Influence of integrated nutrient management on economics of Brinjal (*Solanum melongena*) under Teak (*Tectona grandis*) based Silvi- horticultural system

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ABSTRACT: *The integrated nutrient management is an important aspect of farming including agroforestry in order to reduce excess use of chemical fertilizers. The approach of INM lead to long term beneficial influence on crops/plants and the whole farm system. The present study was carried out at the College Farm of N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat during the year of 2016-17. In the experiment, Surati Ravaiya variety of Brinjal (Solanum melongena L.) was tested under twenty-three years old Teak (Tectona grandis L. f.) plantation with 14 treatments of INM including control (Sole crop with 100% RDF i.e., NPK @ 100:50:50 kg/ha). Results showed that growing of brinjal crop in open condition (with recommended dose of fertilizer) resulted in significant increase in yield and economic return as compared to growing brinjal crop under teak with different INM treatments. Significantly maximum fruit yield (29.73 t/ha) was recorded in T_{14}: 100 % RDF in open condition, followed by INM treatments- T_1: 100 % RDF (19.61 t/ha) and T_{11}: 75 % RDF + Vermicompost (18.29 t/ha) under teak plantation. In contrast, minimum fruit yield (8.65 t/ha) was noted in T_2: Azotobactor under teak plantation. In the case of economics, maximum net realization and benefit cost ratio (BCR) recorded in T_{14} 100 % RDF in open condition was Rs. 1,88,692.00/ha and 1:1.74, respectively. In the case of Brinjal based teak silvi-horticultural system, the highest net realization (Rs. 1,23,658/ha) and BCR (1.71) was recorded from T_1: 100% RDF, followed by T_{11}: 75 % RDF + Vermicompost with net realization of Rs. 105795.00 and BCR of 1.37. Therefore, teak farmers are suggested to grow brinjal under teak to obtain additional income.*

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1. INTRODUCTION

Integrated nutrient management (INM) is used to maintain fertility of soil and supply of nutrients to plants at an optimum level for sustaining the desired productivity through management of all the sources of organic, inorganic and biological components in an integrated manner. Efficient use of all the nutrient sources including organic sources, recyclable wastes, mineral fertilizers and bio-fertilizers should therefore be promoted through integrated nutrient management (Roy *et al.,* 2006). The main aim of INM is to integrate the use of natural and man-made soil nutrients to increase crop productivity and preserve soil productivity for future generations (FAO, 1995).

The silvi-horticultural system has emerged as a viable option for achieving land cover as well as to fulfil the demand of vegetable crops and timber for household needs and industries. 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 horticultural crops like vegetable within the alleys of tree rows.

Among vegetable crops, Brinjal (*S. melongena* L.) is one of the economic crops grown in different parts of the country and is regarded as a horticultural paradise (Saravaiya *et al.*, 2010). Brinjal is being cultivated in India over an area of 7.30 lakh ha with an average annual production of 128.00 lakh tonnes with productivity of 17.5 t/ha (Anon., 2018). Gujarat occupied an area of brinjal cultivation was 81,673 ha with an annual production of 16.25 lakh tonnes and productivity of 19.89 t/ha (Anon., 2023). The growth, yield and fruit quality of Brinjal are largely dependent on number of interacting factors. Amongst 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. By looking into these, an experiment was undertaken to assess the yield of brinjal and economics of its cultivation under teak plantation using INM treatments.

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2. MATERIALS AND METHODS:

