Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(6): 1853-1858
Received: 04-09-2019
Accepted: 06-10-2019

Jaya Bahiriya
Research Scholar, M.Sc. Forestry (Department of Silviculture and Agroforestry) College of Horticulture & Forestry, Jhalrapatan, Jhalawar, Rajasthan, India

SBS Pandey
Head, Department of Silviculture and Agroforestry, CH&F, Jhalawar, Rajasthan, India

B Nagar
Asstt. Prof., Dept. of Forest Products and Utilization, CH&F, Jhalawar, Rajasthan, India

J Singh
Head, Department of Fruit Science, CH&F, Jhalawar, Rajasthan, India

CK Arya
Asstt. Prof. Dept. of Natural Resource Management, CH&F, Jhalawar, Rajasthan, India

Corresponding Author:
SBS Pandey
Head, Department of Silviculture and Agroforestry, CH&F, Jhalawar, Rajasthan, India

Influence of FYM application on curcumin content and economics of cultivation on intercropping turmeric (*Curcuma longa* L.) under mandarin based agroforestry system in South-Eastern Rajasthan

Jaya Bahiriya, SBS Pandey, B Nagar, J Singh and CK Arya

Abstract
A field investigation was conducted during the 2018-19 to study "Evaluation of different doses of Farmyard manure and Intercropping Turmeric (*Curcuma longa* L.) under Mandarin (*Citrus reticulata* Blanco*)* based Agroforestry system." at College of Horticulture and Forestry, Jhalawar (Rajasthan). Eleven years old plantations of mandarin (*Citrus reticulata* Blanco.) at 6 x 6 m spacing were used for intercropping of five varieties of Turmeric (*Curcuma longa* L.) as an intercrop viz. 'Sugandham, Udaipur local, Gujrat Navsari Turmeric-1, Chittor local and Kesar planted at 30 x 45 cm were selected. The experiment was laid out in randomized block design with three replications and applied different doses of FYM (10, 15 and 20 t/ha). The significant result was found in respect of Curcumin content (%) of Turmeric and the maximum curcumin content was found in T_{15} (3.31 %) followed by T_{13} (3.22 %) where as higher benefit-cost ratio was found in T_{13} (3.15) (Mandarin + *Curcuma longa* L.var. GNT-1 @ 20 tonne FYM/ha) followed by T_{28} (3.02) (*Curcuma longa* L.var.GNT-1 Sole @ 20 tonne FYM/ha). Therefore GNT-1 and Kesar varieties of Turmeric are recommended as an intercrop among five varieties in Mandarin Orchard as well as a sole crop at the spacing of 30X45 cm with the application of 20 tonne/ha FYM in South-Eastern Rajasthan.

Keywords: Turmeric, curcumin, mandarin, intercropping, net returns and benefit cost ratio

Introduction
Agroforestry is a system which is rather localized in its concept for managing the unit of land for maximizing production of agriculture crops and forest trees complimentary with each other. Agroforestry can be defined as a "Sustainable land management system which increases the overall yield of the land combines the production of crops (including tree crops) and forest plants and/or animals simultaneously or sequentially, on the same unit of land and applies management practices that are compatible with the cultural practices of the local population. (King and Chandler, 1978). Agroforestry enables returns from land even in extreme droughts or other natural calamities when pure agriculture fails and also allows diversified land use and reduces the risk associated with monoculture. It generates high income and minimizes risk in cropping enterprises (Rahangdale, 2011) [6]. Organic farming comprises of diversified agriculture techniques like intercropping, crop rotation, green manuring, organic manures (FYM and compost), organic residues; biofertilizers etc. Organic manures include farmyard manure, vermicompost, biofertilizers, green manures etc. Most commonly used organic manure is FYM in which cattle dung constitutes the major source of nutrients and contains 0.72, 0.35 and 0.80 percent N, P and K respectively. Similarly, vermicompost enriches the soil by improving the residual build up of organic carbon and available N, P and K in soil. Vermicompost greatly increases surface area, providing more microsites for microbial decomposing organisms and strong adsorption and retention of nutrients (Shi-wei and Fu-Zhen, 1991) [9]. Organic manure is well suited to achieve both production and conservation goals. Sometimes yield reductions in various intercrops have been reported due to such interactions but the crop yield loss may well be compensated by economically through yield of timber, fodder and fuel wood tree species.

