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Effect of organic, inorganic and bio-fertilizers on growth, yield and quality of moringa (*Moringa oleifera*)

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Abstract

The present investigation entitled "Effect of Organic, Inorganic and Bio-fertilizers on Growth, Yield and Quality of Moringa (*Moringa oleifera*)" was conducted at the Horticulture Research Field, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, during September, 2025 to April, 2026. The experiment was laid out in a Randomized Block Design comprising nine treatments including control replication thrice with a spacing of 2.5 m x 2.5 m row to row and plant to plant. The results showed significant variations, treatment T₇ (80% RDN through chemical fertilizer+ 20%through FYM + VAM + Azospirillum), recorded superior performance for highest plant height at harvesting stage (4.267 m), stem diameter (55.333 cm), number of new branches (6.833), days to first flowering (73.000), days to fifty percent flowering (90.000), number of flower per panicle (97.660), number of panicle per tree (34.643), pod weight (73.880 g), number of seed per pod (19.000), pod yield per hectare (63.237 t). Ascorbic acid (8.723 mg/100 g), and total soluble solids (8.030 °Brix). under the agro-climatic conditions of Prayagraj.

Keywords: VAM, Azospirillum, Number of panicles per tree, yield, Vitamin C

Introduction

Among the thirteen species of Moringaceae, *Moringa oleifera* alone has the multitude uses. Moringa possess many valuable properties, which make it of great scientific interest. Few of them are: high protein content in leaves, high protein and oil content in seeds, the large number of unique polypeptides in seeds that can bind many moieties, the presence of growth factor in the leaves etc. (Foidl *et al.*, 2001) ^[12].

It is used for animal forage, biogas production, dye extraction, gum collection, rope making, and pulp for papermaking, tannin extraction and soap making. The powdered seed is commercially used for water clarification (Folkard *et al.*, 2001) ^[16]; Moringa is in cultivation for fleshy pods in India, for seeds to extract oil and prepare flocculent with dried powder in Tanzania and for edible leaf harvest in Nigeria. Both the social appeal owing to its nutritive richness and medicative properties and commercial appeal in view of the use of seed powder in water purification and oil of ben in lubrication industries, have gained a status for moringa.

Consequent to the release of PKM-1 annual moringa a bushy type amenable for seed propagation, the commercial cultivation has gained momentum in India. About 8,000 ha in Tamil Nadu, 6,000 ha in Andhra Pradesh and 2,000 ha in Maharashtra are under PKM-1 moringa. After first ratoon, the crop is removed and resown again for new crop. Among the limiting factors of productivity, the nutrients application and their response in the growth and development of moringa largely decide the productivity and is a vital factor in as much as the soil, crop response which is always dynamic and vary extremely.

The moringa growing areas are cropped nearly eight months in a year and varying quantities of fertilizers have been applied over the years. This practice has resulted in the soil health deterioration and makes the soil, crop response and uptake of nutrients more complex that leads to deficiency of one or two elements. The restoration of soil health and enhancing the quality of the produce are considered as prime factors in recent times. A judicious combination of organics, inorganics and biofertilizers can sustain the commercial production

of moringa rather than the exclusive organic or inorganic production system.

Among the organic inputs, poultry manure is a cheap source and it contains more N, small amounts of urea and ammonium. VAM fungi have also been found to increase symbiotic nitrogen fixation and enhance the N uptake from soil. NPK stands for Nitrogen (N), Phosphorus (P), and Potassium (K), the three major essential nutrients required by plants for healthy growth and development. Farmyard Manure improves the physical, chemical and biological properties of soil.

Poultry manure releasing nutrients that can become available for plant uptake. Vesicular-Arbuscular Mycorrhiza colonizes the root system and develops fungal structures that help the plant explore a greater volume of soil. It improves the uptake and availability of plant nutrients, particularly phosphorus, and can also support better root development and plant growth. Azospirillum improve plant growth through biological nitrogen fixation and the production of plant growth-promoting substances.

The continuous use of inorganic fertilizers can increase crop productivity, but excessive or imbalanced application may contribute to soil degradation, nutrient losses, environmental pollution, and increased production costs. Organic manures, on the other hand, improve soil structure, organic matter, moisture retention, and microbial activity while supplying nutrients gradually. Bio-fertilizers can further enhance nutrient availability through beneficial microorganisms involved in nitrogen fixation, phosphate solubilization, and other biological processes. Therefore, integrating organic, inorganic, and bio-fertilizer sources may provide a more sustainable approach to nutrient management than relying on any single source to increase production, productivity and quality. Although several studies have examined fertilizer effects on moringa, information is still needed on the comparative and combined effects of different.

Nutrient sources on growth, yield, and quality under Prayagraj agro-climatic and soil conditions. Therefore keeping in view the above fact the present investigation is going to be carried on "Effect of organic, inorganic and biofertilizers on growth, yield and quality on moringa (*moringa oleifera*)" with the following objectives: To study the effect of different combination and treatment of organic manure, inorganic fertilizer and bio fertilizers on growth, yield and quality of moringa and to assess the economics of different treatments.