The present study was carried out at the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari, Gujarat during the year of 2016-17. The twenty-three-year-old plantation of Teak (*T. grandis* L.f.) planted at 3 m x 2 m spacing was used and brinjal (*S. melongena* L.) variety–Surati Ravaiya was selected for cultivation in the study. FYM was applied at the rate of 10 tonnes per hectare to all the plots uniformly and incorporated in soil before ridges and furrows were formed. The phosphorus and potash were applied as a basal dose at the rate of 50 kg/ha to each plot of treatment T_1 and other treatment of inorganic fertilizer. The experiment consists of fourteen treatments *viz*., T_1: 100% RDF (100:50:50 NPK kg/ha), T_2: Azotobactor, T_3: Vermicompost, T_4: Neem cake, T_5: Bio-compost, T_6: 50% RDF + T_2, T_7: 50% RDF + T_3, T_8, 50% RDF + T_4, T_9: 50% RDF + T_5, T_{10}: 75% RDF + T_2, T_{11}: 75% RDF + T_3, T_{12}: 75% RDF + T_4 and T_{13}: 75% RDF + T_5 under teak and T_{14}: 100% RDF (100:50:50 NPK kg/ha) in open condition with three replications. The experiment was laid in randomized block design. All the organics and bio-fertilizer were applied on the basis of nitrogen content. The quantity of organics and biofertilizer (per hectare basis) used in this study is given Appendix – I. Brinjal crop was planted with the spacing of 90 cm x 60 cm in the late *Rabi* season (Feb-2016) just to get advantage of leafless period of teak in the plot of 2.0 x 6.0 m. Ten plants of brinjal were grown between eight plants of teak. Observations were recorded on yield, and net realization and benefit cost ratio were worked out. The cost of cultivation of brinjal on per hectare basis is given in Appendix – III.

3. RESULTS AND DISCUSSION:

In the present study, fruit yield and its economics are worked out. The data pertaining to fruit yield of brinjal as affected by various INM treatments under teak based silvi-horticulture system and with open condition are presented in Table–1. Result showed that there was a significant variation among INM treatments and control for fruit yield of brinjal under teak based silvi-horticulture system and in open condition. Result indicated that when brinjal was grown in open condition with application of 100 % RDF (T_{14}) showed significantly higher fruit yield (29.73 t/ha), followed by T_1: 100 % RDF (100:50:50 NPK/ha) (19.61 t/ha) and T_{11}: 75 % RDF + Vermicompost (18.29 t/ha) under teak plantation. However, brinjal fruit yield (7.86 t/ha) was found to be the least in T_2: Azotobactor under teak plantation. The fruit yield performed well in open condition as compared to INM treated under teak based silvi-horticultural system. The probable reason for it might be better availability of light in open condition as compared to teak based silvi-horticultural system. Moreover, higher yield under T_{11}: 75 % RDF + Vermicompost might be due to nature of nutrients in vermicompost (VC), since it is rich in macro and micronutrients, vitamins and growth hormones (Bhawalkar, 1991). The results are analogous with earlier findings of Srinivas *et al.* (2008) in Coleus, Panneerselvam and Arthanarib (2011) in Sunflower, Tripathi *et al.* (2014) in Mungbean and Lata *et al.* (2014) in Aswagandha. However, positive impact of INM in open condition on various crops was also noted by Sendur *et al.* (1998) in Tomato, Giraddi and Smitha (2002) in Chilli, Reddy and Reddy (2005) in Onion, Prabhu *et al.* (2006) in cucumber; Ullah *et al.* (2008), Munshi (2014) and Kashyap *et al.* (2014) in Brinjal.

Table - 1: Yield of brinjal (*S. melongena* L.) as affected by various INM treatment under teak (*T. grandis* L. f.) based silvi-horticultural system and in open condition

Treatments	Fruit yield (t/ha)
T_1: 100% RDF (100:50:50 NPK/ha)	19.61
T_2: Azotobactor	7.86
T_3: Vermicompost	10.38
T_4: Neem cake	8.65
T_5: Bio-compost	9.50
T_6: 50% RDF + T_2	11.29
T_7: 50% RDF + T_3	14.33
T_8: 50% RDF + T_4	11.50
T_9: 50% RDF + T_5	13.28
T_{10} :75% RDF + T_2	15.39
T_{11}:75% RDF + T_3	18.29
T_{12}: 75% RDF + T_4	16.52
T_{13}: 75% RDF + T_5	17.74
T_{14}: 100% RDF (100:50:50 NPK/ha) in Open condition	29.73
SEm (+)	0.62
CD @5%	1.75
CV (%)	10.93

The results on economics of brinjal fruit yield as affected by various INM treatments are given in Table – 2. The highest net realization and benefit cost ratio (BCR) was recorded in T_{14}: 100 % RDF in open

Table 2: Economics of brinjal crop as affected by INM treatment under teak based silvi-horticultural system and open cond

