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EFFECT OF INTEGRATED NUTRIENT MANAGEMENT ON STEM GROWTH PARAMETERS OF OKRA (*ABELMOSCHUS ESCULENTUS* L.MOENCH) C.V. ARKA ANAMIKA

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ABSTRACT

Okra is an essential vegetable / food crop cultivated worldwide including India. This crop, contributes to the livelihoods of millions of small farmers (FAO, 2023b). India is the largest producer of okra, accounting for ~70% of the world's production (FAO, 2021). Integrated Nutrient Management (INM) has emerged as an effective approach for improving crop productivity while maintaining soil health. The present study, conducted during the Zaid season of 2022-23, 2023–24 at the Horticulture Research Farm, CCR(PG) College, Muzaffarnagar (U.P.), evaluated the effects of Integrated Nutrient Management (INM) on growth and yield of okra (*Abelmoschus esculentus* L. Moench) Cv. Arka Anamika. The experiment included eight treatments combining organic manures (FYM, poultry manure, vermicompost) and inorganic fertilizers, laid out in a Randomized Block Design with three replications. Among the treatments, T6 (FYM @ 10 t/ha + VC @ 5 t/ha) and F9 (NPK @ 50% RDF + VC @ 5 t/ha) significantly enhanced plant height, number of leaves, branches, nodal development, fruit yield, and biomass accumulation. Maximum yield (48.32 q/ha) was recorded with T6. The study highlights the potential of INM, particularly the synergistic use of FYM and vermicompost, in improving okra productivity and soil health. Adoption of such sustainable nutrient strategies can reduce dependency on chemical fertilizers while enhancing crop performance.

Keywords: Organic Manure, vermicompost, , NPK, Morphology, Growth, Okra

INTRODUCTION

Okra, commonly referred as bhendi (*Abelmoschus esculentus* (L.) Moench), is an annual vegetable belonging to the family Malvaceae (Puneeth et al., 2022). Okra is a warm-season vegetable well adapted to tropical and subtropical climates. Okra is an essential food crop cultivated worldwide including India. This crop, contributes to the livelihoods of millions of small farmers (FAO, 2023b). India is the largest producer of okra, accounting for ~70% of the world's production (FAO, 2021). It is a highly versatile crop with significant applications in culinary, medicinal, and industrial fields. The tender green pods are widely used in cooking, adding flavor and texture to dishes such as curries, stews, and gumbo. Due to its mucilaginous nature, okra also serves as a natural thickening agent in soups and sauces. In many cultures, it is pickled or served as a side dish. Nutritionally, okra is an excellent source of dietary fiber, vitamins A, C, and K, folate, and antioxidants, all of which contribute to improved digestion, cardiovascular health, and blood sugar regulation.

Organic manures, including farmyard manure, compost, and vermicompost, are derived from natural sources and play a vital role in enhancing soil health. These inputs improve soil structure, increase water-holding capacity, and stimulate beneficial microbial activity, thereby contributing to overall soil fertility (Gayathri and Krishnaveni, 2015). They supply essential macronutrients such as nitrogen, phosphorus, and potassium in a slow-release form, promoting sustained nutrient availability and balanced plant growth over time.

Application of inorganic fertilizers can lead to negative consequences, including soil acidification, nutrient leaching, and environmental pollution. Prolonged dependence on chemical fertilizers may also reduce soil organic matter content, ultimately compromising long-term soil fertility and sustainability (Bodamwal et al., 2006). In okra cultivation, the application of organic manures has been shown to improve plant vigor, enhance root development, and boost the plant's resistance to biotic stresses such as pests and diseases (Kachari and Gogoi, 2020). Moreover, these amendments strengthen the soil's resilience against erosion and contribute to sustainable farming practices by minimizing environmental degradation.

Although organic manures generally contain lower nutrient concentrations compared to synthetic fertilizers—necessitating the application of larger quantities to meet crop nutrient requirements—they remain indispensable for restoring soil organic matter and maintaining long-term ecological balance (Kaur et al., 2022).

Arka Anamika is a prominent okra variety developed by the ICAR–Indian Institute of Horticultural Research. It is widely recognized for its high yield potential, resistance to pests, and adaptability to diverse agro-climatic conditions. Despite these advantages, maximizing the performance of *Arka Anamika* remains a challenge due to various biotic and abiotic stresses, particularly those arising from suboptimal soil fertility and improper nutrient management practices (Narwariya et al., 2023). This study, therefore, seeks to develop an optimized INM approach tailored to the specific needs of this cultivar, thereby contributing to both scientific knowledge and practical agricultural advancement.

