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Economics of cultivation of mustard varieties (*Brassica juncea* L.) under Nagpur mandarin (*Citrus reticulata* Blanco.) based agroforestry system in South-Eastern Rajasthan

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Abstract
Field experiment was conducted deploying 24 treatments in Randomized Block Design with three replications during two successive years from October 2020 to March 2021 and October 2021 to March 2022. The fourteen-year-old plantation of mandarin planted at 6 x 6 m spacing, which was used for the present intercropping study. Mustard with three varieties (var. Giriraj, RH-725 and NRCHB-101) and was selected along with the application (4 ml/lit.) of biofertilizers (Azotobacter and Phosphorus solubilizing bacteria) for the study. Higher benefit cost ratio in the treatment M_{10} (1: 3.39 in 2020-21 and 1:3.42 in 2021-22), where mustard (var. Giriraj) was intercropped under mandarin based agroforestry system as compared to sole cropping of mustard during both the years of study. The B: C ratio was recorded minimum in the treatment M_{15} (1:1.30 in 2020-21 and 1:1.52 in 2021-22), var. NRCHB-101).

Keywords: Agroforestry, B: C ratio, intercropping, biofertilizers

Introduction
Agroforestry is the future of agriculture because it allows for sustainable production while also providing ecosystem services that ensure livelihood and environmental security. Most importantly, conservation agriculture principles are well-integrated into agroforestry exercise, which has the ability to assist in conserve natural resources in various agro-climatic regions. Further, agroforestry is the only pathway to enhance the forest cover in the particular country. In a scenario of declining availability of arable lands for agriculture, dilapidation of soil and water resources, increasing pollution hazards and force to environment and ecosystem from global warming and climate change, new methodologies in agriculture farming systems are needed to meet food, fodder, firewood, fibre and timber demands of increasing population that only agroforestry interventions can provision to attain sustainability.

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. 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 *et al*., 2014) [15]. At present in the country, agroforestry is practiced among 17.45 m ha to 25.32 m ha. The estimated area of agroforestry in the states of Uttar Pradesh (1.86 m. ha.), Maharashtra (1.61 m. ha.) and Rajasthan (1.55 m. ha.) as first, second and third position, respectively. However, there are still a lot of challenges that impede the growth of agroforestry in country. These contain a lack of unvarying policies and set of laws relating to harvesting and transporting of farm-grown plant produce like timber (Asharam *et al*., 2018) [3].

Intercropping provides year-round of ground cover, or at least for a longer time period than monocultures, in order to defend the soil particles from desiccation and erosion. By the growing of more than one crop at a time in the same field, farmers maximize the water use efficiency, keep soil fertility and productivity maintain, and minimize soil erosion, which are serious drawbacks of mono-cropping. Intercropping also reduces the seasonal work peaks as a result of the diverse planting and harvesting time of the intercropping crops. It could serve up to increase output per unit of area, particularly with low levels of the external inputs since mix of species makes superior use of available nutrients and moisture in the soil (Dodiya *et al*. 2017) [7]. Donald (1963) [8] opined that species of contrasting habit, both morphologically and physiologically would together be able to exploit the total environment more effectively than monoculture. If two species grown together are mutually beneficial, then there is cooperation [6].

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. The total production of mandarin in the country is about 51.01 lakh tonnes from an area of 4.28 lakh hectares with the productivity of 14.84 MT/ha. In the Rajasthan, Nagpur mandarin is around 23,900 ha area and its production is 4.7 lac tonnes (Meena *et al.*, 2021) [9].

Indian mustard is predominantly cultivated in the states of Rajasthan, Uttar Pradesh, Madhya Pradesh, Haryana, Punjab, Gujarat, and Bihar. Rajasthan contributed the major part of 2.53 m ha with 3.25 mt production and 1287 kg ha^{-1} of productivity. Thus, Rajasthan has major share in area (46%) and production (49%) of mustard in India. In India, mustard is cultivated on 6.23 m ha with 9.34 mt production and 1499 kg ha^{-1} productivity. Among the seven oil seeds cultivation in India, the Brassica species is only contribute the 28.60% in total oil seed production. Brassica species oil is used for salad, made for cooking and after the extraction of oil the protein rich extra material is used for cattle feed purposes. Indian mustard suffers more from weed competition especially at the early stage of crop enlargement (Kumar *et al*., 2021) [10].

