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Effect of Integrated Nutrient Management of Brinjal (*Solanum melongena* L.) under Moringa (*Moringa oleifera*) based Agroforestry system

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ABSTRACT
The present investigated the effect of different levels of organic manure on the growth and yield of Brinjal (Solanum melongena L.) under Moringa (Moringa oleifera) based agroforestry system conducted at the research and nursery area of the Department of Silviculture and Agroforestry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India during the period of October-March 2019-2020. The four years old plantations of Moringa (Moringa oleifera) planted at 7m x 2m spacing and vegetable crop viz., Brinjal (Solanum melongena L.) Variety- F 1 hybrid Navina was selected for the present study. The readings obtained from the experiment was collected on five randomly selected healthy plants from each replication and different observations were recorded.The results were the plant height (27.093cm), number of leaves (no) per plant (22.473) were recorded highest in T_9 and T_9 for 60 DAS and highest plant height (cm) in T_5 (77.103), highest number of leaves (no) per plant in T_9 (50.630), number of leaves (no) per plant in T_0 (36.917) for 120 DAS and highest number of branches (no) per plant in T_9 (6.717). Similarly, various yield parameters viz., days to 50% flowering (%), number of flowers per plant (no), number of fruits per plant (no), fruit length (cm), fruit circumference (m^2), fruit weight (gm) and fruit yield (kg) was also recorded maximum in T_9 (50% FYM + 50% Neem cake). Moreover, INM treatment under Moringa based Agroforestry system resulted minimum in T_0, T_1, T_3 reported minimum growth and yield parameters.
Key words: Integrated Nutrient Management, Brinjal, Moringa, Agroforestry system.

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INTRODUCTION

The silvi-horticultural system has emerged as a viable option for achieving land cover on one hand and to fulfil the demand of vegetable crops and timber to human and industry on the other hand. It is an improved indigenous cropping system in India which fully utilizes the growing season and markedly increases the return per unit area per unit time. In this system we can increase the total output from land by growing mainly short duration crops within the alleys of such timber crops. India is bestowed with vast diversity of flora, fauna, soil and agro-climatic conditions. This makes feasible to grow the largest number of vegetable crops in the world and is regarded as a horticultural paradise [11].

Moringa oleifera is a multipurpose tropical tree that belonging to the family of moringaceae is an effective remedy for malnutrition and has originated from the Himalayan tract of northwest part of India. Drumstick (*Moringa oleifera*) native to India, grows in the tropical and subtropical regions of the world.It has diploid chromosome 2n=28,