Nagpur mandarin (*Citrus reticulata* Blanco.) belongs to family Rutaceae having shizofysigenic oil gland and particular aroma indicating flavor of particular citrus species. It is considered to be one of the most important cultivated species among citrus and is being commercially grown in specific region of the country like Nagpur mandarin in Central India, Khasi mandarin in North Eastern regions and Coorg mandarin in Southern regions. Though, it is grown in every

state, certain pockets have emerged as the leading producers. Nagpur mandarin is chiefly grown in Satpura hills (Vidarbha region) of Central India, hilly slopes of Darjeeling (West Bengal), Coorg (Karnataka) and Jhalawar (Rajasthan). Black vertisols with enriched calcium carbonate, is highly suitable for Nagpur mandarin cultivation in Jhalawar.

The total production of mandarin in India is 34.31 lakh tonnes from an area of 3.30 lakh hectares with the productivity of 10.4 MT/ha (Anonymous, 2015). In Rajasthan state, the acreage of Nagpur mandarin is around 22,500 ha area, out of which 13,000 ha are in the fruit bearing stage, and the production is 2 lac tonnes.

Meenakshi *et al.* (2001) conducted a study in Karnataka to determine the effect of planting material and phosphorus (P) and potassium (K) nutrition on the yield and quality of turmeric cv. Cuddapah. The highest curcumin content of 3.13% was observed in the mother rhizome and among the fertilizer levels, the highest rate recorded the maximum curcumin content (3.41%). The interaction effects of planting material and P and K nutrition were non-significant with respect to yield, curing percentage and cured rhizome yield, but were significant for curcumin content and thereby maximum curcumin content of 3.64% was obtained in mother rhizome with P and K at 100:100 kg/ha.

Shinde *et al*. (2016) [8] studied the influence of fertilizer management on turmeric (*Curcuma longa* L.) CV. Salem under Konkan condition and found maximum curcumin content (3.26 %) of turmeric.

Sharma *et al.* (2003) [7] conducted field experiments at Jabalpur, M.P. to evaluate the effects of organic manures and chemical fertilizers, alone or in combination, on the yield of turmeric. The following treatments were established: control; 10 t FYM/ha; 10 t vermicompost/ha; 100% RDF; 50% RDF; 50% RDF + 5 t FYM/ha; 50% RDF + 5 t vermicompost/ha; 50% RDF + 10 t FYM/ha; 50% RDF + 10 t vermicompost/ha and 50% RDF + 5 t FYM/ha + 5 t vermicompost/ha. Continuous application of chemical fertilizers reduced turmeric yield in the subsequent year, whereas the addition of FYM or vermicompost enhanced the yield of turmeric by 7-10% over the preceding year. Application of 50% RDF + 10 t vermicompost/ha improved soil porosity, reduced soil bulk density and increased organic carbon content (from 0.44 to 0.72%). This Treatment recorded the highest yield (250.4 q /ha), net return (Rs.192785/ha) and benefit-cost ratio (3.35)

Pandey *et al*. (2016) [5] Conducted research on Economic Comparison of Intercropping of Ginger and Turmeric Under Sapota-Jatropha Based agro-Forestry Systems in South Gujarat. Significantly higher B:C ratio was noted in intercropping of ginger with Sapota + Jatropha or jatropha based agroforestry systems as compared to sole cropping or intercropping under sapota, whereas in intercropping of turmeric with Sapota or Sapota + Jatropha agroforestry systems as compared to Intercropping under Jatropha or sole cropping. The overall economic analysis states that the total cost of production found higher in the case of ginger but net income, as well as BCR, observed higher in the case of turmeric.

Materials and Methods

The present experiment was conducted at the College of Horticulture and Forestry, Jhalrapatan city, Jhalawar. The experiment was laid out in Randomized Block Design with Three replications and applied different doses of FYM (10, 15 and 20 t/ha) during 2018-19. Geographically, District Jhalawar falls in Zone-V i.e. Humid south eastern plains, which extends over 6.32 Lac hectare land area among 23°4' to 24°52' N (latitude) and 75°29' to 76°56' E (longitude) in South Eastern Rajasthan. The district has attained premier position in cultivation of mandarin orange. Major Kharif crops of the district are soybean, maize and pulses, while in Rabi, wheat, mustard, coriander and garlic are main crops. The climate of the zone is sub-humid and sub-tropical characterized by mild winter and warm summer associated with relatively high humidity during the month of July to September. The region has mean annual rainfall of 954.7 mm mostly received from South-West monsoon during last week of June to Sept. and sometimes receives scanty showers during winter season. Meteorological data showed that during the growing period of the crop the mean maximum and minimum temperatures ranged between 42.19^{0}C and 7.22^{0}C while, the mean maximum and minimum relative humidity ranged between 87.60 and 47.32 percent.

