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Coffee - cardamom, black pepper and mandarin mixed cropping system - a case study

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Abstract

Experiments were conducted at Chettalli, a predominantly coffee growing area in Kodagu District (Karnataka, India) to study the yield potential of coffee (*Coffea robusta*), cardamom (*Elettaria cardamomum*), black pepper (*Piper nigrum*) and mandarin (*Citrus reticulata*) in a mixed cropping system. Dry yield of coffee was significantly higher when it was grown as mono crop (2163 kg/ha) compared to mixed crop (1568 kg/ha). Cardamom when introduced as a single hedge by trimming the side branches of alternate rows of coffee, recorded an yield of 204.83 kg/ha. Black pepper vines trained on live standards of shade trees yielded 1222.15 kg/ha. Mandarin was severely infested with greening disease and there was no appreciable yield. The study indicated the feasibility of inroduction of high value crops like cardamom and black pepper as mixed crops for increasing the production and productivity of coffee plantations.

Key words : black pepper, cardamom, coffee, mandarin, mixed cropping.

Introduction

There is an urgent need to increase the production and productivity of coffee plantations by introducing compatible component crops to harness land, water and solar energy with maximum efficiency. Cultivation of economic orchard crops such as orange (Coorg mandarin) in Kodagu (Karnataka), black pepper in Wynad (Kerala) and banana in Pulneys (Tamil Nadu) in coffee gardens has become an established practice in recent years. However in Kodagu, mandarin as a mixed crop with coffee has become non productive due to greening disease. Hence, cardamom was introduced as a complementary crop to black pepper and mandarin cropping system in coffee gardens. However, even after introducing cardamom, mandarin was retained to provide shade to cardamom plants. Studies were conducted at Chettalli

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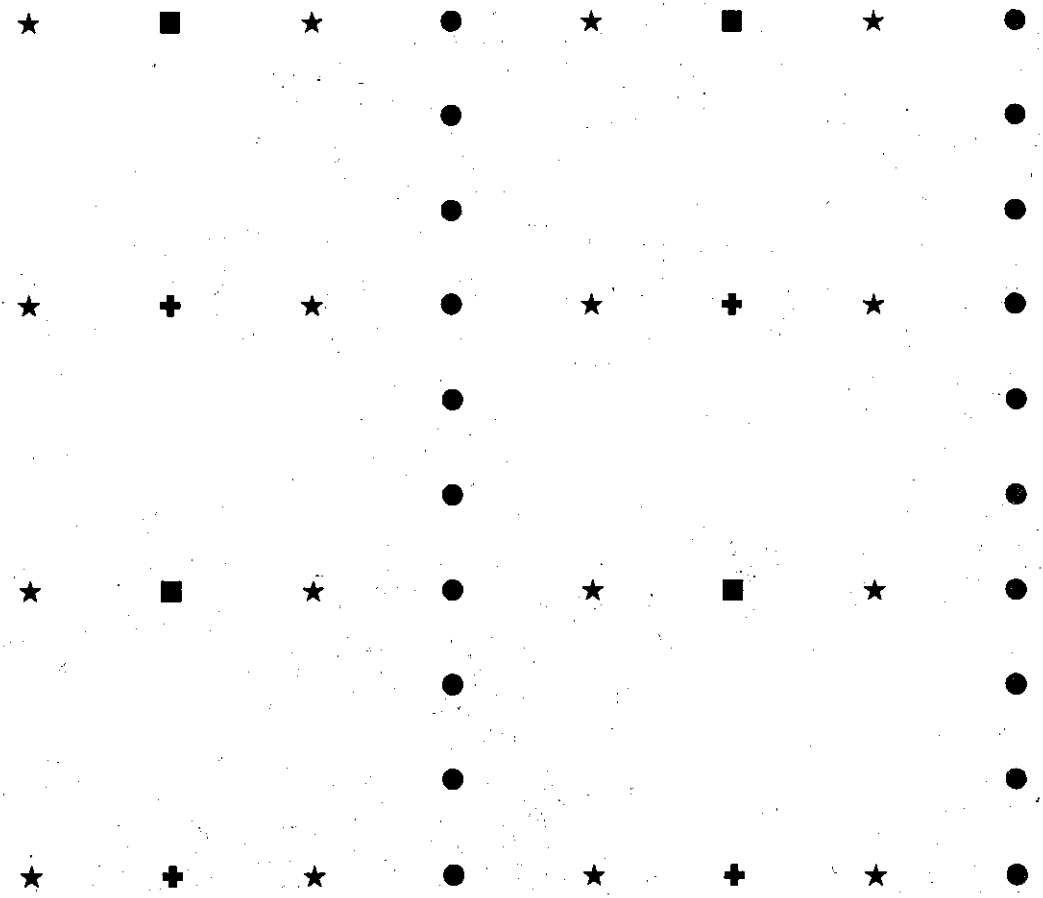
(Kodagu District, Karnataka, India) on compatibility and production potential of mixed cropping of coffee (*Coffea robusta* Linden ex de Wild) with cardamom (*Elettaria cardamomum* Maton), black pepper (*Piper nigrum* L.) and mandarin (*Citrus reticulata* Blanco) and the results are reported here.

