Research Article

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Intercropping of medicinal and aromatic plants in coconut gardens

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Abstract

A field study was conducted at Horticulture Research Station, Arsikere, Karnataka during 2006-07 to 2008-09 to identify suitable medicinal and aromatic plants for intercropping in coconut gardens of *maidan* tract of Karnataka. The experiment consisted of 14 medicinal and aromatic crops *viz.*, Kalmegh (*Andrographis paniculata*), Makoi (*Solanum nigrum*), Coleus (*Coleus forskohlii*), Garden rue (*Ruta graveolens*), Lepidium (*Lepidium sativum*), Tulsi (*Ocimum sanctum*), Arrow root (*Maranta arundinaceae*), Kacholam (*Kaemferia galanga*), Cowhage (*Mucuna pruriens*), Roselle (*Hibiscus sabdariffa*), Ambrette (*Abelmoschus moschatus*), Citronella (*Cymbopogon winteranus*), Lemon grass (*Cymbopogon flexuosus*) and Vetiver grass (*Vetiveria zizanoides*). The yield of all the medicinal and aromatic crops grown as intercrop in coconut garden were reduced compared to their sole crop yields. The reduction in yield was less in lemon grass (6.4 %), tulsi (23.5 %), arrow root (23.9 %), vetiver grass (25.1 %), kalmegh (25.7 %), makoi (29.1 %), citronella (30.2 %) and garden rue (30.5 %). The nut yield of coconut was improved with intercropping of medicinal and aromatic crops. The andrographolide content in kalmegh (4.40 to 3.20 %), rutin alkaloids in garden rue (1.68 to 1.40 %) and oil content in lepidium (19.60 to 17.23 %) were significantly reduced when grown as intercrops in coconut garden as compared to sole crop. However, the forskohlin content in coleus (0.43 to 0.61 %) and essential oil content in ambrette (0.24 to 0.29 %) were significantly increased by intercropping. In other medicinal and aromatic crops, the quality parameters were not significantly influenced by intercropping. The intercropping system of growing lemon grass under coconut recorded the highest net income (Rs. 91,561/ha) and B:C ratio (2.89) followed by garden rue (Rs. 81,865/ha and 2.79), tulsi (Rs. 77,472/ha and 2.71), kalmegh (Rs. 75,163/ha and 2.56), arrow root (Rs. 72,211/ha and 2.28) and makoi (Rs. 67,058/ha and 2.68). Hence, intercropping of lemon grass, garden rue, tulsi, kalmegh, arrow root and makoi with coconut can be recommended for *maidan* tract of Karnataka.

Keywords: Coconut, intercropping, medicinal and aromatic plants

Introduction

Medicinal and aromatic plants constitute a major segment of the flora, which provides raw materials for use in the pharmaceuticals, cosmetics and drug industries. They play an important role in the health care of people. China, Cuba, India, Sri Lanka, Thailand, and a few other countries have endorsed the official use of traditional systems of medicine in their healthcare programmes. For example, the Indian systems of medicine 'Ayurveda', 'Siddha' and 'Unani' entirely and homeopathy to some extent, depend on plant materials or their derivatives for treating human ailments.

The demand for plant-based medicines, health products, pharmaceuticals, food supplements and cosmetics is increasing day by day both in domestic and international market (Ved and Goraya, 2008). As a result, collection of medicinal and aromatic herbs from natural forest has increased and hence many of such plants have become rare or endangered. Problems arising out of rapid genetic loss of these plants forced the need for conservation and cultivation of medicinal and aromatic plants to ensure the availability for future generations. It was reported that intercropping of medicinal plants with other medicinal plants/ food crops/ horticulture crops or with tree components is an attractive option, as that would increase land use efficiency and simultaneously improve the economic status of the farmers (Kurian *et al*., 2003). Therefore, a field experiment was carried out to identify suitable medicinal and aromatic crops for intercropping in coconut gardens of *maidan* tract of Karnataka.

Materials and Methods

Investigations were carried out during 2006-07 to 2008-09 at Horticulture Research Station, Arsikere, Hassan District, Karnataka, which is situated at 13° 15'

N latitude and 76° 15' E longitude with an altitude of 808 m above mean sea level (MSL). The Research Station receives an annual rainfall of 816 mm distributed mainly during April to October. There are two peaks in rainfall distribution, one in May and the other during October. The soil of the experimental site was red sandy loam with low in available nitrogen (253 kg N/ha) and medium in available phosphorous (24 kg P_2O_5/ha) and potassium (295 kg K_2O/ha).

