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RESPONSE OF MORINGA LEAVES EXTRACT ON THE GROWTH AND YIELD OF OKRA (*ABELMOSCHUS ESCULENTUS* L.)

Pooja Barthwal*, Rakesh Kumar and Akash Kumar
School of Agricultural Studies Quantum University, Roorkee - Dehradun Highway, Mandawar, Roorkee, Uttarakhand 247662, India
*Corresponding author E-mail: poojabarthwal30@gmail.com
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ABSTRACT

The effects of Moringa Leaf Extract (MLE) treatments on okra (*Abelmoschus esculentus L.)* growth and yield parameters were assessed in a field experiment. The effects of six treatments including a control (T_1) were evaluated in terms of plant height, flowering, leaf area index, branch count, pod length, and yield. The findings showed that treatment T_3 considerably increased plant productivity and growth at every stage. T_3 had the highest leaf area index (2.62), the greatest number of branches (9.18), the earliest 50% flowering (32.00 days), and the highest plant height (58.78 cm) at 90 DAS. The highest cumulative yield of 2763.52 g per 10 pods was obtained by T_3, which also produced the longest pods and showed superior pod weights (16.27 g, 20.57 g, and 22.31 g) over the course of three harvests. The control (T_1), on the other hand, had the lowest values in almost every parameter. The importance of MLE treatments, especially T_3, in improving growth and yield performance was validated by statistical analysis. These results imply that MLE may be a viable environmentally friendly bio stimulant to enhance okra's growth characteristics and yield.

***Keywords*:** Plant Growth, Yield Attributes, Pod Weight, Leaf Area Index, Bio stimulant, Flowering, Sustainable Agriculture.

Introduction

Okra (*Abelmoschus esculentus* L.) is a widely consumed vegetable crop found in tropical and subtropical regions of the world, also known as lady's finger. Okra is consumed as a vegetable and a source of antioxidants, minerals (including calcium and potassium), dietary fiber, vitamin A and vitamin C, and vitamin K. It belongs to the Malvaceae family (Nwachukwu & Obi, 2009). Aside from having significant nutritional value, okra contributes highly to smallholder farmers' agricultural income generation and food security, particularly in developing countries (Arora *et al.,* 2011). Seed germination, seedling vigor, and soil borne pathogen attack continue to be some of the main limitations to okra productivity.

Seed treatment, which enhances seed performance by protecting it from pathogens, increasing germination rates, and supporting uniform emergence and early-seedling development is one of the efficient and sustainable ways to address these issues (Taylor *et al.,* 2001). The seed can be treated using chemical fungicides, bio-fertilizer, botanical extracts, and growth-promoting agents. The experiment was a factorial structure using a Randomized Block Design (RBD) that consisted of six treatments and three replications. The treatments included seed soaking in different concentrations of Moringa Leaf Extract (MLE) as well as a concentration of vitamins, minerals, and growth hormones like zeatin, a natural cytokinin; and, this botanical extract has been researched and considered as a natural biostimulant. MLE is shown to improve root growth, seed germination and yield in crops in general (Foidl *et al.,* 2001; Yasmeen *et al.,* 2013). Additionally, when MLE is applied as a seed treatment, the physiological and biochemical processes can enhance stress tolerance and important yield factors, which can help improve yield in various crops including okra. Therefore, this study aims to evaluate impact of Moringa Leaves Extract

based seed treatment impacts growth, flowering and yield of okra in field conditions.

Material and Methods

Experimental Site and Design

A field experiment was carried out in Kharif 2024-2025 at the Agriculture Research Farm, Hasanpur, Quantum University, to evaluate the impact of Moringa Leaf Extract (MLE) seed treatments on growth and yield of Okra variety (Laxmi (500) (*Abelmoschus esculentus* L.). The trial was control - Seeds were treated with different concentrations of MLE solutions i.e., 20% MLE (T2), 40% MLE (T3), 60% MLE (T4), 80% MLE (T5), and 100% MLE (T6) as well as a control (T1). Seeds were treated for 24 hours in their respective treatments and were shade-dried before planting.

