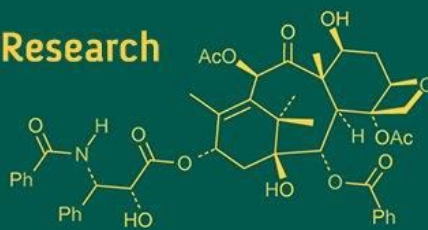


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Performance evaluation of Moringa (*Moringa oleifera*) for Prayagraj's farmers

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Abstract

At the All India Coordinated Research Project on Vegetable Crops, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj-211007, (U.P.), India, the current study, "Performance evaluation of Moringa (*Moringa oleifera*) for Prayagraj's farmers," was carried out starting in maize 2024. Three replications, four genotypes, and a Randomized Block Design were used to set up the experiment. The experiment's primary goals were to assess the variety's growth, yield, floral characteristics, pod character (both quantitative and qualitative), and pod character. Based on the results of this investigation, it can be said that the following characteristics of the moringa variety—V1-PKM-1, V2-PKM-2, and V3-ODC—were found to be superior: days to germination, number of branches at transplanting, plant height after 60, 90, and 120 days, stem thickness (cm), number of pod per plant, pod diameter (cm), pod weight (g), pod length (cm), and pod yield (q/ha). Selection based on these characteristics will lead to the development of high yielding superior genotypes of Moringa (*Moringa oleifera*).

Keywords: Growth, yield, and variety, Moringa

1. Introduction

Plants have been a significant source of drugs in Indian and other ancient systems of medicine. The Rig-Veda, Charaka Samhita, and Sushruta Samhita provide extensive descriptions on various medicinal herbs. Over 80 percent of the world's population still relies on plant-based traditional medicines, with around 45, 000 plant species found in the Indian subcontinent. Of these, around 3, 500 species are of medicinal value. Around 80 percent of the plants used by the contemporary Ayurvedic industry are procured from wild areas, mostly forest land. (Kirtikar and Basu, 1934) ^[10]

Moringa oleifera (Lam.), also known as the 'Drumstick tree', is one of the thirteen species of the Moringaceae family. It is native to the sub-Himalayan part of north-western India and has been introduced into many warm countries in the Tropics. Moringa is drought tolerant and resistant to many pests and diseases, making it suitable for reforestation. It is cultivated as a multi-purpose crop in more than 60 countries, with *M. oleifera* and *M. peregrina* being the most important economically at the agricultural and medicinal levels.

Moringa is widely used as a vegetable and is grown commercially for its edible pods and leaves in the eastern and southern regions of India. The annual production of Moringa ranges from 2.20 to 2.40 million tons of tender pods, indicating an area of 38, 000 hectares. In India, the annual production ranged from 2.20 to 2.40 million tons of tender pods, resulting in a productivity of about 63 tons per hectare.

Moringa is a highly nutritive plant that is widely used to treat human malnutrition due to micronutrient shortages in many African countries. Its leaves are the most useful among them, providing benefits such as increased immunity, skin nourishment and protection, liver protection, cancer treatment, relief from depression and fatigue, heart failure, wound healing, diabetes and asthma reduction, blood pressure reduction, and protection against kidney disorders. Moringa seeds are the best natural coagulants, and over 300 ailments are cured or prevented using the leaves, roots, and bark of this plant. (Akshay *et al.*, 2014) ^[1]

Important varieties of Moringa include Moolanur Moringa, Valayapatti Moringa, Chavakacheri Moringa, Chemmurungai, Jaffna Type, Kattu Moringa, Kodikkal Moringa, Palmurungai, Punamurungai, and Palamedu Moringa.

Understanding the nature and extent of source variation in relation to seed, germination, and seedling characteristics is important for producing high-quality planting stock.

2. Materials and Methods

The current inquiry in 2024-2025, a Performance evaluation of Moringa (*Moringa oleifera*) for Prayagraj's farmers was carried out. The 4 hybrids that made up the planting materials for this study were gathered from the Prayagraj market in the area (Table 1). For each replication, three randomly chosen plants were the subjects of the observations. Statistical analysis was performed using the analysis of variance approach on the data gathered on various parameters throughout the inquiry (Panse and Sukhatme 1957) ^[13]. To determine if the treatment effect was significant or not, the "F" variance ratio test was used. At the 5% level of significance, the calculated "F" value (variance ratio) was compared to the table value of "F." A computed value was deemed important if it was more than the table value.

