Research Article *Journal of Plantation Crops, 2013, 41(3): 384-388*

Performance of medicinal and aromatic plants as intercrops in coconut plantations in Konkan region of Maharashtra

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(Manuscript Received: 26-06-13, Revised: 28-09-13, Accepted: 01-10-13)

Abstract

A field experiment was conducted at Regional Coconut Research Station, Bhatye, Ratnagiri (AICRP on Palms) during 2006-2011 to develop appropriate cropping system with medicinal and aromatic plants as intercrops compatible with coconut. The experiment consisted 'shatavari' *(Asparagus racemosus*), 'adulasa' (*Adhatoda vasica*), arrowroot (*Maranta arundincea*), lemon grass (*Cymbopogum citratus*) and citronella *(Cymbopogum winterianus*) replicated four times in randomized block design. The yield of different medicinal/aromatic plants was maximum in lemon grass (31 t ha^{-1}) followed by citronella (22 t ha^{-1}), arrowroot (16 t ha^{-1}), adulsa (2.1 t ha^{-1}) and shatavari (0.8 t ha^{-1}). The yield of intercrops in terms of coconut equivalent yield was higher with lemongrass (7750 nuts ha^{-1}) followed by arrowroot (6000 nuts ha^{-1}), adulasa (4725 nuts ha^{-1}), citronella (4125 nuts ha^{-1}) and shatavari (3500 nuts ha^{-1}). The yield of coconut increased from 12 to 21 per cent after planting the intercrops. The net return was maximum in coconut + lemongrass (Rs. 96,200/- per ha) followed by coconut + arrowroot (Rs. 93,200/- per ha), coconut + shatavari (Rs. 83,300/- per ha), coconut + adulasa (Rs. 78,300/- per ha) and coconut + citronella (Rs. 73,800/- per ha). Further, it was observed that shatavarin and saponins in shatavari, alkaloid in adulasa, citranol in citronella and sugar in arrowroot were higher with intercropping whereas citral in lemon grass slightly reduced with intercropping. Considering the performance of different medicinal crops as intercrop and market demand, arrowroot, lemongrass, adulasa, citronella and shatavari have been recommended as intercrops in coconut plantation for Konkan region of Maharashtra.

Keywords: Coconut, intercrop, medicinal and aromatic plants

Introduction

Adoption of coconut based cropping system provides the additional income per unit area as well as sufficient work to the family labourers throughout the year (Nelliat, 1973). Spices are high value commercial crops which can be grown profitably inter/mixed crops with coconut. Nelliat *et al.* (1979) have reported that the beneficial effect of growing cocoa, black pepper, clove, nutmeg and cinnamon in terms of higher productivity and net returns per unit area. Further, higher net returns from coconut and nutmeg followed by coconut and clove, coconut and black pepper and coconut and cocoa was reported (Nair *et al*., 1991).

Studies indicated that under coconut based high density multispecies cropping system (HDMSCS) and mixed cropping system black pepper, clove and nutmeg performed better (CPCRI, 2004; Maheswarappa and Anithakumari, 2005; Reddy *et al.*, 2002). Further, intercropping of tree spices like cinnamon, clove, nutmeg, garcinia, black pepper and all spice in coconut garden at Ratnagiri (Maharashtra) increased the nut yield of coconut compared to monocrop (Nagwekar *et al.*, 2002).

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Growing medicinal plant in coconut garden is an age old practice in India. Nair *et al.* (1989) reported that growth and yield of number of medicinal species did not adversely affect when grown as intercrop in twelve year coconut palms. Among the 13 medicinal crops tried at Pilicode, Kerala, India, kacholam (*Kaempferia galanga* L.), arrowroot (*Maranta arundinacea* L.) and *Sida retusa* performed well under full/partial shade of coconut (Rajgopalan *et al.*,1992). Maheswarappa (1997) reported that growth and yield of arrowroot and kacholam were higher when grown as intercrop in coconut garden than when grown in open space. Further, it was observed that kacholam intercropped in 30 year old coconut plantation produced higher yield compared to sole crop (Maheswarappa *et al.,* 1998). Arrowroot grown as an intercrop had recorded higher yield, starch content and crude protein content compared to arrowroot grown in open space (Maheswarappa *et al.,* 2000).

