International Journal of Environmental Sciences
ISSN: 2229-7359
Vol. 11 No. 24s, 2025
https://www.theaspd.com/ijes.php

The Effect of Organic Fertilizers on Bitter Gourd (Momordica Charantia) Agronomic and Quality Traits

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Abstract:
This study examines how different organic fertilizers, such as vermicompost, farmyard manure, and biofertilizers, affect the growth, flowering, and yield of bitter gourds (Momordica charantia) in the field during the summer in Sonipat district, Haryana. To evaluate the effects of various combinations of organic and inorganic nutrients on growth metrics such as plant height, leaf count, flower number, fruit number, and fruit length, a Randomized Complete Block Design (RCBD) comprising six treatments and three replications was used. At 75 days after sowing, treatment T5 (biofertilizer, vermicompost, and farmyard manure) yielded optimal results: 150 cm plant height, 104 leaves, 75 blooms, 35 fruits per plant, and an average fruit length of 7 cm. On the other hand, the control treatment (T0), which was devoid of fertilizer, continuously displayed the lowest results across the board. These results strongly imply that the combined use of organic fertilizers greatly increases the productivity of bitter gourds and can be used as a sustainable farming method to improve soil health and yield. The goal of the current study was to determine whether various organic inputs, such as vermicompost, farmyard manure, and biofertilizers, could improve bitter gourd growth and yield characteristics in the field when used alone or in combination. The objective was to improve soil health and lessen reliance on chemicals in order to advance sustainable agriculture.
***Keywords**: bitter gourd, biofertilizer, vermicompost, farmyard manure, NPK.*

1.INTRODUCTION-

The bitter gourd belongs to the Cucurbitaceae family and is one of the most important vegetable crops in the world. Eastern Asia is most likely where the bitter melon was domesticated, most likely in eastern India or southern China [1]. There are around sixty species of the native genus Mordica, which is found in Paleotropical areas. Bitter gourd is utilized as a food and medicine in tropical and subtropical regions, which include portions of South America, Asia, the Caribbean, and East Africa.

Momordica is derived from the Latin word "to bite," which refers to the uneven edges of the leaves that resemble biting marks. Research has demonstrated that the plant's medicinally used fruits and leaves have anti-inflammatory, antioxidant, anti-cancer, anti-cholesterol, anti-Alzheimer, antibacterial, and antifungal properties [2,3,4]. Bitter gourd is a warm-season vegetable that can withstand mild cold and thrives in hot, subtropical climates. As per Asna and [5], vines flourish at temperatures ranging from 25 to 30 degrees Celsius and on well-drained sandy to sandy loam soils with a pH between 4.3 and 8.7 [6]. The summer crop in the plains is usually planted in January or February, while the rainy season crop is usually planted in May. Compared to other species of the Cucurbitaceae, bitter gourds grow more slowly and need help to thrive. For healthy growth and development, organic fertilizers and manures are required. The structure of the soil is strengthened, and its capacity to hold water is increased by vermicompost and other organic manure [7,8,9]. It also facilitates simpler soil aeration. Vermicompost is created when a range of worm species, including red wigglers, white worms, and other earthworms, break down food scraps, bedding materials, and vegetable waste. This process results in vermicast (10). Nitrogen (N) stimulates the growth of leaves and stems, which makes plants bigger and more verdant. It is necessary for proteins, chlorophyll, and other essential plant chemicals. [11].

Plants require phosphorus (P) in order to develop roots, blossom, bear fruit, store and transmit energy, and produce DNA and other essential compounds [12]. Plants need potassium because it supports a number of physiological functions, including controlling water intake, increasing resistance to disease, improving photosynthesis, and generally increasing plant vigor [13]. Cropping systems can benefit from farmyard manure (FYM), an organic manure, as it enhances the physical properties of the soil and promotes nutrient recycling [14]. FYM helps plants grow by providing them with essential macro- and micronutrients, enhancing the relative C:N balance, adding organic matter to the soil, and facilitating plant nutrient absorption [15,16]. “Biofertilizers "are natural fertilizers composed of live microbial inoculants comprising bacteria, fungi, and algae that, either alone or in combination, boost the availability of nutrients to plants. Biofertilizers are goods that include one or more species of microorganisms that have the ability to mobilize chemicals of nutritional significance into a form that plants can use [17]. The bitter gourd shares a somatic chromosomal count of 22 [18], making it related to the African cucumber, bitter melon, balsam pear, and bitter cucumber [19].