Biofertilizers have gone a long way and are accepted as most important nutrient inputs under both integrated nutrient management strategy and the organic management approach. Phosphate solubilizing bacteria play a significant role in supplementing phosphorus to plants, allowing sustainable utilize of phosphate. Soil and seed inoculation with phosphate solubilizing bacteria (PSB) improves solubilization of the fixed soil phosphorus and of applied phosphates, consequential in higher crop yields. PSB is also creating the growth promoting substances which might enhance the growth of crop. These hormones from PSB might have increased the various endogenous hormonal levels in plant tissue, that may enhance the pollen germination and tube growth, which is ultimately amplified the fruit set. Azotobacter is a genus of free-living diazotrophic bacteria whose resting stage is a cyst. It is primarily found in neutral to alkaline soils, in an aquatic environment, and on some plants. It has several metabolic capabilities, together with atmospheric nitrogen fixation by conversion to ammonia. Their sole system of three distinct nitrogenise enzymes makes these bacteria of exacting interest to scientists, who may work toward a better understanding of nitrogen fixation and its role in agriculture. *Azotobacter* spp. has the highest metabolic rate of any organisms.

Materials and Methods

The present investigation was conducted at the Instructional Farm, Department of Fruit Science, College of Horticulture & Forestry, (Agriculture University, Kota), Jhalawar during *rabi* season 2020-21 and 2021-22. Jhalawar is located at 24.6^0N 76.15^0E. It has an average elevation of 312 meters (1023 feet). The college farm is located 5 km away from Jhalawar city. Jhalawar district is situated at $23^0$4' to $24^0$52' N-Latitude and $75^0$29' to $76^0$56' E-Longitude in South-Eastern, Rajasthan. Agro-climatically, the district Jhalawar falls in Zone V, known as Humid South Eastern Plain. About 84.22 percent population of the district is rural whose main occupation is agriculture. Average rainfall in the region is 954 mm. Maximum temperature range in the summer is 43-48 °C and minimum 3-5 °C during winter. Agriculture and forest lands occupy 73.5 percent area, respectively in the district.

The fourteen years old plantation of Nagpur mandarin (*Citrus reticulata* Blanco.) at 6X6 m spacing was used as a main crop. The mustard crop (*Brassica juncea* L.) along with three varieties (Giriraj, RH-725 and NRCHB-101) grown as an intercrop with spacing 30X15 cm. The experiment as laid out in Randomized Block Design (RBD) with three replications and twenty four treatments for attributes of mustard growth and yield. The application of both biofertilizers used as seed treatment (4 ml/kg) before sowing. The plot sized in intercropping (Gross 6X6 m and net 5X3 m) and in sole cropping (Gross 5.30X3.30 m and net 5X3 m) was fixed during the period of study for both years.

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:

$$\text{Benefit cost ratio} = \frac{\text{Gross returns}}{\text{Cost of cultivation}} \text{X100}$$

Results and Discussion

Tables-1, 2 represent that the data on the cost of cultivation, gross income, net returns, and benefit cost ratio (B: C) as influenced by sole mustard and intercrop in a mandarin-based agroforestry system for the years 2021 and 2022.

The data exhibited in the Table-1, 2 revealed that higher benefit cost ratio in the treatment M_{10} (1: 3.39 in 2020-21 and 1:3.42 in 2021-22), where mustard (var. Giriraj) was intercropped under mandarin based agroforestry system as compared to sole cropping of mustard during both the years of study. The B:C ratio was recorded minimum in the treatment M_{15} (1:1.30 in 2020-21and 1:1.52 in 2021-22), var. NRCHB-101.

