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A Scientific Assessment of Integrated Nutrient Management Effects on the Growth and Productivity of *Trichosanthes anguina* L. (Snake Gourd)

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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

A field-based experimental investigation was undertaken from March to July 2020 at the Horticultural Farm of Sher-e-Bangla Agricultural University (SAU) in Dhaka, Bangladesh, to assess the impact of integrated nutrient management on the growth and yield of snake gourd (*Trichosanthes anguina* L.). The study employed a Randomized Complete Block Design with three

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replications, incorporating a total of 11 nutrient combinations. Various growth, reproductive, and yield parameters, including vine length, number of leaves per plant, leaf dimensions, flowering onset, fruit development, and yield metrics, were evaluated. The results consistently demonstrated positive effects across these parameters in response to different nutrient combinations. The highest recorded yield of snake gourd, at 50.10 t ha^{-1}, was observed in the T_{10} ((OM ($CD_5PM_5V_2$ t ha^{-1}) + $N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} + Mg_7 kg ha^{-1} + Zn_6 kg ha^{-1} + B_2 kg ha^{-1}) treatment, while the lowest yield, at 14.72 t ha^{-1}, was associated with the T_0 (control) treatment. This experiment highlights the prospective efficacy of integrated nutrient management methodologies in augmenting snake gourd production and optimizing crop yield. It provides valuable insights for the improvement of agricultural practices in the specified geographic region.

Keywords: Snake gourd; cow dung; poultry manure; vermicompost; NPKS; yield.

1. INTRODUCTION

Trichosanthes anguina L., an example of a vining vegetable species known as snake gourd, is a member of the day-neutral herbaceous Cucurbitaceae family. It is primarily grown in fields and household areas in Bangladesh throughout the summer. It plays an important role during early kharif season to meet up acute shortage of vegetables. Additionally, due to its great keeping quality, it has enormous export potential [1]. 100 grams of snake gourd contains the following nutrients: Calories 18, Protein 0.5gm, Carbohydrates 3.3 gm, Fibre 0.8gm, Fat 0.3gm, Calcium 26gm, Iron 1.51gm, Beta carotene 2.25gm. One of the most significant aspects in increasing production is plant nutrition, and a balanced diet that includes both macro and micronutrients is thought to be a must for high-quality and optimal plant growth [2]. The total production of snake gourd during 2016-17 was 38692 m. ton on the area of 19130 acres of land [3] which indicates the low yield potentiality as compared to India and Thailand. The yield of vegetables in our country is not satisfactory in comparison to our requirement [4]. Low yield of this crop in Bangladesh is mostly caused by a lack of nutritional combination. It is necessary to create a cost-effective fertilizer package that can supply all the necessary nutrients from both organic and inorganic sources in order to increase output while keeping production costs within the reach of the typical farmer. Multiple issues have arisen as a result of the excessive usage of just chemical fertilizers to attain high production [5]. Continuous application of heavy doses of chemical fertilizers without organic manures has led to deterioration of soil health in terms of physical and chemical properties of soil, decrease in soil microbial activities, and also reduction in soil humus [6]. According to the philosophy underpinning sustainable agricultural production, natural resources should be utilized to increase productivity and incomes, particularly for low-income people, without diminishing the natural resource base. INM asserts that in this situation, soils act as repositories for plant nutrients required for vegetative growth. INM strives to combine the use of all natural and artificial sources of plant nutrients in order to increase agricultural production in a cost-effective and environmentally responsible manner without affecting the soil productivity of future generations. INM success depends on a number of factors, such as knowledge transfer, appropriate fertilizer use, and conservation researchers and farmers who are knowledgeable about INM techniques [7]. A crucial component is organic stuff. It enriches the soil with organic matter, which could enhance soil aeration, moisture retention, structure, and water infiltration [8]. Vermicompost augments crop yield, augments soil moisture retention capabilities, enhances soil oxygenation, and enriches soil microbiota [9]. Therefore, present study is undertaken for evaluation of yield and growth of Snake gourd by using organic and inorganic fertilizer.

2. MATERIALS AND METHODS

2.1 Experimental Site and Design

The experiment was conducted at the Horticulture Farm of Sher-e- Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka, during the month from March 2020 to July 2020. The single factor experiment was laid out in Randomized Complete Block Design (RCBD) with three replications. There were 33 plots altogether in the experiment. The size of each plot was 1.5m × 1.5m.

2.2 Plant Materials

Pakunda, a locally grown Snake Gourd cultivar from Bangladesh, was the crop used in the experiment.