To address these challenges, Integrated Nutrient Management (INM) has emerged as an effective approach for improving crop productivity while maintaining soil health. INM promotes the balanced use of chemical fertilizers, organic manures, and bio-fertilizers to optimize nutrient availability, enhance soil biological activity, and improve overall soil structure (Panta and Parajulee, 2021). This integrated approach not only rectifies nutrient imbalances but also reduces reliance on synthetic inputs and contributes to environmentally sustainable agriculture (Choudhary et al., 2015).

In light of these considerations, the present investigation has been conducted with aiming To investigate the individual and combined effects of organic manures and inorganic fertilizers on the stem growth parameters of okra.

MATERIALS AND METHOD

The present field experiments were conducted during the Zaid season of 2023–24 at the Horticulture Research Farm, Department of Horticulture, CCR (PG) College, Muzaffarnagar, Uttar Pradesh (India) situated at 29.01°N latitude and 77.43°E longitude, with an elevation of 222 meters above mean sea level.

The site is geographically located in the subtropical belt of Northern India. The meteorological data recorded during the experimental period are presented in Table 1. The maximum temperature ranged up to 29.2°C, while the minimum dropped to 4.9°C. Relative humidity varied between 88.2% and 35.31%, and a total of 64.32 cm rainfall was received during the month of May.

Table- 1 Mean monthly meteorological data recorded during the experimental period (2023-24)

SMW	Week Period	2023		2024		2024		2023		2024	
		Temp. Max (°C)	Temp. Min (°C)	Temp. Max (°C)	Temp. Min (°C)	RH Max (%)	RH Min (%)	RH Max (%)	RH Min (%)	Rainfall (cm)	Rainfall (cm)
10	Mar 5 – Mar 11	29.2	14.1	30.2	13.1	88.2	40.23	80.2	38.5	0	0
11	Mar 12 – Mar 18	29.2	14.1	30.1	15.1	88.2	40.23	85.2	38.8	0	0
12	Mar 19 – Mar 25	29.2	14.1	32.2	14.1	88.2	40.23	86.2	38.5	0	0
13	Mar 26 – Apr 1	29.2	14.1	31.1	14.1	88.2	40.23	87.2	38.9	0	0
14	Apr 2 – Apr 8	25.1	10.8	26.5	11.9	84.67	35.31	85.87	35.89	0	0
15	Apr 9 – Apr 15	25.1	10.8	26.5	12	84.67	35.31	85.87	35.78	0	0
16	Apr 16 – Apr 22	25.1	10.8	26.5	12.5	84.67	35.31	84.67	35.31	0	0
17	Apr 23 – Apr 29	25.1	10.8	27	12.5	84.67	35.31	86.5	35.68	0	0
18	Apr 30 – May 6	21	4.9	22	6	91.2	41.21	91.2	42.21	16.08	0
19	May 7 – May 13	21	4.9	23	6	91.2	41.21	93	42.2	16.08	0
20	May 14 – May 20	21	4.9	22	6.5	91.2	41.21	92.5	42.3	16.08	0
21	May 21 – May 27	21	4.9	24	6	91.2	41.21	92	44	16.08	0
22	May 28 – Jun 3	21	4.9	22	5	91.2	41.21	92	43.3	0	0
23	Jun 4 – Jun 10	21.3	8	23.3	8.5	86.53	45.41	85.5	45.2	0	11
24	Jun 11 – Jun 17	21.3	8	22	8.9	86.53	45.41	85.7	44.5	0	10
25	Jun 18 – Jun 24	21.3	8	22.2	8.8	86.53	45.41	87.5	44.8	0	15
26	Jun 25 – Jul 1	21.3	8	22.9	8.9	86.53	45.41	85.5	49.2	0	16

The topography of the field experiment was fairly uniformed. The soil samples were collected before the sowing of okra from the depth 0-15 cm from the soil surface was air dried, sieved through 2 mm stainless steel sieved and then stored in the plastic bag for physical and chemical analysis. The soil sample was analyzed from the soil testing lab Meerut. On the bases of analysis, the physical and chemical properties of experimental field soil are present in table 2 showed that the soil was loamy sand and texture,

Table-2: Physical and Chemical value of experimental field soil (2024)