Materials and Methods

The experiment entitled "Effect of organic, inorganic and bio-fertilizers on growth, yield and quality of moringa (*Moringa oleifera*)" was carried out at Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj, and Uttar Pradesh during the month of September, 2025 - April, 2026. The experiment was laid in Randomized Block Design with 09 treatments including control in 03 replications. The experiment materials consist of morning variety PKM-1 with nine treatments were tried and replicated thrice viz. T₀: RDN (Control 45:15:30 NPK (g) + 15 kg FYM) per pit, T₁: 80% RDN through chemical fertilizer+ 20% through FYM, T₂: 80% RDN through chemical fertilizer + 20% through Poultry Manure, T₃: 80% RDN through chemical fertilizer + 20%through FYM + VAM, T₄: 80% RDN through chemical fertilizer + 20%through Poultry Manure+ VAM, T₅: 80% RDN through chemical fertilizer+ 20%through FYM + Azospirillum, T₆: 80% RDN through chemical fertilizer+ 20%through Poultry Manure + Azospirillum, T₇: 80% RDN through chemical fertilizer+

20%through FYM + VAM + Azospirillum, T₈: 80% RDN through chemical fertilizer+ 20% through Poultry Manure +VAM + Azospirillum with the spacing 2.5 m x 2.5 m were applied three times at the interval of one month. The data was collected for the parameters were Plant height at harvesting stage, Stem diameter, Number of new branches, Days to first flowering, Days to 50 per cent flowering, Number of flowers per panicle, Number of panicles per tree, Pod weight, Number of seeds per pod.

Pod Yield per hectare, Ascorbic acid, Total soluble solids (°Brix), Five plants were randomly selected for recording observations for growth, yield and quality parameters. The data collected during course of investigation were subjected to statistical analysis of variance (ANOVA) as described by Fisher (1950).

Results and Discussion

Effect of organic, inorganic and bio-fertilizers on growth parameters

Results in Table 1 showed significant differences and, Maximum plant height at harvesting stage was found in treatment T₇ (4.267 m), and minimum was found in T₀ (2.517 m), maximum stem diameter was found in treatment T₇ (55.333 cm), and minimum was found in T₀ (41.000 cm), maximum number of new branches treatments T₇ (6.833), minimum was found in T₀ (2.500). Enhanced vegetative growth with plants receiving 80% RDN through chemical fertilizer, 20% through FYM, VAM and *Azospirillum* might be due to N which has a strong direct effect in promoting protein synthesis, chlorophyll formation and cell division thereby, promoting vegetative growth. P promotes root development and energy metabolism and meristematic activity, while K improves photosynthesis, water regulation and carbohydrate translocation. Application of FYM could have further increased vegetative through gradual nutrient release and improvement of soil structure, moisture retention and microbial activity. VAM colonization might have increased the effective absorbing area of root system and particularly improves phosphorus, micronutrient and water uptake while *Azospirillum* might have promoted root development and nutrient acquisition as well as produces plant-growth-promoting substances, particularly auxin-like compounds, root proliferation and nutrient uptake, indirectly increasing shoot biomass and stem development thereby, providing greater resources for shoot development and branching. Thus, integrated application of inorganic.

Fertilizers with organic manures and bio-fertilizers might have resulted in increased plant height, improved stem diameter and promoted production of more number of new branches.

Effect of organic, inorganic and bio-fertilizers on earliness

Minimum days to first flowering was found in treatment T₇ (73.000), maximum was found in T₀ (93.333), minimum days to fifty percent flowering was found in treatment T₇ (90.000), and maximum was found in T₀ (110.333). presented in table 1. Earliness in plants receiving 80% RDN through chemical fertilizer, 20% through FYM, VAM and *Azospirillum* might be due chemical fertilizers which provided P and K which are especially important during transition from vegetative to reproductive growth. However, excessive nitrogen may prolong vegetative growth and delay flowering. Adequate P supports energy metabolism and reproductive development. VAM-mediated phosphorus uptake can be particularly beneficial during reproductive development. FYM and microbial inoculants might have accelerated flowering indirectly by

improving nutrient availability and root activity. Thus, first flowering was obtained under balanced nutrition which generally reduces number of days required to reach first flowering and fifty percent flowering.