The current study depends on figuring out how various organic fertilizers, such as vermicompost, biofertilizers, and farm waste, impact the growth, blooming, and yield of biter gourds. By using organic inputs to enhance soil structure, microbe activity, and nutrient availability, this study aims to promote sustainable farming practices. By aiding in the discovery of effective organic treatment combinations that optimize plant growth and output while reducing environmental impact, the research will contribute to the long-term sustainability of bitter gourd farming.

2. MATERIAL AND METHODS-

2.1 History of cropping and experimental site:

Investigation was conducted in an open field in the hamlet of Gamri, Sonipat district, during the summer of April 2024. The site is precisely located at latitude 29.149941 N and longitude 76.76377 E, or 197 meters above mean sea level. This area has 567 mm of annual rainfall on average, and its typical subtropical temperature is between 24°C and 34°C.

2.2 Properties of manure and soil:

Sandy loam was the kind of soil that was discovered at the test location. At a depth of 0 to 30 cm, soil samples were taken from the experimental plots. Before being examined nutritionally, these items were crushed and run through a 2 mm screen filter. The soil was physically and chemically analyzed at the Department of agriculture and farmers welfare, Haryana Krishi Bhawan Sector-21, Budanpur, Panchkula, soil testing laboratory of the Agricultural Directorate**.**

2.3 Methods and Experimental Settings:

A randomized complete block design (RCBD) analysis was conducted with three replications for five different dosages of organic fertilizers as treatments (T0 = control, T1 = basic NPK, T2 = biofertilizers, T3 = vermicompost, T4 = farmyard manure, and T5 = biofertilizer + vermicompost + farmyard manure). They collected the seeds of the bitter gourd. The seeds of the bitter gourd variety, vermicompost, Anushka F1 (clause), and NPK were gathered from the Gohana District (Sonipat). Cattle FYM served as the FYM in this experiment. It began to decay, and it took five months for it to reach maturity.

In the experimental setting, 18 plots, each measuring 24×21 meters, were used. Plants and rows were separated by 4 m and 20 cm, respectively. The experimental field had a total net area of 6.01 square meters, divided into three rows per plot.

2.4 Seeding and field preparation:

The field was initially ploughed with a tractor-drawn disc plow, and then it was harrowed twice. The seeds were steeped for an entire day before being buried 15 centimeters in the earth.

2.5 Applying manure and organic fertilizers:

At the time of sowing, vermicompost and farm manure (FYM) were applied at predetermined rates for each treatment. The following was the design of the experimental treatments: The following treatments were used: T5 was a combination treatment that included 290 g of farmyard manure, biofertilizers, and vermicompost. 80 g of basic NPK fertilizer was given to T1, 90 g of biofertilizer was given to T2, 105 g of vermicompost was given to T3, 95 g of farmyard manure was given to T4, and T0 was the control, which received no input. The purpose of these treatments was to compare how various nitrogen sources affected crop performance.

2.6 Bitter gourd culture:

2.6.1 Intercultural operations and gap filling:

Unhealthy and weak plants were cleared out. The field was allowed to develop sound seedlings, and appropriate weeding, watering, and staking methods were used. Starting 10 days after sowing (DAS) following germination, the experimental field was continually watered every 2-3 days during the dry season.

2.6.2 Collection:

Harvesting the fruit by hand was done after it was the right size and shape. Bitter gourds were harvested when they were nearly full, the seeds had not yet developed and set, and the skin had not yet produced a uniform green color. Individual fresh weights of each following harvest were recorded every other day.

Fig 1: ***Momordica charantia***

Results:

2.7. Growth metrics:

2.7.1. Height of plant (cm):

Using a meter scale, the tagged plants from each plot were measured in centimeters at 10 DAS. To calculate the mean height of the plant during the course of its development period, up to 75 DAS, further data was collected every 10 days. This data collection process was performed every 10 days. Similarly, the information was obtained by counting the number of leaves at regular intervals.