In Konkan region of Maharashtra, coconut is cultivated an area of 21000 ha (2010-11) and area under coconut is increasing every year. A field experiment was conducted to find out the feasibility of shatavari, adulasa (malbar nut), arrowroot, lemon grass and citronella plants for intercropping in coconut garden in the Konkan region of Maharashtra.

Materials and methods

A field experiment was carried out at Regional Coconut Research Station, Bhatye, Ratnagiri (Maharashtra) under All India Co-ordinated Research Project on Palm during 2006-11. The center is situated at 17°00' N latitude and 73°40' E longitudes with an altitude of 3 m above mean sea level. Konkan region receives an annual rainfall of 2700 to 4000 mm distributed mainly during four months from June to September. The soil of experiment site was sandy with low available nitrogen (128 kg N ha^{-1}) medium in phosphorus (48 kg P_2O_5 ha^{-1}) and high potassium (305 kg K_2O ha^{-1}).

The experiment was conducted with five medicinal and aromatic plants *viz*., shatavari *(Asparagus racemosus*), adulasa (*Adhatoda vasica*), arrowroot (*Maranta arundincea*), lemon grass (*Cymbopogum citratus*) and citronella *(Cymbopogon winterianus*). The experiment was laid out in randomized block design with four replications and six coconut palms per plot. All the plants were planted 2 m away from the bole on either sides of 47 year old coconut palms planted at a distance of 7.5 x 7.5 m. The experimental plots were prepared by ploughing and then applying FYM and mixing thoroughly with soil and leveled as a flat bed. The lemon grass and citronella were planted at 60 x 60 cm, whereas adulasa and shatavari at 90 x 60 cm spacing and arrowroot at 90 x 90 cm distance. Another set of five medicinal and aromatic plats were planted in open space as a sole crop. The recommended doses of fertilizers were applied in the organic form only. However, other recommended cultivation practices were followed for main and component crops regularly. The coconut and component crops were irrigated regularly after rainy season during October to May by sprinkler irrigation system.

The medicinal and aromatic plants were harvested at maturity stage depending on the economic part required for medicinal or essential oil purposes and yield was recorded. The active ingredients like shatavarin, saponins, alkaloids, sugar, citral and citranol in the economic parts were determined by following the standard procedure in which filtrate was used as a sample for HPTLC to detect secondary metabolites. Sample application was done by using LINOMAT 5 (CAMAG made) with 8 mm band length and 8 mm from Y axis on silica gel F 254 plate. Plate was run in solvent system as toluene:ethyl acetate:diethyl amine (70:20:10) for alkaloids, toluene: ethyl acetate (93:07) for citral and citranol, ethyl acetate:methanol:water (75:15:10) for shatavarin, chloroform:glacial acetic acid:methanol:water (64:32:12:08) for saponin, isopropanol:ethyl acetate:water (23:65:12) for sugars. Then plate was scanned by using densitometric scanner for different wave lengths from 254 to 480 nm.

Coconuts were harvested at bi-monthly intervals and yield was recorded form July to June. The yield data of coconut was analyzed as suggested by Panse and Sukhatme (1978). The gross return of main and intercrop was worked out based on prevailing market prices. The cost of production was

calculated considering actual input cost required for each crop. 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. Further, the coconut nut equivalent yield (CEY) was calculated by using the following formula

$$CEY = \frac{\text{Yield of intercrops (t ha}^{-1}\text{) x Rate of intercrop (Rs kg}^{-1}\text{)}}{\text{Rate of coconut per nut}}$$

