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Performance of different varieties and hybrids of black pepper (*Piper nigrum* L.) as mixed crop in arecanut garden of Assam, India

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ABSTRACT

A field experiment was conducted at Horticultural Research Station, Assam Agricultural University, Kahikuchi, Guwahati during 2009 to 2016 for evaluation of the performance of black pepper varieties/hybrids grown as mixed crop in 16 years old block of arecanut garden (Variety-Kahikuchi Local). Varieties such as, Panniyur-2, , Panniyur-4, Panniyur-5, Sreekara, Subhakara, Panchami, Pournami, PLD-2, Chumala, Karimunda and hybrids such as Panniyur-1 and Panniyur-3 were grown in three replications. Among the varieties /hybrids, Karimunda, Panniyur-5, Sreekara, Subhakara and Panchami produced higher number of laterals with more spread at six years age compared to the other varieties. Panniyur-5 recorded significantly higher number of spikes (210.3) followed by Karimunda (186.2); whereas the lowest was recorded in Panniyur-2 (62.8). The spike length was the highest in Panniyur-1 (16.4 cm), but was on par with Panniyur-1 and Subhakara. Sreekara recorded the lowest spike length of 10.2 cm. Three years mean dry berry yield indicated that , the yield was significantly higher with Panniyur-5 (1.25 kg/vine) followed by Panniyur-1 (1.15 kg/vine) and Subhakara (1.12 kg/vine) which differed significantly over the other varieties. Variety PLD-2 recorded higher oleoresin content (13.84%) and was on par with Panchami and Pournami. Piperine content was the highest in Panniyur-2 (4.65%) followed by Panniyur-1 (4.26%). Due to the mixed cropping of black pepper in arecanut garden, an improvement in the arecanut yield was observed (2.21 kg chali/ palm/year) during 2015-16 compared to the arecanut monocrop (1.96 kg chali/palm/year) during 2009-2010.

Key words: Arecanut, Black pepper varieties, Chali, Mixed crop, Quality, Yield.

INTRODUCTION

Arecanut (*Areca catechu*) is a traditionally important plantation crop of India and is the source of arecanut commonly referred to as betelnut or supari. Arecanut industry forms the economic backbone of nearly ten million people in India and for many of them it is a sole means of livelihood. It is a crop of small and marginal farmers in the major arecanut growing states of Karnataka, Kerala and Assam (Thomas and Balasimha, 2011) Arecanut contributes substantially to the Gross National Product as the palm is cultivated in India in 4,50,000 ha with a production of 7,46,000 tonnes during 2014-15 (Vinayak,2016). In Assam and West Bengal, arecanut is used as an important commodity in religious ceremonies and chewing (Murthy, 1968). Arecanut as a sole crop does not utilize the natural resources like soil, space and light fully. The compact nature of arecanut crown, and erect growth raised well above the ground (10-15m), allows more sunlight to pass down to ground and maintain high humidity which, in turn, favour excellent growth of shade loving crops (Thomas and Balasimha, 2011). Studies at Central Plantation Crop Research have revealed that orientation and structure of arecanut canopy permits 32.7-47.8 % incident radiation to penetrate down depending on the time of day (Muralidharan, 1980). Normally in an arecanut garden spaced at 2.75 m x 2.75 m, the light energy reaches the ground and is wasted. Rooting pattern revealed that arecanut palms planted at 2.75 m x 2.75 m spacing could use effectively only 30% of the land area (Shama Bhat and Leela, 1969). The normal cultural operations are also confined within about 75-80 cm radius from the base. Thus, the areca palm exploit only 2.27 m^2 of land area (r=0.85 m) out of 7.29 m^2 (2.75 m x 2.75 m) land available to each palm. So, growing only one crop as mixed crop in a arecanut garden would not maximize the resource use and this has led to the concept of high-density multispecies cropping system, where more than one crop is grown as mixed crops (Bavappa *et al.*, 1986). Thus, arecanut offers excellent opportunities for inclusion of compatible component crops for effective utilization of natural resources for increasing productivity and maximizing returns per unit area. In humid tropics, higher efficiency of utilization of the basic resources of crop production *viz.* land, solar radiation and water can be achieved by adopting intensive cropping system *(*Nelliat, 1973).

Black pepper (*Piper nigrum* L.) is one of the major export earners among the various crops grown in India. This crop is raised exclusively as mixed crop in homestead garden

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in Kerala and Karanataka, wherein, vines are trained on coconut and arecanut trunks. The review of work done on mixed cropping of black pepper with coconut and arecanut plantation in different agro-climatic zones of the country has established its suitability as a remunerative crop in various cropping models (Reddy and Thomas, 2001).Black pepper is an excellent crop for mix cropping with arecanut and high economic return can be expected (Abraham, 1974; Nair, 1982; Nayar, 1982). While evaluating the performance of six varieties of black pepper in the multi-storeyed cropping system, Potty *et al*. (1979) suggested that Karimunda and Panniyur-1 varieties performed better under mixed cropping.