Table 1: List of the of Moringa variety used in the Experiment:

S. No	Variety	Name of the Hybrids
1	V1	V1-PKM-1
2	V2	V2-PKM-2
3	V3	V3-ODC
4	V4	V4-Local

3. Results and Discussion

3.1 Growth and Flower Parameters

3.1.1 Germination percentage

The maximum days to germination was V3-ODC (89.47), followed by V1-PKM-1 (85.8), V4-Local (85.60), while the minimum days to germination of moringa was recorded in V2-PKM-2 (82.46). However, there was no at par found between variety. A similar study by Thirusenduraselvi and Jerlin (2010) ^[16] on moringa seeds demonstrated that pre-germination resulted in faster and more uniform seed germination, leading to improved seedling emergence. This suggests that pre-germination techniques can be beneficial for promoting efficient and successful establishment of moringa seedlings.

Table 2: Mean Performance of different varieties of Moringa on growth and floral parameter

Variety	Days to germination	No. of branches at the time of transplanting	Plant height (cm)	Stem thickness (cm)
V1-PKM-1	85.8	2.93	108.1	5.03
V2-PKM-2	82.46	3.07	100.02	4.96
V3-ODC	89.47	3.04	105.84	5.82
V4-Local	85.6	3.01	103.66	5.38
F-test	S	S	S	S
SE(m)	0.587	0.039	2.324	0.2
C. D. (P = 0.05)	1.211	0.08	4.796	0.414
C.V.	0.258	0.001	4.049	0.03

3.2 Yield and Quality Parameters

3.2.1 Pod diameter (cm)

The maximum Pod diameter (cm) was V3-ODC (1.83), followed by V1-PKM-1 (1.8), and V4-Local (1.76), while the minimum Pod diameter (cm) of moringa was recorded in V2-PKM-2 (1.7). However, the variety V1, V2 and V4 were found statistically at par with V3. The length of pods may be due to its hybrid vigour and adoptability to Allahabad agroclimatic conditions. The Similar findings were previously reported by Mishra *et al.* (2019) ^[12].

3.1.2 No. of branches at the time of transplanting

The maximum No. of branches at the time of transplanting was V2-PKM-2 (3.07), followed by V3-ODC (3.04), and V4-Local (3.01), while the minimum No. of branches at the time of transplanting of moringa was recorded in V1-PKM-1 (2.93). However, the variety V1, V3 and V4 were found statistically at par with V2. To achieve a better result on the number of branches at the time of transplanting in Moringa, focus on optimizing the seedling stage and the planting process. Use a high-quality seed source, ensure proper soil conditions (well-drained, with a pH around 6.3-7.0), and consider soaking seeds before planting to aid germination. Also, consider spacing plants appropriately (wider spacing can lead to more branches per plant) and avoid frequent harvesting in the early years, similar study by Thirusenduraselvi and Jerlin (2010) ^[16].

3.1.3 Plant height (cm) at 120 DAS

The maximum Plant height (cm) at 120 DAS was V1-PKM-1 (108), 1 followed by V3-ODC (105.84), V4-Local (103.66), while the minimum Plant height (cm) of moringa was recorded in V2-PKM-2 (100.02). However, there was no at par found between variety. Similar results were reported by Reddy *et al.* (2019) ^[17]. Also, A longer plant height in moringa indicates better plant health and growth, potentially leading to higher pod yield and quality. Factors like fertilizer application and plant growth regulators can influence vine length and consequently, plant performance. Krishnamoorthy and Ananthan (2017) ^[2].

4. Stem thickness (cm)

The maximum Stem thickness (cm) was V3-ODC (5.82), followed by V4-Local (5.38), and V1-PKM-1 (5.03), while the minimum Stem thickness (cm) of moringa was recorded in V2-PKM-2 (4.96). However, the variety V1, V2 and V4 were found statistically at par with V3. Similar result were Pinkard (2000) ^[14] reported that the Moringa plants, stem thickness (diameter) is often measured in centimeters (cm). While specific values can vary based on factors like growth conditions, variety, and age, a good general range for healthy Moringa stems is 4.96-5.82 cm. The study found that wider spacing can lead to thicker stems.

