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EFFECT OF ORGANIC NUTRIENTS ON GROWTH PARAMETERS OF MORINGA (*MORINGA OLEIFERA* LAM.) FOR LEAF PRODUCTION

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Abstract

The present study on the effect of organic nutrients on growth parameters of moringa for leaf production (*Moringa oleifera* Lam.) was carried out 2018-2019 in the vegetable unit, Department of Horticulture, Faculty of Agriculture, Annamalai University, Annamalai Nagar. The experiment was carried out with thirteen treatments and three replications under randomized block design. The organic treatments of soil application with vermicompost (5 t ha^{-1}) + azospirillum and phosphobacteria @ 2kg ha^{-1} + foliar spray of panchakavya @ 3 percent has shown significant improvement in growth parameters like plant height, number of branches, plant spread and leaf area than all other treatments at different harvesting stages of *Moringa oleifera*.

Keywords: Plant height, Number of branches, plant spread, Leaf area.

Introduction

Drumstick (*Moringa oleifera*), belongs to the family Moringaceae. It is a handsome softwood tree, native of India, occurring wild in the sub Himalayan regions of Northern India and now grown worldwide in the tropics and subtropics, whereas in India it is grown all over the subcontinent for its tender pods and also for its leaves and flowers. Moringa trees have been used to combat malnutrition especially among infants and nursing mothers. Since moringa thrives in arid and semiarid environments, it may provide a versatile, nutritious food source throughout the year. Moringa leaves have been proposed as an iron-rich food source to combat iron deficiency. The leaves can serve as rich source of Beta-carotene (Nambiar and Seshadri, 2001), vitamin C, vitamin E and polyphenolics. Moringa, an indigenous plant, is now valued for providing the leaves and fruits for vegetable with nutraceutical traits. Leaf, flower, bark, root and even wood are also used. Thus is considered as one of the world's wonder crop, packed with nutrients in all its plant parts. Traditionally, moringa was used by people to prevent and protect various physiological disorders, since it contains 7 times more vitamin C than orange, 4 times more calcium than milk, 4 times more vitamin A than carrot, 2 times more protein than milk and 3 times more potassium than banana, besides, its richness in iron. The pods and leaves of moringa contains high amount of calcium, magenesium, potassium, zinc, and iron. (Aslam *et al.,* 2005). Moringa contain antioxidants called flavonoids, polyphenols and ascorbic acid in the leaves. Organic manuring has positive influence on soil texture and water holding capacity. Farm yard manure, vermicompost and biofertilizers are gaining importance for obtaining higher yield and quality. Hence the present study was undertaken with the objective of studying the growth parameters of moringa, under organic nutrient management system.

Materials and Methods

The present investigation on the effect of organic nutrients on growth parameters of moringa (*Moringa oleifera* Lam.) for leaf production, was carried out at the vegetable unit of the Department of Horticulture, Faculty of Agriculture, Annamalai University during 2018-2019. The design followed was randomized block design with thirteen treatments and three replications. The thirteen treatment combinations were T_1-FYM @12.5t ha^{-1} + azospirillum and phosphobacteria @ 2kg ha^{-1}, T_2-FYM @ 25t ha + azospirillum and Phosphobacteria @ 2 kg ha^{-1}, T_3 _Vermicompost @ 2.5 t ha^{-1} + azospirillum and phosphobacteria @ 2 kg ha^{-1}, T_4- Vermicompost @ 5 t ha + azospirillum and phosphobacteria @ 2kg ha^{-1}, T_5-FYM @ 12.5t ha^{-1} + azospirillum and phosphobacteria @ 2 kg ha^{-1} + panchakavya @ 3 percent foliar spray, T_6-

