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CURCUMIN AND ESSENTIAL OIL CONTENTS OF THREE TURMERIC (*CURCUMA DOMESTICA* VAL.) CULTIVARS GROWN IN MONOCULTURE AND AS INTERCROP IN COCONUT GARDEN*

K. V. SATHEESAN** and A. RAMADASAN***
Central Plantation Crops Research Institute, Kasaragod 670 124, Kerala, India

ABSTRACT

The concentration and accumulation of curcumin and essential oil in the rhizomes of three turmeric cultivars grown in monoculture and as intercrop in coconut garden were determined. The maximum concentration of both curcumin and essential oil attained prior to the maturity of the rhizome. The cultivars showed differential response towards the cropping systems in their curcumin and essential oil contents in the rhizome. The change in the accumulation as well as concentration of essential oil was different from those of curcumin as influenced by the cropping systems.

INTRODUCTION

Turmeric is valued principally for the pigment curcumin. Apart from curcumin, turmeric possesses specific aroma also owing to the presence of a significant quantity of essential oil. Pigment and essential oil content of turmeric rhizomes can differ considerably among cultivars(Rao, Reddy and Subbarayudu, 1975; Krishnamurthy et al., 1975, 1976; Mathai, 1976). Even-though turmeric is presently cultivated in different cropping systems, little information is available on the curcumin and essential oil contents of different cultivars as influenced by various environmental conditions. In the present study, the concentration and accumulations of curcumin and essential oil in the rhizomes of three turmeric cultivars grown in monoculture and in association with coconut were investigated at different stages of crop growth.

MATERIALS AND METHODS

The study was conducted in the experimental farm of CPCRI, Kasaragod with three turmeric (*Curcuma domestica* Val.) cultivars *viz.*, Cls. No. 24 (C_1), Cll. 328 Sugandham (C_2) and Duggirala (C_3) for two years in 1977 and 1978. Generally the temperature and input of photosynthetically active radiation (PAR) were lower, and precipitation was higher during the early period of crop growth (June to August) than during the latter period (September to November) (Table I). During the early period of

* *Part of the Ph.D., thesis submitted by the first author to the University of Calicut, Kerala*
** *College of Forestry, Vellanikkara 680 654, Trichur, Kerala*
*** *National Research Centre for Spices, Marikunnu, P. O., Calicut 673 012, Kerala*

Table I. *Monthly mean values of temperature, photosynthetically active radiation (PAR) and rain fall from June to December (turmeric growing season) during the years 1977 and 1978*

Months	Temperature (°C)				PAR (E $m^{-2}d^{-1}$)		Rainfall (mm)	
	Maximum		Minimum					
	1977	1978	1977	1978	1977	1978	1977	1978
June	29.8	28.1	23.2	22.5	27.3	18.2	915	1337
July	28.5	27.6	22.5	22.5	22.1	19.8	1577	1178
August	29.1	27.9	23.1	23.1	32.2	24.7	354	914
September	29.7	28.6	23.2	22.8	38.4	34.9	165	285
October	31.5	30.6	22.6	23.0	37.1	40.6	252	119
November	30.8	31.5	22.6	22.3	34.9	39.6	218	148
December	32.8	32.9	19.6	22 0	48.0	40.9	2	7

crop growth, the precipitation was lower and PAR input was higher in 1977 than in 1978. But this trend was reversed during the latter peried of crop growth. The only environmental variable found consistently different between the two cropping systems was the solar radiation. On an average, intercropped stand received about 46 per cent of the incoming PAR.

The crop was raised under monoculture or in association with coconut (West Coast Tall (WCT) variety) which is 30 years of age adopting a completely randomised design with five replications. Both coconut and turmeric (pure as well as intercropped stands) were manured as per the recommended package of practices. Rhizome samples were taken for the determination of curcumin and essential oil contents at 4th, 6th, 8th, 11th, 14th, 18th, 22nd, 26th and 30th weeks after planting. At each interval, eight plants, representing an area of 0.6 m^2 of land (*i.e.*, four plants randomly selected from each of the two inner rows) were taken from each replication.

Curcumin content was estimated spectrophotometrically following the ASTA method (Anonymous, 1968). Essential oil was estimated gravimetrically. Ten g of dried and finely ground rhizome samples were extracted for 24 h in petroleum ether (60-80°C) in a Soxhlet extractor. The concentration (per cent dry weight basis) and accumulation (g per sq. m.) of curcumin and essential oil in the rhizomes were then calculated.