3.2.2 Pod weight (g)

The maximum Pod weight (g) was V1-PKM-1 (60.9), followed by V3-ODC (58.5), and V4-Local (57.8), while the minimum Pod weight (g) of moringa was recorded in V2-PKM-2 (57.5). However, this can vary significantly based on factors like variety, growing conditions, and maturity at harvest. Nutrient availability, water supply, and other environmental factors can impact pod weight. These results are similar with findings by Harshitha *et al.* (2019) ^[6].

3.2.3 Pod length (cm)

The maximum Pod length (cm) was V1-PKM-1 (42.3), followed by V3-ODC (38.4), and V4-Local (37.00), while the minimum Pod length (cm) of moringa was recorded in V2-PKM-2 (36.3). However, there was no at par found between variety. The Pod length moringa plant is influenced by various factors, including plant vigor, nutrient availability, water management, and pollination success. A well-nourished plant, with proper irrigation and pollination, can produce a higher number of pods. Healthy, strong plants with good vegetative growth are more likely to produce a higher number of pods. These results are similar with findings by Harshitha *et al.* (2019) [6], Krishnamoorthy and Ananthan (2017) [2].

3.2.4 Number of pods per plant

The maximum No. of pods per plant was V1-PKM-1 (72.33), followed by V3-ODC (65.66), and V4-Local (63.27) V2-PKM-2, while the minimum No. of pod per plant of moringa was recorded in V2-PKM-2 (62.07). However, there was no at par found between variety.

To maximize the number of pods per Moringa plant, several factors need careful management. Specifically, focusing on proper pruning, adequate sunlight, and nutrient supply are crucial for achieving high yields. Additionally, managing flower drop and ensuring pest and disease control can significantly impact the final pod production. Similarly conformity with the findings of Azam *et al.* (2019) [4].

3.2.5 Pod yield (t/ha)

The maximum Pod yield (t/ha) was V1-PKM-1 (29.73), followed by V3-ODC (25.93), and V4-Local (24.68), while the minimum pods yield (t/ha) of moringa was recorded in V2-PKM-2 (24.09). However, there was no at par found between variety. To maximize pod yield (in tan per hectare)

in Moringa, several factors contribute. These include proper pruning techniques, using high-yielding varieties, and employing effective fertilization and irrigation practices. Additionally, foliar application of Moringa leaf extract (MLE) can enhance yield and pod quality. The Pod length ridge gourd plant is influenced by various factors, including plant vigor, nutrient availability, water management, and pollination success. A well-nourished plant, with proper irrigation and pollination, can produce a higher number of pods. Healthy, strong plants with good vegetative growth are more likely to produce a higher number of pods. These results are similar with findings by Sanchez *et al.* (2006) [15] and Intrigliolo *et al.*, (1999) [7].

3.2.6 Total leaf yield per plant (kg)

The maximum Total leaf yield per plant (kg) was V1-PKM-1 (2.26), followed by V3-ODC (2.05), and V4-Local (1.97), while the minimum Total leaf yield per plant (kg) of moringa was recorded in V2-PKM-2 (1.94). However, there was no at par found between variety. To maximize pod yield (in quintals per hectare) in Moringa, several factors contribute. These include proper pruning techniques, using high-yielding varieties, and employing effective fertilization and irrigation practices. Additionally, foliar application of Moringa leaf extract (MLE) can enhance yield and pod quality. The Pod length ridge gourd plant is influenced by various factors, including plant vigor, nutrient availability, water management, and pollination success. A well-nourished plant, with proper irrigation and pollination, can produce a higher Total leaf yield per plant. Healthy, strong plants with good vegetative growth are more likely to produce a higher number of pods. These results are similar with findings by Sanchez *et al.* (2006) [15] and Intrigliolo *et al.*, (1999) [7].

Table 3: Mean Performance of different variety of Moringa on Yield parameters

Variety	Pod diameter (cm)	Pod weight (g)	Pod length (cm)	No. of pod per plant	Pods yield (q/ha)	Total leaf yield per plant (kg)
V1-PKM-1	1.8	60.9	42.3	72.33	29.73	2.26
V2-PKM-2	1.7	57.5	36.3	62.07	24.09	1.94
V3-ODC	1.83	58.5	38.4	65.66	25.93	2.05
V4-Local	1.76	57.8	37	63.27	24.68	1.97
F-test	S	S	S	S	S	S
SE(m)	0.035	0.2	0.2	2.765	1.379	0.086
C. D. (P = 0.05)	0.073	0.414	0.414	5.706	2.846	0.178
C.V.	0.001	0.03	0.03	5.732	1.426	0.006

