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Crop diversification in black pepper gardens with tuber and fodder crops

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Abstract

With an objective to augment the income from black pepper plantation by intercropping tuber and fodder crops, a field experiment was conducted in RBD at Ambalavayal (Kerala) for two years 2007 to 2009. Based on yield performance , tuber crops such as cassava, elephant foot yam , coleus, and spices like ginger and turmeric, and fodder crops *viz*. hybrid napier grass, guinea grass, congo signal grass were selected as treatments apart from a control (sole crop of black pepper). The results indicated that higher black pepper yield was obtained under intercropping situation compared to sole crop. The maximum black pepper equivalent yield (1,147 kg/ha) was recorded by elephant foot yam followed by ginger (956 kg/ha). In the case of fodder crops, maximum pepper equivalent yield was recorded by hybrid napier grass Co 3 (2,633 kg/ha) followed by guinea grass (2,347 kg/ha). Maximum net return of ₹ 2, 70, 230/ ha was obtained from black pepper + elephant foot yam followed by black pepper + ginger (₹ 2, 60,657/ ha). Among the fodder crops, hybrid napier grass recorded maximum net return (₹ 2, 05,950/ ha) followed by guinea grass. Benefit: cost ratio was higher for inter cropping hybrid napier grass (3.7) followed by ginger (3.5) and elephant foot yam (3.4) in black pepper gardens.

Keywords: Black pepper, economics, equivalent yield, inter cropping.

Introduction

Black pepper (*Piper nigrum* L.), popularly known as King of spices, is one of the important foreign exchange earners for the country. India is one of the major producers of the crop and contributes about 25 % to 40 % of total world production and it occupies unique position in the international spice trade. However, our productivity is very low (281 kg/ ha). Black pepper holdings being small, the income derived from such small holdings is not sufficient to sustain the farm family. Cultivation of crops such as elephant foot yam, ginger and turmeric in coconut gardens is a profitable proposition (Manjunath *et al.*, 2002., Girijadevi and Nair 2003 and Subramanian *et al*., 2007). Crop diversification in black pepper garden is essential for higher returns. Intercropping is a strategy for maximizing land use and it provides more employment opportunities as the number of crops grown per year is increased. Black pepper is usually planted at a spacing of 3 x 3 m. The available inter space and resources can be effectively utilized for growing an array of crops.

One of the major components in dairy farming is the provision of green roughage year round along with dry roughage and concentrates depending upon the milking capacity of dairy animals. Nowadays farmers undertake intensive dairying for want of graze land. In this context, it is very essential for the farmer to utilize the available space for fodder production too. Studies conducted at Indian Institute of Spices Research (IISR), Calicut showed that growing Congo signal grass (*Brachiaria muziziensis*) in the inter space of pepper garden and manuring with NPK fertilizers @ 50 kg/ ha increased organic matter status, physico- chemical properties and soil fertility, besides increasing yield of black pepper (Sadanandan, 2000). Ginger was found the most profitable inter crop in pepper gardens (Sadanandan, 2000) and suitable for growing under shade. There was no adverse effect on the yield of black pepper when grown as mixed crop in bearing arecanut and raising elephant foot yam as intercrop (Sadanandan, 2000). Girijadevi and Wahab (2000) reported that elephant foot yam could be raised under 25% shade in coconut garden without

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reduction in corm yield. Black pepper roots extend up to about 90 cm from the base and effective root zone of black pepper was reported to be 30 cm radius (Sankar *et al*., 1988). Therefore, the scope exists for intercropping in black pepper plantation. However, not much work has been done on this aspect. Hence, an investigation was undertaken to assess the feasibility of raising tuber and fodder crops to maximize productivity and return per unit area.

Materials and Methods

Field experiments were conducted for two years (2007-2009) in grown up bearing black pepper garden (aged more than 15 years) at Regional Agricultural Research Station (RARS) Ambalavayal, Wayanad. The station lies between 11° 26' and 11° 59' N latitudes and 76° 26' and 75° 46' E longitudes. It is situated at an altitude of 974 M above msl and enjoys a mild sub-tropical climate. The station receives an annual rainfall of around 3000 mm, maximum and minimum temperatures of 36 °C and 21 °C, respectively. The soil of experimental site was forest loam with a pH of 4.6, available N 189 ppm, available P 0.20 ppm and available K 221 ppm, respectively.

Inter crops such as cassava (SreeJaya), elephant foot yam (Gajendra), ginger (Varada), turmeric (Prathiba), coleus (Nidhi), congo signal grass, guinea grass and hybrid napier grass (Co 3) along with a sole crop of black pepper (Panniyur 1) as control were the treatments laid out in RBD with three replications. Recommended package of practices of Kerala Agricultural University KAU (2002) was followed for these crops. The intercrops were planted during April-July in the interspaces of four black pepper plants. The silver oak was the standard for black pepper spaced at 3 x 3 m. A uniform dose of FYM @10 kg/plant along with NPK 140: 55: 270 g/plant were given in two splits to black pepper plants. The schedule followed for cultivation of different crops is given in Table1.