The experiment consisting of 14 medicinal and aromatic crops *viz.*, Kalmegh (*Andrographis paniculata*), Makoi (*Solanum nigrum*), Coleus (*Coleus forskohlii*), Garden rue (*Ruta graveolens*), Lepidium (*Lepidium sativum*), Tulsi (*Ocimum sanctum*), Arrow root (*Maranta arundinaceae*), Kacholam (*Kaemferia galanga*), Cowhage (*Mucuna pruriens*), Roselle (*Hibiscus sabdariffa*), Ambrette (*Abelmoschus moschatus*), Citronella (*Cymbopogon winteranus*), Lemon grass (*Cymbopogon flexuosus*) and Vetiver grass (*Vetiveria zizanoides*) was laid out in randomized complete block design with three replications. The MAPs were grown in 84 % of the area in the interspaces of coconut leaving 16 % area in the coconut basins. Recommended cultivation practices for the crops were followed (Anon., 2005). The crops were harvested at full bloom stage/ mature green berry stage/maturity stage depending on the economic part required for medicinal or essential oil purpose and yield data was recorded. The reduction in yield of MAPs was calculated considering the area of both MAPs and coconut basins. The medicinal and aromatic contents like alkaloids, andrographolide, forskohlin, L-DOPA, fixed oil, essential oil, starch, crude protein, oleoresin, anthocyanin and ascorbic acid in the economic parts were determined following standard procedures (AOAC, 1970).

The gross income from the economic produce of medicinal and aromatic crops was worked out based on the prevailing market prices. The cost of production was calculated considering labour charges, manures, fertilizers, seeds and other inputs used for raising the crops. The net income was computed as the difference between gross income and cost of production. The benefit-cost ratio was calculated by dividing the gross income by the cost of production.

Land equivalent ratio (LER) and Area time equivalent ratio (ATER) were computed to quantify the land use efficiency of the intercropping system.

Land equivalent ratio (LER) was calculated as per the formula described by Mead and Willey (1980).

$$LER_{ab} = Y_{ab}/Y_{aa} + Y_{ba}/Y_{bb} = L_a + L_b$$

Where,

LER_{ab} is the land equivalent ratio for the ab intercrop

Y_{ab} is the yield of crop a in the ab intercrop

Y_{ba} is the yield of crop b in the ab intercrop

Y_{aa} and Y_{bb} are the yields of crop a and b in monoculture

L_a and L_b are the component LERs for crops a and b

Area time equivalent ratio (ATER) was worked out by using the formula as suggested by Hiebsch and McCollum (1987).

$$ATER = [(Ry_a \times t_a) + (Ry_b \times t_b)] / T$$

Where,

Ry_a and Ry_b are the relative yield of crops a and b

t_a and t_b are the duration (days) of crops a and b

T is the duration for the intercropping system

The data was subjected to Fisher's method of analysis of variance (ANOVA). The significance between sole crop and intercrop means of quality parameters of MAPs was tested through 't' test by estimating the variances of both the populations.

Results and Discussion

Yield of medicinal and aromatic plants (MAPs) as intercrops in coconut garden

The yields of all medicinal and aromatic plants were reduced when grown as intercrop in coconut garden compared to their sole crop yields (Table 1). The reduction in yield was minimum with lemon grass (6.4 %) followed by tulsi (23.5 %), arrow root (23.9 %), vetiver grass (25.1 %), kalmegh (25.7 %), makoi (29.1 %), citronella (30.2 %) and garden rue (30.5 %). The decrease in yield of MAPs can be attributed to the effect of coconut on intercrops coupled with loss in area due to coconut. The medicinal and aromatic plants were grown in 84 % of the area and the remaining 16% was the uncropped coconut basins. The poor availability of light to the understorey crop in intercropping system reduced the photosynthetic efficiency and resulted in lower yield of crops (Chundawat *et al*., 1983). Similarly, the available reports indicated reduction in herb yield of lemon grass, Java citronella and Japanese mint under poplar (Chauhan, 2000), palmarosa and lemon grass under coconut (Singh, 2003), aloe, kalmegh, stevia, citronella, lemon grass, palmarosa and patchouli under teak (Pujar *et al*., 2007) and kalmegh under artificial shade (Saravanan *et al*., 2008).

