20	5.38	45.38	47.92	52.66	66.66
T_6	Presmud 1.5 t/ha	99.22	8.35	6.34	42.18	42.76	48.18	61.24
T_7	MOP 50% + Presmud 50%	81.44	7.81	5.67	46.03	48.57	53.31	67.31
T_8	Presmud 50% + Ash 50%	115.64	8.77	6.49	40.94	41.21	46.23	60.00
'F' test		S	S	S	S	S	S	S
CV.		0.56	0.73	0.98	0.44	0.39	0.76	1.24
SE. m (±)		1.42	0.14	0.23	0.11	0.42	0.22	0.42
CD. at 5%		4.26	0.42	0.69	0.33	1.26	0.66	1.26

Table 2. Effect of organic and inorganic K fertilizers on yield and quality parameters of Okra

Treatment Details		No of pods per plant	Average pod length (cm)	Average pod diameter (cm)	Average pod weight	Pod yield per hectare (t/ha)	TSS [°Brix]
T_0	Control	11.57	14.75	4.49	17.22	7.89	7.74
T_1	Ash 100%	13.91	17.23	5.48	17.64	9.78	8.63
T_2	MOP 100%	21.08	19.85	7.07	27.95	12.90	14.19
T_3	MOP 50% + Ash 50%	16.56	14.73	6.13	18.02	9.95	10.62
T_4	Presmud 5 t/ha	16.87	15.93	4.89	20.52	9.36	8.49
T_5	Presmud 2.5 t/ha	17.72	14.81	6.48	17.63	12.21	8.84
T_6	Presmud 1.5 t/ha	18.13	18.42	5.37	20.44	12.17	12.19
T_7	MOP 50% + Presmud 50%	15.95	17.33	6.31	22.97	9.42	11.07
T_8	Presmud 50% + Ash 50%	20.66	19.25	6.54	24.10	12.57	12.87
'F' test		S	S	S	S	S	S
CV.		3.21	4.28	4.63	6.30	1.68	0.77

Treatment Details	No of pods per plant	Average pod length (cm)	Average pod diameter (cm)	Average pod weight	Pod yield per hectare (t/ha)	TSS [°Brix]
SE. m (±)	0.86	0.41	0.77	1.47	1.65	0.32
CD. at 5%	2.58	1.23	2.31	4.42	4.95	0.96

Table 3. Effect of organic and inorganic K fertilizers on economic parameters of Okra

Treatment		Pod Yield (t/ha)	Total cost of cultivation (Rs)	Gross Return (Rs)	Net return (Rs)	B:C Ratio
T_0	Control	7.89	79,450	118350	38900	1.49
T_1	Ash 100%	9.78	82,950	146700	63750	1.77
T_2	MOP 100%	12.90	82,122	193500	111378	2.36
T_3	MOP 50% + Ash 50%	9.95	82,536	149250	66714	1.81
T_4	Presmud 5 t/ha	9.36	94,450	140400	45950	1.49
T_5	Presmud 2.5 t/ha	12.57	86,950	183150	96200	2.11
T_6	Presmud 1.5 t/ha	12.17	83,950	182550	98600	2.17
T_7	MOP 50% + Presmud 50%	9.42	94,286	141300	47014	1.50
T_8	Presmud 50% + Ash 50%	12.21	94,700	188550	93850	1.99

Rate of per kg Okra: Rs 15/kg

Similar findings were reported by Lakra et al., [11] and Mishra et al., [12] in Okra.

It was found that among various treatments applied, T_2 (MOP 100%) had highest pod yield per hectare (12.90 t/ha) at par with T_8 (Presmud 50% + Ash 50%) having 12.57 t/ha whereas the lowest pod yield per hectare was observed in treatment T_0 (control) with 7.89 t/ha. Okra crops treated with a 100% MOP (Muriate of Potash) application have higher pod yields because potassium is crucial for overall plant growth and fruit production. MOP offers a concentrated and easily accessible source of potassium, an essential nutrient for fruit setting, flower development, and pod expansion. On the other hand, different presmud and ash treatments, either used separately or in different combinations, might not provide adequate or balanced potassium levels. A potassium deficit can hinder the growth of flowers and fruits, resulting in a lower yield of pods. The group treated with MOP experiences improved reproductive processes, which raises the pod yield of the okra crop. Similar findings were reported by Mishra et al., [12] and Kumar et al., [10] in Okra.

It was found that T.S.S. (°Brix) content among different treatments varied significantly. The maximum T.S.S. (14.19 °Brix) was observed in treatment T_2 (MOP 100%) followed by T_8 (Presmud 50% + Ash 50%) with 12.87 °Brix. The minimum T.S.S. (7.74 °Brix) was noticed in treatment T_0 (Control). Okra crops treated with 100% MOP (Muriate of Potash) application have higher Total Soluble Solids (TSS) content because potassium plays a crucial role in improving fruit quality. Potassium, which affects sugar content and fruit maturation, is essential for TSS accumulation and is concentrated and easily obtainable in MOP. Other presmud and ash treatments, whether used singly or in various combinations, might not offer enough or a balanced amount of potassium, which would lead to lower TSS levels. Better fruit quality in the MOP-treated group results in a higher TSS content in the okra crop, which increases its desirability for consumption. These results are in close conformity with the findings of Mishra et al., [12] in Okra.

Maximum gross returns were recorded in treatment T_2 (MOP 100%) with (Rs 193500/ha) followed by T_8 (Presmud 50% + Ash 50%) with Rs 188850/ha and the minimum (Rs 118350/ha) was recorded in treatment T_0 (Control). Maximum net returns were recorded in treatment T_2 (MOP 100%) with (Rs 111378/ha) followed by T_6 (Presmud 1.5 t/ha) with Rs 98600/ha and the minimum (Rs 38900/ha) was recorded in treatment T_0 (Control). Maximum benefit: cost ratio was recorded in T_2 (MOP 100%) with 2.36 followed by T_6 (Presmud 1.5 t/ha) with 2.11 and the minimum 1.49 was recorded in treatment T_0 (Control). Because farmers must consider economics when making decisions about the application of scientific knowledge and techniques, T_2 (MOP 100%) produced one of the highest gross returns, net returns, and cost benefits because of its higher yield quality and productivity, which raises the fruit's market value. Similar findings were reported by Kumar et al., [10] in Okra [13-15].

4. CONCLUSION

From the above experimental finding it may be concluded that the treatment T_2 (MOP 100%) was found to be best in the terms of growth yield and quality of Okra. The highest net return was found in the T_2 (MOP 100%) with (Rs 111378/ha) and the highest B:C ratio was found in the same with 2.11.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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