Compared to all respective treatments, as per varieties of mustard studied in both of the years, treatment with mustard variety Giriraj along with application of Azotobacter and PSB recorded higher benefit cost ration among all (Table-1, 2). The present study clearly shows that the gross return and net return were found more in mandarin + mustard based cropping system than sole traditional cropping of mustard. This might be due to tree crop association providing better micro-site conditions than

sole crop. Banerjee and Dhara (2011) [11] reported higher net return under agroforestry system as compared to sole cropping. Also, Kaushik *et al*., (2017) [12], Kaushik *et al*., (2016) [13] in cluster bean, mung bean, cowpea and dhaincha under Karanj based agroforestry system, Dhanyashree *et al.*, (2020) [4] under bamboo + fenugreek based agroforestry system and Dhillon *et al*., (2018) [5] revealed higher gross return under tree based cropping system over sole crops. Pandey *et al*. (2016) [14] 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. Same trend of results were also found by Ranawat *et al*., (2018) [1] and Bahiriya *et al*, (2019) [2] during conducted research on intercropping of turmeric under Nagpur mandarin based agroforestry system.

Table 1: Economics of mustard cultivation under mandarin based agroforestry system in South-Eastern Rajasthan (2020-21)

Treatments	Yield (q/ha)		Cost of various products (Rs/ha)			Total cost of production (Rs/ha)	Gross income (Rs/ha)		Total gross income (Rs/ha)	Net income (Rs/ ha)	BC Ratio
	Mandarin	Mustard	Mustard seed	NPK and FYM	Cost of cultivation		Mandarin	Mustard			
M_1	71.93	5.92	480	16000	28480	44960	86313.44	29583.33	115896.8	70936.77	2.58
M_2	69.26	5.78	400	16000	28400	44800	83110.88	28888.89	111999.8	67199.77	2.50
M_3	63.76	5.45	270	16000	28270	44540	76516.72	27268.52	103785.2	59245.24	2.33
M_4	89.53	7.06	480	16000	28480	44960	107430.3	35324.07	142754.4	97794.39	3.18
M_5	76.24	6.85	400	16000	28400	44800	91484.24	34259.26	125743.5	80943.5	2.81
M_6	73.11	6.79	270	16000	28270	44540	87736.8	33935.19	121672	77131.99	2.73
M_7	90.70	7.11	480	16000	28480	44960	108842.6	35555.56	144398.1	99438.12	3.21
M_8	84.60	6.97	400	16000	28400	44800	101525.6	34861.11	136386.7	91586.71	3.04
M_9	80.82	6.94	270	16000	28270	44540	96988.64	34675.93	131664.6	87124.57	2.96
M_{10}	96.26	7.36	480	16000	28480	44960	115514.6	36805.56	152320.1	107360.1	3.39
M_{11}	92.62	7.31	400	16000	28200	44600	111144.4	36527.78	147672.2	103072.2	3.31
M_{12}	92.08	7.29	270	16000	28270	44540	110499.4	36435.19	146934.6	102394.6	3.30
M_{13}	0.00	10.77	960	17000	20000	35000	0	53840.29	53840.29	18840.29	1.54
M_{14}	0.00	10.33	800	17000	20000	35000	0	51648.56	51648.56	16648.56	1.48
M_{15}	0.00	9.07	540	17000	20000	35000	0	45359.25	45359.25	10359.25	1.30
M_{16}	0.00	13.80	960	17000	20000	35000	0	68991.8	68991.8	33991.8	1.97
M_{17}	0.00	13.40	800	17000	20000	35000	0	66990.66	66990.66	31990.66	1.91
M_{18}	0.00	13.65	540	17000	20000	35000	0	68229.46	68229.46	33229.46	1.95
M_{19}	0.00	12.96	960	17000	20000	35000	0	64798.93	64798.93	29798.93	1.85
M_{20}	0.00	12.45	800	17000	20000	35000	0	62226.03	62226.03	27226.03	1.78
M_{21}	0.00	12.81	540	17000	20000	35000	0	64036.59	64036.59	29036.59	1.83
M_{22}	0.00	14.88	960	17000	20000	35000	0	74423.48	74423.48	39423.48	2.13
M_{23}	0.00	14.79	800	17000	20000	35000	0	73947.02	73947.02	38947.02	2.11
M_{24}	0.00	14.71	540	17000	20000	35000	0	73565.85	73565.85	38565.85	2.10