Pruning of standard was done twice, during April and September. Soil samples were collected after the experiment and soil nutrient status was estimated by standard procedures. Available N was determined by Kjeldahl method (Subbiah and Asija 1956), P by Bray method (Bray and Kurtz, 1945) and K by Atomic Absorption Spectro photometer (Hesse, 1994). Availability of solar radiation received in the garden was measured using portable photosynthesis system (LCA 4). Solar radiation received in open condition varied between 1800-1900 micro moles. In medium shaded conditions, solar radiation varied between 500-700 micro moles and this area was selected for intercropping study.

The economic produce was harvested as and when ready and the yields were recorded. Intercrop yield were converted to black pepper equivalent yield in order to test for statistical significance. Land equivalent ratio was found out using the formula mentioned by Mead and Willey (1980). The cost of cultivation and economics was worked out based on prevailing market rates (Table1). Benefit cost ratio was calculated by dividing gross income by cost of cultivation. Data was statistically analyzed for variance by the procedure given by Panse and Sukhatme (1985).

Results and Discussion

Yield of main crop

Intercropping tuber and fodder crops in pepper gardens influenced black pepper yield considerably. The mean yield of main crop (black pepper) for two years (2007-08 and 2008-09) ranged between 1,867 and 2,275 kg/ ha (Table 2). The maximum black pepper yield of 2,275 kg/ ha was obtained when elephant foot yam was intercropped. This was followed by turmeric (2,260 kg/ha), ginger (2,159 kg /ha), cassava (2,022 kg /ha) and coleus (1,867 kg /ha). However, it was higher than that of sole crop. Intercropping elephant foot yam and turmeric increased black pepper yield by 41 % and 40 %,

Table 1. Agro techniques for tuber and fodder crops in black pepper gardens

Crops	Spacing (cm)	Variety	Planting material	Crop duration (months)	Price of economic produce (₹/kg)
Tapioca	90x90	SreeJaya	Stem cuttings	7	9.0
Elephantfootyam	90x90	Gajendra	Corms	9	13.0
Coleus	30x30	Nidhi	Stem cuttings	6	20.0
Greater yam	90x90	Sree Keerthi	corms	8	8.0
Ginger	25x25	Varada	Rhizome	8	14.0
Turmeric	25x25	Prathiba	Rhizome	8	12.0
Hybrid napier	50x50	Co3	Slips	3	1.0
Congo signal	40x20	Local	Slips	3	1.0
Guinea grass	40x20	Local	Slips	3	1.0
Black pepper	3x3	Panniyur1	Rooted cuttings	>15 years	102

Table 2. Economics of inter cropping crops in black pepper gardens of more than 15 years old

Crops	Pooled Mean black pepper yield (kg/ha)	Pooled Mean intercrop yield (kg/ha)	Black pepper equivalent yield	Gross income (₹) and LER	Cost of cultivation (₹/ha)	Net income (₹/ha)	B:C ratio
BP+ cassava	2,022	3,600	317	2,38,644 1.56	77,000	1,61,644	2.1
BP+elephant foot yam	2,275	9,000	1,147	3,49,050 1.70	78,820	2,70,230	3.4
BP+ coleus	1,867	2,760	541	2,45,634 1.28	72,000	1,73,634	2.4
BP+ ginger	2,159	6,970	956	3,17,798 1.68	69,483	2,60,657	3.5
BP+turmeric	2,260	8,016	943	2,98,640 1.50	78,893	2,11,485	2.8
BP+hybrid napier	1,900	67,150	658	2,60,950 2.10	55,000	2,05,950	3.7
BP+congo signal grass	2,010	26,016	255.1	2,31,036 1.64	55,000	1,76,036	3.2
BP+guinea grass	2,090	29,413	288.4	2,42,593 1.70	55,000	1,87,593	3.4
Black pepper	1,616	-	-	1,64,832 -	40,000	1,24,832	3.1
CD (P=0.05)	18.1	-	0.22	-	-	-	-

BP= Black pepper

respectively over control. Higher main crop yield of 2,090 kg/ ha was recorded when pepper was intercropped with guinea grass compared to other fodder grass. Similar results of increased main crop yield due to intercropping was reported in coconut (Girija devi and Nair 2003) and arecanut (Sujatha *et al.*, 2006.) Performance of guinea grass was also good in black pepper gardens. Jayashree and Suneetha (2006) reported profitable cultivation of guinea grass in arecanut and coconut gardens. Better utilization of nutrients under congenial microclimate involving weed free condition might have resulted in increased growth and yield of black pepper. Nayar and Suja (2004) reported no yield reduction in the main crop when the base crop and intercrops were adequately fertilized.

