Research Article

Performance of Green Leafy Vegetable Crops under *Ailanthus Excelsa* Based Silvihorticultural System in Western Zone of Tamil Nadu

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Abstract

Field experiments were conducted in western zone of Tamil Nadu to develop a suitable *Ailanthus excelsa* based silvihorticultural system for higher productivity. Green leafy vegetable crops *viz*., Chinese amaranth, spleen amaranthus, tropical amaranth, Chinese spinach and palak were intercropped with 4 years old *Ailanthus excelsa* to study the growth and productivity of these intercrops and their effect on the growth of the tree. Results revealed that the growth and yield of intercrops were reduced under intercropping when compared to sole cropping. Among the test crops, palak was most affected and Chinese spinach was least affected. The benefit cost ratio from the crop was highest with Chinese spinach (3.08) and the lowest with tropical amaranth (1.70).

Growth of *Ailanthus* was influenced due to intercropping with palak. The tree height and DBH of *Ailanthus* were observed highest when intercropped with palak (20.24 % and 20.48 % increase over tree alone and the lowest was observed with Chinese spinach (5.95 % and 5.85 % increase over tree alone).

Keywords: *Ailanthus*, intercrops, growth attributes, yield

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Introduction

Vegetables constitute an important component of a balanced diet for man. Indian horticulture achieves a significant increase in vegetable production with a total of 133.7 million tonnes (2009-10). The requirement of vegetables is estimated to be 160 million tonnes in 2020-2021. Vegetables especially the green leafy vegetables are rich in protein, minerals, carbohydrate, calcium, iron, phosphorus and all vitamins. The chlorophyll supplied by the green leafy vegetables are antimutagenic and antitumorigenic. Supply of nutrient component through balanced diet is more effective than supplementation through synthetic vitamins and mineral tablets. Dieticians recommend 300 g of vegetables per day which includes 125 g of green leafy vegetables. But the per capita availability of the total vegetables worked is about 92 g. This gap has to be bridged by increasing the production and productivity of vegetables. They also generate high income and employment, particularly for small farmers. Leafy vegetable crops in comparison to field crops are high output crops. Being short term crops, their cultivation is intensive and in a year, three to ten crops can be obtained. They are also crops which can be fitted into many cropping patterns like intercropping.

Silvihorticulture is the integration of woody plants with horticultural crops to derive both economic and ecological benefits. Furthermore, intercropping of annuals in timber trees compared with sole tree woodlots may offer the advantages of reduced tree establishment costs, income generation during the unproductive phase of the trees and efficient use of natural and input resources. In this context, mixing of both the components (vegetables and trees) is essential, profitable and additional income generation up to the productive phase of the tree. *Ailanthus excelsa* native of Indian peninsula is a leguminous tree, presently getting momentum among the farmers due to its matchwood utility and protein rich fodder value. Works on the intercropping of vegetables under *Ailanthus* is very meager. In this situation, identification of suitable shade tolerant vegetable crops under this tree is a viable option to meet the food, fuel and small wood requirements.

Materials and Methods

A field experiment was conducted during August 2012 to February 2013 at Idigarai village, Coimbatore district situated in Western zone of Tamil Nadu (10.98 º N latitude, 76.95 º E longitude, 409 MSL). The average rainfall is 64.7 mm of which North - East monsoon contributes maximum. The average maximum and minimum temperature

ranged between 37.3 º C and 17.1 º C respectively with a mean RH of 57.1 % during the cropping period. The soil type is sandy clay loam with a pH of 8.0 and EC of 0.13 dsm^{-1}. The initial soil sample values were available N 155 kg/ha, available P 20 kg/ha and available K 938 kg/ha.

Chinese amaranth (Arakeerai in tamil) - *Amaranthus tricolor* var. *tristis* (cv. CO 3), Spleen amaranthus (Mulai keerai in tamil) - *Amaranthus dubius* (cv. CO 1), Tropical amaranth (Siru keerai in tamil) - *Amaranthus polygonoides* (local type), Chinese spinach (Thandu keerai in tamil) - *Amaranthus tricolor* (cv. CO 2) and Palak -*Beta vulgaris* var. *bengalensis* (cv. All Green) were grown in between the rows of *Ailanthus excelsa* (4 years old) on 30.08.12 (first season) and 07.12.12 (second season) with the plot size of 9 x 7 m to study their growth and productivity as well as their effect on the growth of trees so as to evaluate the suitable intercrop(s) for *Ailanthus* based silvihorticultural systems.

Ailanthus excelsa were planted at a spacing of 4.5 x 3.5 m. The agronomic practices for all the intercrops were used as per the recommendations. The following growth and yield attributing parameters in intercrops were observed. Benefit cost ratio and crop equivalent yield (kg ha^{-1}) were also calculated. Crop equivalent yield (kg ha^{-1}) was derived by dividing the net income of the individual intercrop by the price per kg of the intercrop which gave the highest net income. The data were statistically analyzed for the comparison of intercrops [9].