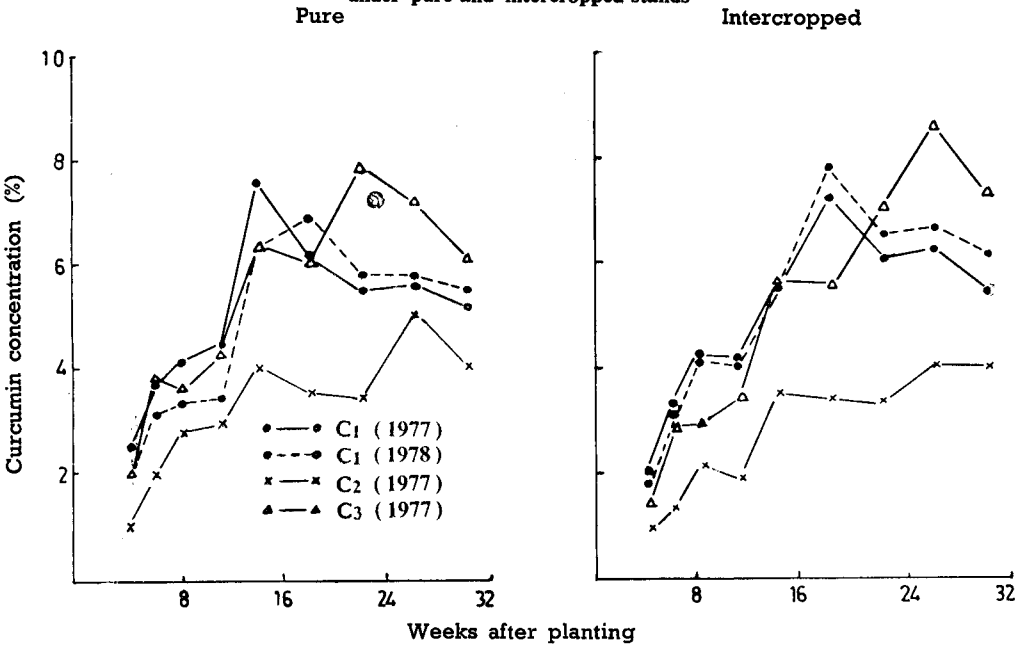
RESULTS AND DISCUSSION

The curcumin and essential oil contents did not show much variation between the two years of study in the cases of cultivars Sugandham (C_2) and Duggirala (C_3), while it differed markedly for the Cls. No. 24 (C_1).

Curcumin

The maximum curcumin concentration in the rhizome was attained prior to the maturity and showed a reduction at the time of harvest (Fig. 1). In the case of Cls. No. 24, this was during 14th

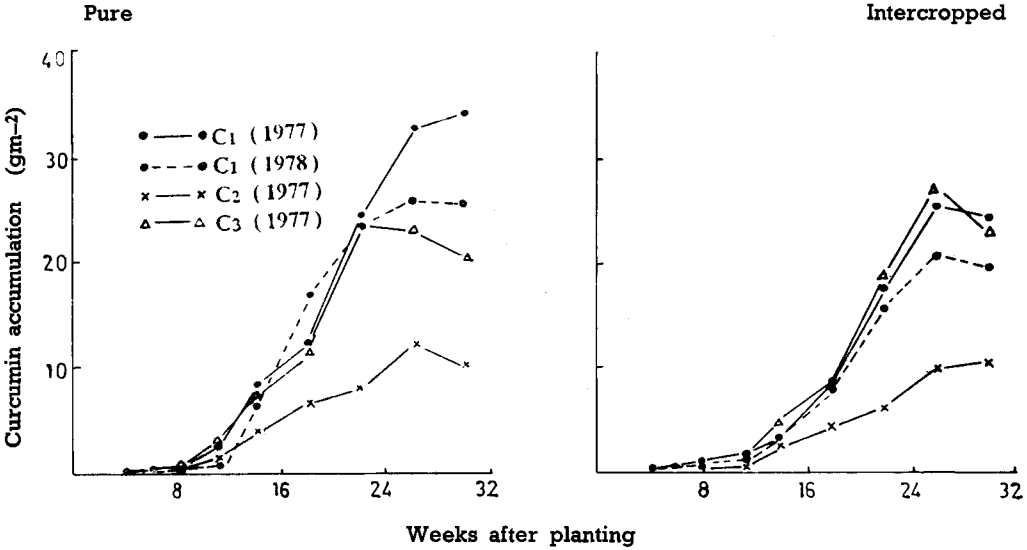
Fig. 1. Curcumin concentration in the rhizomes of three turmeric cultivars (C1, C2 and C3) under pure and intercropped stands



and 18th weeks after planting for pure and intercropped stands respectively, during the year 1977. During the year 1978, the curcumin content of this cultivar registered higher values from 18th week onwards when the dry matter accumulation in the rhizome was less as compared to 1977. Cultivar Sugandham registered maximum curcumin concentration during 26th week after planting, while in the case of cultivar Duggirala this was during 22nd and 26th weeks for the pure and intercropped stands respectively. Krishnamurthy et al., (1975) found that the pigment content of turmeric increased to a peak and then declined during the maturation of rhizome, while Mehta, Rao and Patel, (1980) did not find such a reduction. At maturity, the curcumin concentration of the cultivar Duggirala under the itercropping system was considerably higher than under the monocropping system but no such difference was noticed for the other two cultivars thereby showing the differential response of turmeric cultivars to varied environmental conditions.