with sometree flowering throughout the year while the other flower in two distinct [3, 8]. Moringa is rich in nutrition owing to the presence of a variety of essential phytochemicals present in its leaves, pods and seeds. In fact, moringa is said to promote seven times more vitamin C than oranges, ten times more vitamin A than carrots, 17 times more calcium than milk, nine times more protein than yoghurt, 15 times more potassium than bananas and 25 times more iron than spinach J.L. Rockwood *et al.*, [7]. The fact that moringa is easily cultivable makes it a sustainable remedy for malnutrition. Countries like Senegal and Benin treat children with moringa J.N. Kasolo *et al.*, [5]. Brinjal (*Solanum melongena* L.*)* popularly known as eggplant belongs to family Solanaceae and India is its center of origin and diversity. It can be grown in almost all states of India except in the higher altitudes. It is a popular and principle fruit vegetable grown in India and other parts of tropical and subtropical world but in temperature regions, it is grown mainly during warm season. It is highly productive and usually finds a place as a "poor man's crop". Major states growing brinjal are West Bengal, Orissa, Bihar and Gujarat. Eggplant due to its texture and bulk, can be used as a meat substitute in vegetarian cuisine. Brinjal is used in a variety of culinary preparations since ancient times. It is a staple vegetable in many tropical countries. The productivity of brinjal can be increased by using several techniques viz, organic farming, integrated nutrient management and good hybrid seeds. Since the nutrient turnover in soil plant system is considerably, high in intensive vegetable cultivation, neither the chemical fertilizer nor the organic manure alone can help achieve sustainable production [4]. The growth, yield and fruit quality of brinjal are largely dependent on number of interacting factors. Among them, INM system is the most crucial as well as basic factor and is found to exert a great influence not only on growth, yield and fruit quality of brinjal but also for obtaining sustained productivity. Plant requires essential 17 mineral elements for proper growth and completion of life cycle. Application of organic manures to soil not only improves the physical properties but also increases the availability of nutrients as well as organic carbon content and cation exchange capacity (CEC). Moreover, it supplies plant nutrients including micronutrients and increases the yield of crop [12]. It is obvious that organic manures have both direct and indirect effects on crop productivity and environment. Organic farming will reduce the additional burden of environmental pollution that is caused while manufacturing these synthetic fertilizers at the source [9]. Hedge [2] reported that solanaceous vegetables (tomato, eggplant, chilli and bell pepper) generally take up large amounts of nutrients. The quality depends on the quantity of fruit and DM they produce, which in turn is influenced by a number of genetic and environmental variables, the eggplant need 3-3.5kg N, 0.2-0.3kg P, 2.5-3kg K. Godse [1] conducted an experiment to study the effect of organic manures and fertilizers on pest complex of brinjal and rationalization of spray schedule under south Gujarat conditions. In brinjal fruit, he recorded 2.13-3.26% N, 0.24-0.30% P, 2.73-4.03% K contents. The brinjal crop is attacked by a number of insect pests; among them brinjal shoot and fruit borer (*Leucinodes orbonalis*). Sinha *et al.*, [10] conducted an experiment brinjal and noticed that the percentage of shoot and fruit borer infestation was significantly increased with increasing level of nitrogen.

MATERIAL AND METHODS

The present investigation entitled**,** "Effect of different levels of organic manure on the growth and yield of Brinjal (*Solanum melongena* L.) under Moringa (*Moringa oleifera*) based agroforestry system was conducted at the research and nursery area of the Department of Silviculture and Agroforestry, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, Uttar Pradesh, India during the period of October-March 2019-2020. The four years old plantations of Moringa (*Moringa oleifera*) planted at 7m x 2m spacing and vegetable crop viz., Brinjal (*Solanum melongena* L.) Variety- F 1 hybrid Navina was selected for the present study. The readings obtained from the experiment was collected on five randomly selected healthy plants from each treatment and different observations were recorded. The experiment consists of ten treatments Viz., T_0 : Control, T_1 : Recommended doses of FYM, T_2 : Recommended doses of Urea, T_3 : Recommended doses of Vermicompost, T_4 : Recommended doses of Biofertilizer (Azospirillum), T_5 : Recommended doses of Neem Cake, T_6 : 50% FYM + 50 % Urea, T_7 : 50% FYM + 50% Vermicompost, T_8 : 50% FYM + 50% Biofertilizer Azospirillum, T_9 : 50% FYM + 50% Neem Cake shade condition with three

replications. Brinjal were planted in the plot with the spacing of 90cm x 60cm. Obsevation recorded with respect to growth parameters i.e., Plant height, Number of leaves per plant, Number of branches per plant and yield parameters i.e.,Days to 50% flowering, Number of flowers per plant, Number of fruits per plant, Fruit length, Fruit Circumference, Fruit weight, Fruit yield. Recorded observations were analyzed with the help of Randomized Block Design as prescribed by Panse and Sukhatme [6].

RESULT AND DISCUSSIONS

Growth parameters

The readings obtained from the experiment pertaining to various growth parameters of Brinjal (*Solanum melongena* L.) as affected by various INM treatments under Moringa (*Moringa oleifera*) based Silvi-horticultural system in open condition are presented in Table-1. From the data it is evident that the application of INM had a great influence at all stages of the brinjal crop. Significant differences were observed in growth parameters.

