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Influence of spacing and intercropping on biomass and essential oil yield of patchouli [*Pogostemon cablin* (Blanco) Benth.]

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Abstract

A field experiment was carried out in a semi-arid tropical climate at Bangalore (Karnataka) to investigate the influence of spacing (60 cm x 45 cm and 75 cm x 45 cm) and intercropping systems (patchouli sole crop, patchouli + blackgram, patchouli + soybean, patchouli + French bean and patchouli + lady's finger) on the biomass and essential oil yield and oil quality of patchouli (*Pogostemon cablin* (cv. Johore). The spacing of 60 cm x 45 cm was superior to 75 cm x 45 cm and produced 11.6 t ha^{-1} total biomass yield (total of two harvests; 12.1% higher than that of 75 cm x 45 cm spacing) and 88.9 kg ha^{-1} total essential oil yield (10.9% greater than that of 75 cm x 45 cm). Intercropping with legumes and vegetables did not affect total biomass yield and total essential oil yield of patchouli and yielded 0.40, 0.35, 5.40 and 4.50 t ha^{-1} over and above that of patchouli sole crop. Quality of oil was not influenced by plant spacing and intercropping systems. Maximum gross return was obtained with patchouli + French bean (Rs.1,66,470/-) followed by patchouli + lady's finger (Rs.1,51,770/-).

Keywords: food legumes, intercropping, patchouli, *Pogostemon cablin*, vegetables, yield.

Introduction

Patchouli [*Pogostemon cablin* (Blanco) Benth.], an important, multi-harvest aromatic crop is propagated vegetatively through rooted terminal stem cuttings. The transplanted cuttings have a characteristic initial slow growth and are susceptible to weed competition during their lag phase leading to yield loss. Though different spacings ranging from 45 cm x 45 cm to 60 cm x 60 cm were recommended for patchouli in various agro-climatic locations, these recommendations were based on general cultivation practices, rather than experimental evidences (Sarwar *et al*. 1980).

The present study was, therefore, conducted to investigate the influence of plant spacing and intercropping legumes and vegetables on biomass production, oil yield and quality of patchouli in a semi-arid tropical climate.

Materials and methods

The field experiment was conducted during 2003 and 2005 at the Research Farm of Central Institute of Medicinal and Aromatic Plants, Resource Centre, Bangalore, India. The

experimental location experiences semi-arid tropical climate. The soil of the experimental site is a red sandy loam (alfisol) with pH of 6.5, organic C 0.35%, available N 190 kg ha^{-1}, available P 10.5 kg $ha^{-1}$and exchangeable K 170 kg ha^{-1}. The experiment was laid out in a factorial randomized block design with 10 treatments and 3 replications. The treatments were factorial combinations of two plant spacings (75 cm x 45 cm and 60 cm x 45 cm) and five intercropping systems (sole crop of patchouli (cv. Johore) (spacings of 60 cm x 45 cm and 75 cm x 45 cm), patchouli intercropped with food legumes namely, blackgram (*Vigna mungo* (L.) Hepper) (cv. T9), soybean (*Glycine max* Merill) (cv. Brag) and vegetables namely, French bean (*Phaseolus vulgaris* L.) (cv. Local) and lady's finger (*Abelmoschus esculentus* Moench) (cv. Local). One row of inter crops were sown between two rows of patchouli. The experiment was irrigated every 5 days and kept weed-free by manual weeding. Patchouli was fertilized with 200 kg N (435.0 kg urea), 50 kg P_2O_5 (312.5 kg single superphosphate) and 50 kg K_2O (83.3 kg muriate of potash) per ha^{-1} $year^{-1}$. Fertilizers were not applied to intercrops. Single superphosphate and muriate of potash were applied prior to planting and thoroughly mixed with the soil. Urea was applied in four equal splits at two splits per harvest. Patchouli was harvested twice during the year. Planting and harvesting schedule of patchouli and intercrops are given in Table 1 and weather parameters during experimentation is given in Table 2.