The pattern of curcumin accumulation in the rhizomes of the turmeric cultivars is depicted in Fig. 2. Under the pure stand, cultivar Cls No. 24 continued to accumulate curcumin in the rhizome upto maturity, while for the cultivars Sugandham and Duggirala the maximum accumulation reached at 26th and 22nd weeks respectively, followed by a decline towards the maturity. Under the intercropped stand all the cultivars showed maximum curcumin accumulation by 26th week itself. The maximum curcumin yield recorded and curcumin yield at harvest of cultivar

Fig. 2. Curcumin accumulation in the rhizomes of three turmeric cultivars (C1, C2 and C3) under pure and intercropped stands

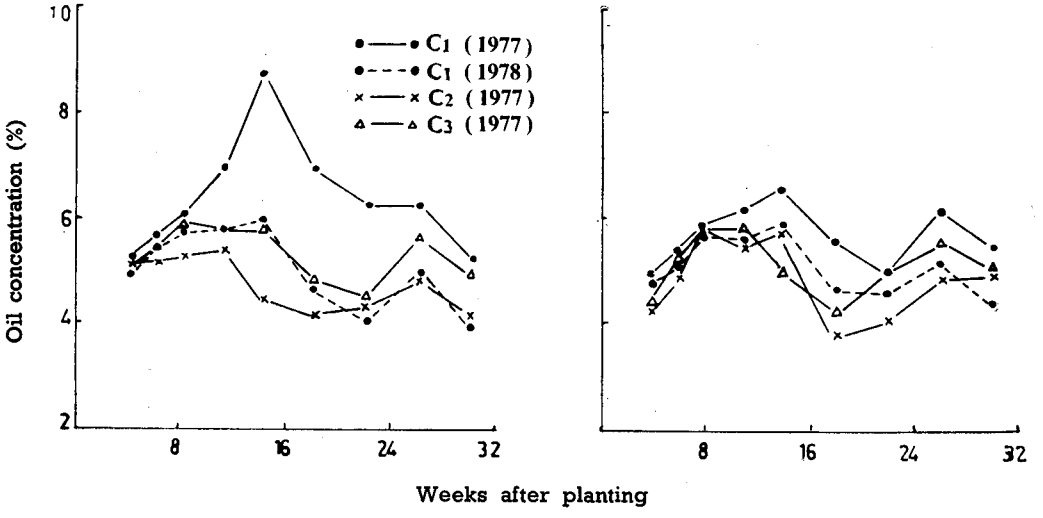


Cls. No. 24 was significantly higher under the pure stand than under the intercropped stand during both the years, while these values for cultivar Duggirala were significantly higher under the intercropped stand (Table II). In the case of cultivar Sugandham no significant difference was noticed for the curcumin yield between the two cropping systems. The curcumin yield of cultivar Cls. No. 24 was considerably reduced in the second year as compared to the first year, which was due to lower dry matter accumulation in the rhizome during the second year of study. The results indicated that the optimum time for harvest in terms of curcumin yield can vary according to a particular

Table II. *Yield of curcumin (g m^{-2}) of three turmeric cultivars under pure (S_1) and intercropped (S_2) stands during the years 1977 and 1978*

Cultivars	1977						1978					
	Maximum yield			Yield at harvest			Maximum yield			Yield at harvest		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
Cls. No. 24 (C_1)	34.6	25.5	30.1	34.6	24.3	29.5	26.2	20.6	23.4	25.6	19.6	22.6
Cll. 328 sugandham (C_2)	12.2	10.6	11.4	10.3	10.6	10.5	12.5	10.4	11.5	10.1	10.4	10.3
Duggirala (C_3)	22.9	26.7	24.8	20.6	23.9	22.3	23.2	26.9	25.1	20.3	23.5	21.9
Mean	23.2	20.9		21.8	19.6		20.6	19.3		18.7	17.8	
CD (P = 0.05)												
Cultivars (C)	1.94			1.95			1.61			1.63		
Cropping systems(S)	1.58			1.59			NS			NS		
C×S	2.74			2.75			2.28			2.30		
CV (%)	9.5			10.2			8.7			9.7		

Fig. 3. Essential oil concentration in the rhizomes of three turmeric cultivars (C1, C2 and C3) under pure and intercropped stands