Curcumin content (%)

The curcumin content was estimated by adopting the method given by Geethanjali *et al*. (2016) [3]. The cured rhizomes were grinded in the fine powder and 1g of the sample was refluxed with 75 ml acetone for 1 hour after which it was filtered and made up to 200 ml (with a sieved solution and added the 125 ml pure acetone). From this further 1 ml was taken and made up to 100 ml (mixed in 99 ml pure acetone) in a standard flask. The flasks were wrapped with dark colored paper and dark conditions maintained since curcumin is light sensitive. The UV spectral reading for this solution was recorded under 420 nm. A UV spectrum was recorded for standard curcumin. The obtained absorption of samples was compared with the standard value and percentage curcumin in samples calculated using the formula:

$$\text{Curcumin content}(\%) = \frac{\text{Ds} \times \text{As}}{100 \times \text{Ws} \times 1650} \times 100$$

Where,

Ds - Dilution volume of the sample (i.e., 200 × 100 = 20000 ml)

Ws - Weight of the sample taken in grams

As - Absorbance of the sample

1650 - Standard value calculated by experts

Benefit cost ratio

The gross realization in terms of rupees per hectare was worked on the basis of the yield of each treatment. The price of economic yield of particular crop was accounted on the basis of the prevailing market price. The net returns per hectare were calculated by deducting the cost of cultivation from gross return per hectare. The benefit cost ratio was calculated as per following formula:

$$\text{Benefit cost ratio} = \frac{\text{Gross returns}}{\text{Cost of cultivation}}$$

Results and Discussion

Curcumin content (%) of Turmeric

The result on the curcumin content among the different doses of FYM of Turmeric as a sole crop and under mandarin based agroforestry system presented in the Table 1. and Figure 1. The Turmeric intercrop under Mandarin based Agroforestry system recorded Maximum Curcumin content (%) in T_{15} (3.31) and Minimum in T_7 (2.07). The result was observed as significant in curcumin content % of Turmeric. The curcumin content (%) showed significantly higher as compared to sole

cropping. However Turmeric var. Kesar and GNT-1 performed better than the other. The results are in consequence with the findings of Chamroy *et al.* (2015) [1] has studied the effect of organic and inorganic manurial combinations on turmeric, Shinde *et al.* (2016) [8] also reported the similar result as well as Kumar and Gill (2009) in turmeric (Curcuma longa L.). Meenakshi *et al.* (2001) conducted a study in Karnataka to determine the effect of planting material and phosphorus (P) and potassium (K) nutrition on the yield and quality of turmeric.

Economics of cultivation

The data on the cost of cultivation, gross returns, net returns and benefit-cost ratio (B: C) as influenced by sole turmeric and intercrop under mandarin based agroforestry system were worked out on per hectare basis and presented in table 2. Among the different doses of FYM, turmeric intercrop under mandarin based Agroforestry system recorded a higher benefit-cost ratio (B: C) followed by sole turmeric. The higher benefit-cost ratio was found in T_{13} (3.15) followed by T_{28} (3.02) whereas the lowest was found in T_{16} (1.76) (Table - 2 and Figure -2).The total cost of production, total gross return and Net returns were calculated and shown in Figure 3.

The data pertaining to cost-benefit ratio revealed the maximum cost-benefit ratio obtained in GNT-1 (20 t/ha FYM) and Kesar (20 t/ha FYM) varieties of Turmeric, which showed highest Net return. It indicates that the intercropping with different doses of FYM to turmeric showed higher benefit cost ratio as compared to sole cropping. The reason can be adaptability of turmeric as intercrop in mandarin in regards of their development, nutrient management as well as light and moisture conditions which showed better productivity and higher economic yield return as compare to sole crop. This is supported by Singh *et al*. (2012) worked on nutrient management on growth, yield and economics of turmeric, Shinde *et al*. (2016) [8], Pandey *et al*. (2016) [5] in intercropping of ginger and turmeric under Sapota-Jatropha based Agro-forestry systems in south Gujarat, Shinde *et al.* (2016) [8] also reported the similar result was significant and Kumar and Gill (2009) in turmeric (*Curcuma longa* L.)