Results and discussion

A) Effect of intercropping on coconut yield

Coconut yield data presented in Table 1 revealed that before planting the intercrops in coconut yield for four years (2002-2006) was found non-significant within the treatments and ranged from 72 to 89 nuts palm^{-1} year^{-1}. However, the yield of coconut increased significantly after growing different intercrops and ranged from 84 to99 nuts palm^{-1} year^{-1}. The highest yield was recorded in coconut and shatavari plot (99 nuts palm^{-1}) followed by coconut and arrowroot (93 nuts palm^{-1}) and they were statistically at par and significantly superior over other crop combinations *viz*. coconut and adulasa, coconut and lemongrass, coconut and citronella and coconut monocrop. Further, the percent increase in nut yield over pre treatment yield was maximum in coconut and adulasa (21.4%) followed by coconut and arrowroot (20.25%), coconut and lemongrass (15%), coconut and citronella (12.6%) and coconut and shatavari (12.3%). Similar observations were made by Maheswarappa (1997) in intercropping system of coconut and kacholam and coconut and arrowroot, intercropping of different medicinal plants under coconut increased yield of 14.16 per cent (Gosh *et al*., 2007). The nut yield of coconut was improved in the intercropping situation compared to sole crop (Basavaraju *et al*., 2011). Further, Nagwekar *et al.* (2002) reported that after planting spice crops (nutmeg, cinnamon, clove and black pepper) as intercrops, the yield of coconut was found to increase between 24 to 94 percent as compared to the previous year yield. The increase in the yield of coconut was mainly due to frequent irrigation and intensive cultivation. Sujatha *et al.* (2009) reported that all the medicinal and aromatic crops contributed to productivity increase varying between 10.7 per cent with basil to 53 per cent with shatavari in terms of chali equivalent per hectare of arecanut garden.

Table 1. Yield of coconut

Treatment	Pre-treatment period yield* (nuts ha^{-1})	Post treatment period yield** (nuts ha^{-1})	Per cent increase over pre-treatment yield
Coconut and shatavari	89	99	12.3
Coconut and adulasa	72	87	21.4
Coconut and arrowroot	80	93	20.25
Coconut and lemon grass	74	85	15.00
Coconut and citronella	75	84	12.6
Coconut	79	80	1.3
SE +	5.54	4.27	-
CD (5%)	N.S.	6.47	

*2002-06: Average of four years; **2006-11: Average of five years

B) Yield of medicinal and aromatic plants

The data presented in Table 2 revealed that the yield of medicinal/aromatic plants was maximum in lemon grass (31 t ha^{-1}) followed by citronella (22 t ha^{-1}), arrowroot (16 t ha^{-1}), adulasa (2.1 t ha^{-1}) and shatavari (0.8 t ha^{-1}). Further, coconut equivalent yield was recorded highest with lemon grass (7750 nuts ha^{-1}) followed by arrowroot (6000 nuts ha^{-1}), adulasa (4725 nuts ha^{-1}), citronella (4125 nuts ha^{-1}) and shatavari (3500 nuts ha^{-1}). Similar results were reported by Maheswarappa *et al.* (1998) in kacholam or galangal intercropped in a 30 year old coconut plantation produced 6.1 t ha^{-1} of rhizomes compared with 4.8 t ha^{-1} as a sole crop. Further, growing arrowroot as an intercrop in coconut also had recorded higher yield compared to the arrowroot

Table 2. Yield of medicinal and aromatic plants and coconut equivalent yield in intercropping with medicinal and aromatic plants

Treatment	Yield of medicinal and aromatic plants (t ha^{-1})	Coconut equivalent yield in coconut based cropping system (no. of nuts ha^{-1})		
		Coconut	Intercrop	Total
Coconut and shatavari	0.8	17325	3500	20825
Coconut and adulasa	2.1	15225	4725	19950
Coconut and arrowroot	16.0	16275	6000	22275
Coconut and lemon grass	31.0	14875	7750	22625
Coconut and citronella	22.0	14700	4125	18825
Coconut	-	14350	-	14350

grown in open space (Maheswarappa *et al.*, 2000). Basavaraju *et al.* (2011) observed that intercropping of coconut and lemon grass recorded significantly higher coconut equivalent yield (28016 nut ha^{-1}) followed by coconut and arrowroot (25725 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.

Sujatha *et al.* (2009) reported that shatavari produced fresh root yield of 14.3 t ha^{-1} of arecanut garden and contributed maximum kernel equivalent yield (2045 kg ha^{-1}). Further, aromatic plants like lemongrass, pachouli, davana, palmarosa and basil performed better with chali equivalent varying between 406 kg ha^{-1} with basil to 1286 kg ha^{-1} with lemon grass as intercrops.