S. No.	Soil characteristics	Value obtained	Method used
1	Fined sand	55.1 %	Hydrometer Method
2	Silt	24.3 %	Hydrometer Method
3	Clay	21%	Hydrometer Method
4	Texture	Sandy loam	International pipette Method
5	Organic carbon	0.44%	Black's Method
6	Total Nitrogen	0.051%	Subbiah Method
7	Available Phosphorus	0.078 %	Olsen' s Method
8	Available Potash	0.0201%	Flame Photometer Method
9	Zink	0.009%	Flame Photometer Method
10	Boron	0.0022%	Flame Photometer Method
11	Molybdenum	0.0012%	Flame Photometer Method
12	pH	7.4	Beckman's pH meter
13	Electric Conductivity (EC) m. mhos./cm	3.1	Conductance Method

Table -3: Details of experimental treatment

Sr. No	Notation	Treatment
1	T	Control
2	T_2	Farm yard manures (FYM)@ 20 t/ha
3	T_3	Poultry manure (PM)@10t/ha
4	T_4	Vermin-compost (VC) @ 10t/ha
5	T_5	Farm yard manures (FYM)@ 10 t/ha+ PM@5t/ha
6	T_6	Farm yard manures (FYM)@ 10 t/ha+ VC@5t/ha
7	T_7	Poultry manure (PM)@ 5t/ha+VC@5t/ha
8	T_8	NPK@50%RDF+FYM@10t/ha
9	T_9	NPK@50%RDF+VC@5t/ha
10	T_{10}	NPK@50%RDF+PM@5t/ha

Design and Layout of the Experiment

Variety	Arka Anaika
Design of layout	Randomized block design (RBD)
Number of treatments	10
Number of replications	3
Number of plants per plot	15
Plant distance	50x40 cm2 (Row x Plant)
Net plot size	1.215x27= 32.805 m2
Width of path	1 meter
Width of main irrigation channel	1 meter
Width of experimental border	30 cm
Width of experimental field	13.85 m
Length of experimental field	24.30 m
Size of experimental field	13.5x7.2= 97.2 m2

The land was brought to a fine tilt by ploughing with mould board plough and harrowing twice after the harvest of the previous crops. The plots were laid out as per the plan of the layout. Organic manures were applied according to the treatment specifications (Table 3) after the layout of the experimental field was completed.

Arka Anamika is a prominent okra variety which was used in experiments. This okra variety was developed through interspecific hybridization between Abelmoschus esculentus and A. manihot ssp. tetraphyllus var. tetraphyllus, followed by backcross breeding. Released by ICAR-IIHR, Bengaluru. Hybrid variety of okra (Arka Anamika) was used in the study which was sowed on 1st of March, 2023 by hand dibbling of one and two seeds per holl at 2-3cm depth with a spacing of 50x40 cm between plant to plant and row to row respectively. Gap filling was done two weeks after sowing of the seeds in order to maintain proper plant population.

Irrigation was given once in 8-10 days during the crop growth till harvesting period depending upon the weather condition. In order to check weed growth and to maintain the field weed free field, manual weeding with the help of khurpi was done regularly during the early crop growing days. 18 Hoeing and thinning at the plant quality or proper distance in plants a know control of disease and air circulation plants interval of 15 days starting from 30 days after sowing. A mixture of Chlorpyriphos 20% E.C and Thiamethoxam 25% WG power was sprayed to prevent caterpillars and green aphids from feeding on the foliage.The fruit was harvest manually by hand picking at an interval of 2-3 days and. A total number of six pickings were done,

In order to assess the effect of different foliar nitrogen spray on the growth and yield of the crop, periodical observations were recorded from each net plot, five plants were randomly selected and observations on growth was recorded periodically 30,45, 60, Days After Sowing (DAS) and at harvest.

RESULTS

Plant height (cm)

Plant height of okra increased progressively with the advancement of crop age and was significantly influenced by the foliar application of various nitrogen sources. At 30 DAS, the tallest plants (16.63 cm) were observed in treatments involving integrated nutrient application (Table 4.1, Figure 4.1, Plate 2). The final plant height at the time of first picking ranged significantly among treatments, with the maximum height (79.69 cm) recorded in treatment T6 (FYM @ 10 t/ha + VC @ 5 t/ha), followed closely by T9 (NPK @ 50% RDF + VC @ 5 t/ha) which recorded 76.74 cm. These treatments showed the highest percentage increase in plant height over the control (60.3 cm), with T6 showing a 32.15% increase and T9 a 27.26% increase. In contrast, the lowest growth was observed in the untreated control (T1), which also recorded the minimum per cent increase. These results clearly indicate that the combined application of organic manures and reduced levels of inorganic fertilizers significantly enhances vegetative growth in okra.