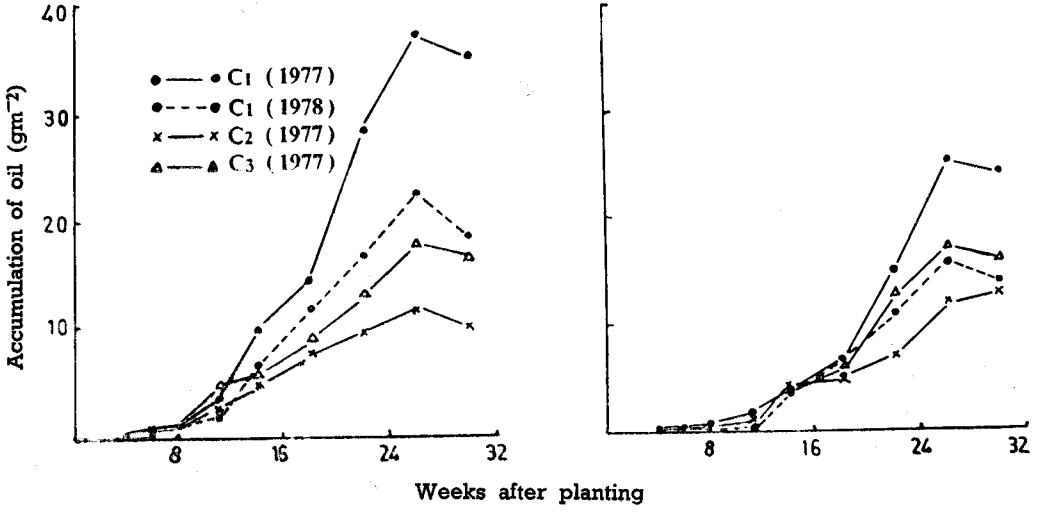


cultivar and under different cropping systems.

Essential oil

The maximum oil concentration in the rhizome was attained much earlier in the growth cycle than that of the curcumin, by the 14th week in the case of cultivar Cls. No. 24 and between 8th and 11th week for the other two cultivars. (Fig. 3). The oil concentration decreased upto 22nd week followed by

Fig. 4. Essential oil accumulation in the rhizomes of three turmeric cultivars (C1, C2 and C3) under pure and intercropped stands



a further rise during 26th week. The cultivars showed a drop in the oil concentration at the time of harvest. Unlike in the case of curcumin concentration, the cultivar Cls. No. 24 showed a clear superiority over the other two cultivars for the oil concentration under both the cropping systems; and the maximum values attained under the monocropping was considerably higher than those attained under intercropping during the first year of study. During the second year of study, cultivar Cls. No. 24 registered lower values of oil concentration than in the first year when the dry matter accumulation in the rhizomes was also less. While the curcumin concentration at maturity showed higher values under the intercropping than under the monocropping for the cultivar Duggirala in the case of oil concentration, this trend was noticed for cultivar Sugandham.

All the cultivars continued to accumulate oil in the rhizome upto 26th week after planting (Fig.4). This was followed by a reduction in the oil accumulation towards maturity except for the intercropped stand of the cultivar Sugandham. As in the case of curcumin yield, the oil yield of cultivar Cls. No. 24 was significantly higher under the pure stand than under the intercropped stand, but, unlike in the case of curcumin yield, cultivar Duggirala did not show any such difference in its oil yield between the two cropping systems (Table III). The oil yield of cultivar Cls. No. 24 was reduced during the second year of study as compared to first year as a consequence of reduced dry matter accumulation in the rhizome. Apart from the differential behaviour of turmeric cultivars in their oil contents when grown under monocropping and intercropping systems, the study also revealed that the trend of changes in the concentration and accumulation of essential oil of turmeric cultivars as influenced by these cropping systems was found to be deviated from those of curcumin.

Table III. *Yield of essential oil (g m^{-2}) of three turmeric cultivars under pure (S_1) and intercropped (S_2) stands during the years 1977 and 1978*

Cultivars	1977						1978					
	Maximum yield			Yield at harvest			Maximum yield			Yield at harvest		
	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean	S_1	S_2	Mean
Cls No. 24 (C_1)	37.9	25.5	31.7	35.9	24.8	30.4	23.0	16.2	19.6	19.0	14.1	16.6
Cll 328 Sugandham (C_2)	13.0	13.3	13.2	10.9	13.3	12.1	12.2	13.0	12.6	10.6	13.0	11.8
Duggirala (C_3)	19.9	18.7	19.3	17.2	16.7	17.0	18.6	17.5	18.1	16.9	16.4	16.7
Mean	23.6	19.2		21.3	18.3		17.9	15.6		15.5	14.5	
CD (P = 0.05)												
Cultivars (C)		1.80			1.85			1.28			1.36	
Cropping systems (S)		1.47			1.51			1.04			NS	
C×S		2.54			2.61			1.81			1.93	
CV (%)		9.1			10.1			8.3			9.8	

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