C) Effect of intercropping on quality parameters of medicinal and aromatic plants

The effect of intercropping on the quality parameters was analysed for sole as well as intercropping (Table 3). Shatavarin and saponins in shatavari, alkaloid in adulasa, citranol in citronella and sugar in arrowroot was higher when grown as intercropping whereas citral in lemon grass slightly reduced with intercropping. Similar results was reported by Maheswarappa *et al.* (2000) that growing of arrowroot as an intercrop had recorded higher starch content and crude protein content compared to the arrowroot grown in open space. Further, Channabasappa *et al.* (2007) reported that essential oil content in citronella and lemon grass increased under shade of trees. Basavaraju *et al.* (2011) observed increased essential oil content in citronella and lemon grass under coconut.

Table 3. Quality of medicinal and aromatic plants as sole crop and as intercrop in coconut garden

Name of the crop	Quality particulars	Sole crop	Intercrops
Shatavari	Shatavarin,	0.61 mg ml^{-1}	0.85 mg ml^{-1}
	Saponins	0.37 Rf value	0.45 Rf value
Adulasa	Alkaloid	2.94 mg ml^{-1}	6.56 mg ml^{-1}
Arrowroot	Sugar	0.67 mg ml^{-1}	0.72 mg ml^{-1}
Lemon grass	Citral	0.16 mg ml^{-1}	0.14 mg ml^{-1}
Citronella	Citranol	7.18 mg ml^{-1}	14.18 mg ml^{-1}

D) Economics of intercropping

The data presented in Table 4 regarding economics of coconut based intercropping system revealed that the highest net return per ha was recorded under coconut and lemon grass model (Rs. 96,200/-), followed by coconut and arrowroot (Rs. 93,200/-), coconut and shatavari (Rs. 83,300/-), coconut and adulasa (Rs. 78,300/-) and coconut and citronella (Rs. 73,800/-). The B:C ratio was maximum from model coconut and lemon grass (2.13), followed by coconut and arrowroot (2.10), coconut and shatavari (2.09), coconut and adulasa (1.96) and coconut and citronella (1.75) whereas in coconut monocrop it was 1.73 only.

Maheswarappa *et al.* (1997) reported similar results that intercropping kacholam and arrowroot in coconut garden resulted in additional income and employment without affecting coconut growth and yield. Ghosh *et al.* (2007) also reported similar economic advantage as of intercropping system of coconut with arrowroot, brahmi, batch and sarpagandha. Basavaraju *et al.* (2011) obtained similar beneficial results from coconut based cropping system with lemongrass, garden rue, tulsi, kalmegh, arrowroot and makoi. Sujatha *et al.* (2009) reported that the net return accurred by intercropping

Table 4. Economics of medicinal and aromatic plants as intercrops in coconut garden

Treatment	Yield		Gross Return (Rs. ha^{-1})	Cost of cultivation (Rs. ha^{-1})	Net Return (Rs ha^{-1})	Net Return of intercrops (Rs. ha^{-1})	B:C Ratio
	Coconut (nuts ha^{-1})	Inter crops (t ha^{-1})					
Coconut and shatavari	17325	0.8	170600/-	75000/-	83300/-	17000/-	2.09
Coconut and adulasa	15225	2.1	159600/-	81300/-	78300/-	19300/-	1.96
Coconut and arrowroot	16275	16	178200/-	84800/-	93200/-	33000/-	2.10
Coconut and lemon grass	14875	31	181000/-	84800/-	96200/-	43500/-	2.13
Coconut and citronella	14700	22	150600/-	84800/-	73800/-	14800/-	1.75
Coconut	14350	-	114800/-	66300/-	48500/-	-	1.73

1) Coconut : Rs. 8 per nut 2) Shatavari: Rs. 35/- per kg 3) Adulasa: Rs. 18/- per kg

4) Arrowroot: Rs. 3/- per kg 5) Lemon grass :Rs. 2/- per kg 6) Citronella: Rs. 1.5/- per kg

of shatavari per ha of arecanut plantation was the highest (Rs. 80,000/-) and aromatic plants like lemon grass, pachouli, davana and plamarosa were found highly profitable with net returns of Rs. 22,700 to Rs. 58,387 per hectare of arecanut plantation.

Considering the performance of different medicinal crops as an intercrop and market demand, the arrowroot, lemongrass, shatavari, adulasa and citronella can be recommended as intercrops in coconut plantation for Konkan region of Maharashtra.

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