Results and Discussion

Growth and productivity of intercrops

The data on growth and yield attributes of intercrops are given in **Table 1**. Compared to open field, the growth and yield attributing characters of five intercrops were reduced under *Ailanthus excelsa*. The results showed that among the intercrops tried, the maximum significant reduction in plant height at harvest than sole cropping was observed in palak with the reduction of 21.79 per cent (Table1). The lowest reduction in plant height was reported in Chinese spinach with the reduction of 14.13 per cent. The reduction in the plant height of intercrops might be due to competition for the resources like light, moisture and nutrients. This kind of reduction in height in four agricultural crops was already observed under *Simarouba glauca* [7] and in sorghum under *Ailanthus excelsa* based agro forestry system [3].

Table 1 Effect of *Ailanthus* on growth and yield attributes of intercrops in Western zone (mean of two seasons)

SI. No.	Inter crops	Plant height (cm)		No. of branches		No. of leaves		Leaf area (cm^2)		Length of the largest leaf (cm)		Breadth of the largest leaf (cm)		Yield (t/ha)	
		Inter crop	Sole crop	Inter crop	Sole crop	Inter crop	Sole crop	Inter crop	Sole crop	Inter crop	Sole crop	Inter crop	Sole crop	Inter crop	Sole crop
1	Chinese amaranth	33.95 (14.75)	39.82	8.78 (14.13)	10.23	29.95 (14.13)	34.88	88.77 (14.46)	103.78	6.53 (13.66)	7.57	2.45 (13.36)	2.85	8.48 (12.12)	9.66
2	Spleen amaranthus	13.40 (15.33)	15.83	7.95 (15.22)	9.38	21.38 (13.56)	24.73	83.77 (13.75)	97.13	6.12 (13.71)	7.09	2.52 (13.14)	2.90	5.69 (12.33)	6.49
3	Tropical amaranth	20.43 (14.62)	23.93	12.41 (13.72)	14.38	31.46 (14.12)	36.63	101.95 (14.10)	118.69	5.52 (13.21)	6.36	2.38 (13.60)	2.76	4.68 (11.78)	5.31
4	Chinese spinach	17.67 (14.13)	20.58	10.13 (13.12)	11.66	29.12 (13.32)	33.60	217.39 (13.37)	250.94	9.96 (12.60)	11.40	5.92 (12.41)	6.76	8.46 (11.15)	9.52
5	Palak	6.57 (21.79)	8.40	13.94 (20.62)	17.56	13.91 (20.93)	17.59	1687.68 (22.50)	2177.65	23.68 (20.31)	29.71	11.64 (21.50)	14.83	6.73 (20.26)	8.44
S. Ed		1.16		0.76		0.64		27.36		1.52		0.88		0.56	
CD(P=0.05)		2.34		1.54		1.32		54.82		3.08		1.80		1.13	

Figures in parenthesis indicate the per cent reduction over the sole crop

With regard to the number of branches, the highest significant reduction at harvest than sole cropping was observed in palak with a reduction of 20.62 per cent (Table 1). The lowest reduction was reported in Chinese spinach with the reduction of 13.12 per cent. This might be due to the fact that the intercrops would have been affected due to the competition for resources. This kind of reduction in three vegetables under ten months old *Melia dubia* was already observed [1].

Compare to open field, the yield and yield attributing characters of five intercrops were reduced under *Ailanthus excelsa*. The number of leaves per plant of the five intercrops was reduced under trees when compare to the pure crops (Table 1). Among the five intercrops, maximum significant reduction in number of leaves was observed in palak (20.93 %) and minimum in Chinese spinach (13.32 %). Similarly significant maximum reduction in leaf area, length of the largest leaf and breadth of the largest leaf were maximum in palak with a reduction of 22.50 %, 20.31 %

and 21.50 % respectively and minimum in Chinese spinach with a reduction of 13.37 %, 12.60 % and 12.41 % respectively (Table 1). Among the five intercrops, maximum reduction in yield was observed in palak with a reduction of 20.26 % and minimum in Chinese spinach with a reduction of 11.15 % (Table 1). The reduction was significantly maximum than sole cropping. Similar reduction in yield of intercrops under trees than pure cropping was observed [10]. During 2009 under *Ailanthus excelsa* based agro forestry system and under *Populus deltoids* and *Melia composita* based agro forestry systems [11].