Crop Management

Uniform sized seeds of a common okra variety (Laxmi 500) were sown at a spacing of 45 cm × 20 cm. All agronomic practices and other management practices, such as tillage, watering, fertilization, pest management, were done the same way on all of the plots. The experiment was done in an open field without using any kind of chemical growth regulator or foliar spray.

Observations Recorded

Growth and yields parameters (phenological parameters, growth parameters, and yield parameters) were recorded at different crop growth stages. Agronomic methods that are standard practice were used to record all parameters. A portable leaf area meter was used to measure the Leaf Area Index and an electronic weighing balance was used to measure the weight of the pods.

Preparation of botanical extracts

The extracts were made from the leaves of *Moringa oleifera*. Fresh Moringa leaves were selected and washed with clean water. Moringa leaves in total were dried in the shade for six hours only. The woody stems were removed. Weighing 500 g of moringa leaves (dry weight). A kitchen electric grinder was used to grind these dried leaves separately until it was a paste. After it was ground, the paste was mixed with 500 ml water. The second paste-water solution was strongly mixed well, then muslin fabric was used to filter it. Optimally, the leaf extract that was prepared this way with a concentration of 1:1 (w/v). The extract is used and then diluted before use as required. The seeds were soaked before planting in the solution with the varying concentrations for 24 hours.

Statistical Analysis

We performed a Randomized Block Design Analysis of Variance (ANOVA) on the data collected from the investigation. We used either OPSTAT or MS Excel for our analysis. We determined the Critical Difference (CD) at the 5% probability level to measure how meaningful the differences were among treatment means. We also reported the Standard Error of Mean SE(m) and determined the Coefficient of Variation (CV %).

Result and Discussion

50% days to flowering

Treatment T3 had the earliest 50% flowering, at 32.00 days, which was a lot earlier than the control (T_1), which had flowering at 43.33 days. Natural cytokinins like zeatin in MLE are responsible for this improvement in flowering because they boost hormonal activity and cell division (Yasmeen *et al.,* 2013).

Plant Height

Based on the data collected at three distinct periods (30, 60 and 90 DAS), all the treatments displayed large variability across all the periods assessed. Treatment 3 resulted in the tallest okra plants (12.23cm at 30 DAS, 24.13 cm at 60 DAS, and 58.78 cm at 90 DAS), followed by treatments 4 and 5, while the control treatment resulted in the shortest plants (T1). This increase in height may have been a result of being treated with seed treatment in treatment 3, which may have helped the plants uptake more nutrient and hormones. These results are consistent with other research done by Kumar *et al.* (2021), who also found that okra plants subjected to seed treatments with various abundantly available bio-stimulants and botanical extracts to increase growth and nutraceutical content, the resulting treated plants got taller. According to Patel *et al* (2018), if seedlings exhibit early and strong growth, plants will also be taller as they enter the vegetative stage of growth.

Pod Length

The pod length improved significantly from one harvest to another. T3 consistently had the longest pod at the first (7.40 cm), second (14.71 cm), and third (18.65 cm) harvests. T1 had the shortest pods (5.38 cm, 6.43 cm, and 9.63 cm respectively) and the lengthening of pods in T3 means that the plants are better at assimilating photosynthetic products and translocating nutrients to the sink organs. Reddy *et al.* (2017) said if seeds are treated with bio formulations, they become more capable of flowering successfully and forming pods effectively, thus leading to longer pods. Meena *et*

al. (2018) also observed that seeds that were treated brought about strong plant growth and improved seed production count.