Table 1. The following dosages of manures and fertilizers were used.

Nutrient	Recommended dose/ha (kg)	Doze/plot (plot size: 2.25 m^2)										
		T_0	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T	T_9	T_{10}
N	80 kg	0	0	20g	20g	20g	20g	20g	20g	20g	20g	20g
P	35kg	0	0	40g	40g	40g	40g	40g	40g	40g	40g	40g
K	75 kg	0	0	34g	34g	34g	34g	34g	34g	34g	34g	34g
S	18kg	0	0	23g	23g	23g	23g	23g	23g	23g	23g	23g
Zn	6 kg	0	0	0	0	3g	0	0	3g	3g	0	3g
Mg	7 kg	0	0	0	0	0	0	3g	0	3g	3g	3g
B	1 kg	0	0	0	0	0	2.5 g	0	2.5 g	0	2.5 g	2.5 g
Cow dung	10000	0	2.2 kg	0	1.1 kg	1.1 kg	1.1 kg	1.1 kg	1.1 kg	1.1 kg	1.1 kg	1.1 kg
Poultry Manure	10000	0	2.2 kg	0	1.1 kg	1.1 kg	1.1 kg	1.1 kg	1.1 kg	1.1 kg	1.1 kg	1.1 kg
Vermicompost	5000	0	1 kg	0	500g	500 g	500 g	500 g	500 g	500 g	500 g	500 g

2.3 Treatment of the Experiment

The experiment consisted of various single factor:

T_0:control(No OM and inorganic fertilizer), **T_1**:OM($CD_{10}PM_{10}V_5$ t ha^{-1}),**T_2**: $N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} (RDF), **T_3**:OM ($CD_5PM_5V_2$ t ha^{-1})+$N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} (RDF), **T_4:**OM ($CD_5PM_5V_2$ t ha^{-1}) + $N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} + Mg_7 kg ha^{-1}, **T_5**: OM ($CD_5PM_5V_2$ t ha^{-1}) + $N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} + Zn_6 kg ha^{-1}, **T_6**: OM ($CD_5PM_5V_2$ t ha^{-1})+$N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1}+ B_2 kg ha^{-1}, **T_7**: OM ($CD_5PM_5V_2$ t ha^{-1})+$N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} + Zn_6 + B_2 kg ha^{-1}, **T_8**:OM ($CD_5PM_5V_2$ t ha^{-1}) + $N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1}+Mg_7 kg ha^{-1}+ Zn_6 kg ha^{-1}, **T_9**: OM ($CD_5PM_5V_2$ t ha^{-1}) + $N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} + Mg_7 kg ha^{-1} + B_2 kg ha^{-1} and **T_{10}**: OM ($CD_5PM_5V_2$ t ha^{-1}) + $N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} + Mg_7 kg ha^{-1} + Zn_6 kg ha^{-1} + B_2 kg ha^{-1}.

2.4 Application of Manures and Fertilizers

Following the endorsed guidelines for fertilizer application rates, the experimental plot received the application of both organic manures and synthetic fertilizers.[10].

2.5 Seed Sowing

Before planting, seeds were air dried because water saturated the seeds to aid in germination. On March 11, 2020, the seeds for Snake Gourd were planted. Before planting, the seeds were treated with Bavistin to prevent the spread of the illness. In a carefully prepared plot, seeds were sown with a row-to-row spacing of 30 cm and a plant-to-plant spacing of 10 cm (about).

2.6 Data Analysis

The data collected for various traits underwent statistical analysis using the software "Statistics 10." The mean values for all the recorded traits were computed, and an analysis of variance was conducted through the application of the 'F' test, which assesses variance ratios. To determine the statistical significance of the differences among the treatment means, Duncan's Multiple Range Test (DMRT) was employed at a significance level of 5%. [11].

3. RESULTS AND DISCUSSION

3.1 Vine Length (cm)

Application of various levels of organic and inorganic nutrients had a statistically significant impact on snake gourd vine length (cm) at all phases of growth (Table 2). At the vegetative stage, T_{10} treatment produced the longest vines (69.36 cm), which were statistically identical (65.91 cm) to T_9 treatment, and T_0 (control) treatment produced the shortest vines (42.48 cm). The T_{10} treatment produced the longest vines (211.69 cm), which were statistically identical to T_9 treatment (197.14 cm), during the blooming stage, whereas T_0 (control) treatment produced the shortest vines (107.29 cm). At the fruiting stage, T_{10} treatment had the longest vines (234.51 cm) and T_0 (112.43 cm) having the shortest vines (112.43 cm). Vine length is a crucial indicator of plant growth and vigor. The treatment T10, which involved the application of OM ($CD_5PM_5V_2$ t ha^{-1}) + $N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} + Mg_7 kg ha^{-1} + Zn_6 kg ha^{-1} + B_2 kg ha^{-1} demonstrated the most substantial improvement in vine length at all stages. This finding is consistent with the work of [12] who reported enhanced plant growth and nutrient uptake with combined organic and micronutrient treatments.