FYM '@ 25t ha^{-1} + azospirillum and phosphobacteria @ 2kg ha^{-1} + panchakavya @ 3 percent foliar spray, T_7 - Vermicompost @ 2.5 t ha^{-1} + azospirillum and phosphobacteria @ 2 kg ha^{-1} panchakavya @ 3 percent foliar spray, T_8-Vermicompost @ 5 t ha^{-1} + azospirillum and phosphobacteria @ 2 kg ha^{-1} + Panchakavya @ 3 percent foliar spray, T_9-FYM @ 12.5 t ha^{-1} + azospirillum and phosphobacteria @ 2 kg ha^{-1} + neemcake extract @ 10 percent foliar spray T_{10}-FYM @ 25 t ha^{-1} + azospirillum and phosphobacteria @ 2 kg ha^{-1} + neemcake extract @ 10 percent foliar spray, T_{11}-Vermicompost @ 2.5 t ha^{-1} + azospirillum and phosphobacteria @ 2 kg ha^{-1} + Neemcake extract @ 10 percent foliar spray, T_{12}- Vermicompost @ 5 t ha^{-1} + azospirillum and phosphobacteria @ 2 kg ha^{-1} + neemcake extract @ 10 percent foliar spray, T_{13}-Absolute control.

Observations on growth parameters were recorded on 35 days intervals starting from 70 days after sowing and totally six harvest were made during the study period. Observations were recorded on plant height, number of branches $plant^{-1}$, number of leaves $plant^{-1}$ and plant spread. The statistical analysis of data was done by Panse and Sukhatme (1985). The critical difference was worked out for 5 percent level of significance. The IRRISTAT software was used for the statistical analysis of data.

Results and Discussion

Plant height

The data recorded on the effect of organic nutrients on plant height at (35, 70, 105, 140, 175, 210) days after planting are furnished in the table 1, which showed significant variations for the trait among different treatments. Gradual increase in plant height was observed in all the treatments at periodical intervals. Among the treatments tested, the plants which received the application of T_8 (Vermicompost @ 5t ha^{-1} + azospirillum and phosphobacteria @ 2kg ha^{-1} +panchakavya @ 3 percent foliar spray) recorded the highest plant height of 84.73, 114.28, 138.90, 143.18, 151.18 and 163.26 cm at (35, 70, 105, 140, 175 and 210 DAP) The lowest plant height was recorded at T_{13} control which recorded 53.13, 80.28, 102.66, 105.74, 111.34 and 122.16 cm at (35, 70, 105, 140, 175 and 210DAP) respectively.

The reasons for the increased plant height might be due to vermicompost which contains major and minor nutrients in available forms, enzymes, antibiotics, vitamins, beneficial microorganisms and other plant growth hormones and have definite advantage over other organic manures in respect of growth, yield, quality and shelf life of produce which as stated by Meerabai *et al.,* (2001). This is found to be in accordance with the findings of Abdul (2008) who stated that organic amendments like vermicompost increased microbial activity and enzyme production, which in turn, bring about the aggregate stability of soil particles, resulting in better aeration and they also have a property of binding mineral particles like calcium, magnesium and potassium in the form of colloids of humus and clay, facilitating stable aggregates of soil particles for desired porosity to sustain plant growth. According to Kandil and Gad (2009), organic manures also enhances soil aggregation, water holding capacity and supports the root system by flow of nutrients which in combination creates favourable conditions for root respiration, nutrients absorption, root and shoot growth. Increase in plant height due to vermicompost has been reported by several workers such as Sharma and Sunita (2014) in Spinach and Elumalai (2013) in okra.

Panchakavya is a fermented organic manure with high microbial load which includes effects of microorganisms and methylotrophs profile bacteria, would have enhanced the production of phytohormones like auxin and giberellins that have inturn stimulated the growth by increasing the plant height as evidenced from the work of Xu *et al.,* (2000). Panchakavya enhanced the biological efficiency of crop plants and improved the growth and yield of vegetables. Natarajan, (2002).

Azospirillum and phosphobacteria were found to improve available N and P in soil there by sustaining the soil health, thus helps to improve the growth parameters