Table 1. Planting and harvesting schedule of various crops

Crop	2003		2005	
	Date of planting	Date of harvesting	Date of planting	Date of harvesting
Patchouli	17 January	1st harvest, June 2nd harvest, November	20 January	1st harvest, June 2nd harvest, November
Blackgram	17 January	10 April	20 January	15 April
Soybean	17 January	30 April	20 January	1 June
French bean	17 January	2 April to 30 May-10 times (once in 6 days)	20 January	15 April to 4 June-10 times (once in 5 days)
Lady's finger	17 January	2 April to 30 May-12 times (once in 5 days)	20 January	15 April to 4 June-10 times (once in 5 days)

Table 2. Weather parameters during experimentation

Month	Temperature (°C)				Rainfall (mm)		Relative hmidity (%)	
	Min.		Max.		2003	2005	2003	2005
	2003	2005	2003	2005				
January	14.6	10.1	27.8	19.4	0.0	0.0	67.5	48.0
February	17.1	15.2	30.7	30.4	0.0	1.8	62.5	61.5
March	18.9	17.2	32.7	32.8	5.8	10.2	58.0	57.0
April	20.4	19.6	33.5	32.4	104.0	105.4	57.5	58.5
May	21.5	21.0	34.6	33.9	3.2	53.2	55.5	59.5
June	20.3	20.0	31.3	30.2	30.2	40.2	61.0	66.5
July	19.6	19.6	28.9	28.7	90.4	122.4	68.5	71.0
August	19.2	19.0	27.7	27.7	107.6	249.2	72.0	73.0
September	18.7	19.2	28.3	27.6	65.8	198.2	69.0	73.0
October	18.4	18.8	27.4	26.8	231.9	523.6	73.0	76.0
November	16.3	16.1	27.0	25.0	4.8	52.4	71.5	74.0

Observations on plant height, plant spread and biomass yield were taken. The harvested air dried leaves of patchouli were distilled in Clevenger's apparatus. The essential oil yields per unit area (kg ha^{-1}) were calculated by multiplying the biomass yield with essential oil content and specific gravity of the essential oil. As the intercrop yields cannot be directly compared with patchouli essential oil yield (marketable economic yield), the intercrop yields were converted into patchouli essential oil equivalent yields (PEOE) by using the following formula: PEOE (kg ha^{-1}) = Monetary value of the yield of intercrop / price of patchouli essential oil kg^{-1} (Rao 2000). The data were subjected to statistical analysis using analysis of variance (ANOVA) technique as applicable to randomized block design (Cochran & Cox 1959).

Results and discussion

Plant height

Plant height of patchouli was not influenced by spacing during both the seasons (Table 3). Intercropping influenced plant height of patchouli to a great extent. Sole crop of patchouli significantly resulted in taller plants (38.17 cm) compared to other intercropping systems, which ranged between 34.23 cm to 35.84 cm in the first harvest. This significant reduction in plant height of patchouli in the intercropping system may be due to crop competition. But there was no appreciable effect during the second harvest, as the intercrops were harvested and competition between main and intercrops was absent.

Plant spread

Availability of abundant space between the rows encouraged horizontal growth of patchouli plants in wider row spacing of 75 cm leading to plants with significantly greater canopy spread (Table 3). But intercrops adversely affected plant spread during the early stage (during I harvest), which recovered later.

Biomass yield

Biomass yields of first and second harvests and total biomass yield were significantly higher in 60 cm x 45 cm spacing than wider spacing of 75 cm x 45 cm (Table 3) due to more number of plants per unit area. Moreover, the better interception of solar radiation by the completely covered crop canopy (as evident from plant spread data) might have contributed to higher biomass yield. Total

Table 3. Effect of plant spacing and intercrops on growth and herbage (biomass) yield of patchouli (pooled data of 2 years)

Treatment	Plant height (cm)		Canopy spread (m^2)		Biomass yield (t ha^{-1})		
	Harvest number		Harvest number		Harvest number		
	1	2	1	2	1	2	Total
Plant spacing (cm)							
60 x 45	35.02	36.50	0.23	0.25	6.39	5.21	11.60
75 x 45	35.95	36.75	0.29	0.32	5.39	4.96	10.35
CD (P=0.05)	NS	NS	0.02	0.03	0.17	0.15	0.32
Cropping system							
Patchouli sole crop	38.17	38.45	0.38	0.37	6.35	5.15	11.50
Patchouli + blackgram	34.23	37.70	0.22	0.36	5.73	5.10	10.83
Patchouli + soybean	35.84	37.55	0.27	0.35	5.69	4.91	10.60
Patchouli + French bean	34.24	36.99	0.23	0.34	5.92	5.01	10.93
Patchouli + lady's finger	35.12	37.65	0.20	0.35	5.74	4.90	10.64
CD (P=0.05)	2.06	NS	0.04	NS	0.26	NS	NS

biomass yield of patchouli was not influenced by cropping systems but during first harvest, yield was profoundly influenced which may be due to competition between main crop and intercrops.