Materials and methods

The field experiment was initiated during 1990 in a 13 year old Robusta coffee plantation at M/s Chettoli Estate, Chettalli. The soils of the experimental site were sandy loam and classified as kandic paleustaf type. The soils were modertately acidic, rich in organic matter, low in available phosphorus and medium in available potash. The average rainfall was 1400 mm with 125 rainy days per annum wherein nearly 2/3rd of the precipitation is received du-ring the South West monsoon. Black pepper was planted and trained on *Ery-thrina lithosperma* standards in 1980 in the plantation where coffee and man-darin were planted simultaneously during 1978. Cardamom was introduced during 1990 without removing coffee plants (rows) but by trimming only the alternate side branches so as to make room for introduction of cardamom in a single hedge. The details of the experimental layout are given in Table 1 and Fig. 1. Coffee pulp compost @ 3 tonnes/ha (during May-June) and the recommended dose of fertilizers were applied to coffee and other component crops in

Table 1. Experimental layout of mixed cropping systems in coffee

Design	:	Factorial RBD
No of replications	:	10
Treatments (cropping systems)		
M_1	:	Mono cropping of coffee
M_2	:	Mixed cropping of coffee with mandarin, black pepper and cardamom
Cropping season	:	4 years (1990-91 to 1993-94)
Plot size		
Gross	:	500 m^2
Net	:	400 m^2
Crop and variety		
Coffee	:	Perdinia (Robusta)
Mandarin	:	Coorg mandarin
Black pepper	:	Panniyur - 1
Cardamom	:	Cl.37 Malabar (prostrate panicles)
Spacing and plant population		
Mono cropping coffee	:	3 m x 3 m (1111 plants/ha)
Mixed cropping		
Coffee	:	3 m x 3 m (1111 plants/ha)
Mandarin	:	6 m x 6 m (278 plants/ha)
Black pepper	:	6 m x 6 m (278 plants/ha)
Cardamom	:	6.0 m x 1.2 m (1389 plants/ha)



Crop	Spacing	Plant population
✚ Black pepper	6.0 m x 6.0 m	278/ha
● Cardamom	6.0 m x 1.2 m	1389/ha
★ Coffee	3.0 m x 3.0 m	1111/ha
■ Mandarin	6.0 m x 6.0 m	278/ha
		Total 3056/ha

Fig. 1. Planting pattern of mixed cropping of coffee with mandarin, black pepper and cardamom (single hedge)

the system in two splits during June and September, respectively. The crops were irrigated during January to May at an interval of 15 days. Regular cultural operations and plant protection measures were also carried out. The photosynthetically active radiation (PAR) was recorded by using a Leaf Chamber Analyser (LCA-3). The crop was harvested at different intervals and pooled at the end of each crop season.

Results and discussion

Light interception

In perennial plantations crops, the structure of overhead canopy and orientation of leaves in the crown decide light transmission to the ground which can be profitably exploited for raising mixed crop species in multistoreyed cropping systems. In the present multistoreyed cropping system, the overhead shade trees (15-18 m) formed the top most storey (tier), followed by mandarin (8.0-8.5 m) which constituted the second tier, black pepper trained on *E. lithosperma* (6 m) constituted the third tier, cardamom (2.0-2.5 m) the fourth tier and coffee (1.6-1.8 m) the fifth and lower most (ground) tier.