Stem base diameter (cm)

Integrated nutrient management practices significantly influenced the stem base diameter of okra plants (Table 4.2, Figure 4.2). The thickest stems were observed in T6 (FYM @ 10 t/ha + VC @ 5 t/ha), which recorded a stem base diameter of 2.25 cm, corresponding to a 33.14% increase over the control (T1: 1.69 cm). Among the other treatments, T9 (NPK @ 50% RDF + VC @ 5 t/ha) and T7 (PM @ 5 t/ha + VC @ 5 t/ha) showed notable improvements, with stem diameters of 2.07 cm (22.49% increase) and 1.95 cm (15.38% increase) over the control, respectively. The significant increase in stem base diameter under integrated nutrient treatments highlights the positive impact of combining organic and inorganic nutrient sources on okra plant vigor.

Number of branch per plants (cm)

At 30 DAS, the highest number of branches (3.44) was recorded in treatment T9 (NPK @ 50% RDF + VC @ 5 t/ha), while the lowest (1.23) was recorded in the control (T1) (Table 4.3, Figure 4.3, Plate 2). Regardless of the treatment, the number of branches increased progressively with plant age. At the time of harvest, the maximum number of branches (3.98) per plant was observed in treatment T7 (PM @ 5 t/ha + VC @ 5 t/ha), whereas the control consistently showed the lowest number of branches. These results emphasize the positive impact of integrated nutrient management on branching in okra, particularly when poultry manure and vermicompost are used in combination.

Fresh weight of plants (g)

The highest mean fresh weight at harvest (14.43 g) was recorded in treatment T9 (NPK @ 50% RDF + VC @ 5 t/ha), which was significantly superior to the control (8.90 g). However, the maximum fresh weight (15.48 g) and per cent increase over control (89.01%) were recorded in treatment T6 (FYM @ 10 t/ha + VC @ 5 t/ha) (Table 4.12, Figure 4.12). These results suggest that integrated nutrient management involving both organic and inorganic sources significantly enhances the biomass accumulation in okra plants.

Dry Weight of Plant (g/plant)

The dry weight of okra plants was significantly influenced by different nutrient management treatments. The highest dry plant weight (4.11 g) was recorded in treatment T9 (NPK @ 50% RDF + VC @ 5 t/ha), which was significantly greater than that of all other treatments (Table 4.13, Figure 4.13).. However, the maximum dry weight (5.01 g) and corresponding percent increase were achieved with T6 (FYM @ 10 t/ha + VC @ 5 t/ha), emphasizing the synergistic effect of combined organic manures in enhancing total dry matter accumulation in okra.

Table 4.1 Effect of Integrated Nutrient Management on plant height (cm) of Okra

Treatments	Notation	Plant height (cm)	Per cent increase over control
Control	T_1	60.3	-----------
Farm yard manures (FYM)@ 20 t/ha	T_2	74.83	24.09
Poultry manure (PM)@10t/ha	T_3	74.47	23.49
Vermin-compost (VC) @ 10t/ha	T_4	74.88	24.17
Farm yard manures (FYM)@ 10 t/ha+ PM@5t/ha	T_5	74.4	23.38
Farm yard manures (FYM)@ 10 t/ha+ VC@5t/ha	T_6	79.69	32.15
PM@ 5t/ha+VC@5t/ha	T_7	75.57	25.32

NPK@50%RDF+FYM@10t/ha	T_8	75.49	25.09
NPK@50%RDF+VC@5t/ha	T_9	76.74	27.26
NPK@50%RDF+PM@5t/ha	T_{10}	75.29	24.85
CD at 5%		0.538	
SEm (±)		0.180	