Essential oil yield

Essential oil yields of individual harvests and total essential oil yield (Table 4) followed the same trend as that of biomass yield. The essential oil content was not influenced by plant spacings in any of the harvests (Table 4). The essential oil yield increase in 60 cm x 45 cm plant spacing over 75 cm x 45 cm plant spacing were: 10.3% (first harvest), 11.7% (second harvest) and 10.9% (total oil yield). The difference in essential oil yields of individual harvests and total essential oil yield were not significant in sole and intercropping systems because of non significant variation in biomass yields in these cropping systems.

Content and quality of oil

Content and quality of essential oil of patchouli were not significantly influenced by plant spacing and intercropping systems (Table 4).

Yields of intercrops

Vegetables registered greater essential oil equivalent yields than food legumes. Among the intercrops, blackgram produced the least equivalent yield of patchouli. Though the prices of blackgram (Rs. 25 kg^{-1}) and soybean (Rs. 30 kg^{-1}) were higher, French bean (Rs. 7 kg^{-1}) and lady's finger (Rs. 5 kg^{-1}), recorded greater equivalent yields due to higher yields. Thus vegetables proved to be more remunerative intercrops than food legumes.

Gross return

Patchouli intercropped with French bean or lady's finger generated maximum monetary returns followed by patchouli intercropped with blackgram (Table 5). Minimum monetary return was given by patchouli + soybean.

The study thus indicated that intercropping vegetables (French bean and lady's finger) and food legume (blackgram) in patchouli spaced at 60 cm x 45 cm was a feasible and profitable enterprise.

Table 4. Effect of plant spacing and intercrops on oil content, essential oil yield and alcohol content of patchouli (pooled data of 2 years)

Treatment	Oil content (%)		Essential oil yield ($kg\ ha^{-1}$)			Acohol content (%)	
	Harvest number		Harvest number			Harvest number	
	1	2	1	2	Total	1	2
Plant spacing (cm)							
60 x 45	2.82	2.95	48.37	40.50	88.87	44.5	45.0
75 x 45	3.05	3.10	43.86	36.25	80.11	45.1	44.7
CD (P=0.05)	NS	NS	3.93	3.17	5.75	NS	NS
Cropping sytem							
Patchouli sole crop	3.13	3.10	49.67	42.32	91.99	44.5	43.8
Patchouli + blackgram	3.03	3.05	46.51	44.15	90.66	45.7	44.3
Patchouli + soybean	2.84	2.95	43.03	42.75	85.78	46.0	43.7
Patchouli + French bean	2.82	2.96	46.98	41.80	88.78	45.0	44.1
Patchouli + lady's finger	2.87	3.00	44.18	42.00	86.18	44.3	43.9
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS

Table 5. Effect of intercropping patchouli with food legumes and vegetables on total essential oil yield of patchouli, yields of intercrops, essential oil equivalent yields and gross returns (pooled data of 2 years)

Treatment	Total essential oil yield (kg ha^{-1})	Intercrops		Gross returns (Rs ha^{-1} year^{-1})
		Yield (t ha^{-1})	PEOE yield (kg ha^{-1})	
Patchouli sole crop	91.99	-	-	1,37,985
Patchouli + blackgram	90.66	0.40	6.67	1,45,995
Patchouli + soybean	85.78	0.35	7.00	1,39,170
Patchouli + French bean	88.78	5.40	25.20	1,66,470
Patchouli + lady's finger	86.18	4.50	15.00	1,51,770
CD (P=0.05)	NS	-	-	-

Prices of blackgram @ Rs. 25 kg^{-1}, soybean @ Rs. 30 kg^{-1}, bean @ Rs. 7 kg^{-1}, lady's finger @ Rs. 5 kg^{-1} and patchouli oil Rs. 1500 kg^{-1}
PEOE = Patchouli essential oil equivalent

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