The PAR was highest (295.50 μ mol m^{-2} sec^{-1}) in coffee as a mono crop. In the mixed cropping system also coffee recorded the highest PAR (205.30 μ mol m^{-2} sec^{-1}) followed by black pepper (108.20 μ mol m^{-2} sec^{-1}), mandarin (103.20 μ mol m^{-2} sec^{-1}) and cardamom (102.90 μ mol m^{-2} sec^{-1}).

Root distribution

Root distribution of a crop decides soil moisture absorption, uptake of nutrients and also adequate anchorage. In coffee, feeder roots were found to concentrate very close to the surface in most of the plants, with an effective horizontal spread of 45-70 cm. The tap root was extensively branched and extended up to 70-85 cm depth. The roots of mandarin extended between 120-175 cm vertically and 90-120 cm horizontally. Black pepper had a shallow root system with nearly 75 per cent of the feeder roots in a radius of 50 cm. In cardamom, 80 per cent of the lateral roots were concentrated at a radius of 30 cm and penetrated up to 40 cm vertically. The rooting pattern of the main crop of coffee provided sufficient unutilised space which could be utilised by the mixed crops in the system. The rooting pattern of shade trees was not studied; however most of them had a deep tap root with secondary and tertiary roots penetrating different soil horizons.

Performance of coffee

Dry yield of coffee was significantly higher when it was grown as mono crop (1.970 kg/plant; 2163 kg/ha) compared to mixed crop (1.415 kg/plant; 1568 kg/ha) since cutting and removing of lateral branches of alternate rows (covering the centre) resulted in comparatively lesser bearing laterals (Table 2). Dry yield of coffee significantly varied with years and was highest (1.850 kg/plant; 2055 kg/ha) during 1992-93.

Coffee generally had a high and low crop yielding tendency during alternate years (Fig.2). This is a common phenomenon in woody perennial plantation/orchard crops. In mango, nitrogen and carbohydrate reserves play an important role in flower bud initiation during succeeding years suggesting the possible role of C:N ratio in yield of perennial fruit trees. This yield pattern appears to be closely associated with hormonal balance as in mango (Majumdar & Sharma 1985). A similar situation probably holds good in coffee also.

Performance of mandarin

The performance of mandarin with respect to yield was dismal due to severe infestation with greening disease caused by mycoplasm like organisms. Hence, the yield of mandarin was not recorded and accounted for in the study.

Table 2. Dry yield of coffee grown as mono or mixed crop with black pepper, cardamom and mandarin

Year	Yield (kg/plant)			Yield (kg/ha)		
	Mixed crop	Mono crop	Mean	Mixed crop	Mono crop	Mean
1990-91	1.559	2.037	1.798	1731	2263	1997
1991-92	1.325	1.879	1.602	1452	2085	1769
1992-93	1.494	2.206	1.850	1660	2451	2055
1993-94	1.282	1.667	1.474	1429	1853	1641
Mean	1.415	1.947	-	1568	2163	-
	F test	SE m±	CD (P=0.05)	F test	SEm±	CD (P=0.05)
Cropping system	**	0.056	0.156	**	62	173
Year	**	0.079	0.268	**	88	245
Interaction	NS	0.112	-	NS	124	-