Effect of organic, inorganic and bio-fertilizers on yield parameters

Maximum number of flower per panicle was found in treatment T₇ (97.660), and minimum was found in T₀ (63.780), maximum number of panicle per tree was found in treatment T₇ (34.643), and minimum was found in T₀ (22.377), maximum pod weight was found in treatment T₇ (73.880), and minimum was found in T₀ (29.883), maximum number of seed per pod was found in treatment T₇ (19.000), and minimum was found in T₀ (8.000), and maximum pod yield per hectare was found in treatment T₇ (63.237), and minimum was found in T₀ (19.253). Presented in table 1. Yield of plants receiving 80% RDN through chemical fertilizer, 20% through FYM, VAM and *Azospirillum* might be due to P which supports reproductive development and Energy transfer, while K might have improved enzyme activation, photosynthesis, carbohydrate transport and assimilation, promotes successful fertilization, embryo development and seed filling. Adequate N might have provided proteins, enzymes needed for reproductive growth and developing seed tissues. FYM can supplement inorganic fertilizers by improving soil structure, moisture retention, microbial activity and nutrient availability. VAM improves phosphorus acquisition and may enhance the availability of other nutrients, whereas *Azospirillum* promotes root growth and nutrient-use efficiency. This

combined effect might have increased flower production, number of panicles per tree, heavier pods because of better assimilate supply during pod development, better seed setting and higher number of seeds per pod. Pod yield is the cumulative result of plant growth, flowering, pod setting, pod size and seed development.

Effect of organic, inorganic and bio-fertilizers on quality parameters

Maximum ascorbic acid was found in treatment T₇ (8.723), minimum was found in T₀ (3.723), maximum TSS was found in treatment T₇ (8.030), minimum was found in T₀ (4.030). Presented in table 1. Improved quality of plants receiving 80% RDN through chemical fertilizer, 20% through FYM, VAM and *Azospirillum* might be due to better photosynthesis resulting from adequate N, together with improved P nutrition which improves carbohydrate production. K is particularly important because it activates enzymes involved in carbohydrate metabolism and facilitates translocation of photosynthates. FYM might have indirectly improved plant quality by improving overall plant nutrition and physiological activity. VAM-mediated improvement in nutrient and water uptake and growth-promoting effects of *Azospirillum* might have enhanced photosynthetic performance and metabolic activity thereby, contributing to improved ascorbic-acid accumulation. Consequently, higher ascorbic acid content and total soluble sugar content under an integrated nutrient treatment may indicate improved photosynthetic efficiency and carbohydrate accumulation resulting in higher soluble-sugar accumulation.

Table 1: Effect of organic, inorganic and bio fertilizer on growth parameter on vegetative, earliness, yield and quality of moringa

Treatments Notation	Plant height (m) at harvesting stage	Stem diameter (cm)	Number of new branches	Day to first flowering	Days to fifty percent flowering	Number of flower per panicle	Number of panicle per tree	Pod weight (g)	Number of seed per pod	Pod yield per hectare (t)	Ascorbic Acid (mg/100)	TSS (°Brix)
T ₀	2.517	41.000	2.500	93.333	110.333	63.780	22.377	29.883	8.000	19.253	3.723	4.030
T ₁	2.963	38.333	2.667	91.333	107.333	74.817	24.577	42.963	10.000	24.137	4.720	4.060
T ₂	3.200	41.333	3.833	88.667	105.000	79.817	26.670	47.780	11.000	32.043	5.707	5.030
T ₃	3.743	43.667	4.167	85.333	102.333	84.310	27.903	53.187	12.000	38.403	6.377	5.397
T ₄	3.907	46.667	5.167	83.333	98.667	90.817	29.610	61.790	15.000	49.043	7.727	6.713
T ₅	3.823	44.000	4.500	81.000	95.667	87.583	28.403	57.237	13.000	42.930	6.720	6.033
T ₆	3.950	48.667	5.333	78.333	93.000	93.183	31.170	65.177	16.000	53.177	8.047	7.057
T ₇	4.267	55.333	6.833	73.000	90.000	97.660	34.643	73.880	19.000	63.237	8.723	8.030
T ₈	4.017	53.000	6.167	74.000	91.000	95.663	32.677	72.063	17.000	60.177	8.400	7.393
F-Test	s	s	s	s	s	s	s	s	s	s	s	s
C.D. 0.05	0.120	2.068	0.795	0.732	0.732	3.491	0.932	4.531	0.582	0.815	0.487	0.487
SE(d) ±	0.056	0.967	0.372	0.342	0.342	1.633	0.436	2.119	0.272	0.381	0.228	0.228
C.V. (%)	1.908	2.587	9.951	0.504	0.423	2.345	1.862	4.634	2.479	2.796	4.176	4.668

Conclusion

From the present study it is concluded that treatment T₇ with (80% RDN through chemical fertilizer + 20% through FYM + VAM + *Azospirillum*), recorded highest growth, yield and quality parameters of moringa. It recorded the highest plant height at harvesting stage, stem diameter, number of new branches, days to first flowering, days to 50 per cent flowering, and number of flowers per panicle, number of panicles per tree, pod weight, number of seeds per pod, pod yield per hectare, Ascorbic acid and total soluble solids. Therefore, the application of 80% RDN through chemical fertilizer + 20% through FYM, VAM and *Azospirillum* was found be the most effective treatment for improving the growth, yield and quality of moringa under Prayagraj agroclimatic conditions.

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