Table 1. Yield of medicinal and aromatic plants as intercrop in coconut garden as compared to sole crop during 2006-07 to 2008-09

Sl.No.	Crop	Economic part	Yield as intercrop				Yield as sole crop				Reduction (-) or increase (+) in yield of intercrop (%)*
			2006-07	2007-08	2008-09	Mean	2006-07	2007-08	2008-09	Mean	
1.	Kalmegh	Dry herbage (3 harvests/yr)	3650	3265	3274	3396	4998	4827	3891	4572	-25.7 (-9.7)
2.	Makoi	Dry herbage	2946	2979	2852	2926	4139	4276	3956	4124	-29.1 (-13.1)
3.	Coleus	Dry tuberous roots	472	399	384	418	1463	895	537	965	-56.7 (-40.7)
4.	Garden rue	Dry herbage (3 harvests/yr)	3192	3946	3650	3596	4993	5689	4835	5172	-30.5 (-14.5)
5.	Lepidium	Seeds	550	467	459	492	1125	786	619	843	-41.6 (-25.6)
6.	Tulsi	Dry herbage (3 harvests/yr)	4309	4291	3780	4127	7093	4793	4306	5397	-23.5 (-7.5)
7.	Arrow root	Fresh rhizome	3679	6541	5804	5341	6553	7906	6600	7020	-23.9 (-7.9)
8.	Kacholam	Fresh rhizome	967	1147	1125	1079	964	1567	1353	1295	-16.6 (-0.6)
9.	Cowhage	Seeds	3319	2427	2592	2779	7136	4901	3346	5128	-45.8 (-29.8)
10.	Roselle	Dry calyces seeds	486	454	379	440	826	714	529	690	-36.3 (-20.3)
			447	356	499	434	737	675	625	679	-36.1 (-20.1)
11.	Ambrette	Seeds	454	237	415	368	938	475	571	661	-44.3 (-28.3))
12.	Citronella	Green leaves (2-4 harvests/yr)	31548	25667	17595	24937	38014	44738	24424	35725	-30.2 (-14.2)
13.	Lemon grass	Green leaves (2-4 harvests/yr)	27725	59173	50465	45788	31907	58605	56173	48895	-6.4 (+9.6)
14.	Vetiver grass	Dry roots	2355	2122	2052	2176	3151	2816	2752	2906	-25.1 (-9.1)

*Of the total reduction in yield of intercrops, 16.0% was due to loss in area as intercrops were grown in the interspaces of coconut occupying 84% of the area The values in parentheses indicate the reduction or increase in yield of intercrops due to effect of coconut

The coconut equivalent yield was significantly higher in intercropping systems of MAPs with coconut compared to yield of sole crops of MAPs and coconut (Table 2). Among the intercropping systems, coconut + lemon grass recorded significantly higher coconut equivalent yield (28016 nuts ha^{-1}) followed by coconut + arrow root (25725 nuts ha^{-1}), coconut + garden rue (25523 nuts ha^{-1}), coconut + kalmegh (24645 nuts ha^{-1}) and coconut + tulsi (24557 nuts ha^{-1}). This can be attributed to better performance of these MAPs in intercropping situation and also better market prices for their economic plant parts.

Yield of coconut in intercropping system

The nut yield of coconut was improved in the intercropping situation (97 nuts $palm^{-1}$) compared to sole crop (71 nuts $palm^{-1}$). This can be attributed to better growth as indicated by increase in the number of functional leaves from 29.3 to 32.9 (Table 3). The congenial microclimate due to intercropping might have favoured the growth and yield of coconut. Similar observations were made by Maheswarappa (1997) in intercropping systems of coconut + kacholam and coconut + arrow root; and Ghosh *et al*. (2007) in coconut + arrow root and coconut + sarpagandha.

Table 2. Coconut equivalent yield of medicinal and aromatic plants grown as sole crop and intercrop in coconut garden (Mean of 3 years: 2006-07 to 2008-09)

