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Study on economic feasibility of intercropping of lemon (*Citrus limon* Burm) with vegetables in the hilly terrain of Mizoram

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Abstract

An experiment was carried out to study the production potential and economic feasibility of intercropping lemon and vegetable crops. The productivity of the intercropping systems was found to differ significantly. The highest gross return was obtained from the lemon + French bean intercropping system and the lowest gross return was obtained from sole lemon for two years in a row. The highest benefit - cost ratio was recorded in lemon + French bean intercropped (3.94), followed by T_7 (3.70) and T_4 (3.54). From the present investigation, it was apparent that the lemon + French bean intercropping system was found to be the best from the view point of equivalent yield and economics.

Key words: Intercropping; citrus; agriculture crops; economics; Mizoram.

Introduction

Citrus occupies a prominent place among the extensively grown subtropical fruits. It is the third major commercially cultivated fruit crop of India after mango and banana. Citrus is one of the major and popular fruit crops of Mizoram where the total area of plantation covered is 9,165 ha with a production of 35,097 tonnes.[1]

Lemon is also an important citrus fruit extensively grown in Northeast India, especially in Mizoram. Several workers studied intercropping of citrus species with agriculture crops.[2,3] Intercropping of citrus with groundnut, cotton or soyabean in kharif season and with wheat or gram in rabi season can be successful.[4] Alternate land-use system such as agroforestry, agro- horticultural, agro-pastoral and agro-silvipastoral are more effective for soil organic matter restoration.[5] Bhatt and Mishra reported that in Meghalaya, guava and lemon-based agri-horticultural agroforestry systems gave 2.96 and 1.98 times higher net return respectively, in comparison to farmlands without trees.[6] Intercropping is intended to maximize land and space use efficiency to generate supplemental income, to protect the interspaces from losses through weeds,

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erosion, impact of radiation, temperature, wind and water.[7-10]

Selection of suitable intercrops in orchard is essential to increase production from main crop as well as from the intercrops. However, no proper study is made on the economics of lemon based intercropping system in Mizoram. Thus, present study has been carried out with the following objectives: i) to study the production potential and economic feasibility of intercropping in lemon orchard; and ii) to find out the suitable intercrop(s) for lemon orchard.

Materials and Methods

Experimental site

The experiment was conducted at the outskirt of Serchhip in a 3 years old lemon orchard. The experimental site was situated at 23° 36' 38" and 23° 59'07" latitude and 92° 40' 30" and 93° 11' 09" E longtitude having an elevation of 1281 m altitude from mean sea level. The study site has sub-tropical climate with hot summer and cold winter. Pre-monsoon rain occurs in March-April, monsoon normally sets in from June and extends up to August-September. Normally, the period from November to February is cool and dry. Composite soil samples collected at a depth of 25 cm shows the following characteristics (Tables 1&2):

Experimental design

The study was carried out on productivity of intercropping of lemon with six crops *viz*. pea, *Calocasia*, cowpea, lady's finger, French bean and tomato. The design adopted for the experiment was randomized block design (RBD) with three replications. There were seven plots representing seven treatments in each replication. There were seven plots representing seven treatments (T_1– lemon sole, T_2– lemon + pea, T_3– lemon + *Calocasia*, T_4– lemon + cowpea, T_5– lemon + lady's finger, T_6– lemon + French bean, T_7– lemon + tomato) in each replication, measuring 5 x 5 m each, covering four lemon plants planted 3 years earlier at the spacing of 3 x 3 m. Seven treatments were allotted randomly in each replication. The intercrops were grown in the interspaces presents between the lemon rows, leaving one meter from the base of the lemon plant. Manures and fertilizers were applied to the different crops as per recommendation given in the package of practices prepared by Department of Agriculture, Government of Mizoram. Five sample plants from each plot were selected randomly and ten plant parts were selected from each plant for observing different growth and yield attributing characters and the average was calculated.

The parameters used for the study of productivity of lemon and intercrops are total yield and benefit-cost ratio. Total yield was calculated by adding the yield of lemon (main crop) and the lemon equivalent yield of intercrops and expressed in t/ha. The yield of different vegetable crops (intercrops) are recorded and expressed in lemon equivalent yield in tonnes per hectare. Lemon equivalent yield was calculated by using the following expression.

$$\text{Lemon equivalent yield (t/ha)} = \frac{\text{Weight of intercrop (t/ha) x Price of intercrop (Rs/ton)}}{\text{Price of lemon fruits (Rs/ton)}}$$

Table 1. Soil physical properties.