Table 2: Effect of organic nutrients on plant height (cm) in moringa cv. PKM-1

Treatment	Plant Height (cm)					
	35DAP	70DAP	105DAP	140DAP	175DAP	210DAP
T_1	55.90	83.23	105.79	108.97	114.77	125.71
T_2	61.38	89.07	111.99	115.37	121.57	132.75
T_3	58.65	86.16	108.90	112.18	118.18	129.24
T_4	64.09	91.96	115.06	118.54	124.94	136.22
T_5	74.57	103.32	127.14	131.02	138.22	149.90
T_6	79.69	108.84	133.06	135.14	144.74	156.62
T_7	69.37	97.68	121.14	124.82	131.62	143.10
T_8	84.73	114.28	138.90	143.18	151.18	163.26
T_9	71.98	100.51	124.15	127.93	134.93	146.51
T_{10}	77.14	106.09	130.11	134.09	141.49	153.27
T_{11}	66.74	94.83	118.11	121.69	128.29	139.67
T_{12}	82.22	111.57	135.99	140.17	147.97	159.95
T_{13}	53.13	80.28	102.66	105.74	111.34	122.16
Grand mean	69.01	97.15	120.61	123.95	131.48	140.64
$S.E_D$	0.59	0.40	0.74	0.76	0.54	0.83
CDP =(0.05)	1.23	0.82	1.54	1.57	1.12	1.71

as reported by Bhunia *et al.,* (2006).

Number of branches

The data recorded on number of branches in moringa due to the effect of different organic nutrients is presented in table 2. Significant differences were recorded due to the application of different organic nutrients. The number of branches was found to be the highest in T_8 which received the application of Vermicompost @ 5t ha^{-1} + azospirillum and phosphobacteria@ 2kg ha^{-1} + panchakavya @ 3 percent foliar spray which recorded 3.65, 4.65, 5.98, 6.88, 7.16 and 7.45 (at 35, 70, 105, 140, 175 and 210 DAP). The least number of branches was recorded in T_{13} (control) which recorded 1.01, 1.00, 1.02, 1.08, 4.52 and 4.81 (at 35, 70, 105, 140, 175 and 210 DAP) respectively.

The reason for the highest number of branches was due to enhanced release of N from the growth promoting substances produced by the microbes present in panchakavya which might have resulted in the induction of more laterals.

Higher number of branches observed in the panchakavya treatments, might be due to the fact that adequate quantity of enzymes present in cells of microbes favoured rigid growth. Similar findings were also reported by Phate *et al.,* (2014) in tomato and Khan *et al.,* (2019) in spinach.

Table 2: Effect of organic nutrients on number of branches $plant^{-1}$ in moringa cv.PKM-1

Treatment	Number of branches $plant^{-1}$					
	35DAP	70DAP	105DAP	140DAP	175DAP	210DAP
T_1	1.34	1.36	1.38	2.08	4.85	5.14
T_2	1.94	2.04	2.31	2.25	5.45	5.74
T_3	1.65	1.65	1.80	2.31	5.16	5.45
T_4	2.21	2.41	2.80	3.28	5.72	6.01
T_5	3.09	3.69	4.56	4.25	6.60	6.89
T_6	3.41	4.21	5.32	6.64	6.92	7.21
T_7	2.69	3.09	3.72	4.14	6.20	6.49
T_8	3.65	4.65	5.98	6.88	7.16	7.45
T_9	2.90	3.40	4.15	4.06	6.41	6.70
T_{10}	3.26	3.96	4.95	6.49	6.77	7.06
T_{11}	2.46	2.76	3.27	3.54	5.97	6.26
T_{12}	3.54	4.44	5.67	6.77	7.05	7.34
T_{13}	1.01	1.00	1.02	1.08	4.52	4.81
Grand mean	2.55	2.97	3.61	5.76	6.0	6.28
$S.E_D$	0.05	0.06	0.07	0.03	0.04	0.03
CDP =(0.05)	0.10	0.12	0.15	0.06	0.08	0.06

Table 3: Effect of organic nutrients on plant spread (cm) in moringa cv. PKM-1

Treatment	Plant spread (cm)					
	35DAP	70DAP	105DAP	140DAP	175DAP	210DAP
T_1	45.22	59.57	63.49	67.74	68.08	79.73
T_2	52.06	64.77	69.49	74.14	74.68	86.73
T_3	48.65	62.18	66.50	70.95	71.39	83.24
T_4	55.45	67.34	72.46	77.31	77.95	91.20
T_5	69.09	77.42	84.14	89.79	89.83	103.88
T_6	76.21	79.24	89.86	95.91	97.15	110.60
T_7	62.17	72.42	78.34	83.59	84.43	97.08
T_8	83.25	87.18	95.50	101.95	103.39	117.24
T_9	65.50	74.93	81.25	86.70	87.64	100.49
T_{10}	72.66	79.89	87.01	92.86	94.00	107.25
T_{11}	58.82	69.89	75.41	80.46	81.20	93.65
T_{12}	79.74	84.77	92.69	98.94	100.28	113.93
T_{13}	41.77	56.94	60.46	64.51	64.75	76.20
Grand mean	62.17	71.83	78.09	83.34	84.18	96.68
$S.E_D$	0.32	0.36	0.99	0.96	0.97	0.99
CDP =(0.05)	067	0.76	2.05	2.0	2.01	2.05