Pod Weight

The treatments also had significant impacts on the weight of the pods. At all three harvests, Treatment T_3 had the heaviest pods (16.27 g, 20.57 g, and 22.31 g), while Treatment T_1 had the lightest pods (6.26 g, 9.65 g, and 11.19 g). The heavier pods in T_3 might be because the plants were healthier and got more nutrients, which helped the pods grow better. These results are in line with what Singh and Yadav (2020) found that seed priming and botanical seed treatment make okra plants much better at producing seeds. Treating seeds can help them grow into stronger seedlings, which is very important for the later stages of pod development (Anwar *et al.,* 2007).

Leaf Area Index

Seed treatment with Moringa Leaf Extract (MLE) had a significant impact on the Leaf Area Index (LAI), which is an important indicator of plant photosynthetic potential and canopy growth (Table 1.1). T3 had the highest LAI (2.62) with T2 (2.13) and T4 (2.12) following closely behind. T1, under the control treatment with no MLE application, had the lowest LAI (1.40). The large increases in LAI under T3 could be the result of MLE's many natural cytokinins (zeatin), vitamins (A, C, E), minerals, and antioxidants that promote plant growth, and it has been shown that these bioactive compounds elicit cell division and extension, resulting in larger leaves and greater growth of the canopy (Yasmeen *et al.*, 2013; Foidl *et al.,* 2001).

Number of Branches per Plant

The number of branches was very different among the treatments. Treatment T3 had the most branches (9.18), followed by Treatment T4 (6.13) and Treatment T5 (5.10), while Treatment T1 had the fewest branches (3.04). Treatment T3 may have increased branching by making the active vegetative phase a more active environment while enhancing hormone activity, especially cytokinin that helps lateral shoots grow. Sharma *et al.* (2019) indicates that utilizing bio stimulants on seeds makes morpho-physiological trait improvements in plants, like branching.

Pod Yield

Table 1.2 provides data that demonstrates the variation in the number of pods produced per plant over three harvests. Treatment T3 had the largest total pod yield (2747.00 g), followed by T4 (1691.14 g) and T2 (1293.01 g). The control (T1) had the lowest total pod yield (726.14 g). The seed treatment or growth pre-treatment intervention in the other treatments demonstrated some efficacy. Treatment T3 had a ~278% higher cumulative yield than the control, indicating that it performed significantly better. Treatments T2 and T4 also significantly increased yield compared to the control; however, the yield response was not as great as for T3. T5 and T6 reduced the lost yield as well. These findings are similar to previous research that demonstrated that both botanical and chemical seed treatments had a significant effect on pod yield and other improvement on agronomic traits (Yadav *et al.*, 2013; Singh & Sharma, 2015).

Conclusion

Moringa leaf extract (MLE) at 40% addition (T3) performed the best because it produced the highest leaf area index (2.62), most branches (9.18), earliest 50% flowering time (32.00 days) and measured the tallest plant (58.78 cm) at 90 DAS. Overall, T3 produced the highest total yield of the highest number of pods at 2763.52 g per 10 pods. For the three harvests, T3 also had the longest pods and yet contained the most weight of 16.27 g, 20.57 g, and 22.31 g over three harvests. In comparison, the control treatment (T1) again produced the lowest results for all parameters. It is important to consider MLE instead of synthetic growth enhancers, and to utilize it as a part of an overall holistic approach to nutrition and crop management in organic and conventional growing systems.

Table 1 : Performance of MLE to the growth of the Okra

Treatment	50% days of Flowering	Plant Height(cm)			Pod Length (Cm)			Leaf Area Index	No of Branch
		30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS		
T_1(Control)	43.33	4.60	10.01	23.44	5.38	6.43	9.63	1.40	3.04
T_2	40.67	5.10	10.71	23.60	5.93	9.09	10.76	2.13	4.18
T_3	**32.00**	**12.23**	**24.13**	**58.78**	**7.40**	**14.71**	**18.65**	**2.62**	**9.18**
T_4	38.33	5.63	17.10	29.64	6.41	10.18	12.34	2.12	6.13
T_5	41.00	6.26	16.83	29.52	5.71	9.42	10.83	1.95	5.10
T_6	40.00	4.79	10.10	37.02	5.66	7.87	10.17	1.68	3.28
CD	1.244	0.48	0.249	0.858	0.209	0.482	0.236	0.14	0.355
SE(m)	0.39	0.15	0.078	0.269	0.065	0.151	0.074	0.044	0.111
CV	1.721	4.05	0.911	1.383	1.863	2.721	1.061	3.839	1.736