Though, many black pepper varieties/ hybrids have been released in the country in recent past, assessment of their performance in terms of yield, and quality when grown as mixed crop in arecanut garden is meagre. Hence, a field experiment was undertaken at Horticultural Research Station, Assam Agricultural University, Kahikuchi, Guwahati to evaluate the performance of different black pepper varieties/ hybrids as mixed crop in arecanut garden under rainfed condition of Assam.

MATERIALS AND METHODS

The experiment was conducted at Horticultural Research Station, Assam Agricultural University, Kahikuchi, Guwahati which is situated at 26.3^{0}N latitude and 91.7^{0}E longitude at an elevation of 64.0 m above MSL. During the study period (2010 to 2016), the experimental area received an average annual rainfall of 1450.45 mm and expected mean maximum temperature ranging between 33.4 and 34.3^{0}C and mean minimum temperature ranging between 12.2 and 13.6^{0}C. The soil of the experimental site was mainly alluvial clay with the pH ranging between 4.4 and 5.5. The available N, P, K was found to be low. The study was conducted with Kahikuchi Local variety of arecanut planted during 1998 spaced at 2.75 m x 2.75 m.

Different black pepper varieties/ hybrids such as Panniyur-1, Panniyur-2, Panniyur-3, Panniyur-4, Panniyur-5, Sreekara, Subhakara, Panchami, Pournami, PLD-2, Chumala and Karimunda were grown with three replications in a RBD with the plot size of four black pepper vines on individual arecanut palm per treatment. The rooted cuttings were planted 60 cm away from the bole of the arecanut in North –East direction during April-May, 2010. The recommended package of practices as per CPCRI, Regional Centre, Kahikuchi was followed for black pepper, whereby 100:40:140 g NPK per vine was applied in two splits (½ during April-May and ½ during Sept-October months. The arecanut palms were fertilized with 100:40:140 g NPK per palm per year in two equal doses during the same months as in case of black pepper. Integrated disease management approach involving application of fungicides (Ridomil @ 2 g in one litre of water during May and bio agent (*Trichoderma viride*) blended with neem cake during Sept. - Oct. Months was practiced to manage the wilt disease of black pepper. Though the crops were grown rainfed, basin irrigation during the month of January, February and March was done to escape extreme drought. Mulching was practiced using split banana pseudo stem.

Observation on growth characters were carried out during September 2014, 2015 and yield attributing characters were recorded from all the vines during January 2015 and 2016. The number of laterals and number of spikes were recorded in one meter column height at one meter above the ground. The harvested spikes were heaped, threshed, boiled for 7 minutes in boiling water and dried under sun for 6-7 days and dry weight was taken as yield per vine. Quality parameters such as oleoresin was estimated by ASTA (1968) method, while piperine was estimated by HPLC method (Wood *et al.*,1988). Individual arecanut yield was recorded in the month of April and nut yield obtained in the year 2010 was taken as pre- treatment yield, 2011 to 2013 was taken as transition period and that of 2014 to 2016 was considered as post treatment yield. Economic analysis was carried out based on the prices of input and output prevailed during the period of study. The establishment cost for black pepper was considered for the first three years after planting along with variable cost for arecanut and fourth year onwards, the variable cost involved for arecanut together with black pepper was considered to work out the cost of production. Average market price for arecanut (Chali) @ Rs. 200/- per kg and black pepper @Rs.300/- per kg of dry pepper during the experimental period was considered to work out gross return.

RESULTS AND DISCUSSION

Performance of black pepper

Growth characters: Among the different varieties/hybrids of pepper evaluated, in general, the incidence of wilt disease was observed in Panchami, Sreekara, Panniyur-2 and Panniyur-3. With regards to growth characters recorded at five years age, Karimunda and Subhakara had recorded significantly higher number of laterals (32.8 and 31.2 at one m column, respectively) and the spread of vine in North-South and East- West direction was also higher compared to other varieties (Table 1). Other varieties *viz.*, Panniyur-5, Panchami and Sreekara also [produced higher number of laterals and their spread also higher. Panniyur-2 and Panniyur-3 recorded significantly lower growth characters. All the varieties/ hybrids started flowering from third year of planting.