Sl. No.	Crop	Coconut equivalent yield of sole crops of MAPs (Nuts ha^{-1})	Coconut equivalent yield in intercropping system		
			Coconut (Nuts ha^{-1})	Intercrop (MAPs) (Nuts ha^{-1})	Total (Nuts ha^{-1})
1	Kalmegh	20117	9701	14944	24645
2	Makoi	16495	9701	11703	21404
3	Coleus	9650	9701	4183	13884
4	Garden rue	22758	9701	15822	25523
5	Lepidium	8433	9701	4920	14621
6	Tulsi	19430	9701	14856	24557
7	Arrow root	21059	9701	16024	25725
8	Kacholam	5179	9701	4319	14020
9	Cowhage	20511	9701	11117	20818
10	Roselle	7544	9701	4814	14515
11	Ambrette	6613	9701	3687	13388
12	Citronella	14290	9701	9975	19676
13	Lemon grass	19558	9701	18315	28016
14	Vetiver grass	14532	9701	10882	20583
15	Coconut as sole crop		7100		7100
	S.Em +	2227	186	1414	1378
	C.D (P=0.05)	6173	516	3921	3821

Table 3. Growth and yield of coconut in intercropping system with medicinal and aromatic plants during 2006-07 to 2008-09

Sl. No.	Parameter	Initial	Experimental period			
			2006-07	2007-08	2008-09	Mean
1.	No. of functional leaves	29.33	32.50	32.50	33.67	32.89
2.	Nut yield/palm/year	71.00	84.68	96.71	109.64	97.01
3.	Nut yield/ha/year	7100	8468	9671	10964	9701

Content and yield of principal medicinal or aromatic constituents in MAPs

The effect of intercropping on the principal medicinal or aromatic constituents in MAPs was varied with the crop. The principal medicinal constituents like andrographolide in kalmegh (4.40 to 3.20 %), rutin alkaloids in garden rue (1.68 to 1.40 %) and oil content in lepidium (19.60 to 17.23 %) were significantly reduced with intercropping in coconut garden (Table 4). However, the forskohlin content in coleus was significantly increased by intercropping (0.43 to 0.61 %). The alkaloid content in makoi, protein and starch content in arrow root, oleoresin in kacholam, L-DOPA content in cowhage, and anthocyanin and ascorbic acid content in roselle were not significantly different between sole and intercrop of medicinal plants. The essential oil content was significantly increased with intercropping only in ambrette (0.24 to 0.29 %), while in tulsi, citronella, lemon grass, vetiver grass and kacholam, the intercropping had no significant influence on the essential oil content. The variation in the principal medicinal or aromatic constituents in MAPs between sole crop and intercrop could be attributed to the role of light in altering photosynthesis and respiration (Biscoe and Gallagher, 1977), thereby changing the flux of metabolites and reducing power generated through the light reaction which may in turn modify the synthesis and accumulation of principal constituents in MAPs (Saravanan *et al*., 2008).

The yield of principal medicinal or aromatic constituents of all the MAPs was significantly reduced in intercropping situation in coconut garden except kacholam and lemon grass (Table 4). The essential oil yield in kacholam and lemon grass and oleoresin yield in kacholam were not significantly differed between sole crop and intercrop. The reduction in the yield of andrographolide in kalmegh (200.9 to 108.4 kg ha^{-1}), rutin alkaloids in garden rue (86.9 to 50.3 kg ha^{-1}) and oil in lepidium (165.2 to 84.8 kg ha^{-1}) was due to reduction in yield of economic parts and also the content of principal constituents. Though the yield of forskohlin in coleus and essential oil in ambrette significantly increased with intercropping, it does not compensate for the loss in the yield of forskohlin or essential oil due to greater reduction in the yield of economic parts.

The reduction in the yield of essential oil in tulsi (52.9 to 41.7 kg ha^{-1}), citronella (339.4 to 244.4 kg ha^{-1}) and vetiver grass (24.1 to 17.8 kg ha^{-1}), alkaloid in makoi (21.0 to 15.2 kg ha^{-1}), protein (214.8 to 179.2 kg ha^{-1}) and starch (1352.2 to 1117.0 kg ha^{-1}) in arrow root, L-DOPA in cowhage (161.5 to 87.0 kg ha^{-1}), and anthocyanin (0.45 to 0.31 kg ha^{-1}) and ascorbic acid (1.36 to 0.79 kg ha^{-1}) in roselle was mainly attributed to reduced yield of economic part due to intercropping (Table 4).