Table 1: Curcumin content (%) of Turmeric under Mandarin based Agroforestry system

Treatment	Curcumin content (%)
T_2 Mandarin + *Curcuma longa* L.var.Udaipur local @ 10 tonne FYM/ha	2.62
T_3 Mandarin + *Curcuma longa* L.var.GNT-1 @ 10 tonne FYM/ha	2.84
T_4 Mandarin + *Curcuma longa* L.var.Chittor local @ 10 tonne FYM/ha	2.21
T_5 Mandarin + *Curcuma longa* L.var.Kesar @ 10 tonne FYM/ha	2.38
T_6 Mandarin + *Curcuma longa* L.var. Sugandham @ 15 tonne) FYM/ha	2.60
T_7 Mandarin + *Curcuma longa* L.var.Udaipur local @ 15 tonne) FYM/ha.	2.07
T_8 Mandarin + *Curcuma longa* L.var.GNT-1 @ 15 tonne) FYM/ha	2.47
T_9 Mandarin + *Curcuma longa* L.var.Chittor local @ 15 tonne) FYM/ha	2.32
T_{10} Mandarin + *Curcuma longa* L.var.Kesar @ 15 tonne) FYM/ha	2.31
T_{11} Mandarin + *Curcuma longa* L.var. Sugandham @ 20 tonne FYM/ha.	2.60
T_{12} Mandarin + *Curcuma longa* L.var.Udaipur local @ 20 tonne FYM/ha..	3.01
T_{13} Mandarin + *Curcuma longa* L.var.GNT-1@ 20 tonne FYM/ha.	3.22
T_{14} Mandarin + *Curcuma longa* L.var.Chittor local @ 20 tonne FYM/ha..	3.04
T_{15} Mandarin + *Curcuma longa* L.var.Kesar @ 20 tonne FYM/ha.	3.31
T_{16} *Curcuma longa* L.var.Sugandham Sole @ 10 tonne FYM/ha.	2.42
T_{17} *Curcuma longa* L.var.Udaipur local Sole @ 10 tonne FYM/ha.	2.99
T_{18} *Curcuma longa* L.var.GNT-1 Sole @ 10 tonne FYM/ha.	3.13
T_{19} *Curcuma longa* L.var.Chittor local Sole @ 10 tonne FYM/ha..	2.16
T_{20} *Curcuma longa* L.var.Kesar Sole @ 10 tonne FYM/ha.	2.54
T_{21} *Curcuma longa* L.var.Sugandham Sole @ 15 tonne) FYM/ha.	2.45
T_{22} *Curcuma longa* L.var.Udaipur local Sole @ 15 tonne) FYM/ha	2.39
T_{23} *Curcuma longa* L.var.GNT-1 Sole @ 15 tonne) FYM/ha	2.60
T_{24} *Curcuma longa* L.var.Chittor local Sole @ 15 tonne) FYM/ha	2.57
T_{25} *Curcuma longa* L.var.Kesar Sole @ 15 tonne) FYM/ha	3.04
T_{26} *Curcuma longa* L.var.Sugandham Sole @ 20 tonne FYM/ha.	2.41
T_{27} *Curcuma longa* L.var.Udaipur local Sole @ 20 tonne FYM/ha.	2.43
T_{28} *Curcuma longa* L.var.GNT-1 Sole @ 20 tonne FYM/ha.	3.19
T_{29} *Curcuma longa* L.var.Chittor local Sole @ 20 tonne FYM/ha.	2.74
T_{30} *Curcuma longa* L.var.Kesar Sole @ 20 tonne FYM/ha.	2.77
C.D. at 5 %	0.301
SE(m)	0.106
C.V.%	6.919

Table 2: Economics of cultivation for Turmeric as an intercrop under Mandarin based Agroforestry system