The plant height (27.093cm), number of leaves (no) per plant (22.473) were recorded highest in T_9 and T_9 respectively while the lowest were recorded in T_3 (20.497), T_0 (10.667) at 60 DAS. Highest plant height in T_3(44.960cm), highest number of leaves (no) per plant highest in T_9 (30.440) while the lowest were recorded in T_0 (32.350), T_0 (19.573) respectively for 90DAS and highest plant height in T_5 (77.103), highest number of leaves (no) per plant in T_9 (50.630) while the lowest were recorded in plant height T_0 (66.023cm), number of leaves (no) per plant in T_0 (36.917) for 120 DAS and highest number of branches (no) per plant in T_9 (6.717) while lowest were recorded in T_0 (4.587). The lowest growth might be due to less availability of sunlight under Moringa as compared to shade condition.

Table 1: Growth and yield parameters of Brinjal (*Solanum melongena* L.) as affected by various INM treatments under Moringa (*Moringa oleifera*) based agroforestry system.

Treatments	Plant height (cm)			No. of leaves per plant (No)			No. of branches per plant (No)	Days to 50% flowering (%)	No. of flowers per plant (No)	No. of fruits per plant (No)	Fruit Length (cm)	Fruit Circumference (m^2)	Fruit weight (gm)	Fruit yield (kg)
	60DAS	90 DAS	120DAS	60DAS	90DAS	120 DAS								
T_0	23.66	32.35	66.02	10.67	19.57	36.92	4.59	68.23	21.69	25.87	6.82	6.34	32.59	1.28
T_1	22.25	40.89	70.19	12.62	26.84	38.25	5.60	68.49	22.33	27.36	9.39	6.45	32.47	1.41
T_2	24.60	36.25	70.66	11.85	22.54	43.80	5.52	67.80	25.43	28.50	10.85	6.58	32.99	1.52
T_3	20.50	44.96	75.45	11.12	24.27	39.77	5.77	69.33	27.46	28.93	9.81	6.17	33.76	1.30
T_4	22.87	39.81	71.51	16.35	26.42	46.35	5.88	66.77	30.59	30.91	11.02	6.90	33.25	1.37
T_5	24.12	44.74	77.10	19.89	27.71	49.08	6.14	67.02	31.96	36.29	11.70	6.32	33.62	1.43
T_6	25.73	39.62	72.29	15.92	24.29	45.22	5.88	63.58	31.74	32.55	10.64	6.53	34.32	1.50
T_7	24.82	42.56	69.31	16.06	27.07	44.49	6.05	63.36	33.17	34.10	12.63	6.71	37.51	1.52
T_8	25.66	41.96	72.14	18.55	26.18	48.41	6.29	61.93	35.58	36.88	11.56	7.08	38.62	1.68
T_9	27.09	43.95	74.14	22.47	30.44	50.63	6.72	60.89	38.86	41.07	12.78	7.45	38.96	1.69
C. D	1.331	1.107	2.123	0.741	1.260	0.947	0.611	3.258	0.931	0.959	0.628	0.701	1.418	0.259
SE(m)	0.445	0.370	0.709	0.247	0.421	0.316	0.204	1.088	0.311	0.320	0.210	0.234	0.474	0.086
SE(d)	0.629	0.523	1.003	0.350	0.595	0.447	0.289	1.539	0.440	0.453	0.297	0.331	0.670	0.122

Yield parameters

The data pertaining to various yield parameters of Brinjal as affected by various INM treatments under Moringa based Silvi-horticultural system in shade condition were presented inTable-1. It can be seen from the data presented in Table-1 the application of INM significantly influenced the various yield parameters.