3.2 Number of Leaves Plant^{-1}

The number of leaves per plant is a critical parameter for *Trichosanthes anguina* L. (Snake Gourd) as it significantly influences photosynthetic processes. Notably, different nutrient combinations had statistically significant effects on the number of leaves per plant at all growth stages (Table 2). During the vegetative stage, T_{10} treatment produced the highest number of leaves per plant (56.14), statistically similar to T_5 (49.10), T_8 (53.08), and T_9 (53.40) treatments, while the lowest count (28.23) was recorded in the control group (T_0).

At the flowering stage, T_{10} also had the highest number of leaves per plant (87.30), statistically akin to T_9 (82.33) and T_8 (82.10) treatments, with the lowest count (45.78) observed in the control group (T_0).

Moving to the fruiting stage, T_{10} again displayed the highest number of leaves per plant (93.24), statistically identical to T_9 (89.87), and statistically similar to T_6 (81.95), T7 (83.31), and T_8 (86.39) treatments. The lowest number of leaves per plant (49.14) was found in the control group (T_0) during the fruiting stage. The number of leaves is an essential indicator of plant health and vigor. Integrated nutrient management (INM) significantly influenced the number of leaves in snake gourd plants. Incorporation of organic matter, such as cow dung (CD) and poultry manure (PM), in treatments T_8 to T_{10} resulted in a substantial rise in the number of leaves compared to the control treatment (T_0).

3.3 Days Required to First Male Flowering

Different dosages of organic and inorganic fertilizers had a statistically significant impact on how long it took for snake gourds to produce their first male flower (Table 2). The number of days needed for the first male flowers to develop has a significant impact on fruit set and production. The T_0 (control) treatment showed the highest days needed to reach first male flowering (60.06 days), whereas the T_{10} treatment, which produced results that were statistically identical to those of T_9 (48.12 days), exhibited the lowest number of days needed to reach first male flowering (47.97 days). INM treatments generally reduced the number of days to the first male flowers compared to the control. The minimum days to first fruit male flowering was recorded due to higher accessibility of nitrogen in the form of organic manure that induced protein production which might cause more meristem cells and finally cell division leads to earliness. The present result is in consonance with [13].

3.4 Days Required to First Female Flowering

Early fruit harvest is desirable for maximizing crop productivity. Similar to flowering, INM treatments accelerated the days to first fruit harvest compared to the control. When different doses of organic and inorganic nutrients were applied, the snake gourd's days until the first female flowering varied statistically significantly (Table 2). The T_0 (control) treatment had the highest number of days needed to reach first female flowering (56.31), whereas the T_{10} treatment had the lowest number of days needed (44.68). These results imply that INM treatments can significantly expedite flowering, potentially leading to increased fruit set and yield.

3.5 Number of Male Flowers Plant^{-1}

According to the experiment's findings, statistical analysis revealed a significant variance among the diverse combinations of organic and inorganic fertilizers in terms of the number of male flowers per plant (Fig. 1). The largest number of male flower plant^{-1} (79.85) was observed following the application of the T_{10} treatment, whilst the lowest number (55.98) was observed following the T_0 (control) treatment.

3.6 Number of Female Flowers Plant^{-1}

The study revealed a statistically significant correlation between the quantity of female flowers per plant in snake gourd and the application of various levels of organic and inorganic fertilizers, as illustrated in Figure 2. The experimental findings indicated that the highest number of female flowers per plant (25.65) was observed in treatment T_{10}, while the lowest number (15.67) was recorded in the control group, denoted as T_0.

Table 2. Effect of varying levels of organic and inorganic fertilizers on snake gourd plant (*Trichosanthes anguina* L.) vine length (cm), number of leaves plant^{-1} during different growth stages, days required for first male and female flowering, and days required for first fruiting.