3.3 Quality Parameters

3.3.1 Moisture content of fresh leaves (%) per 100 gm

The maximum Moisture content of fresh leaves (%) per 100 gm was V2-PKM-2 (76.66), followed by V3-ODC (75.46), and V1-PKM-1 (74.46), while the minimum Moisture content of fresh leaves (%) per 100 gm of moringa was recorded V4-Local (69.76). However, the variety V2 were found statistically at par with V4. A good moisture content for fresh leaves is typically considered to be around 76.66-69.76%. The reason for this high moisture content is due to the leaves' role in plant metabolism, including photosynthesis and transpiration. High moisture levels also contribute to the plant's ability to store nutrients and maintain turgor pressure, essential for plant structure and growth. Similarly, Kenghe *et al.* (2015) [9].

3.3.2 Total Chlorophyll (mg/100 g)

The maximum Total Chlorophyll (mg/100 g) was V4-Local

(50.3), followed by V2-PKM-2 (49.1), and V1-PKM-1 (48.10), while the minimum Total Chlorophyll (mg/100 g) of moringa was recorded in V3-ODC (43.40). However, the variety V2 were found statistically at par with V4. Ramkumar and Anuja (2017) [17] observed that the chlorophyll content of moringa leaves decreased in the closer spacing and increased in the wider spacing. Interaction made significant impact on the total chlorophyll in second harvest but no impact during first harvest.

3.3.3 TSS

The maximum TSS was V3-ODC (8.00) followed by V1-PKM-1 (7.40) and V4-Local (7.10) while the minimum TSS of moringa was recorded in V2-PKM-2 (6.70). However, the variety V1, and V4 were found statistically at par with V3. Factors like plant growth regulators can also influence TSS, potentially by stimulating metabolic pathways that increase the production of sugars and other soluble

solids. Additionally, increased leaf area and photosynthetic activity can lead to more assimilate availability for the developing pods, resulting in higher TSS. Similar findings

were previously reported by Aruna & Swaminathan *et al.* (2012) [3] and Iqbal, M *et al.* (2018) [8].

Table 4: Mean Performance of different variety of Moringa on Quality parameters

Variety	Moisture content of fresh leaves (%) per 100 gm	Total Chlorophyll (mg/100 g)	TSS
V1-PKM-1	74.46	48.1	7.4
V2-PKM-2	75.46	49.1	6.7
V3-ODC	69.76	43.4	8
V4-Local	76.66	50.3	7.1
F-test	S	S	S
SE(m)	0.577	0.577	0.2
C. D. (P = 0.05)	1.192	1.192	0.414
C.V.	0.25	0.25	0.03

3.4 Economics Analysis

Economics of all varieties were calculated according to the expenditure occurred from then raising till harvesting of pods viz. Cost of cultivation, gross return, net return, and benefit: cost ratio has been worked out for 4 varieties. The data on gross return in different treatment variety in moringa crop revealed that the highest gross return of 118932.219 ha-1 was obtained from the V1-PKM-1 and so on. The data

on net return in different variety in moringa crop revealed that the highest net return of (78760.2 ha-1) was obtained from the V1-PKM-1 and so on. The data on benefit-cost ratio in different hybrids variety in moringa crop revealed that the highest B:C ratio of (1: 1.97) was recorded from the treatments, V1-PKM-1 and minimum was (1:1.40) in V2-PKM-2.

Table 5: Cost benefit ratio of different varieties of ridge gourd

Treatments	Cost of cultivation (Rs/ha)	Total yield (g/ha)/200 sq. mt	Gross return (Rs/ha)	Net return Rs/ha	Benefit cost ratio
V1-PKM-1	40097.00	29.73	118932.219	78835.2	1.97
V2-PKM-2	40097.00	24.09	96363.675	56266.7	1.40
V3-ODC	40172.00	25.93	103709.97	63538	1.58
V4-Local	40022.00	24.68	98739.162	58717.2	1.47

4. Conclusion

The results from the present investigation concluded that the Performance of moringa variety viz., V1-PKM-1, followed by V2-PKM-2 and V3-ODC were identified as the superior traits like Survival percentage, No. of branches at the time of transplanting, Plant height after (60 days, 90 days, 120 days), Stem girth (cm), No. of pod per plant, Pod diameter (cm), Pod weight (g), Pod length (cm), Pod yield (t/ha), and V4-ODC performed best in terms of maximum Total leaf yield per plant (kg).

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