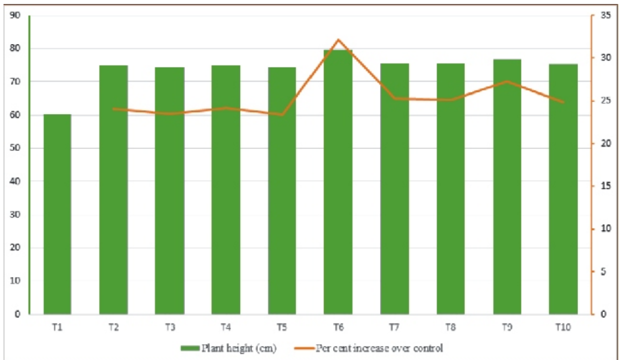

Fig 4.1. Effect of Integrated Nutrient Management on plant height (cm) of Okra

Table 4.2. Effect of Integrated Nutrient Management on Stem base diameter (cm) on Orka

Treatments	Notation	Stem base diameter(cm)	Per cent increase over control
Control	T_1	1.69	————————-
Farm yard manures (FYM)@ 20 t/ha	T_2	1.81	7.10%
Poultry manure (PM)@10t/ha	T_3	1.8	6.51%
Vermin-compost (VC) @ 10t/ha	T_4	1.84	8.88%
Farm yard manures (FYM)@ 10 t/ha+ PM@5t/ha	T_5	1.79	5.92%
Farm yard manures (FYM)@ 10 t/ha+ VC@5t/ha	T_6	2.25	33.14%
PM@ 5t/ha+VC@5t/ha	T_7	1.95	15.38%
NPK@50%RDF+FYM@10t/ha	T_8	1.89	11.83%
NPK@50%RDF+ VC@5t/ha	T_9	2.07	22.49%
NPK@50%RDF+PM@5t/ha	T_{10}	1.85	9.47%
CD at 5%		0.200	
SEm (±)		0.067	

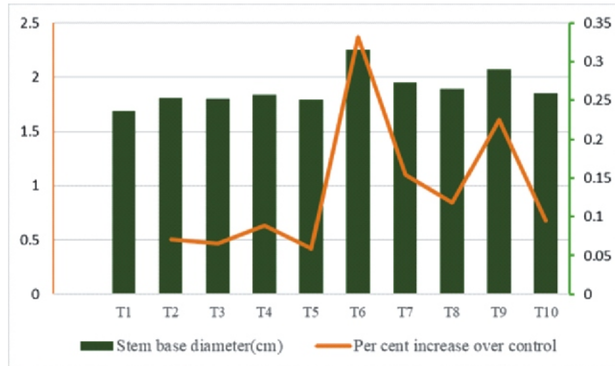

Figure 4.2. Effect of Integrated Nutrient Management on Stem base diameter (cm) of Okra

Table 4. Effect of Integrated Nutrient Management on Number of branch/plants of Okra

Treatments	Notation	Number of branch/ plants	Per cent increase over control
Control	T_1	1.23	-----------
Farm yard manures (FYM)@ 20 t/ha	T_2	3.13	154.47
Poultry manure (PM)@10t/ha	T_3	3.12	153.65
Vermin-compost (VC) @ 10t/ha	T_4	3.04	147.15
Farm yard manures (FYM)@ 10 t/ha+ PM@5t/ha	T_5	3.12	153.65
Farm yard manures (FYM)@ 10 t/ha+ VC@5t/ha	T_6	3.98	223.57
PM@ 5t/ha+VC@5t/ha	T_7	3.1	152.03
NPK@50%RDF+FYM@10t/ha	T_8	3.07	149.59
NPK@50%RDF+ VC@5t/ha	T_9	3.44	179.67
NPK@50%RDF+PM@5t/ha	T_{10}	3.22	161.78
CD at 5%		0.087	
SEm (±)		0.029	

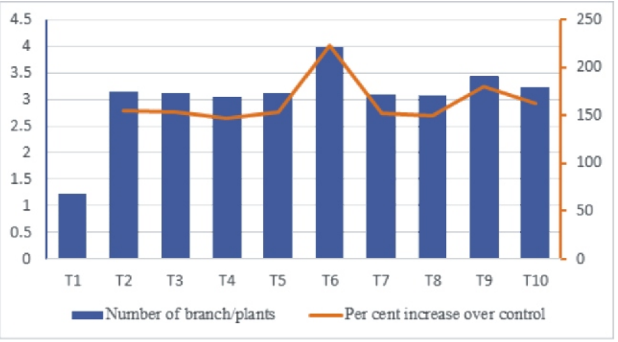

Fig 4.3. Effect of Integrated Nutrient Management on number of branch/plants of Okra

Table 4.13. Effect of Integrated Nutrient Management on Dry weight of plant of Okra