Treatment	Vine length (cm)			Number of leaves per plant			Days required for first flowering		Days required for first fruiting
	Vegetative Stage(cm)	Flowering Stage(cm)	Fruiting stage (cm)	Vegetative Stage	Flowering Stage	Fruiting stage	Male	Female	
T_0	**42.48 g**	**107.29 d**	**112.43 e**	**28.23 g**	**45.78 g**	**49.14 g**	60.06 a	56.31 a	65.77 a
T_1	45.25 fg	112.80 d	117.58 e	34.58 fg	52.72 fg	56.17 fg	58.88ab	55.60 ab	64.57 b
T_2	45.87 fg	135.48 c	140.73 d	40.91 ef	61.60 ef	64.91 ef	57.78 bc	55.21 bc	64.09 b
T_3	50.41 ef	142.51 c	145.84 d	42.58 de	64.86 de	70.88 de	56.68 cd	55.10 bc	63.12 c
T_4	52.36 de	150.66 c	152.40 d	44.56 de	65.59 de	73.83 cde	56.29 d	54.19 c	61.96 d
T_5	55.09 cde	148.88 c	154.03 d	45.28 cde	71.93 cd	77.67 bcd	53.56 e	52.77 d	60.11 e
T_6	56.17 cd	149.13 c	155.55 d	49.10 abcd	72.44 bcd	81.95 abcd	52.11 f	50.72 e	58.70 f
T_7	60.21 bc	178.29 b	185.51 c	48.09 bcde	76.77 bc	83.31 abc	50.79 g	49.14 f	56.78 g
T_8	64.95 ab	195.63 ab	198.88 bc	53.08 abc	82.10 abc	86.39 ab	50.60 g	48.61f	56.68 gh
T_9	65.91 a	197.14 a	206.51 b	53.40 ab	82.33 ab	89.87 a	48.12 h	45.07 g	55.85 h
T_{10}	**69.36 a**	**211.69 a**	**234.51 a**	**56.14 a**	**87.30 a**	**93.24 a**	47.97 h	44.68 g	54.41 i
$LSD_{(0.05)}$	**5.6297**	**17.753**	**18.896**	**7.8564**	**10.247**	**11.554**	1.3179	**1.0291**	0.8947
CV%	**5.98**	**6.63**	**6.77**	**10.23**	**8.67**	**9.02**	**6.35**	**6.64**	**5.89**

In a column, means with similar letter (s) are not significantly different and those having dissimilar letter (s) are significantly different by LSD at 5% level of significance. Where, T_0: control (No organic manure and inorganic fertilizer), T_1:OM ($CD_{10}PM_{10}V_5$ t ha^{-1}), T_2:$N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} (RDF),T_3:OM ($CD_5PM_5V_2$ t ha^{-1})+$N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} (RDF),T_4:OM($CD_5PM_5V_2$ t ha^{-1})+$N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1}+Mg_7 kg ha^{-1},T_5:OM($CD_5PM_5V_2$ t ha^{-1})+$N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} + Zn_6 kg ha^{-1}, T_6: OM ($CD_5PM_5V_2$ t ha^{-1}) + $N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1}+ B_2 kg ha^{-1}, T_7: OM ($CD_5PM_5V_2$ t ha^{-1})+ $N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} + Zn_6 + B_2 kg ha^{-1}, T_8: OM ($CD_5PM_5V_2$ t ha^{-1}) + $N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} + Mg_7 kg ha^{-1}+ Zn_6 kg ha^{-1}, T_9:OM($CD_5PM_5V_2$ t ha^{-1}) + $N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} + Mg_7 kg ha^{-1} + B_2 kg ha^{-1} and T_{10}: OM ($CD_5PM_5V_2$ t ha^{-1}) + $N_{80}P_{35}K_{75}S_{18}$ kg ha^{-1} + Mg_7 kg ha^{-1}+Zn_6 kg ha^{-1} + B_2 kg ha^{-1}