Yield of inter crops

Among inter crops, elephant foot yam (9,000 kg) and turmeric (8,016 kg) produced higher yield. Hybrid napier yielded the maximum fodder yield (67,150 kg), which was significantly higher than the yield of guinea grass and congo signal grass. Regarding black pepper equivalent yield (PEY), elephant foot yam produced maximum yield (1,147 kg) followed by ginger (956 kg). The better performance may be due to congenial microclimate prevailing in the black pepper garden, better utilization of natural resources like light (medium shade), space, nutrients etc. than that of sole crop of black pepper. Work done at CPCRI also showed that ginger and elephant foot yam were profitable intercrops in arecanut gardens (Sadanandan, 1974). Hardy (1958) attributed the better performance of the crops under shade to the presence of threshold illumination intensity beyond which the stomata of shade loving plant tend to close. Better performance of ginger in shaded condition due to better nutrient uptake and higher photosynthetic rate was reported earlier (Ajithkumar *et al.*, 2002). Cultivation of intercrops far away from the effective root zone of black pepper also helped to avoid competition for nutrients. Earlier reports indicate that yield of black pepper was not adversely affected when grown as intercrop. Suitability of elephant foot yam for inter cropping in arecanut gardens has been reported (Sadanandan, 2000).

Among grasses hybrid napier grass, Co 3 produced significantly higher black pepper equivalent yield (658 kg). Successful cultivation of fodder grass in coconut garden was reported (Subramanian *et al.*, 2007). Manjunath *et al.* (2002) reported that hybrid napier had higher drymatter content than guinea grass when raised as intercrop in coconut garden. Successful cultivation of guinea grass in coconut and arecanut gardens was reported (Jayasree and Suneetha, 2006). Mixed cropping was more efficient and productive than sole cropping because of higher combined yield (calories and protein) and better energy use efficiency (Willey, 1979). In all the treatment combinations, LER was greater than unity which demonstrated the yield advantage for inter cropped plots. In particular hybrid napier gave the highest LER of 2.1, implying that 210 % more land would be required as sole crops to produce the yield obtained under intercropping situations.

Economic feasibility

The net income was the highest in the crop combination of black pepper + elephant foot yam (₹ 2, 70, 230/ ha) followed by black pepper + ginger (₹ 2,05, 950 /ha (Table 3). This could be due to higher black pepper equivalent yield and better price for the produce. The variation in net return was due to the variation in the cost of cultivation of different crops and market value of inter crops.

Table 3. Nutrient status of black pepper gardens of more than 15 years intercropped with tuber and fodder crops

Crop	pH	N	P	K
			(kg/ha)	
BP+cassava	4.9	402	2.6	580
BP+elephant foot yam	4.6	302	2.6	553
BP+coleus	4.6	388	2.4	542
BP+ginger	4.8	378	2.2	378
BP+turmeric	4.6	342	2.4	354
BP+hybrid napier	4.8	292	2.2	532
BP+ congosignal	4.8	382	2.6	762
BP+ guinea grass	4.6	298	2.4	420
Black pepper	4.7	298	2.4	422
CD(P=0.05)	0.18	0.76	NS	3.77

BP= Black pepper
NS=Not significant

Studies conducted by Girijadevi and Nair (2003) indicated that the net income was maximum in the crop combination of coconut + banana + elephant foot yam. Sairam *et al.* (1997) obtained higher net income from ginger when grown as inter crop in coconut gardens. The present findings are in agreement with that of Ghosh (2008). Among the fodder crops, black pepper + hybrid napier recorded maximum (₹ 2,05,950) followed by black pepper + guinea grass (₹ 1,87,593). All the fodder crops had B:C ratio more than 1, which indicated suitability of grasses for intercropping in black pepper garden. With regard to benefit-cost ratio, hybrid napier grass recorded maximum (3.7) followed by ginger (3.5) and elephant foot yam (3.4). Sadanandan (2000) reported increased yield and improvement of physico- chemical properties of soil by growing congo signal grass in black pepper gardens. Ginger had maximum B:C ratio followed by elephant foot yam. This result is in close conformity with the findings of Sairam *et al.* (1997) and Girijadevi and Wahab (2007).

Soil nutrient status

Intercropping influenced the soil nutrient status. In general, N content in intercropped plots was significantly higher than sole crop of black pepper. Maximum N content was observed in black pepper + cassava crop combination followed by black pepper +coleus. The lowest N content was observed in black pepper inter cropped with hybrid napier grass. Intercropped plots had significantly higher K content than sole crop of black pepper, except in the case of turmeric, ginger and guinea grass. Maximum K content was observed in the crop combination black pepper + congo signal grass followed by black pepper + cassava.

Income obtained from cassava and coleus was less compared to other inter crops. Higher N and K content in soil observed in these combinations might be due to the less absorption of nutrients in shaded situation which might have resulted in poor photosynthesis, translocation and bulking of tubers. Earlier reports indicate the sun loving nature of cassava, delay in tuberization and poor yield under shade (Ramanujam *et al.*, 1984). As the income obtained from black pepper garden is high, these combinations were also found to be profitable.

The present investigation showed that intercropping in black pepper gardens enhanced the black pepper yield and generated additional income than sole black pepper. Crops such as elephant foot yam (Gajendra), ginger (Varada), turmeric (Prathiba), hybrid napier grass (Co 3), guinea grass and congo signal grass are suited for intercropping in black pepper gardens. However, it was also realized that better returns were obtained from elephant foot yam, ginger and hybrid napier grass grown in black pepper gardens.

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