Table 4. Quality parameters of medicinal and aromatic plants as sole crop and as intercrop in coconut garden (Mean of 3 years: 2006-07 to 2008-09)

Sl.No.	Crop	Economic part	Quality parameter	Content of active principle (%)			Yield of active principle (kg/ha)		
				Sole crop	Intercrop	F-test	Sole crop	Intercrop	F-test
1.	Kalmegh	Dry herbage	Andrographolide	4.40	3.20	*	200.9	108.4	*
2.	Makoi	Dry herbage	Total alkaloids	0.51	0.52	NS	21.0	15.2	*
3.	Coleus	Dry tuberous roots	Forskohlin	0.43	0.61	*	4.1	3.0	*
4.	Garden rue	Dry herbage	Rutin alkaloids	1.68	1.40	*	86.9	50.3	*
5.	Lepidium	Seeds	Oil content	19.60	17.23	*	165.2	84.8	*
6.	Tulsi	Dry herbage	Oil content	0.98	1.01	NS	52.9	41.7	*
7.	Arrow root	Fresh rhizome	Protein	3.06	3.36	NS	211.0	179.2	*
			Starch	19.10	20.90	NS	1352.2	1117.0	*
8.	Kacholam	Dry rhizome	Oleoresin	2.34	2.16	NS	4.42	5.27	NS
			Oil content	0.90	0.92		1.88	2.24	NS
9.	Cowhage	Seeds	L-DOPA	3.15	3.13	NS	161.5	87.0	*
10.	Roselle	Dry calyces	Anthocyanin	64.56	69.97	NS	0.45	0.31	*
			Ascorbic acid	196.87	179.73	NS	1.36	0.79	*
11.	Ambrette	Seeds	Oil content	0.24	0.29	*	1.59	1.07	*
12.	Citronella	Green leaves	Oil content	0.95	0.98	NS	339.4	244.4	*
13.	Lemon grass	Green leaves	Oil content	0.51	0.53	NS	249.4	242.7	NS
14.	Vetiver	Dry roots	Oil content	0.83	0.87	NS	24.1	17.8	*

Note: The anthocyanin and ascorbic acid in Roselle is expressed in mg/100g of dry calyx
*Significant at P=0.05 NS: Not Significant

Similarly, Maheswarappa (1997) reported increased essential oil and oleoresin contents in kacholam and starch and crude protein yield in arrow root under coconut. Gunathilake *et al*. (2002) observed increased piperine content of pepper and essential oil content of kacholam under coconut. Channabasappa *et al*. (2007) observed increased essential oil content in citronella, lemon grass and palmarosa and alkaloid content in kalmegh under shade of trees. However, Chauhan (2000) observed decreased essential oil yield of lemon grass, Java citronella and Japanese mint under poplar. Hegde *et al*. (2006) noticed decreased oleoresin content in ginger under coconut. Saravanan *et al*. (2008) observed reduced andrographolide content of kalmegh under shade.

Economics and resource use efficiency of intercropping system of MAPs with coconut

The economic analysis of growing medicinal and aromatic plants in coconut garden (Table 5) indicated that lemon grass recorded highest net income (Rs. 61,946 ha^{-1}) and B:C ratio (3.09) followed by garden rue (Rs. 52,250 ha^{-1} and 2.95), tulsi (Rs. 47,857 ha^{-1} and 2.81), kalmegh (Rs. 45,548 ha^{-1} and 2.56), arrow root (Rs. 42,596 ha^{-1} and 2.14) and makoi (Rs. 37,443 ha^{-1} and 2.78). Similarly, the intercropping system of coconut + lemon grass recorded the highest net income (Rs. 91,561 ha^{-1}) and B:C ratio (2.89) followed by coconut + garden rue (Rs. 81,865 ha^{-1} and 2.79), coconut + tulsi (Rs. 77,472 ha^{-1} and 2.71), coconut + kalmegh (Rs. 75,163 ha^{-1} and 2.56), coconut + arrow root (Rs. 72,211 ha^{-1} and 2.28) and coconut + makoi (Rs. 67,058 ha^{-1} and 2.68). The higher net income and B:C ratio in these intercropping systems can be attributed to better performance of these MAPs as indicated by the minimum reduction in the yield of economic parts and gross income from the crops. Shanthamallaiah *et al*. (1982) and Hanumanthappa *et al*. (1996) also reported similar results of increased economic income in the intercropping systems of coconut with field crops. The economic advantages of intercropping systems of coconut with arrow root, kacholam, brahmi and sarpagandha were also reported by Maheswarappa (1997) and Ghosh *et al*. (2007).