2.7.2. Flower count and number of days till initial blossoming:

For every treatment, the number of days until the first flowering was counted and recorded, and the mean values were calculated. Throughout the culture period, flowers were counted every 10 days after the initial bloom. The measurement of the plants' overall flower production and the tracking of blooming trends are made possible by this ongoing observation.

2.8. Yield and factors related to yield:

2.8.1. Number of fruits per plant, length of fruit (cm):

Specifically for the chosen plants, the dataset contained the number of fruits produced by each plant at the time of harvest. The length of the fruit when it was ready for sale was precisely measured by the tagged plant. The average fruit attributes of the chosen plants may be assessed thanks to the mean values that these measures produced.

2.8.2 Fruit production (t ha^{-} 1*):*

Fruits gathered from many harvests had to be weighed in order to calculate the yield. The plant yield was calculated as the total weight of all the fruits that were collected from a single plant throughout the growing season. The total yield was calculated when the harvest was finished.

3.1 Parameters of growth:

3.1.1 Height of plant (cm):

The plant height data for each treatment at 10, 20, 30, 40, 50, 60, and 75 DAS are shown in Table 1. Plant height was significantly impacted by simultaneously applying organic nutrition sources, outperforming the results of the separate treatments[20]. The average height of the plants varied from 30.45±0.5 cm at 30 DAS to 62.04±0.3 cm at 75 DAS. At 40 DAS, the plants in the combination of biofertilizer, farmyard, and vermicompost treatment grew to be the tallest at 77.25±1.3 cm, while the plants in the treatment control grew to be the shortest at 28.75±1.8 cm. At 75 days after sowing, the vermicompost treatment showed a moderate height of 62.04±0.3 cm, while the combination of biofertilizer, farmyard, and vermicompost treatment showed the highest height of 150.00±0.3 cm, followed by the control (51.00±0.0 cm), as shown in Table 1.

Table 1: The impact of different organic fertilizers on the height of plants.

Treatments	10Days	20 Days	30 Days	40 Days	50 Days	60 Days	75 Days
T0 (Control)	4.3±0.9	6.2± 0.5	13.15±0.2	28.75±1.8	3.35±1.1	42.15± 0.9	51.00± 0.0
T1 (Basic NPK)	4.5±0.8	7.3±0.4	26.05±0.3	36.25±1.7	44.15±1.8	50.25±0.8	59.00±0.1
T2 Biofertilizer	5.2±0.7	8.6± 0.3	28.22±0.4	37.04±1.6	45.20±1.7	50.75±0.7	62.36± 0.2

T3Vermicompost	5.5±0.6	7.7±0.2	30.45±0.5	36.75±1.5	47.00±1.6	52.50± 0.6	62.04± 0.3
T4(Farmyard manure)	5.6±0.5	6.8±0.1	35.33±0.4	40.00±1.4	48.75±1.5	53.75±0.5	65.54± 0.4
T5(Biofertilizer +Vermicompost + Farmyard manure)	9± 0.4	11.1±1.1	64.32±0.2	77.25±1.3	90.15±1.4	110.30±0.4	150.00±0.3

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. SEm(±) = Standard Errors of Means, ** = highly significant difference at $p < 0.0001$. T0:control(without any fertilizer), T1:Basic NPK, T2:Biofertilizer, T3:Vermicompost, T4: Farmyard manure, T5:Biofertilizer +Vermicompost + Farmyard manure.

3.1.2 Count of leaves on each plant

At 75 DAS, it was shown that various fertilizer applications significantly altered the results (Table 2). It was the T5 treatment that produced the most leaves per plant, 39±1.1. In contrast, the T0 treatment had the fewest leaves per plant (30±1.9), whereas the T3 treatment showed a reasonable number of leaves per plant (31±1.5) at 30 days. Treatment T5, which included biofertilizer, vermicompost, and farmyard manure, produced the most leaves per plant (104±1.1), followed by treatment T3 (vermicompost), which produced 73±1.3 leaves per plant, and treatment T0 (control), which produced 65±1.7 leaves per plant. These results suggest that the combination of biofertilizer, vermicompost, and farmyard manure significantly enhances leaf production compared to the control treatment[21]. Further research could explore the underlying mechanisms that contribute to this increased growth and assess the long-term effects on plant health and yield.