Find sand (%)	Coarse sand (%)	Silt (%)	Clay (%)	Textural class
60.23	10.68	12.46	11.12	Sandy loam

Table 2. Soil chemical properties.

Depth (cm)	Organic carbon (%)	Available N (Kg/ha)	Available P_2O_5 (Kg/ha)	Available K_2O (Kg/ha)	pH
0-25	0.95	288.34	21.48	112.75	4.35

Benefit-cost analysis

The cost of cultivation of different crops was estimated individually and was converted Rs/ha. It was calculated by adding cost of cultivation of main crops with intercrops. Expenditure and total monetary returns were worked out taking into account the cultural operations, prevailing prices of inputs and produce. The gross return (Rs/ha), net return (Rs/ha) parameters were worked out as follows:

Gross return = Value of yield (produce) of crops (Rs/ha)
Net return = Gross return (Rs/ha) – total cost of cultivation (Rs/ha)

RESULT AND DISCUSSION

Productivity of various intercropping systems

It was observed from the study that among the different intercropping systems, lemon + French bean intercropped (T_6) shows the highest productivity with lemon equivalent yield (LEY) of 38.95 t/ha and 43.11 t/ha respectively in the first and the second years of the study (Table 3). The second highest LEY was observed in Lemon intercropped with *Calocasia* (T_3) with a LEY of 36.95 t/ha and 38.86 t/ha respectively. During the course of investigation, the lowest LEY was found in sole lemon crops (T_1) with LEY of 13.32 t/ha and 16.46 t/ha respectively.

Table 3. Productivity (lemon equivalent yield) of different intercropping systems.

Treatments	Crops	Yield (t/ha)		Lemon equivalent Yield (t/ha) of intercrops		Total Lemon equivalent yield (t/ha)	
		1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year
T_1	(Lemon)	13.23	16.43			**13.23**	**16.43**
T_2	Lemon	17.45	21.96			17.45	21.96
	Pea	5.09	4.98	11.60	11.42	11.60	11.42
	System total					**29.05**	**33.38**
T_3	Lemon	14.91	18.54			14.91	18.54
	Calocasia	13.88	12.69	22.04	20.32	22.04	20.32
	System total					**36.95**	**38.86**
T_4	Lemon	19.25	23.34			19.25	23.34
	Lady'finger	6.11	5.90	13.01	12.52	13.01	12.52
	System total					**32.26**	**35.86**
T_5	Lemon	15.65	19.76			15.65	19.76
	Cowpea	4.49	14.2	7.83	7.44	7.83	7.44
	System total					**23.48**	**27.20**
T_6	Lemon	22.27	27.38			22.27	27.38
	French bean	6.64	6.16	16.68	15.73	16.68	15.73
	System total					**38.95**	**43.11**
T_7	Lemon	20.38	24.60			20.38	24.60
	Tomato	5.66	4.90	13.70	11.98	13.70	11.98
	System total					**34.08**	**36.58**
SEd±						0.96	1.04
CD (P=0.05)						2.09	2.26

Table 4. Benefit-cost ratio of different intercropping systems.

Treatments	Crops	Gross return (Rs/ha)		Cost of cultivation (Rs/ha)		Net return (Rs/ha)		Benefit:Cost ratio	
		1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year
T_1	Lemon	132858.00	164119.67	44931.72	44931.72	87926.28	119187.95	1.96	2.65
T_2	Lemon	153204.56	191489.36	43611.72	43611.72	109592.85	147877.64	2.51	3.39
	Pea	101800.00	99600.00	10179.84	10179.84	91620.16	89420.16	9.00	8.78
	System total	255004.56	291089.36	53791.56	53791.56	201213.00	237297.80	3.74	4.41
T_3	Lemon	140873.02	173709.36	43611.72	43611.72	97261.30	130097.64	2.23	2.98
	Calocasia	166560.00	152280.00	18754.84	18754.84	147805.16	133525.16	7.88	7.12
	System total	307433.02	325989.36	62366.56	62366.56	245066.46	263622.80	3.93	4.23
T_4	Lemon	162680.64	197964.38	43611.72	43611.72	119068.92	154352.66	2.73	3.54
	Lady's finger	109980.00	106200.00	11649.72	11649.72	98330.28	94550.28	8.44	8.12
	System total	272660.64	304164.38	55261.44	55261.44	217399.20	248902.94	3.93	4.50
T_5	Lemon	143577.98	178953.09	43611.72	43611.72	99966.26	135341.37	2.29	3.10
	Cowpea	71840.00	67360.00	10159.27	10159.27	61680.73	57200.73	6.07	5.63
	System total	215417.98	246313.09	53770.99	53770.99	161646.99	192542.10	3.01	3.58
T_6	Lemon	177294.80	214391.98	43611.72	43611.72	133683.08	170780.26	3.07	3.92
	French bean	132800.00	123200.00	12147.74	12147.74	120652.26	111052.26	9.93	9.14
	System total	310094.80	337591.98	55759.46	55759.46	254335.34	281832.52	4.56	5.05
T_7	Lemon	168346.27	201194.08	43611.72	43611.72	124734.55	157582.36	2.86	3.61
	Tomato	113200.00	98000.00	17633.55	17633.55	95566.45	80366.45	5.42	4.56
	System total	281546.27	299194.08	61245.27	61245.27	220301.00	237948.81	3.60	3.89

