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Intercropping of vegetables with pre-bearing litchi plants for profitable and sustainable production system

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Abstract : A series of intercrop interventions of vegetable and flower crops *viz*. cowpea, okra, cabbage, potato, onion, etc. and *Gladiolus*, respectively were taken. It was found that all the above crops performed well as intercrops for litchi and were profitable to the farmers. The highest net profit was recorded with the Okra - *Gladiolus* intercrop rotation, hence, it as intercrop was rated as ideal with litchi plantation. Inter-cropping of Okra - *Gladiolus* with litchi fetched better cost: benefit ratio as the flowers had high demand in the market.

Keywords: Inter cropping, Vegetables, Litchi

Introduction

Litchi is an evergreen perennial tree and has long gestation period (> 10 years) to reach in flowering and fruiting at economically viable level. However, irregular bearing in litchi starts in the early stage of 4th year and onwards with few fruiting terminal twigs. Sometimes, there will be fruit set and sometimes may not be as the plants are in the developmental stage of vegetative growth. Since the litchi is planted in square or rectangular system of planting at varying 8-10 m spacing provides enough vacant space for cultivation as inter crops. Utilization of these vacant space (> 80-85% of total area under litchi orchard) for growing intercrops with cereals, oilseeds, pulses, vegetable crops and flower crops with litchi as main crops has been intensified recently to understand the biological validity of the system by way of possible increase in yield, efficient use of solar energy and better land use resulting in higher net returns (Verma *et al*., 1981 and Singh *et al*., 2008). The traditional agriculture aimed at increasing the production through two dimensions *viz*. expanding the cultivated area and increasing the potential yield per unit area of the crop. The modern agriculture stresses on efficient use of available resources-land, light water and nutrients. Thus it is need of hour to utilize the resources within a given time by raising two or more crop simultaneously by exploiting the space more effectively by planting crops of varying architecture. The demand and consumption of vegetables is increasing at faster rate in modern time due to increasing population and considering these as protective foods in human nutrition. Their cultivation is of utmost importance to the growers of north India because it offers tremendous potential of bringing higher income per unit area and time. It is a general practice of the farmers to plant litchi and grow field crops (wheat, rice, sugarcane, etc) round the years which leads to slow vegetative growth of the litchi plant and poor returns from the other field crops (cereals). The information for wider adoptability of intercropping with short duration seasonal vegetable crops with pre-bearing litchi trees/ orchard with respect to yield potential and economic return is lacking in subtropical belt of India particularly in the basin of river Gandak and Ganga and its tributaries passing through north Bihar which is hub for growing litchi. Uttar Pradesh and Uttrakhand is the new region for planting litchi in large area. Under the National Horticulture Mission and State Horticulture Mission more than 30,000 ha are likely to be covered in different parts of the country. In light of the above, the present investigation/ trial were planned. The emphasis on diversification has been focused to bring more and more area under pure horticultural crops or mixing in spatial and temporal arrangements with short duration vegetable crops.

Materials and methods

With a view to study the effect of different vegetable as intercrops in litchi based cropping system model on growth, yield and economic potential. A field experiments were conducted during 2006-07, 2007-08, 2008-09 at the experimental farm area of National Research Centre for Litchi, Mushahari, Muzaffarpur. The experimental field soil was sandy loam in texture, alkaline in reaction

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pH (8.1) with low to medium in fertility status *viz.* organic carbon (0.413%), available nitrogen 82.40 kg/ ha, available phosphorus 18.24 kg/ha and available potassium 260.46 kg/ha). All the experimental plants of litchi received uniform cultural practices during the course of studies. The field preparation for transplanting of litchi saplings was done during 2005-06 at a spacing of 8.25 m x 8.25 m thus accommodating (12x12) =144 number of litchi plants per ha. The layout for intercropped was prepared to accommodate plot size (6mx5m) between the recommended spacing of litchi plants. The total area of the experimental plot was 2994.75 m^2 and for intercropping 1200 m^2 for control condition and four intercrops of vegetable. Four replication for each vegetable plots with one litchi plant per replication as unit were selected. Short duration horticultural crops include seasonal vegetable/ flower in rotation (Table 1). Recommended agronomic practices were adopted for raising different intercrops as per the season.

Table 1. Crop combination undertaken as intercropping in newly planted litchi field.

Crops/ Season	*Kharif*	*Rabi*	Summer
1	Cowpea	Cauliflower	Okra
2	Cowpea	Potato	Onion
3	Cowpea	Cabbage	Onion
4	Okra	Gladiolus	-

Good agricultural practices were adopted to raise healthy crops half dose of Nitrogen and full dose of Phosphorus, Potash and FYM during July month as per the age of the litchi plants (50 g N, 100 g P_2O_5, 50 g K_2O and 5 kg FYM/ age of trees starting from 2nd year onward) were applied and remaining half dose during October and March months. Agronomical data on litchi tree TCA, height, spread, no. of vegetative flushes, panicle initiation on litchi were recorded and yield data of intercrops were noted alongwith allelopathic effects of inter crops on main crops were done.