Table 2: Numbers of leaves on different organic fertilizers.

Treatments	10Days	20Days	30Days	40Days	50Days	60Days	75 Days
T0(Control)	3±1.1	16±1.9	30±1.9	38±1.8	47±0.8	58±1.5	65±1.7
T1(Basic NPK)	5±1.2	17±1.8	33±1.8	44±1.8	56±0.7	62±1.6	80±1.5
T2 (Biofertilizer)	5±1.5	19±1.6	36±1.7	41±1.6	64±0.5	70±1.4	78±1.4
T3(Vermicompost)	5±1.4	18±1.4	31±1.5	40±1.5	62±0.4	71±1.3	73±1.3
T4(Farmyard manure)	5±1.2	22±1.2	37±1.2	46±1.3	72±0.3	84±1.2	90±1.2
T5(Biofertilizer+ Vermicompost+ Farmyard manure)	5±1.0	21±1.2	39±1.1	45±1.2	75±0.1	96±1.1	104±1.1

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. SEm(±) = Standard Errors of Means, ** = highly significant difference at $p < 0.0001$. T0:control(without any fertilizer), T1:Basic NPK, T2:Biofertilizer, T3:Vermicompost, T4: Farmyard manure, T5:Biofertilizer +Vermicompost + Farmyard manure.

3.1.3 Numbers of flowers

During the treatment period, the least expensive flower count was observed. At 50 days, Treatment T3 produced the fewest flowers, with an average of 17 (±1.7), while Treatment T0 yielded the most, averaging 12 (±1.1). In contrast, over the course of 75 days, the control group (Treatment T0) recorded the lowest flower count at 23 (±1.5). Treatment T3 showed moderate flower counts at 37 (±1.7), while Treatment T5 had the highest flower counts, achieving a total of 75, thanks to the synergistic effects of vermicompost, farmyard manure, and biofertilizer.

Table 3: Numbers of flowers count

Treatments	10 days	20 Days	30 Days	40 Days	50 Days	60 Days	75 Days
T0(Control)	-	-	-	2±0.8	12±1.1	17±1.7	23±1.5
T1(Basic NPK)	-	-	-	4±0.5	12±1.3	22±1.6	34±1.6
T2(Biofertilizer)	-	-	-	3±0.4	14±1.7	19±1.4	32±1.5
T3(Vermicompost)	-	-	-	5±0.3	17±1.7	26±1.3	37±1.3
T4(Farmyard manure)	-	-	-	5±0.1	9±1.5	19±1.1	36±1.2
T5(Biofertilizer +Vermicompost +Farmyard manure)	-	-	-	8±1.7	19±1.3	37±1.7	46±1.5

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. SEm(±) = Standard Errors of Means, ** = highly significant difference at $p < 0.0001$. T0:control(without any organic fertilizer), T1:Basic NPK, T2:Biofertilizer, VC=Vermicompost, T4: Farmyard manure, T5:Biofertilizer +Vermicompost + Farmyard manure.

3.1.4 Fruit length, and fruit number

Analysis of the data showed a considerable amount of fruit, especially when considering the many treatments that were applied. This implies that the treatments have a major impact on the amount of time needed to produce fruit. The T5 combined treatment, which contained farmyard manure, vermicompost, and biofertilizer, produced the least amount of fruit (5±1.0) at treatment T0 and the highest amount of fruit (12±1.9) at 50 days. Furthermore, the average amount of fruit produced at treatment T2 at 50 days was 6 ± 0.3. According to Table 4, at 75 days, the plant treated with a combination of T5 biofertilizer, vermicompost, and farmyard manure produced the most fruit (35±1.7) and the least amount (11±0.7) at treatment T0.