The high productivity of lemon + French bean intercropping system may be attributed to more amount of nitrogen received by the main crop through the root nodules of leguminous intercrops French bean and may be due to frequent application of manures and fertilizers with intercultural operation where the chance of weed growth was reduced which indirectly helps the main crop to utilize the nutrient and water for its growth and yield. Ghost *et al.*[2] reported that growing of leguminous vegetables like pea as intercrop has beneficial effect on mandarin orange which increased the leaf nitrogen content of mandarin orange and thereby vigour and yield also increased. The lowest LEY found in sole lemon cultivation may be attributed to the absence of the intercrop.

Benefit-cost ratio of various intercropping systems

The benefit-cost ratio of the intercropping system was observed to be highest in lemon + French bean intercropped (T_6) with a B:C ratio of 4.56 and 5.05 for the first and the second years respectively (table 4). This is followed by the B:C ratio of lemon + *Calocasia* intercropping (T_3) with a ratio of 3.93 and 4.23 for the first and the second years respectively. The third highest B:C ratio was recorded in a lemon + pea intercropping system (T_2) with a B:C ratio of 3.74 and 4.41 respectively for the first and the second years of experiment. The lowest B:C ratio of the system was recorded in sole lemon (T_1) with a B:C ratio of 1.96 and 2.65 for the first and the second years respectively.

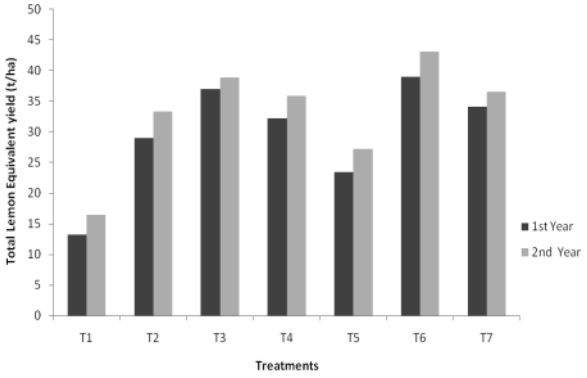

Figure 1. Total lemon equivalent yield of different intercropping systems.

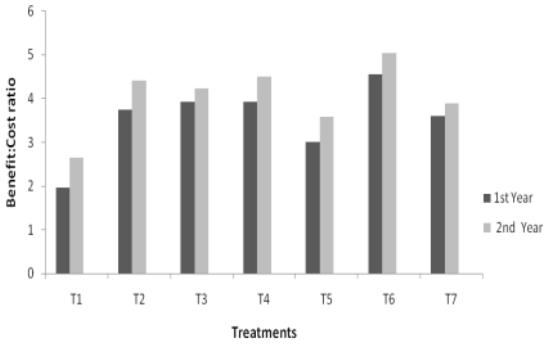

Figure 2. Benefit:cost ratio ofdifferent intercropping systems.

The yield and productivity of the intercropping systems depend on the compatibility of the crops introduced as well as nutrient availability and management. The success of intercropping system under plantation crops depends very much on the selection of compatible crop combination and the geometry of planting in which each crop exploits a distinct and different zone of atmosphere and soil, so that competition for moisture, nutrients, space and solar radiation will be minimum. Whatever, the crop be chosen, it is very important that the subsidiary crop is given adequate attention about its specific requirement less the main crop may suffer.[11]

Conclusion

It has been seen from the present study that the vacant space present between the adjacent rows of citrus can be successfully utilized for cultivation of seasonal vegetables. There are several advantages in growing of intercrops in orchard. Besides providing income to the growers, it controls weed population, check soil erosion, conserve soil moisture and organic matter and protects the soil from leaching of nutrients. But this practice is not always considered to be ideal in all the fruit crops as there may be competition for soil moisture and plant food with the main crop.

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