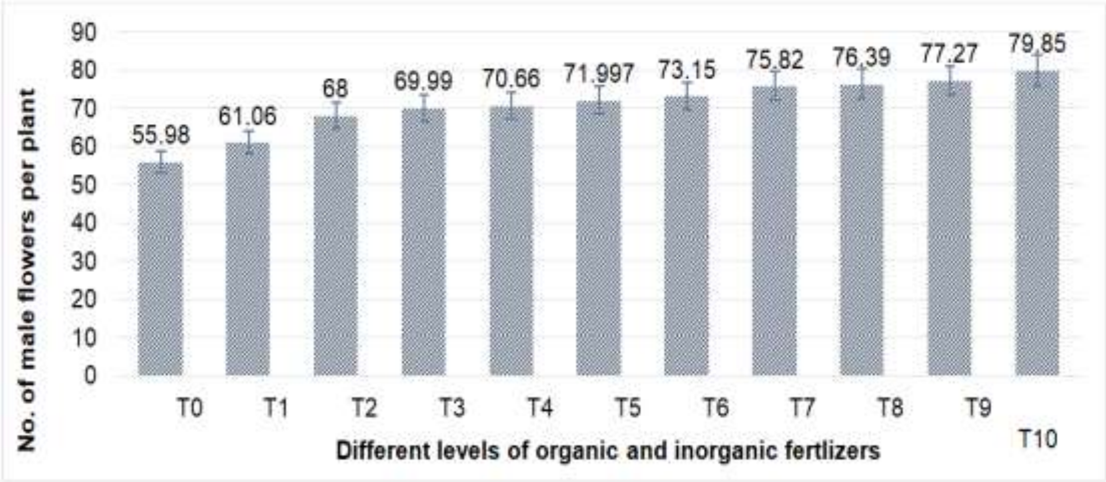

Fig. 1. Influence of various fertilizer concentrations, both organic and inorganic, on the number of male flowering plants in plant of the snake gourd (*Trichosanthes anguina* L.)

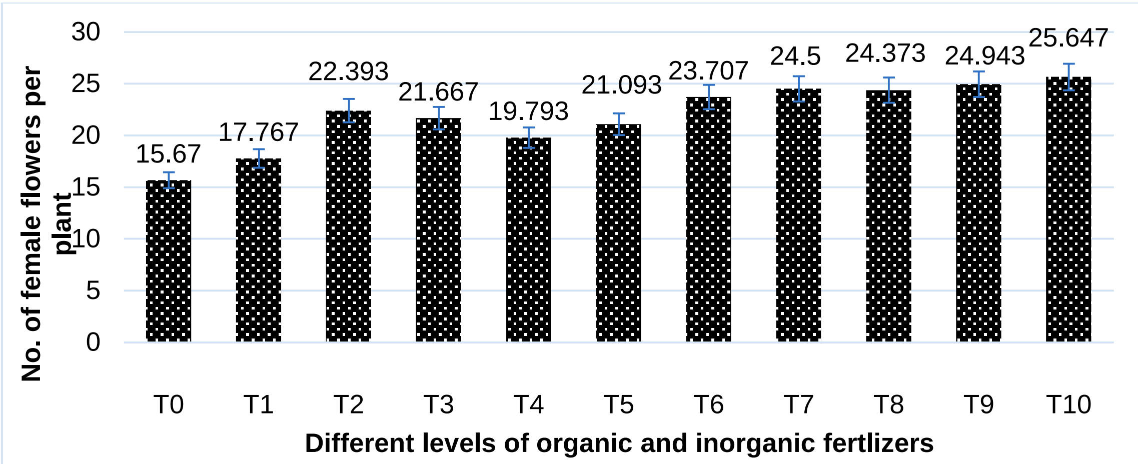

Fig. 2. The impact of various fertilizer concentrations, both organic and inorganic, on the number of female flowering plants in plant-1 of the snake gourd (*Trichosanthes anguina* L.)

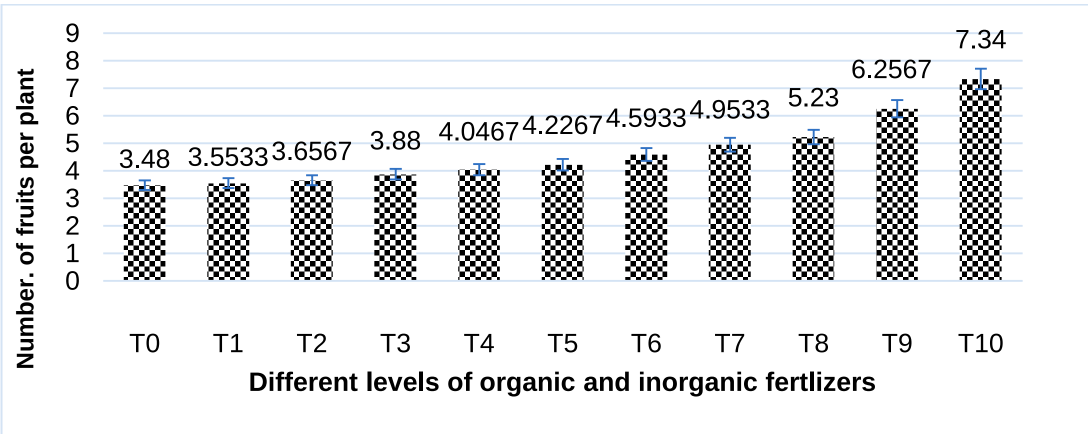

Fig. 3. Impact of various fertilizer concentrations, both organic and inorganic, on the quantity of fruits produced by single plant of the snake gourd (*Trichosanthes anguina* L.)