Treatment	Yield (t/ha)	Fixed cost (Rs/ha)	Variable cost (Rs/ha)	Total cost (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	Benefit cost ratio
T_1: 100% RDF (100:50:50 NPK/ha)	19.61	68862.00	3580.00	72442.00	196100.00	123658.00	1.71
T_2: Azotobacter	7.86	68862.00	420.00	69282.00	78600.00	9318.00	0.13
T_3: Vermicompost	10.38	68862.00	22233.00	91095.00	103800.00	12705.00	0.14
T_4: Neem cake	8.65	68862.00	6948.00	75810.00	86500.00	10690.00	0.14
T_5: Bio-compost	9.5	68862.00	47643.00	116505.00	95000.00	-21505.00	-0.18
T_6: 50 % RDF + T_2	11.29	68862.00	2000.00	70862.00	112900.00	42038.00	0.59
T_7: 50 % RDF + T_3	14.33	68862.00	12906.00	81768.00	143300.00	61532.00	0.75
T_8: 50 % RDF + T_4	11.5	68862.00	5264.00	74126.00	115000.00	40874.00	0.55
T_9: 50 % RDF + T_5	13.28	68862.00	25611.00	94473.00	132800.00	38327.00	0.41
T_{10}:75 % RDF + T_2	15.39	68862.00	2790.00	71652.00	153900.00	82248.00	1.15
T_{11}:75 % RDF + T_3	18.29	68862.00	8243.00	77105.00	182900.00	105795.00	1.37
T_{12}: 75 % RDF + T_4	16.52	68862.00	4422.00	73284.00	165200.00	91916.00	1.25
T_{13}: 75 % RDF + T_5	17.74	68862.00	14595.00	83457.00	177400.00	93943.00	1.13
T_{14}: 100% RDF (100:50:50 NPK/ha) in Open condition	29.73	103241.00	5367.00	108608.00	297300.00	188692.00	1.74

Note : Selling price of Brinjal @ Rs. 10 / kg

condition (Rs. 1,88,692.00/ha and 1.74:1, respectively), which was followed by T_1: 100 RDF (100:50:50 kg NPK/ha) (Rs. 1,23,658.00 and 1.71:1, respectively) under teak based silvi-horticultural system. These results are in line with earlier findings of Patil *et al.* (1998), Selvi and Thiageshwari (2002), Harikrishna *et al.* (2002), Nayak *et al.* (2014) and Mevada *et al*. (2022), where they have documented such positive response.

4. CONCLUSION

From the above findings, it is concluded that, growing of brinjal crop in open condition with application of recommended dose of fertilizer resulted in higher yield as well as higher net realization and benefit cost ratio as compared to growing brinjal crop under teak based silvi-horticultural system with different INM treatments. By considering Teak based silvi-horticultural system, growing of Brinjal under teak with treatments such as T_1 (100 RDF %) and T_{11} (75 % RDF + Vermicompost) resulted in higher fruit yield as well as net realization and BCR. Therefore, it is suggested that teak farmers can grow brinjal crops with specified INM treatments under teak plantation.

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APPENDIX-I: Variable Cost (material inputs) of Various INM Treatments (In 1 ha teak plantation, total area available for inter-cropping is 6670 m^2; therefore, the 6670 m^2 area is considered for calculation)