Plant spread

The data recorded on plant spread due to the effect of various organic nutrients are furnished in table 4. The treatment T_8 which received the application of Vermicompost @ 5t ha^{-1} + azospirillum and phosphobacteria @ 2kg ha^{-1} + panchakavya @ 3 percent foliar spray recorded maximum plant spread of 83.25, 87.18, 95.50, 101.95, 103.39 and 117.24 cm on (35, 70, 105, 140, 175 and 210DAP) respectively. The lowest plant spread was found in T_{13} (control) which recorded 41.77, 56.94, 60.46, 64.51, 64.75 and 76.20 cm on 35, 70, 105, 140, 175 and 210DAP.

The increase in plant spread due to the increased uptake of nutrients might be the reason for increased plant spread in both direction. This is found to be in accordance with findings of Kumar *et al.,* (2013) who stated that the application of vermicompost in broccoli increased the nutrient uptake of the plant resulting in increased plant growth characters.

Leaf area

The data pertaining to the effect of various organic nutrients on leaf area is presented in table 5. The treatment, T_8 (Vermicompost @ 5t ha^{-1} + azospirillum and phosphobacteria @ 2kg ha^{-1} + panchakavya @ 3 percent foliar spray) recorded the highest leaf area of 268.86, 275.60, 288.72, 292.25, 298.20 and 310.34 cm^2 on (35, 70, 105, 140, 175, 210DAP) respectively. The lowest leaf area was recorded in T_{13} which recorded 236.18, 243.16, 254.56, 268.73, 269.16 and 278.90 cm^2 at 35, 70, 105,140, 175 and 210 DAP.

Table 4: Effect of organic nutrients on leaf area (cm^2) in moringa cv. PKM-1

Treatment	Plant spread (cm)					
	35DAP	70DAP	105DAP	140DAP	175DAP	210DAP
T_1	239.01	246.89	257.53	270.80	271.69	281.63
T_2	244.61	252.29	263.41	274.88	276.69	287.03
T_3	240.82	247.60	260.48	272.85	274.20	284.34
T_4	247.38	254.96	266.32	276.89	279.16	289.70
T_5	258.26	265.44	277.68	284.73	288.84	300.18
T_6	263.58	270.56	283.24	287.53	293.56	305.30
T_7	252.86	260.24	272.04	280.85	284.04	294.98
T_8	268.86	275.60	288.72	292.25	298.20	310.34
T_9	255.57	262.85	274.87	282.80	286.45	297.59
T_{10}	260.93	268.01	280.47	286.64	291.21	302.75
T_{11}	250.13	257.61	269.19	278.88	281.61	292.35
T_{12}	266.21	271.09	285.99	291.40	295.89	307.83
T_{13}	236.18	243.16	254.56	268.73	269.16	278.90
Grand mean	252.15	260.19	271.91	281.48	283.30	294.31
$S.E_D$	0.54	0.78	0.65	0.57	0.65	0.45
CDP =(0.05)	1.13	1.62	1.34	1.18	1.34	0.93

Leaf area is an important part of the plant responsible for interception and conversion of solar energy, foliar applied panchakavya might have been absorbed quickly resulting in higher leaf production. Panchakavya acts as a growth promoter and immunity booster. Panchakavya stock solution creates a depression, which facilitates a cosmic ray link. The basic elements for the growth are harmonized by this energy which refresh the growth process (Sundararaman *et al.,* 2001. The result of the present study is in conformity with those vethamani and Thampi (2018) in palak.

Hence it can be concluded that the treatment T_8 (Vermicompost @ 5t ha^{-1} + azospirillum and phosphobacteria @ 2kg ha^{-1} + panchakavya @ 3 percent foliar spray) can be adjudged as the best treatment for enhancing the growth parameters of moringa cv. PKM-1 for leaf production.

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