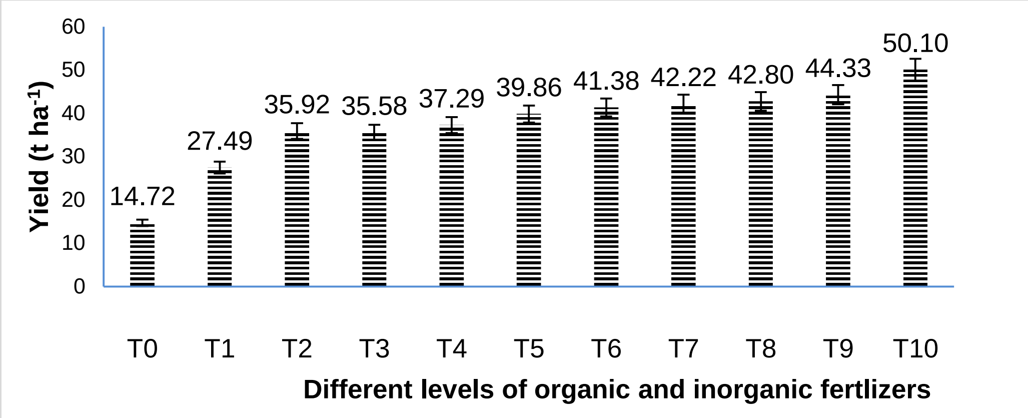

Fig. 4. Influence of various quantities of organic and inorganic fertilizers on the yield (t ha^{-1}) of *Trichosanthes anguina* L., a plant that produces snake gourds

3. 7 Days Required for First Fruiting

Significant statistical variances were detected in the duration necessary for the initial fruiting of snake gourd as a consequence of varying levels of organic and inorganic fertilizer application, as depicted in Table 2. The findings revealed that the greatest duration required for the snake gourd to bear its first fruit (65.77 days) was observed in the T_0 (control) treatment, while the shortest duration for the first fruiting of snake gourd (54.41 days) was observed in the T_{10} treatment. The shortest time to first fruit harvest was observed in T_{10}, emphasizing the synergistic benefits of organic matter, RDF, and micronutrient supplementation in achieving early fruiting. The minimum days to first fruit harvest was recorded due to higher accessibility of nitrogen in the form of organic manure that induced protein production which might cause more meristem cells and finally cell division leads to earliness or maturity of fruits. The present result is in consonance with [13].

3.8 Number of Fruits Plant^{-1}

The quantity of fruits produced per plant and the overall crop yield are pivotal factors in determining the success of a crop and its economic viability. As depicted in Figure 3, the findings demonstrate that the implementation of integrated nutrient management exerted a positive impact on fruit production and yield in the context of snake gourd cultivation. The experimental results indicated that the highest number of fruits per plant (7.34) was observed in the T_{10} treatment, while the lowest number of fruits per plant (3.48) was documented in the T_0 treatment.

Yield is a crucial parameter reflecting the overall success of a crop management strategy. INM treatments consistently outperformed the control in terms of yield. Treatments involving organic matter, RDF, and micronutrients (T_1 to T_{10}) exhibited significantly higher yields compared to the control (T_0). Statistically significant differences in yield (t ha-1) of snake gourd were observed among various nutrient combinations (see Fig. 4). The findings indicated that the maximum yield, 50.10 t ha^{-1}, was obtained in the T_{10} treatment, while the minimum yield, 14.72 t ha^{-1}, was observed in the T_0 treatment. These findings highlight the effectiveness of integrated nutrient management in enhancing snake gourd yield, particularly when combining organic inputs, recommended fertilizers and micronutrients.

4. CONCLUSION AND RECOMMENDATION

The study shows that integrated nutrient management significantly improves the growth, flowering, and fruiting of snake gourd. The application of organic matter, essential nutrients, and micronutrients accelerates these processes, increasing fruit yield and overall production. This suggests that integrated nutrient management can enhance crop profitability. Further research is needed in different agro-ecological zones for regional adaptability and performance. The results are tentative and require more variables for confirmation.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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