Effect of intercrops on tree growth

The results revealed that the tree height varied from 4.41 – 5.97 m and 5.31 – 6.87 m before sowing (August 2012) and after harvesting (February 2013) of inter crops, respectively (**Table 2**). The results showed that there was a difference in height increment in the tree when grown along with intercrops than the sole trees. Among the intercrops tried, the magnitude of height increment in tree was significantly maximum in palak (1.01 m) followed by Chinese amaranth (1.00 m) than tree alone and the lowest was found with Chinese spinach (0.89 m). Tree alone recorded only 0.84 m increment. Per cent increase in tree height due to intercropping with palak and Chinese amaranth was 20.24 % and 19.05 % respectively than *Ailanthus* alone, where as Chinese spinach recorded only 5.95 % increase. Similar findings were observed in babul (*Acacia nilotica*) planted with intercrops than pure trees [4] and by [6] in *Bambusa vulgaris*.

Table 2 Effect of intercrops on the growth of *Ailanthus* in Western zone

SI. No.	Treatments	Tree height (m)		Difference (m)	Diameter at breast height(cm)		Difference (cm)
		Before intercropping	After intercropping		Before intercropping	After intercropping	
1	Chinese amaranth	4.73	5.73	1.00 (19.05)	10.68	13.13	2.45 (19.51)
2	Spleen amaranthus	4.41	5.31	0.90	8.85	11.04	2.19
3	Tropical amaranth	5.97	6.87	0.90	12.96	15.16	2.20
4	Chinese spinach	4.95	5.84	0.89 (5.95)	9.78	11.95	2.17 (5.85)
5	Palak	5.52	6.53	1.01 (20.24)	11.93	14.40	2.47 (20.48)
	Tree alone	5.37	6.21	0.84	11.49	13.54	2.05
S. Ed		-	-	0.08	-	-	0.19
CD(P=0.05)		-	-	0.17	-	-	0.39

Figures in parenthesis indicate the per cent increase over tree alone

The diameter at breast height (DBH) varied from 8.85 – 12.96 cm and 11.04 – 15.16 cm before sowing (August 2012) and after harvesting (February 2013) of intercrops respectively (Table 2). The result showed differences in tree diameter when grown along with intercrops. Among the different intercrops tried, the increase in diameter was significantly maximum in palak (2.47 cm) followed by Chinese amaranth (2.45 cm) than tree alone and the lowest was found with Chinese spinach (2.17 cm). Tree alone recorded only 2.05 cm increase. Per cent increase in tree height due to intercropping with palak and Chinese amaranth was 20.48 % and 19.51 % respectively than *Ailanthus* alone, where as Chinese spinach recorded only 5.85 % increase. Similar findings were observed in babul (*Acacia nilotica*) planted with intercrops than grown alone [4] and by [2] in wild cherry and hybrid walnut trees. Since spleen amaranthus, tropical amaranth and Chinese spinach were uprooted earlier (at 30 days) for harvest, there would not be any dry matter addition to the soil, whereas palak and China amaranth are clipping types (90 days duration) and not uprooted from the soil, it would have enriched the soil which reflected in the increase of tree growth parameters.

Benefit cost ratio of the system

The economic return of Ailanthus based silvihorticultural system was calculated and depicted in **Table 3**. The data reported that the highest BC ratio of 3.08 was obtained from Chinese spinach and the lowest from tropical amaranth (1.70). Among the intercrops, Chinese spinach recorded the highest crop equivalent yield of 5, 710 kg ha^{-1} and tropical amaranth recorded the lowest of 1,930 kg ha^{-1}. On per day production basis, Chinese spinach performed well

(282 kg per ha). The superior performance of Chinese spinach might be due to the production of higher yield per hectare.

Table 3 Benefit cost ratio of *Ailanthus* based cropping system per hectare in Western zone

SI. No.	Inter crops along with *Ailanthus*	Cost of cultivation (Rs.)	Gross income (Rs.)	Net income (Rs.)	Benefit cost ratio (Rs.)	Crop equivalent yield (kg/ha.)	Per day production (kg/ha.)
1	Chinese amaranth	39,000	67,840	28,840	1.74	3,605	94.22
2	Spleen amaranthus	22,000	45,420	23,520	2.07	2,940	189.67
3	Tropical amaranth	22,000	37,440	15,440	1.70	1,930	156.00
4	Chinese spinach	22,000	67,680	45,680	3.08	5,710	282.00
5	Palak	33,000	74, 030	41, 030	2.24	5, 129	74.78

The average price of Chinese amaranth, spleen amaranthus, tropical amaranth and Chinese spinach during the cropping period was Rs. 8 per kg and the price of palak was Rs. 11 per kg.

Conclusion

From these experiments, the suitable *Ailanthus excelsa* based silvihorticultural system for higher productivity was identified. The growth and yield of intercrops were reduced under intercropping when compared to sole cropping. Among the intercrops, Chinese spinach was performed well under *Ailanthus excelsa.* The benefit cost ratio also observed highest with Chinese spinach (3.08) compared to the other crops.

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