Yield attributing characters: The mean yield attributing characters recorded at maturity of the berries during January-February, 2015 and 2016 are presented in Table 2. Among the varieties/hybrids, Panniyur -5 recorded significantly higher number of spikes/plant (210.3 in one m column height) and was on par with Karimunda (186.2) and Pournami (170.4) compared to other varieties/hybrids. The number of

Table 1: Growth parameters of different varieties/hybrids of black pepper at six years of planting

Varieties/ Hybrids	Plant Spread (m) N-S	E-W	No. of laterals in one column
Panniyur-1	0.87	0.90	25.6
Panniyur-2	0.79	0.78	19.4
Panniyur-3	0.73	0.87	20.7
Panniyur-4	0.83	0.81	27.5
Panniyur-5	0.94	0.90	29.8
Sreekara	0.92	0.97	28.3
Subhakara	0.98	1.06	31.2
Panchami	0.89	0.92	29.6
Pournami	0.87	0.90	27.7
PLD-2	0.76	0.87	23.1
Chumala	0.84	0.89	27.9
Karimunda	0.89	0.96	32.8
CD (P=0.05)	0.04	0.06	2.01

N-S: North-South, E-W: East-West

spikes/ plant was significantly lowest in Panniyur-2 (62.8).

The spike length was the highest in Panniyur-1 (16.4 cm) and was on par with Panniyur-5 and PLD-2. The spike length was the lowest in Sreekara (10.2 cm) and was on par with Karimunda and Pournami (10.4 cm)

The number of berries per spike was significantly higher in Panniyur-5 (84.6) and was on par with Panniyur-1 (82.3), Panniyur-2 (79.5) and Panchami (76.8).The lowest number of berries per spike was recorded in Sreekara (42.1) and Subhakara (55.6) varieties (Table 2).

Yield of black pepper: Data on average dry berry yield for last three years indicated that Panniyur-5 had recorded significantly higher yield (1.25 kg/vine) compared to other varieties (Table 3) which was mainly attributed to higher number of laterals per plant. This was followed by Panniyur-1(1.15 kg/vine), Subhakara (1.12 kg/vine) and Karimunda (0.98 kg/vine) and differed significantly over other varieties. PLD-2 and Chumala gave significantly lower dry berry yield which was 0.52 kg/vine and 0.55 kg/vine, respectively.

Evaluation of black pepper varieties carried out by earlier workers (Potty *et al.*, 1979; Mathew *et al*., 1993) in the multi storeyed cropping system and mixed cropping system indicated better performance of Karimunda and Panniyur -1 varieties. Sadanandan *et al.* (1993) reported the superior performance of Panniyur-1 variety compared to other varieties in farmer's field. Maheswarappa *et al*. (2012) also reported similar result where he obtained superior performance of Thevam and Panniyur-5 to other varieties in the mixed cropping system of coconut at CPCRI, Kasaragod, Kerala. Ray *et al.* (2011) had recorded maximum dry pepper yield of 3.08 kg per plant under arecanut based mixed cropping system in their experimental field at CPCRI, Regional Centre, Kahikuchi.

Qualitative characters: Variety PLD-2 recorded higher oleoresin content (13.84%) and was on par with Panchami and Pournami (Table 4). The piperine content was found higher in Panniyur-2 (4.67%) which was on par with Panniyur-1 (4.26%). The piperine content did not differ significantly among the other pepper varieties/hybrids and was found to range between 3.18 to 3.98%.

Yield of arecanut: Arecanut yield recorded during the experimental period indicated no significant difference among the treatments. However, there was an improvement in the nut yield (chali) compared to pre- experimental yield under all the treatments (Table 5). The general mean yield of arecanut (chali) per plant during 2015-16 was 2.21 kg/ plant/year compared to the pre-experimental yield of 1.96 kg/plant/year (2009-2010).Three years mean yield of arecanut also indicated improvement in the yield of arecanut (2.22 kg/plant/year) compared with pre-experimental yield.. This clearly indicates positive influence of mixed cropping of black pepper in arecanut garden. Nayar (1982) had also reported increase in yield of arecanut in a three crop cycle to an extent of 12.4 kg ripe nut/palm to 12.7 kg /palm. Under

Table 2: Yield attributing characters of different varieties/hybrids of black pepper

Varieties/Hybrids	No. of spikes (in one m column height)	Length of spike(cm)	No. of berries/spike
Panniyur-1	132.5	16.4	82.3
Panniyur-2	62.8	13.9	79.5
Panniyur-3	70.4	11.8	75.4
Panniyur-4	90.5	13.2	69.8
Panniyur-5	210.3	15.3	84.6
Sreekara	79.6	10.2	42.1
Subhakara	89.8	11.4	55.6
Panchami	156.3	12.2	76.8
Pournami	170.4	10.4	58.3
PLD-2	80.7	15.9	65.2
Chumala	79.5	11.8	62.9
Karimunda	186.2	10.4	59.3
CD (P=0.05)	47.9	2.1	16.3

Table 3: Dry yield of different varieties/hybrids of black pepper as mixed crop in arecanut garden (Average of three years)