Treatment	Yield/ ha		Cost of various products (Rs/ha)			Total cost of production (Rs/ha	Gross returns (Rs/ha)		Total Gross returns (Rs/ha)	Net returns (Rs/ha)	B:C ratio
	Mandarin (fruit)	Turmeric (rhizome)	Rhizome	FYM & NPK	Cost of Cultivation		Mandarin (Fruit)	Turmeric (Rhizome)			
T_0	119.61	0.00	0.00	16520.98	59078.12	59078.12	143532.00	0.00	143532.00	84453.88	2.43
T_1	135.77	59.00	43750.00	46887.23	166490.65	166490.65	162928.57	236001.48	398930.05	232439.40	2.40
T_2	135.04	51.74	43750.00	46887.23	166490.65	166490.65	162051.76	206946.74	368998.50	202507.85	2.22
T_3	147.34	47.87	43750.00	46887.23	166490.65	166490.65	176808.00	191481.48	368289.48	201798.83	2.21
T_4	132.96	54.61	43750.00	46887.23	166490.65	166490.65	159552.54	218440.44	377992.98	211502.34	2.27
T_5	151.80	52.65	43750.00	46887.23	166490.65	166490.65	182157.28	210594.07	392751.35	226260.70	2.36
T_6	137.96	75.53	43750.00	59387.23	178990.65	178990.65	165552.34	302122.22	467674.56	288683.91	2.61
T_7	146.51	65.23	43750.00	59387.23	178990.65	178990.65	175808.87	260928.30	436737.16	257746.52	2.44
T_8	149.53	74.74	43750.00	59387.23	178990.65	178990.65	179441.77	298974.07	478415.85	299425.20	2.67
T_9	159.82	73.44	43750.00	59387.23	178990.65	178990.65	191789.98	293777.56	485567.53	306576.88	2.71
T_{10}	155.28	70.78	43750.00	59387.23	178990.65	178990.65	186340.62	283119.26	469459.88	290469.23	2.62
T_{11}	162.45	84.94	43750.00	71887.23	191490.65	191490.65	194945.83	339753.33	534699.17	343208.52	2.79
T_{12}	150.79	83.56	43750.00	71887.23	191490.65	191490.65	180946.31	334241.56	515187.86	323697.21	2.69
T_{13}	167.91	100.24	43750.00	71887.23	191490.65	191490.65	201496.07	400974.07	602470.14	410979.49	3.15
T_{14}	152.21	84.49	43750.00	71887.23	191490.65	191490.65	182652.67	337951.85	520604.52	329113.87	2.72
T_{15}	163.08	88.32	43750.00	71887.23	191490.65	191490.65	195698.10	353270.37	548968.47	357477.82	2.87
T_{16}	0.00	44.27	60000.00	30366.24	100656.22	100653.22	0.00	177078.86	177078.86	76425.63	1.76
T_{17}	0.00	45.10	60000.00	30366.24	100656.22	100653.22	0.00	180388.11	180388.11	79734.89	1.79
T_{18}	0.00	53.35	60000.00	30366.24	100656.22	100653.22	0.00	213412.57	213412.57	112759.35	2.12
T_{19}	0.00	48.58	60000.00	30366.24	100656.22	100653.22	0.00	194314.06	194314.06	93660.83	1.93
T_{20}	0.00	58.28	60000.00	30366.24	100656.22	100653.22	0.00	233120.46	233120.46	132467.23	2.32
T_{21}	0.00	67.76	60000.00	42866.24	113156.22	113153.22	0.00	271048.91	271048.91	157895.69	2.40
T_{22}	0.00	65.56	60000.00	42866.24	113156.22	113153.22	0.00	262250.74	262250.74	149097.52	2.32
T_{23}	0.00	70.45	60000.00	42866.24	113156.22	113153.22	0.00	281792.46	281792.46	168639.23	2.49
T_{24}	0.00	70.38	60000.00	42866.24	113156.22	113153.22	0.00	281508.80	281508.80	168355.58	2.49
T_{25}	0.00	73.19	60000.00	42866.24	113156.22	113153.22	0.00	292770.74	292770.74	179617.52	2.59
T_{26}	0.00	75.35	60000.00	55366.24	125656.22	125653.22	0.00	301389.49	301389.49	175736.26	2.40
T_{27}	0.00	83.39	60000.00	55366.24	125656.22	125653.22	0.00	333561.90	333561.90	207908.68	2.65
T_{28}	0.00	94.99	60000.00	55366.24	125656.22	125653.22	0.00	379977.14	379977.14	254323.92	3.02
T_{29}	0.00	80.71	60000.00	55366.24	125656.22	125653.22	0.00	322853.03	322853.03	197199.81	2.57
T_{30}	0.00	87.16	60000.00	55366.24	125656.22	125653.22	0.00	348632.38	348632.38	222979.16	2.77