Results and Discussion

Vegetable Based Model (2006-07)

The crop combinations in rotation *viz.* 1. Cow pea – Cauliflower – Okra 2. Okra – *Gladiolus* 3. Cow pea – Potato – Onion 4. Cow pea – Cabbage – Onion were grown during *kharif, rabi* and summer season, respectively during 2006-2007. Results (Table 1) revealed that intercrop cultivation of Okra - *Gladiolus* in rotation with pre bearing litchi plants gave net-profit of Rs. 114580/ha/year followed by Cow pea-Potato-Onion Rs. 93900/ha/year thus this crop combination was rated ideal for newly litchi plantation in the region.

Vegetable based model (2007-08)

Fresh yield of 39.79 q/ha of cow pea, 54.26 q/ha of okra; 212.52 q/ha of Potato, 96.65 q/ha of cabbage, 147.98 q/ha of cauliflower, 101.54 q/ha of onion and 70898 no. flower spikes/ha of *Gladiolus* were harvested as intercrop yield from the pre-bearing litchi orchard. Results (Table 2) revealed that as intercrop cultivation

Table 2. Average yield of different crops in litchi based cropping system model

Crops	Av. yield (intercrops)		
Fruit based model	(2006-07)	(2007-08)	(2008-09)
Banana	36.07	23.71	18.2
Papaya	12.04	Crop failed	
Guava	Bearing not yet started		
Vegetable based model			
Cow pea (K)	107.32	39.79	36.84
Okra (K)	24.51	212.52	126.87
Radish (K)	93.89	90.42	86.92
Cabbage (R)	134.68	96.65	90.42
Cauliflower (R)	66.24	147.98	122.32
Pea/French bean (seed) (R)	29.77	6.20	4.50
Potato (R)	188.74	212.52	160.32
Onion (S)	122.32	101.54	173.33
Gladiolus spikes (no.)	115867	70898	67987
Field crops based			
Maize	42.0	36.2	32.2
Mustard	10.4	11.4	10.6
Moong bean	12.3	10.2	11.6

Okra-*Gadiolus* was found to be the best performer followed by Cow pea-potato-onion and Cow pea-cauliflower- okra with net profit of Rs. 97847, 50113 and 49291/ha, respectively. 54 per cent litchi plants of the intercropped area exhibited flowering and fruiting.

Vegetable based model (2008-09)

Fresh yield of 20.43 q/ha of Cow pea, 126.87 q/ha of Okra; 160.32 q/ha of Potato, 90.42 q/ha of Cabbage, 4.50 q/ha of French bean (seed yield), 173.33 q/ha of onion and 67987 no. of *Gladiolus* flower spikes/ha were harvested. Crop combination Okra- *Gladiolus* was found to be the best in the crop rotation followed by Cow pea- potato-onion with a net profit of Rs.142694 and Rs.93180 /ha. During the year (2008-09) 70 per cent litchi plants of the intercropped plot exhibited flowering and fruiting.

Table 3. Net profit obtained from Cropping System model

Cropping system model	Net profit (Rs. /ha)			Cumulative profit (Rs.)
Fruit based model	(2006-07)	(2007-08)	(2008-09)	
Litchi + banana	40000	68210	40130	148340
Litchi + Papaya	27240	Crop failed		27240
Litchi + Guava	Bearing started in 3rd yr			
Vegetable based model				
Litchi + (Cow pea-Cauliflower-Okra)	84500	79291	70062	233853
Litchi+ (Cow pea-Pea/F. bean-Radish /Okra)	52198	61812	43668	157678
Litchi +(Okra-Gladiolus)	114580	92398	142694	349672
Litchi + (Cow pea-Potato- Onion)	93900	50113	93180	237193
Litchi + (Cow pea- Cabbage- Okra)	65500	58759	53836	178095
Field crops based				
Litchi + (Maize-Mustard- Moong bean)	49225	48094	46488	143807

Effect of models on sole crops

Altogether three different crop models were studied during the project period and it was found that the model1 (fruit-fruit based) was most suitable with litchi to grow banana for a period upto 3rd year and after that the banana fruit bunches got infested with scarring beetle. Observations recorded on vegetative growth parameters showed that in the initial year vigorous growth of the litchi plants were recorded with respect of plant height, trunk girth and spread of the plant and their corresponding values of plant height (2.07-2.48m), spread N-S (2.45- 2.57m), E-W (2.48- 2.96m) and girth (19-23 cm) against control (1.96m, 2.39m, 2.26m, and 18.29 cm) respectively (Table 4 and 5). The other fruit crop did not performed well as papaya was heavily infected with foot and root rot disease due to occurrence of heavy rainfall in both the years during the crop period.