Treatment	Required quantity of manures & biofertilizer	Cost (Rs.)	Required quantity of chemical fertilizers	Cost (Rs.)	Total cost (Rs)	Total cost (Rs) Round off
T_1: 100% RDF (100:50:50 NPK/ha)	-	-	Urea 144.99	869.94	3579.51 *i.e.* 3580.00	3580.00
			SSP 208.43	1875.87		
			MOP 55.58	833.70		
T_2: Azotobactor	3.5 liters	420.00	-	-	420.00	420.00
T_3: Vermicompost	4446.66 kg	22233.33	-	-	22233.33	22233.00
T_4: Neem cake	1389.58 kg	6947.90	-	-	6947.90	6948.00
T_5: Bio-compost	9528.57 kg	47642.85	-	-	47642.85	47643.00
T_6: 50% RDF + T_2	1.75 liters	210.00	72.50	435.00	1999.74	2000.00
			104.21	937.89		
			27.79	416.85		
T_7: 50% RDF + T_3	2223.33 kg	11116.65	72.50	435.00	12906.39	12906.00
			104.21	937.89		
			27.79	416.85		
T_8: 50% RDF + T_4	694.79 kg	3473.95	72.50	435.00	5263.69	5264.00
			104.21	937.89		
			27.79	416.85		
T_9: 50% RDF + T_5	4764.28 kg	23821.42	72.50	435.00	25611.16	25611.00
			104.21	937.89		
			27.79	416.85		
T_{10}: 75% RDF + T_2	0.875 liters	105.00	108.75	652.50	2789.58	2790.00
			156.32	1406.88		
			41.68	625.20		
T_{11}: 75% RDF + T_3	1111.66 kg	5558.30	108.55	652.50	8242.88	8243.00
			156.32	1406.88		
			41.68	625.20		
T_{12}: 75% RDF + T_4	347.39 kg	1736.95	108.55	652.50	4421.53	4422.00
			156.32	1406.88		
			41.68	625.20		
T_{13}: 75% RDF + T_5	2382.14 kg	11910.7	108.55	652.50	14595.28	14595.00
			156.32	1406.88		
			41.68	625.20		
T_{14}: 100% RDF (100:50:50 NPK/ha)	-	-	217.39	1304.34	5366.79	5367.00
			312.50	2812.50		
			83.33	1249.95		

APPENDIX II: Price of various Organic and Inorganic

FYM (0.5%)	: Rs. 800 /tonnes	Urea	: Rs. 6 / kg
Vermicompost (1.5%)	: Rs. 5 /kg	Single super phosphate	: Rs. 9 /kg
Azotobactor	: Rs. 120 /liter	Murate of potash	: Rs. 15 /kg
Neem cake (4.8%)	: Rs. 5 /kg		
Bio compost (0.7%)	: Rs. 5 /kg		

APPENDIX III: Cost of cultivation (Rs/ha) of Brinjal crop (In 1 ha teak plantation, total area available for inter-cropping is 6670 m^2; therefore, the 6670 m^2 area is considered for calculation)

Description	Rate	Cost (Rs.)
Preparatory tillage		
Ploughing by tractor with (1time) M.B. plough	@Rs.300/ hr for 8 hours	2400
Ploughing by tractor with (2 times) cultivator	@ Rs.200/ hr for 6 hours	2400
Ploughing by tractor with (1 times) Rotavator with planking	@ Rs.600/ hr for 4 hours	2400
Total		**7200**
Lay out and Transplanting		
Layout, Preparation of channel, beds, making furrows, and earthing up (6 labour for 2 days)	@ Rs.178/ /labour/day	2136
Seedlings requires (22000 nos)	@ Rs.0.4/seedling	8800
Transplanting (15 labours for 1 days)	@ Rs.178/ /labour/day	2670
Gap filling (5 labours for 1 days)	@ Rs.178/ /labour/day	890
Total		**14496**
Manures		
FYM 10 t /ha	@ Rs. 800/t	8000
Expenditure on manures application	@ Rs. 100/ t of FYM	2000
Expenditure on fertilizer application (10 labours for 1 day)	@ Rs.178/ /labour/day	1780
Total		**11780**
Intercultural operations		
Weeding (10 labours for 1 day) two times	@ Rs.178/ /labour/day	3560
Total		**3560**
Irrigation application		
Irrigations -7 (@ 20 hr)	@ Rs. 30 per hour	4200
Labour charges (2 men for 1 irrigation)	@ Rs.178/ /labour/day	2492
Total		**6692**
Plant protection		
Labour for spraying (2 men per spray)	@ Rs.288 /labour/day	2880
Chloropayriphos (@ 2 lit) 1 spray	@ Rs. 475/lit	950
Imeda chlor (@ 300ml) 2 sprays	@ Rs. 1340/lit	804
Profenophos (@ 1 lit) 2 sprays	@ Rs. 460/lit	920
Total		**5554**
Harvesting and Marketing		
Harvesting (10 labours for 1 day) ten times	@ Rs.178/ /labour/day	17800
Uprooting the plants (10 labours for 1 day)	@ Rs.178/ /labour/day	1780
Total		**19580**
Grand total		**68862**

Note: Cost of cultivation of brinjal in open condition - Rs 1,03,241 per ha.

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