Note:	
T_0: Mandarin sole,	
T_1 Mandarin + *Curcuma longa* L.var. Sugandham @10 tone FYM/ha,	T_{16}: *Curcuma longa* L.var.Sugandham Sole @ 10tonne FYM/ha
T_2 Mandarin + *Curcuma longa* L.var. Udaipur Local @ 10 tone FYM/ha	T_{17}: *Curcuma longa* L.var.Udaipur local Sole @10tone FYM/ha
T_3: Mandarin + *Curcuma longa* L.var. GNT-1@ 10 tone FYM/ha	T_{18}: *Curcuma longa* L.var.GNT-1 Sole @ 10tone FYM/ha
T_4: Mandarin + *Curcuma longa* L.var. Chittor Local @ 10 tone FYM /ha.	T_{19}: *Curcuma longa* L.var.Chittor Local Sole @ 10tone FYM/ha
T_5: Mandarin + Curcuma longa L.var. Kesar @ 10 tone FYM/ha	T_{20}: *Curcuma longa* L.var.Kesar Sole @ 10tone FYM/ha.
T_6 Mandarin + *Curcuma longa* L.var. Sugandham @15 tone FYM/ha,	T_{21}: *Curcuma longa* L.var.Sugandham Sole @ 15 tone FYM/ha.
T_7 Mandarin + *Curcuma longa* L.var.Udaipur Local @15 tone FYM/ha.	T_{22}: *Curcuma longa* L.var.Udaipur local Sole @15 tone FYM/ha.
T_8: Mandarin + *Curcuma longa* L.var. GNT-1@ 15 tone FYM/ha,	T_{23}: *Curcuma longa* L.var.GNT-1 Sole @ 15 tone FYM/ha.
T_9: Mandarin + *Curcuma longa* L.var. Chittor Local @ 15 tone FYM /ha,	T_{24}: *Curcuma longa* L.var.Chittor local Sole @ 15 tone FYM/ha
T_{10}: Mandarin + Curcuma longa L.var. Kesar @ 15 tone FYM/ha,	T_{25}: *Curcuma longa* L.var.Kesar Sole @ 15 tone FYM/ha,
T_{11} Mandarin + *Curcuma longa* L.var. Sugandham @20 tone FYM/ha,	T_{26}: *Curcuma longa* L.var.Sugandham Sole @20 tone FYM/ha,
T_{12} Mandarin + *Curcuma longa* L.var. Udaipur Local @20 tone FYM/ha,	T_{27}: *Curcuma longa* L.var.Udaipur local @20 tone FYM/ha,
T_{13} Mandarin + *Curcuma longa* L.var. GNT-1@20 tone FYM/ha,	T_{28}: *Curcuma longa* L.var.GNT-1 Sole @20 tone FYM/ha,
T_{14}: Mandarin + *Curcuma longa* L.var. Chittor Local @20 tone FYM/ha,	T_{29}: *Curcuma longa* L.var.Chittor local Sole @20 tone FYM/ha,
T_{15}: Mandarin + Curcuma longa L.var. Kesar @20 tone FYM/ha,	T_{30}: *Curcuma longa* L.var.Kesar Sole @20 tone FYM/ha,
Rate of turmeric rhizome = 35.00Rs/Kg	Price of FYM = 2.5Rs/kg,
Whole sale price of Mandarin = 12.00Rs/Kg	Labour Charges = 215.00Rs/day
Whole sale of Turmeric (Fresh) = 40.00Rs/Kg	Price of Fungicide = 415.00Rs/Kg
Price of Nitrogen = 6.50Rs/Kg	Price of Insecticide = 2130.00 Rs/lit
Price of Phosphorus = 8.00 Rs/Kg	Price of Irrigation = 750 Rs/irrigation