Table 4: Number of fruits

Treatments	10 Days	20 Days	30 Days	40 Days	50 Days	60 Days	75 Days
T0(Control)	-	-	-	-	5±1.0	9±0.9	11±0.7
T1(Basic NPK)	-	-	-	-	7±0.4	15±0.6	18±0.7
T2(Biofertilizer)	-	-	-	-	6±0.3	18±0.3	22±0.5
T3(Vermicompost)	-	-	-	-	5±0.7	8±0.2	13±0.3
T4(Farmyard manure)	-	-	-	-	7±0.2	14±0.3	24±0.5
T5(Biofertilizer+ Vermicompost+ Farmyard manure)	-	-	-	-	12±1.9	19±1.8	35±1.7

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly at 0.05 level of probability. SEm(±) = Standard Errors of Means, ** = highly significant difference at $p < 0.0001$. T0:control(without any organic fertilizer), T1:Basic NPK, T2:Biofertilizer, VC=Vermicompost, T4: Farmyard manure, T5:Biofertilizer +Vermicompost + Farmyard manure.

3.1.5 Fruit Length of *Momordica charantia* at 50 Days After Sowing

In comparison to the T3 vermicompost treatment (3.3±0.5 cm), the maximum fruit length of the combined treatment of T5 biofertilizer, vermicompost, and farmyard manure was 5.2±1.3 cm, indicating a moderate length. The treatment T0 control group's fruit measured 4.6±0.9 cm shorter at 50 days. The highest fruit length of the combined treatment of T5 biofertilizer, vermicompost, and farmyard manure was 7±1.5 cm, suggesting a moderate length compared to the T3 vermicompost treatment's 4.9±0.5 cm[22]. At seventy-five days, the fruit length of the treatment T0 control was 4.6±0.9 cm shorter, as shown in Table 5.

Table 5: Fruit length of *Momordica charantia*

In a column means having similar letter(s) are statistically similar and those having dissimilar letter(s)

Treatments	10 Days	20 Days	30 Days	40 Days	50 Days	60 Days	75 Days
T0(Control)	-	-	-	-	4.3±1.1	4.3±1.9	4.6±0.9
T1 Basic NPK	-	-	-	-	5.1±1.0	5.9±1.0	6.3±0.8
T2 Biofertilizer	-	-	-	-	5.4±0.9	5.25±0.7	6.1±0.6
T3 Vermicompost	-	-	-	-	3.3±0.5	3.6±0.5	4.9±0.5
T4(Farmyard manure)	-	-	-	-	5.1±0.4	5.3±0.4	6.5±0.3
T5(Biofertilizer + Vermicompost+ Farmyard manure)	-	-	-	-	5.2±1.3	6.2±1.8	7±1.5

differ significantly at 0.05 level of probability. SEm(±) = Standard Errors of Means, ** = highly significant difference at $p < 0.0001$. T0:control(without any organic fertilizer), T1:Basic NPK, T2:Biofertilizer, VC=Vermicompost, T4: Farmyard manure, T5:Biofertilizer +Vermicompost + Farmyard manure.

CONCLUSION

The results of this study demonstrate that the combination of farmyard manure, vermicompost, and biofertilizer (T5) considerably enhanced plant growth and development when compared to the other treatments. The plants treated with T5 exhibited the highest height, total number of leaves, maximum number of blooms, maximum length, and maximum fruit production at 50 and 75 days after sowing (DAS). Specifically, plants under the T5 treatment produced 35 fruits, each measuring 7 cm in length, 104 leaves, and an astounding 150 cm in height at 75 DAS.

The unfertilized control group (T0) showed the least plant height, fewest leaves, and lowest fruit production. The smallest fruit length measured at 75 DAS was 4.6 cm. Other treatments, such as farmyard manure (T4), vermicompost (T3), and biofertilizer (T2), also had favorable outcomes, however not as much as the combined treatment of T5.

These findings suggest that using vermicompost, farmyard manure, and biofertilizer together significantly enhances a variety of growth metrics, including plant height, leaf count, flower count, fruit output, and fruit size. It is therefore a very effective and long-lasting way to boost crop output.

Conflict of Interest: The author have no conflict of interest.

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