Treatments	Notation	Dry weight of plant	Per cent increase over control
Control	T_1	2.18	-----------
Farm yard manures (FYM)@ 20 t/ha	T_2	4.04	85.32
Poultry manure (PM)@10t/ha	T_3	4.06	86.23
Vermin-compost (VC) @ 10t/ha	T_4	4.42	102.75
Farm yard manures (FYM)@ 10 t/ha+ PM@5t/ha	T_5	4.08	87.15
Farm yard manures (FYM)@ 10 t/ha+ VC@5t/ha	T_6	5.11	134.4
PM@ 5t/ha+VC @ 5t/ha	T_7	4.15	90.36
NPK@50%RDF+FYM @10t/ha	T_8	4.24	94.49
NPK@50%RDF+VC@5t/ha	T_9	4.88	123.85
NPK@50%RDF+PM@5t/ha	T_{10}	4.36	100
CD at 5%		0.091	
SEm (±)		0.030	

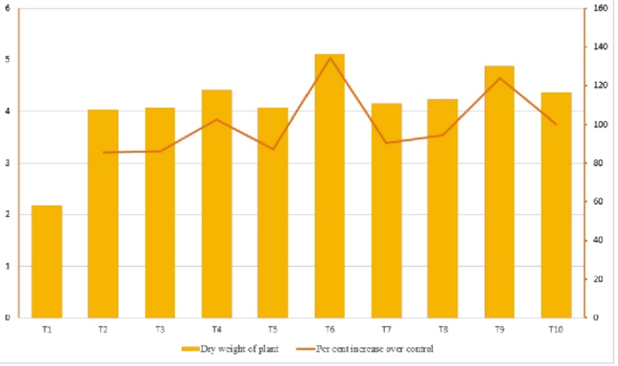

Fig 4.13. Effect of Integrated Nutrient Management on Dry weight of plant (g) of Okra

Table 4.12. Effect of Integrated Nutrient Management on Fresh weight of plant (g) of Okra

Treatments	Notation	Fresh weight of plant (g)	Per cent increase over control
Control	T_1	8.19	-----------
Farm yard manures (FYM)@ 20 t/ha	T_2	13.54	65.32
Poultry manure (PM)@10t/ha	T_3	13.67	66.91
Vermin-compost (VC) @ 10t/ha	T_4	13.92	69.96
Farm yard manures (FYM)@ 10 t/ha+ PM@5t/ha	T_5	13.72	67.52
Farm yard manures (FYM)@ 10 t/ha+ VC@5t/ha	T_6	15.48	89.01
PM@ 5t/ha+VC@5t/ha	T_7	13.82	68.74
NPK@50%RDF+ FYM@10t/ha	T_8	13.86	69.23
NPK@50%RDF+ VC@5t/ha	T_9	14.43	76.19
NPK@50%RDF+ PM@5t/ha	T_{10}	13.97	70.57
CD at 5%		0.112	
SEm (±)		0.037	

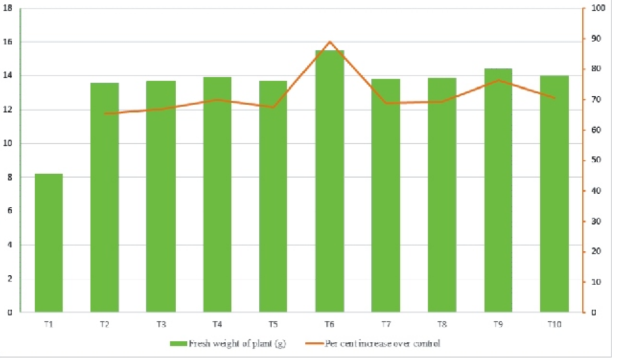

Fig 4.12. Effect of Integrated Nutrient Management on Fresh weight of plant (g) of Okra

DISCUSSION

Plant height (cm)

Plant height in okra increased progressively with crop age and was significantly influenced by the foliar application of various nitrogen sources. At 30 DAS, the tallest plants (16.63 cm) were observed in treatments receiving integrated nutrient application.

At the time of first picking, the maximum plant height (79.69 cm) was recorded in T6 (FYM @ 10 t/ha + VC @ 5 t/ha), followed by T9 (NPK @ 50% RDF + VC @ 5 t/ha) with 76.74 cm. Both treatments showed notable increases over the control (60.3 cm), with T6 and T9 reflecting 32.15% and 27.26% increases, respectively.