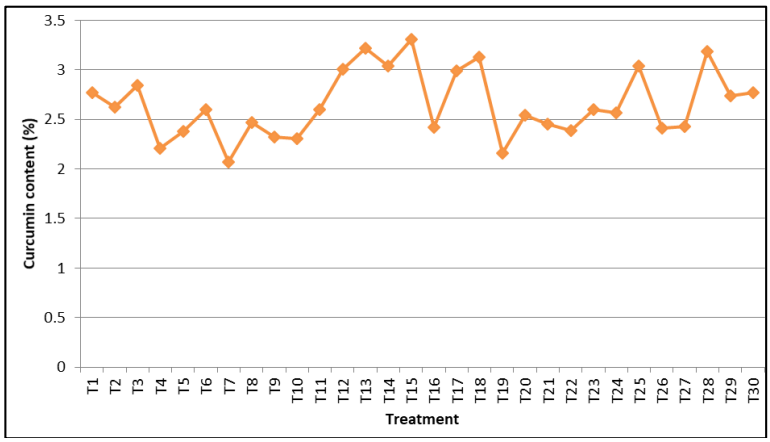

Fig 1: Curcumin content (%) of Turmeric under Mandarin based Agroforestry system

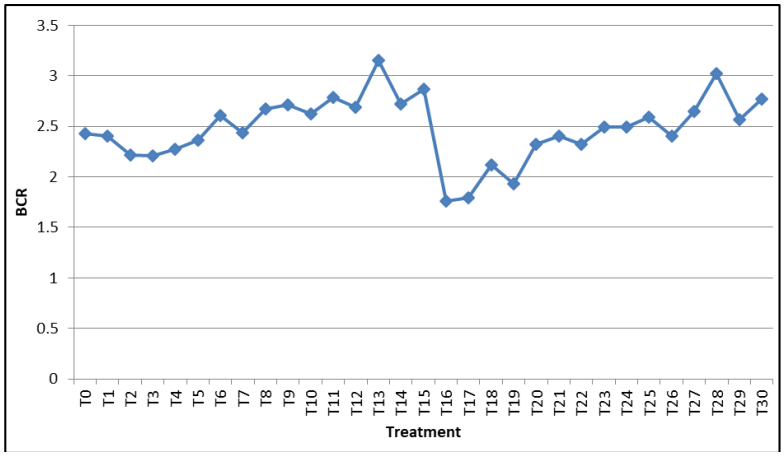

Fig 2: Evaluation of Mandarin based Agroforestry system in South-Eastern Rajasthan with benefit: cost ratio (Rs/ha.).

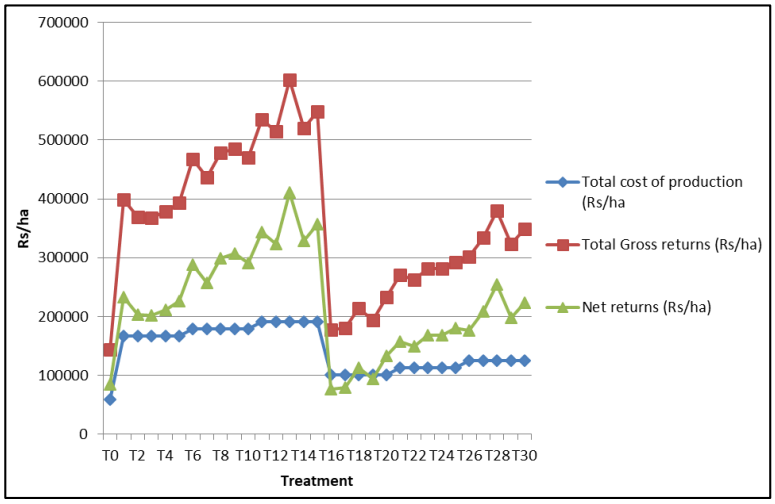

Fig 3: Evaluation of Mandarin based Agroforestry system in South-Eastern Rajasthan with Total cost of production, Total gross returns and Net income (Rs/ha.).

Note: T_0: Mandarin sole, T_1 Mandarin + *Curcuma longa* L. var. Sugandham @ 10 tone FYM /ha., T_2 Mandarin + *Curcuma longa* L.var. Udaipur Local @ 10 tone FYM /ha., T_3: Mandarin + *Curcuma longa* L. var. GNT-1(@ 10 tone) FYM/ha, T_4: Mandarin + *Curcuma longa* L.var. Chittor Local @ 10 tone FYM /ha., T_5: Mandarin + Curcuma longa L. var. Kesar @ 10 tone FYM /ha., T_6 Mandarin + *Curcuma longa* L.var. Sugandham @15 tone FYM/ha., T_7 Mandarin + *Curcuma longa* L. var. Udaipur Local @15 tone FYM/ha., T_8: Mandarin + *Curcuma longa* L. var. GNT-1@15 tone FYM/ha., T_9: Mandarin + *Curcuma longa* L. var. Chittor Local @15 tone FYM/ha., T_{10}: Mandarin + Curcuma longa L. var. Kesar @15 tone FYM/ha., T_{11} Mandarin + *Curcuma longa* L.var. Sugandham @20 tone FYM/ha., T_{12} Mandarin + *Curcuma longa* L.var. Udaipur Local @20 tone FYM/ha., T_{13} Mandarin + *Curcuma longa* L.var. GNT-1@20 tone FYM/ha., T_{14}: Mandarin + *Curcuma longa* L.var. Chittor Local @20 tone FYM/ha., T_{15}: Mandarin + Curcuma longa L.var. Kesar @20 tone FYM/ha., T16: *Curcuma longa* L.var. Sugandham Sole @ 10tonne FYM/ha.T_{17}: *Curcuma longa* L.var. Udaipur local Sole @10tone FYM/ha. T_{18}: *Curcuma longa* L.var.GNT-1 Sole @ 10 toneFYM/ha. T_{19}: *Curcuma longa* L.var.Chittor Local Sole @ 10tone FYM/ha. T_{20}: *Curcuma longa* L.var.Kesar Sole (@ 10tone) FYM/ha. T_{21}: *Curcuma longa* L.var. Sugandham Sole @ 15 tone FYM/ha. T_{22}: *Curcuma longa* L.var. Udaipur local Sole (@15 tone) FYM/ha. T_{23}: *Curcuma longa* L.var.GNT-1 Sole @ 15 tone FYM/ha. T_{24}: *Curcuma longa* L.var.Chittor local Sole @ 15 tone FYM/ha. T_{25}: *Curcuma longa* L.var. Kesar Sole (@ 15 tone) FYM/ha. T_{26}: *Curcuma longa* L.var. Sugandham Sole @20 tone FYM/ha., T_{27}: *Curcuma longa* L.var. Udaipur local Sole @ 20 tone FYM/ha., T_{28}: *Curcuma longa* L.var.GNT-1 Sole @ 20 tone FYM/ha., T_{29}: *Curcuma longa* L.var. Chittor local Sole @20 tone FYM/ha.,. T_{30}: *Curcuma longa* L.var.Kesar Sole @20 tone FYM/ha.