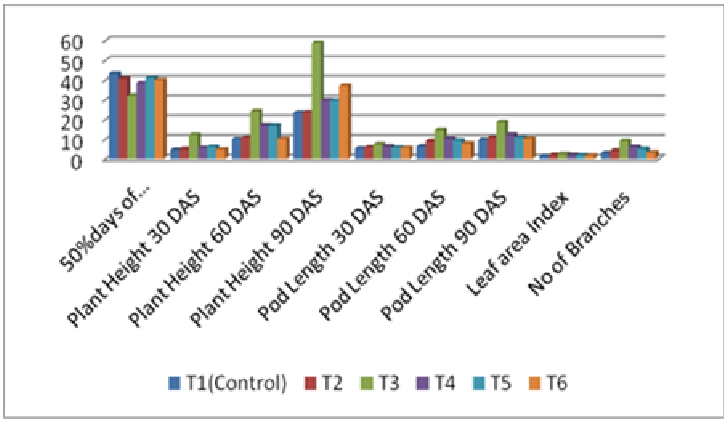

Fig. 1: Performance of MLE to the growth of the Okra

Table 2: Effect of Moringa Leaves Extract in Yield parameter of okra

Treatment	Per 10 Pod Yield(g)				Pod Weight		
	1st Harvesting	2nd Harvesting	3rd Harvesting	Total Yield	1st Harvesting	2nd Harvesting	3rd Harvesting
T_1 (Control)	160.29	214.66	350.63	725.58	6.26	9.65	11.19
T_2	217.71	426.82	650.68	1295.21	9.63	11.24	15.19
T3	**431.51**	**829.07**	**1502.94**	**2763.52**	**16.27**	**20.57**	**22.31**
T4	319.78	522.11	862.17	1704.06	10.54	12.03	18.32
T5	225.13	325.62	465.36	1016.11	9.54	11.16	13.75
T6	177.59	230.38	380.60	788.57	9.26	9.82	11.24
CD	6.184	7.591	4.779	314.313	0.216	0.176	0.103
SE(m)	1.938	2.378	1.497	98.476	0.068	0.055	0.032
CV	1.314	0.970	0.369	37.021	1.144	0.767	0.365

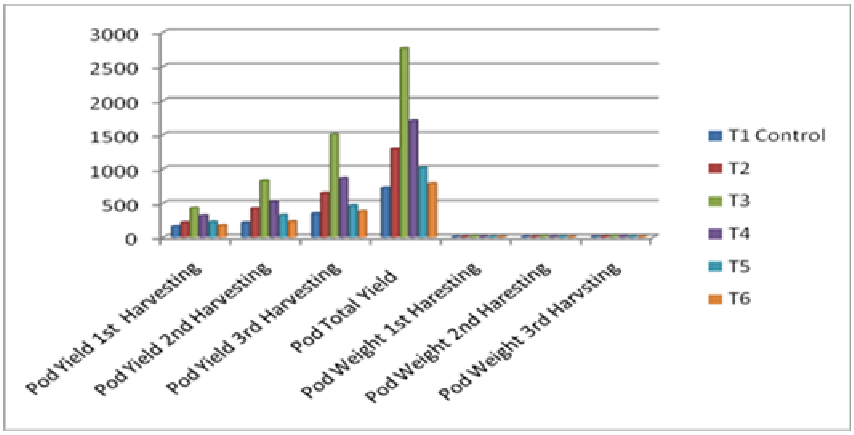

Fig. 2: Effect of Moringa Leaves Extract in Yield parameter of okra

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