The improved plant height under integrated treatments may be attributed to the continuous nutrient release from organic sources, enhancing nitrogen availability and uptake. Nitrogen plays a crucial role in cell elongation and division, thereby promoting vegetative growth (Singh et al., 2014). These results align with findings by Chaudhary et al. (2018) and Miah et al. (2020), who also reported enhanced growth with integrated nutrient management in okra. Kumar et al. (2019) reported that the combined application of organic and chemical fertilizers enhances the plant height of okra. Integrated nutrient management (INM) helps maintain soil organic matter while improving the nutrient content and structural condition of the soil, thereby positively influencing the vegetative growth and reproductive traits of okra.

Stem base diameter (cm)

The stem base diameter of okra plants was also significantly increased under INM treatments. The maximum stem diameter (2.25 cm) was observed in T6, indicating a 33.14% improvement over control (T1: 1.69 cm). Other treatments, such as T9 (2.07 cm; 22.49% increase) and T7 (1.95 cm; 15.38% increase), also showed marked improvements.

The thickening of the stem base may be due to better root proliferation and vegetative vigor promoted by integrated nutrient application. Organic amendments not only improve nutrient uptake but also enhance soil structure and water-holding capacity. Similar findings were reported by Chaudhary et al. (2018), Miah et al. (2020), and Kumar et al. (2019), who demonstrated that the integration of organic and inorganic sources improves overall plant robustness and health.

Number of branch per plants (cm)

At 30 DAS, the highest number of branches (3.44) was observed in treatment T9 (NPK @ 50% RDF + VC @ 5 t/ha), while the control (T1) recorded the lowest (1.23). A consistent increase in the number of branches was noted as the plants matured. At harvest, the maximum branching (3.98 branches per plant) was recorded in treatment T7 (PM @ 5 t/ha + VC @ 5 t/ha), whereas the control remained lowest throughout the growth period.

These results clearly indicate the beneficial effect of integrated nutrient management in promoting lateral growth and branching in okra. The combination of poultry manure and vermicompost in T7 appears particularly effective, likely due to enhanced nutrient availability and improved soil health. Anand and Kadam (2016) found that, maximum number of branches was observed in the treatment of 60% N through neem cake with 40% N through urea. As the nitrogen is essential for the synthesis of proteins and it might have helped in production of more number of branches. Patil et al. (2004) found the same result in tomato plant. Thus it can be inferred from this result that application of INM (organic and inorganic) significantly affected the number of branches per plant.

Fresh weight of plants (g)

The highest mean fresh weight at harvest (14.43 g) was recorded in treatment T9 (NPK @ 50% RDF + VC @ 5 t/ha), which was significantly higher than the control (8.90 g). However, the maximum fresh weight (15.48 g) and the highest percentage increase over control (89.01%) were observed in treatment T6 (FYM @ 10 t/ha + VC @ 5 t/ha).

These results underscore the positive influence of integrated nutrient management in enhancing biomass accumulation in okra. The superior performance of T6 and T9 may be attributed to the combined effects of organic and inorganic nutrient sources, which improve nutrient availability, soil structure, and microbial activity. While poultry manure and vermicompost increased fresh weight significantly, the highest gain was achieved when FYM was combined with vermicompost, likely due to the sustained nutrient release and improved root zone environment.

These findings are consistent with the observations reported by Bhushan et al. (2013), Amran et al. (2014), Singh et al. (2018), and Mishra et al. (2019), who also noted increased fresh biomass in okra under integrated nutrient regimes.

Dry Weight of Plant (g/plant)

The dry weight of okra plants was significantly affected by the various nutrient management treatments. Treatment T9 (NPK @ 50% RDF + VC @ 5 t/ha) recorded the highest dry plant weight among the inorganic-integrated treatments (4.11 g), while the maximum dry weight overall (5.01 g) and the greatest percent increase over control were observed in T6 (FYM @ 10 t/ha + VC @ 5 t/ha).

These results underscore the synergistic effect of combining organic manures in enhancing total dry matter accumulation. The improved biomass may be attributed to the nutrient-solubilizing capacity of vermicompost, which enhances nutrient uptake, particularly NPK. Organic manure also plays a critical role in supporting plant growth by releasing essential macro- and micro-nutrients through mineralization, while simultaneously improving soil structure and microbial activity.

Similar trends have been reported by Abduli et al. (2012), Singh et al. (2014), and Singh et al. (2018), who found that organic nutrient sources significantly boost dry matter production in okra.

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