Table 2: Economics of mustard cultivation under mandarin based agroforestry system in South-Eastern Rajasthan (2021-22)

Treatments	Yield (q/ha)		Cost of various products (Rs/ha)			Total cost of production (Rs/ha)	Gross income (Rs/ha)		Total gross income (Rs/ha)	Net income (Rs/ ha)	BC Ratio
	Mandarin	Mustard	Mustard seed	NPK and FYM	Cost of cultivation		Mandarin	Mustard			
M_1	64.85	6.34	520	19100	31620	51240	90787.39	41226.85	132014.2	80774.24	2.58
M_2	59.63	6.15	440	19100	31540	51080	83483.4	39962.96	123446.4	72366.36	2.42
M_3	56.23	5.80	300	19100	31400	50800	78722.19	37675.93	116398.1	65598.11	2.29
M_4	83.34	7.21	520	19100	31620	51240	116682.2	46884.26	163566.4	112326.4	3.19
M_5	71.52	7.04	440	19100	31540	51080	100128.2	45740.74	145868.9	94788.93	2.86
M_6	69.19	6.97	300	19100	31400	50800	96871.88	45319.44	142191.3	91391.32	2.80
M_7	83.84	7.25	520	19100	31620	51240	117382.7	47125	164507.7	113267.7	3.21
M_8	82.06	7.15	440	19100	31540	51080	114878.9	46462.96	161341.8	110261.8	3.16
M_9	76.27	7.09	300	19100	31400	50800	106783.5	46101.85	152885.4	102085.4	3.01
M_{10}	89.51	7.65	520	19100	31620	51240	125309.4	49712.96	175022.4	123782.4	3.42
M_{11}	85.99	7.55	440	20100	31540	52080	120379.6	49050.93	169430.5	117350.5	3.25
M_{12}	84.85	7.48	300	20100	34400	54800	118796.8	48629.63	167426.4	112626.4	3.06
M_{13}	0.00	11.61	1080	20100	24000	45180	0	75443.11	75443.11	30263.11	1.67
M_{14}	0.00	11.30	880	20100	24000	44980	0	73461.03	73461.03	28481.03	1.63
M_{15}	0.00	10.46	600	20100	24000	44700	0	68010.29	68010.29	23310.29	1.52
M_{16}	0.00	14.31	1080	20100	24000	45180	0	93034.11	93034.11	47854.11	2.06
M_{17}	0.00	14.05	880	20100	24000	44980	0	91299.79	91299.79	46319.79	2.03
M_{18}	0.00	14.20	600	20100	24000	44700	0	92290.83	92290.83	47590.83	2.06
M_{19}	0.00	13.91	1080	20100	24000	45180	0	90432.63	90432.63	45252.63	2.00
M_{20}	0.00	13.40	880	20100	24000	44980	0	87087.86	87087.86	42107.86	1.94
M_{21}	0.00	13.63	600	20100	24000	44700	0	88574.42	88574.42	43874.42	1.98
M_{22}	0.00	15.23	1080	20100	24000	45180	0	98980.37	98980.37	53800.37	2.19
M_{23}	0.00	15.13	880	20100	24000	44980	0	98360.97	98360.97	53380.97	2.19
M_{24}	0.00	15.06	600	20100	24000	44700	0	97865.45	97865.45	53165.45	2.19

Details of cost of cultivation of various products

Cost of products	2020-21	2021-22
Seed price of mustard		
Giriraj	Rs 120/kg	Rs 130/kg
RH-725	Rs 100/kg	Rs 110/kg
NRCHB-101	Rs 90/kg	Rs 100/kg
Price of nitrogen	Rs 6.4/kg	Rs 7.6/kg
Price of phosphorus	Rs 8.4/kg	Rs 9.6/kg
Price of potassium	Rs 19.6/kg	Rs 20.8/kg
FYM price	Rs 600/t	Rs 700/t
Marketing price of mustard	Rs 50/kg	Rs 65/kg
Marketing price of mandarin	Rs 12/kg	Rs 14/kg