The LER and ATER differed significantly between different intercropping systems of MAPs with coconut. All the intercropping systems recorded significantly higher LER and ATER compared to sole crop of coconut. The LER of more than 1 indicates greater biological efficiency of intercropping system. The intercropping systems of coconut with MAPs resulted in higher LER (1.54 – 1.94) than sole crop of coconut (1.00) indicating yield advantages (Table 5). The LER was significantly higher with coconut + lemon grass (1.94) followed by coconut + kacholam (1.83), coconut + tulsi (1.76), coconut + arrow root (1.76), coconut + vetiver (1.75), coconut + kalmegh (1.74), coconut + makoi (1.71), coconut + garden rue (1.70 and coconut + citronella (1.70). The yield advantage in intercropping system can be attributed to better utilization of natural resources than sole cropping of MAPs or coconut, resulting in higher productivity per unit area. Though coconut + kacholam system recorded a higher LER of 1.83, the performance

Table 5. Economics of medicinal and aromatic plants as intercrops in coconut garden (Mean of 3 years: 2006-07 to 2008-09)

Sl.No.	Crop	Economics of intercrop				Economics of intercropping system Land				Use Efficiencies	
		Gross income (Rs)	Cost of production (Rs.)	Net income (Rs.)	B:C ratio	Gross income (Rs.)	Cost of production (Rs.)	Net income (Rs.)	B:C ratio	LER	ATER
1.	Coconut + Kalmegh	74721	29173	45548	2.56	123226	48063	75163	2.56	1.74	1.61
2.	Coconut + Makoi	58514	21071	37443	2.78	107019	39961	67058	2.68	1.71	1.14
3.	Coconut + Coleus	20916	23041	-2125	0.91	69421	41931	27490	1.66	1.43	1.24
4.	Coconut + Garden rue	79113	26863	52250	2.95	127618	45753	81865	2.79	1.70	1.65
5.	Coconut + Lepidium	24612	19219	5393	1.28	73117	38109	35008	1.92	1.58	1.12
6.	Coconut + Tulsi	74280	26422	47857	2.81	122785	45312	77472	2.71	1.76	1.51
7.	Coconut + Arrow root	80119	37523	42596	2.14	128624	56413	72211	2.28	1.76	1.54
8.	Coconut + Kacholam	21588	36263	-14675	0.60	70093	55153	14940	1.27	1.83	1.42
9.	Coconut + Cowhage	55586	24301	31284	2.29	104091	43191	60899	2.41	1.54	1.31
10.	Coconut + Roselle	24066	21193	2873	1.14	72571	40083	32488	1.81	1.64	1.26
11.	Coconut + Ambrette	18424	23360	-4936	0.79	66929	42250	24679	1.58	1.56	1.28
12.	Coconut + Citronella	49874	31184	18690	1.60	98379	50074	48305	1.96	1.70	1.35
13.	Coconut + Lemon grass	91575	29630	61946	3.09	140080	48520	91561	2.89	1.94	1.46
14.	Coconut + Vetiver grass	54404	26793	27611	2.03	102909	45683	57226	2.25	1.75	1.37
15.	Coconut as Sole crop (7100 nuts/ha)	-	-	-	-	35500	18890	16610	1.88	1.00	1.00
	SEm +									0.06	0.04
	CD (P=0.05)									0.17	0.11

Prevailing market prices of MAPs and coconut

	Name of crop	Economic produce	Price (Rs./Kg)
1.	Kalmegh	Dry herbage	22.00
2.	Makoi	Dry herbage	20.00
3.	Coleus	Dry Tuberous roots	50.00
4.	Garden rue	Dry herbage	22.00
5.	Lepidium	Seeds	50.00
6.	Arrow root	Rhizome-Fresh	15.00
7.	Kacholam	Rhizome-Fresh	20.00
8.	Cowhage	Seeds	20.00
9.	Roselle	Dry Calyces	35.00
		Seeds	20.00
10.	Citronella	Green leaves	2.00
11.	Lemon grass	Green leaves	2.00
12.	Vetiver grass	Dry roots	25.00
13.	Coconut	Nuts	5.00/nut

of kacholam crop was poor both as sole crop and intercrop resulting in the lowest net income and B:C ratio and therefore, it cannot be considered as an efficient system.

The LER does not take into consideration the differences in duration of component crops. Hence, the comparison of these intercropping systems was also made on the basis of Area Time Equivalent Ratio (ATER) which takes into consideration the duration of component crops. The ATER was significantly higher with coconut + garden rue (1.65) followed by coconut + kalmegh (1.61), coconut + arrow root (1.54) and coconut + tulsi (1.51) systems compared to other systems indicating a more efficient use of area and time by these intercrops.

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