** Significant at P=0.01; NS = Not significant

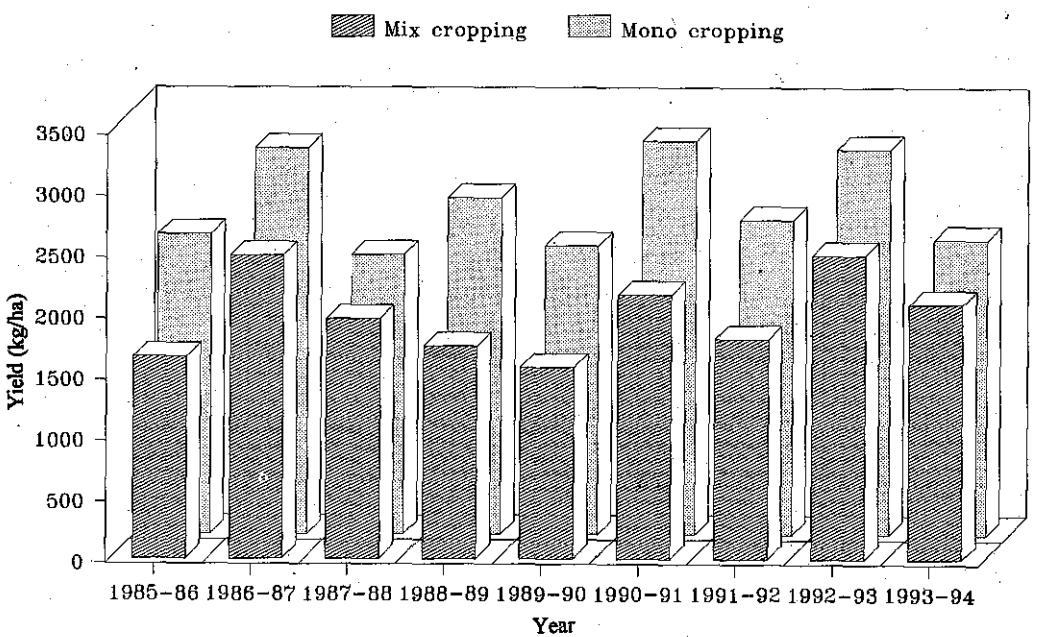


Fig. 2. Yield pattern of coffee mix cropped with cardamom and mono crop of coffee

Performannance of black pepper

Dry yield of black pepper varied significantly with years and was highest during 1992-93 (6 kg/plant; 1667 kg /ha) (Table 3). The growth of black pepper vines could have been influenced by solar radiation regulated by overhead shade trees in the system. The soil environment could also be improved by the decomposing litter fallen from the standards and black pepper vines (Sivakumar & Wahid 1994).

The economically viable and feasible crop to cultivate on shade trees in coffee plantations is black pepper (Korikanthimath & Peter 1992). Robusta coffee requires less shade compared to Arabica and therefore it favours the growth and yield of black pepper as it requires higher light intensity.

Performance of cardamom

Dry yield of cardamom (Table 4) varied significantly with years and was highest during 1992-93 (209 g/plant; 290.5 kg/ha). The average yield of cardamom for three crop seasons (1991-92 to 1993-94) was 204.8 kg dry capsules/ha though the crop had to be accommodated at a wider row spacing with a plant population of 1389 plants/ha in this experiment as against the conventional spacing of 2 m x 2 m.

Table 3. Dry yield of black pepper grown as mixed crop with coffee, cardamom and mandarin

Year	Yield (kg/plant)	Yield (kg/ha)
1990-91	3.3	912.9
1991-92	4.1	1144.6
1992-93	6.0	1667.1
1993-94	4.2	1176.0
F test	**	**
SEm±	0.1	34.3
CD (P=0.05)	0.4	99.7

** Significant at P = 0.01

Table 4. Dry yield of cardamom grown as mixed crop with coffee, black pepper and mandarin

Year	Yield (g/plant)	Yield (kg/ha)
1991-92	90.5	125.7
1992-93	209.0	290.5
1993-94	142.6	198.3
F test	**	**
SEm±	6.8	9.4
CD (P=0.05)	20.2	28.0

** Significant at P = 0.01

In cardamom, especially in the Malabar type, the highest yield is generally obtained either during the third or fourth year after planting. In the present trial the highest crop yield was obtained during the third year (1992-93) of planting which came down during the succeeding year by 32 per cent. One of the reasons for the low yield in cardamom after attaining the highest yield is probably because cardamom is a rhizomatous crop where a majority of vegetative buds (65 per cent) would express their full potentiality due to conversion of most of the suckers (buds) into bearing suckers in a particular year (third year after planting) during which the highest yield is obtained. The suckers which would have already undergone production die off during the succeeding crop season by giving rise to sister/daughter suckers (Korikanthimath 1995).

The present study showed that cardamom and black pepper which are high value crops can be ideal substitute crops for mandarin in coffee estates to increase production and productivity.

References

Korikanthimath V S & Peter K V 1992 Coffee based pepper cropping system. Planter's Chronicle 87 (3) : 121-129.

Korikanthimath V S 1995 Economics of sustained production of cardamom (*Elettaria cardamomum* Maton). J. Spices Aromatic Crops 4 : 119-128.

Majumdar P K & Sharma D K 1985 Mango In : Bode T K (Ed.) Fruits of India, Tropical and Subtropical (p. 98). Naya Prakash, Calcutta.

Sivakumar C & Wahid P A 1994 Effect of application of organic materials on growth and foliar nutrient contents of black pepper (*Piper nigrum* L.). J. Spices Aromatic Crops 3 : 135-141.