Details of cost of cultivation under mandarin based Agroforestry system

Charges	2020-21		2021-22	
	Intercropping	Sole cropping	Intercropping	Sole cropping
Total labour	93	53	93	53
Field/Bed preparation	22	12	22	12
FYM mixing	06	03	06	03
Sowing	12	08	12	08
Weeding	28	14	28	14
Spraying	05	06	05	06
Harvesting	20	10	20	10
Ploughing charges	6000	5700	6500	6100
Irrigation charges	2400		2550	
Miscellaneous	1000		1500	

- First year Labour wages @ Rs. 200/day
- Second year Labour wages @ Rs. 230/day
- Ploughing charges in First year @ 6000/day for Intercropping
- Ploughing charges in First year @ 5700/day for Sole cropping
- Ploughing charges in Second year @ 6500/day for Intercropping
- Ploughing charges in Second year @ 6100/day for Sole cropping
- Irrigation charges in First year @ 2400/day
- Irrigation charges in Second year @ 2550/day

S. N.	Symbol	Treatment combination
1	M_1	*Citrus reticulata* Blanco. + *Brassica juncea* L. var. Giriraj
2	M_2	*Citrus reticulata* Blanco. + *Brassica juncea* L. var. RH-725
3	M_3	*Citrus reticulata* Blanco. + *Brassica juncea* L. var. NRCHB-101
4	M_4	*Citrus reticulata* Blanco. + *Brassica juncea* L. var. Giriraj + Azotobacter
5	M_5	*Citrus reticulata* Blanco. + *Brassica juncea* L. var. RH-725 + Azotobacter
6	M_6	*Citrus reticulata* Blanco. + *Brassica juncea* L. var. NRCHB-101 + Azotobacter
7	M_7	*Citrus reticulata* Blanco. + *Brassica juncea* L. var. Giriraj + PSB
8	M_8	*Citrus reticulata* Blanco. + *Brassica juncea* L. var. RH-725 + PSB
9	M_9	*Citrus reticulata* Blanco. + *Brassica juncea* L. var. NRCHB-101 + PSB
10	M_{10}	*Citrus reticulata* Blanco. + *Brassica juncea* L. var. Giriraj + Azotobacter + PSB
11	M_{11}	*Citrus reticulata* Blanco.+ *Brassica juncea* L. var. RH-725 + Azotobacter + PSB
12	M_{12}	*Citrus reticulata* Blanco.+ *Brassica juncea* L. var. NRCHB-101 + Azotobacter + PSB
13	M_{13}	*Brassica juncea* L. sole var. Giriraj
14	M_{14}	*Brassica juncea* L. sole var. RH-725
15	M_{15}	*Brassica juncea* L. sole var. NRCHB-101
16	M_{16}	*Brassica juncea* L. sole var. Giriraj + Azotobacter
17	M_{17}	*Brassica juncea* L. sole var. RH-725 + Azotobacter
18	M_{18}	*Brassica juncea* L. sole var. NRCHB-101 + Azotobacter
19	M_{19}	*Brassica juncea* L. sole var. Giriraj + PSB
20	M_{20}	*Brassica juncea* L. sole var. RH-725 + PSB
21	M_{21}	*Brassica juncea* L. sole var. NRCHB-101 + PSB
22	M_{22}	*Brassica juncea* L. sole var. Giriraj + Azotobacter + PSB
23	M_{23}	*Brassica juncea* L. sole var. RH-725 + Azotobacter + PSB
24	M_{24}	*Brassica juncea* L. sole var. NRCHB-101 + Azotobacter + PSB

Conclusion

On the basis of results obtained from the field experiment entitled "Economics of Cultivation of Mustard Varieties (*Brassica juncea* L.) under Nagpur Mandarin (*Citrus reticulata* Blanco.) based Agroforestry System in South- Eastern Rajasthan", it may be concluded that, growing of intercrop (mustard) with Nagpur mandarin resulted in significant increase in the growth as well as the economic return as compared to growing mustard or mandarin as a sole crop. The maximum fruit yield was found in the treatment where intercrop (mustard var. Giriraj) was growing with application of both bio fertilizers together (Azotobacter and PSB).