4. Conclusion

It can be concluded that maximum curcumin content can be obtained by *Curcuma longa* L.var. Kesar and var. GNT-1 @ 20 tonnes FYM/ha among intercropping as well as for the sole turmeric. On the other side the higher benefit-cost ratio revealed that GNT-1 and Kesar varieties of Turmeric can be grown under Mandarin based Agroforestry system as well as in sole turmeric. Therefore GNT-1 and Kesar varieties of Turmeric are recommended as an intercrop among five varieties in Mandarin Orchard as well as a sole crop at the spacing of 30X45 cm with the application of 20 tonne/ha FYM in South-Eastern Rajasthan.

5. References

1. Chamroy T, Rajwade TV, Bajad VV. Effect of Organic and Inorganic Manurial Combinations on Turmeric (*Curcuma Longa* L.) Plant Archives. 2015; 15(1):67-69.
2. Datta S, Jana JC, Bhaisare PT, Nimbalkar KH. Effect of organic source of nutrients and biofertilizers on growth, yield and quality of turmeric (*Curcuma longa* L.) Journal of Applied and Natural Science. 2017; 9(4):1981-1986
3. Geethanjali A, Lalitha P, Jannathul FM. Analysis of Curcumin Content of Turmeric Samples from Various States of India. Int. J Pharma Chemi. Res., 2016; 2(1):55-62.
4. Menakshi N, Sulikeri GS, Hedge RV. Effect of planting material and P & K nutrition on plant growth of turmeric. Karnataka Journal of Agricultural Science. 2001; 14(1):194-196.
5. Pandey SBS, Jadeja DB, Singh Manohar Narendra, Tandel MB. Economic Comparison of Intercropping of Ginger and Turmeric Under Sapota-Jatropha Based Agro-Forestry Systems in South Gujarat. International Journal of Science, Environment and Technology. 2016; 5(5):3635-3642.
6. Rahagdale S. Growth and productivity of turmeric under different methods of planting and time earthing in guava based Agrihorticulture practice of Agroforestry. M.Sc. (Forestry) Agroforestry Thesis submitted to JNKVV, Jabalpur, 2011.
7. Sharma DP, Sharma TR, Agrawal SB, Rawat A. Differential response of turmeric to organic and inorganic fertilizers. JNKVV Research Journal. 2003; 37(2):17-19.
8. Shinde VV, Gavade RT, Dubale JJ, Chavan SS. Influence of Fertilizer Management to Turmeric (*Curcuma longa L.*) CV.Salem under Konkan Condition. International journal of current research. 2016; 8(2):26548-26550.
9. Shi WZ, Zhen HF. The nitrogen uptake efficiency from N labeled chemical fertilizer in the presence of earthworm manure (cast). In: Advances in Management and Conservation of Soil Fauna Veeresh G K D, Rajagopal and Viraktamath C A. (eds.). Oxford and IBH publishing Co. New Delhi, Bombay. 1991, 539-542.