The results presented in Table-1 indicated that when Brinjal was grown under in open condition were recorded in various parameters like days to 50% flowering, number of flowers per plant, number of fruits per plant, fruit length, fruit circumference, fruit weight, fruit yield were recorded maximum in T_3 (69.330), T_9 (38.863), T_9 (41.070), T_9 (12.780cm), T_9 (7.450m^2), T_9 (38.960gm), T_9 (1.690kg) while the lowest were recorded in T_9 (60.887), T_0 (21.690), T_0 (25.823), T_0 (6.817cm), T_3 (6.167m^2), T_0 (32.473gm), T_0 (1.277kg) respectively. In days to 50% flowering the lowest the value i.e., early flowering gives the early yield. The various yield parameters performed well in open condition as compared to INM treated under Moringa based Agroforestry system. The portable reason for it might be good

availability of light in shade condition as compared to INM treated under Moringa based Agroforestry system.

Economics

The data pertaining to economics of Brinjal as affected by various INM treatments under Moringa based Silvi-horticultural system in open condition is presented inTable-2. The application of INM significantly influenced the economics of brinjal. The results presented in Table-2 indicated that when Brinjal was grown under in open condition were recorded in economics of brinjal. Application of FYM + Biofertilizers T8 to brinjal plants and moringa plant (i.e., nitrogen application) recorded highest net returns by T8 (Rs 149247.6/ha) and benefit cost ratio by T2 urea (1:3) in Navina variety followed by Farm Yard Manure + Neem cake T9 (Rs 140617.96/ha)and benefit cost ratio by T8 (1:2.9) and the lowest net returns by Vermicompost T3 (Rs 85442.45/ha) and benefit cost ratio by T3 (1:1.1) and the other treatments were intermediary. In the present investigation it was noticed that brinjal variety F1 hybrid Navina recorded higher vegetative growth, dry matter production, higher number of primary branches, number of flowers, fruit volume and fruit weight. By this experiment it is proved that only one component cannot increase the yield but the combined use of organic, inorganic manures and biofertilizers increase the growth and productivity of the crop.

Table 2: Economics of Brinjal (*Solanum melongena* L.) as affected by various INM treatments under Moringa (*Moringa oleifera*) based agroforestry system.

Treatments	Cost of Cultivation (Rs/ha)	Total yield		Return		Gross Return (Rs/ha)	Net return (Rs/ha)	Benefit Cost Ratio
		Brinjal (q/ha)	Moringa (kg/ha)	Brinjal (Rs/ha)	Moringa (Rs/ha)			
T0	44230.4	287.32	750.00	143660	11250	154910	110679.6	1:2.5
T1	54950.4	316.57	750.00	158285	11250	169535	114584.6	1:2.0
T2	45395.61	341.32	750.00	170660	11250	181910	136514.39	1:3
T3	71717.55	291.82	750.00	145910	11250	157160	85442.45	1:1.1
T4	46374.4	308.92	750.00	154460	11250	165710	119335.6	1:2.5
T5	66563.3	322.42	750.00	161210	11250	172460	105897	1:1.5
T6	50172.97	338.17	750.00	169085	11250	180335	130162.03	1:2.5
T7	63333.976	341.32	750.00	170660	11250	181910	118576.02	1:1.8
T8	50662.4	377.32	750.00	188660	11250	199910	149247.6	1:2.9
T9	60757.04	380.25	750.00	190125	11250	201375	140617.96	1:2.3

CONCLUSION

From the above readings, it is concluded that growing of brinjal crop in open condition resulted in significant increase in various growth as well as yield parameters as compared to growing brinjal crop under INM treated Moringa based Agroforestry system. The growth parameters like maximum plant height (cm), number of leaves per plant (no), number of branches (no) per plant in T_9 (50% FYM + 50% Neem cake) in open condition. Similarly, various yield parameters viz., days to 50% flowering (%), number of flowers per plant (no), number of fruits per plant (no), fruit length(cm), fruit circumference (m^2), fruit weight (gm) and fruit yield (kg) was also recorded maximum in T_9 (50% FYM + 50% Neem cake). Moreover, INM treatment under Moringa based Agroforestry system resulted minimum in T_0, T_1, T_3 reported minimum growth and yield parameters.

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