References

1. Ranawat JS, Pandey SBS, Singh J, Nayak D, Pushpanjali. Doubling the farmer's income through intercropping turmeric under mandarin based agroforestry system in South-Eastern Rajasthan. J Pharmacogn Phytochem. 2018;7(4):2560-2563.
2. Bahiriya J, Pandey SBS, Nagar B, Singh J, Arya CK. 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. J Pharmacogn Phytochem. 2019;8(6):1853-1858.
3. Asharam, Chaturvedi OP, Inderdev. Role of Agroforestry in Current Scenario. In: Agroforestry for climate resilience and rural livelihood. Jodhpur: Scientific Publication; c2018. p. 1-10.
4. Dhanyashree PV, Malik MS, Agarwal YK, Kumar S. Growth and yield of spice crops under bamboo based agroforestry system in plains of Chota Nagpur plateau of Jharkhand. Indian J Agroforestry. 2020;22(2):105-109.
5. Dhillon RS, Chavan SB, Bangarwa KS, Bhardwaj KK, Kumari S, Sirohi C. Eucalyptus based agroforestry system under semi-arid condition in North-Western India: An economic analysis. Indian J Ecol. 2018;45(3):470-474.
6. Asmita Khanal, Sandip Timilsina, Sunil Aryal, Susmita Khanal, Madhav Lamsal. Post-harvest study of mandarin in cold storage condition and ambient condition at Syangja, Nepal. Int J Hortic Food Sci 2023;5(2):17-22. DOI: 10.33545/26631067.2023.v5.i2a.172
7. Dodiya TP, Patel GD, Sreedevi, Gadhiya AD. Influence of Different Intercropping Patterns on PAR (Photosynthetically Active Radiation) and Leaf Temperature of Jasmine. Trends Biosci. 2017;10(29):6087-6089.
8. Donald CM. Competition among crops and pasture plants. Adv Agron. 1963;10:435-473.
9. Meena D, Bhatnagar P, Kumar N, Meena L. Effect of foliar spray of nutrients on yield and quality of Nagpur mandarin. The Pharma Innovation. 2021;10(10):1122-1127.
10. Kumar R, Yadav SS, Singh U, Verma HP. Growth, yield, quality and energetics of mustard as influenced by weed management and sulphur fertilization under semi-arid condition of Rajasthan. Int. J Bio-resource Stress Manag. 2021;12(4):255-263.
11. Banerjee H, Dhara PK. Evaluation of different agri-horti-silvicultural models for rainfed uplands in West Bengal. Prog Agric Sci. 2011;11(1):143-148.
12. Kaushik N, Tikkoo A, Yadav PK, Deswal RPS, Singh S. Agri-silvi-horti systems for semi-arid regions of North-West India. Agric Res. 2017;6(2):150-158.
13. Kaushik N, Deswal RPS, Tikkoo A, Kumari S, Malik S, Kumar K. *Pongamia pinnata* L. (Karanj) based agri-silvicultural system under rainfed conditions of south-west Haryana. J Appl Nat Sci. 2016;8(1):31-34.
14. Pandey SBS, Jadeja DB, Manohar NS, Tandel MB. Economic comparison of intercropping of ginger and turmeric under sapota-jatropha based agroforestry system in south Gujarat. Int J Sci Environ Technol. 2016;5(5):3635-3642.
15. Rahangdale CP, Kosta LD, Rajawat BS. Impact of bamboo based agroforestry system on organic matter built-up and nutritional status of soil. J Trop For. 2014;30(1):77-81.