Table 4. Average vegetative growth performance of litchi plants under different models during 2007-08

Cropping system	Plant Girth (cm)	Plant height (cm)	Plant spread (cm)	
			N-S	E-W
Litchi+ fruit crop based				
Litchi + Papaya	14.6	161.5	210.8	231.2
Litchi + Banana	15.3	183.4	223.3	232.2
Litchi + Guava	12.6	128.3	148.3	150.0
Litchi +Vegetable based				
Litchi + cowpea-potato- onion	17.9	183.3	227.1	233.8
Litchi+ okra-cauliflower- cowpea	16.0	149.1	190.8	191.4
Litchi+ okra-cabbage- cowpea	14.8	132.9	197.9	204.2
Litchi+ okra-gladiolus	14.1	141.9	174.3	179.8
Litchi +field based				
Litchi+ maize-mustard- cowpea	16.0	165.2	192.7	204.7

Table 5. Performances of vegetative growth in different model during (2008-09)

Models	Row Number	Girth (cm)	Height (cm)	Plant spread (cm)	
				N - S	E - W
Vegetable based	1	25.83	227.33	294.08	305.42
	2	23.35	221.36	289.91	279.00
	3	23.74	217.73	282.36	281.82
	4	21.39	206.73	264.64	256.91
	5	21.57	200.25	262.08	237.33
Control	6	18.29	196.42	231.83	226.08
	7	20.34	206.00	252.91	257.64
Guava	8	20.89	211.00	252.22	247.89
	9	23.30	247.50	265.92	296.17
Banana	10	20.46	242.55	244.18	259.82
	11	19.61	224.36	245.18	262.64
Papaya	12	19.75	206.83	247.00	262.83

Vigorous vegetative growth of the litchi plants was recorded with the vegetable based model. This was attributed due to conductance of regular intercultural operation during the seasons which provided more sunlight to the litchi plants in comparison to the plants growing in fruit based model.

Economic suitability of cropping models

The economics and net profit were calculated on the basis of cost of cultivation and market price of the produce. The data (Table 3) revealed that maximum net profit was obtained in the vegetable based model followed by fruit based model. The maximum cumulative net profit was Rs. Rs. 349672 recorded with litchi + (Okra- Gladiolus) followed by Litchi +Cowpea-Potato-Onion (Rs. 2,37,193 per ha). Among the different Cropping System models Litchi+ Banana model recorded

the highest cumulative net profit of Rs. 148340 per ha.

Effect on nutrient status of soil

The entire experimental area was barren for a long period and cropping history was also unknown. The initial soil nutrient status was analyzed before the initiation of experiments. The initial soil pH was varied from 8.15-8.23 and available N 73.68 and 84.58 kg/ha with medium in P and K. The nutrient status of the soil was studied at the end of each crop. The results revealed that the soil nutrient status of the different CS model were enhanced and final soil pH lies between 7.84-8.02 in the different block and available N status was raised and varied between 113.14 and 135.66 kg/ha within a period of 4 years in the vegetable based model. On the basis of the results it can be concluded that intercrop of litchi was beneficial in maintaining the soil health and enhancement of nutrient status apart from vigorous growth of litchi plants in the entire block as compared to other block of the same age group. Due to better enrichment of nutrient status of the soil early flowering and fruiting was observed from the block. These results are in agreement with the findings of (Brajendra and Kundan, 2007 and Kumar *et al*., 2001).

Allellopathic effects on main and intercrops and insects and diseases

In the initial year of the experiments allellopathic effects were studied and no adverse effect on the growth of litchi and intercrops was found in the lab and field condition. In the second ratoon of the banana some litchi plants leaves were found to be infested with scarring beetle of banana like symptoms during rainy season. But the symptoms disappeared after rainy season and removal of ratoon crop of banana from the main field. No other incidence of pests and diseases were found from the entire experimental field.

सारांश

एक कड़ी में सहचरी फसलों में (सब्जियों–लोबिया, भिंडी, बंदगोभी, आलू, प्याज, इत्यादि एवं फूलों में ग्लैडियोलस, इत्यादि) क्रमवार से खेती सफल रही। परीक्षण में यह पाया गया की उपरोक्त सभी सहचरी फसलों का उत्पादन सफल रहा और कृषकों के लिए लाभप्रद पाया गया। लीची के साथ सहचरी फसलों में भिंडी–ग्लैडियोलस फसल प्रणाली से सबसे अधिक व्यय : कुल लाभ पाया गया एवं यह फसल प्रणाली आरम्भ के वर्षों में अन्तरवर्ती फसल के रूप में आर्दश रही। सहचरी फसल के रूप में लीची के साथ भिंडी–ग्लैडियोलस में व्यय : कुल लाभ का अनुपात अधिक रहने का कारण फूलों की बाजार में माँग अधिक था।

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