Varieties/Hybrids	Dry berry yield (kg/vine)
Panniyur-1	1.15
Panniyur-2	0.55
Panniyur-3	0.60
Panniyur-4	0.75
Panniyur-5	1.25
Sreekara	0.70
Subhakara	1.12
Panchami	0.75
Pournami	0.85
PLD-2	0.52
Chumala	0.55
Karimunda	0.98
CD (P=0.05)	0.16

Table 4: Chemical constituent of different varieties/hybrids of black pepper as mixed crop in arecanut garden

Varieties/Hybrids	Oleoresin content (%)	Piperine content (%)
Panniyur-1	11.54	4.26
Panniyur-2	9.16	4.67
Panniyur-3	8.92	3.18
Panniyur-4	9.83	3.63
Panniyur-5	10.57	3.98
Sreekara	9.48	3.67
Subhakara	10.24	3.54
Panchami	12.36	3.98
Pournami	12.27	3.75
PLD-2	13.84	2.67
Chumala	9.43	3.42
Karimunda	10.82	3.78
CD (P=0.05)	1.68	0.13

Table 5: Arecanut chali (dried nut) yield as influenced by mixed cropping of black pepper (Kg/plant)

Varieties/Hybrids	2009-2010 (Initial yield)	2013-14	2014-15	2015-16	Mean
Panniyur-1	1.85	2.15	2.25	2.35	2.25
Panniyur-2	1.94	2.25	2.20	2.10	2.18
Panniyur-3	2.10	2.35	2.30	2.25	2.30
Panniyur-4	2.05	2.10	2.20	2.10	2.13
Panniyur-5	1.97	2.15	2.10	2.20	2.15
Sreekara	1.85	2.10	2.15	2.25	2.16
Subhakara	2.10	2.50	2.40	2.35	2.41
Panchami	2.20	2.35	2.55	2.25	2.38
Pournami	2.15	2.45	2.15	2.25	2.28
PLD-2	1.90	2.15	2.10	2.10	2.11
Chumala	1.85	2.10	2.15	2.00	2.08
Karimunda	1.65	2.20	2.10	2.35	2.22
F test	NS	NS	NS	Ns	NS
Overall Mean	1.96	2.23	2.22	2.21	2.22

NS- Not significant

high density multi storeyed cropping system, black pepper provided additional yield and there was improvement in the yield of arecanut as reported earlier (Abraham, 1974; Nair, 1982; Ray *et al*., 2011).

Economic analysis of arecanut + black pepper mixed cropping system: Data on cost of production, gross return and net return is presented in Table 6. The cost of production for arecanut + black pepper system from fourth year onward

Table 6: Economic analysis of arecanut together with black pepper mixed cropping (Rs./ha/year)

Varieties/Hybrids	Cost of production (Mean of 2013-1016)	Gross return (Mean of three years)	Net return (Mean of three years)
Panniyur-1	2,46,750.00	8, 54,500.00	6,07,750.00
Panniyur-2	2,46,200.00	7,09,500.00	4,63,300.00
Panniyur-3	2,43,700.00	7,00,750.00	4,57,050.00
Panniyur-4	2,45,000.00	7,80,600.00	5,35,600.00
Panniyur-5	2,46,100.00	8,56,800.00	6,10,700.00
Sreekara	2,44,100.00	7,40,800.00	4,96,700.00
Subhakara	2,46,500.00	8,52,300.00	6,05,800.00
Panchami	2,44,900.00	7,04,300.00	4,59,400.00
Pournami	2,43,500.00	8,50,100.00	6,06,600.00
PLD-2	2,44,800.00	6,81,100.00	4,36,300.00
Chumala	2,45,200.00	6,70,850.00	4,25,650.00
Karimunda	2,43,750.00	8,50,700.00	6,06,950.00

was Rs. 2,46,750.00 to 2,43,500.00 per ha. The net return was the highest under arecanut + black pepper, variety Panniyur-5 (Rs. 6,10,700/-) followed by Panniyur-1 (Rs. 6,07,750/-) , Karimunda (Rs. 6,06,950/-), Pournami (Rs. 6,06,600/-) and Subhakara (Rs. 6,05,800/-). The lowest net return was recorded in Chumala (Rs. 4, 25, 650/-) and PLD-2 (Rs. 4,36,300/-) owing to their low berry yield. Under coconut based high density multi species cropping system, black pepper provided additional income when grown as mixed crop in coconut under Kasaragod conditionas reported by Maheswarappa *et al.* (2012), Palaniswami *et al.* (2007) and Krishnakumar *et al.* (2010). Similar result was also obtained in arecanut mixed cropping with black pepper in North East Indian condition by Ray *et al.* (2011).

CONCLUSION

Intercropping or mixed cropping is an important means of additional income generation. The present study concluded that under Assam condition, mixed cropping of black pepper with Panniyur-1, Panniyur-5, Subhakara, Pournami and Karimunda can be recommended for growing in arecanut garden. In addition, arecanut together with black pepper mixed cropping resulted in increase in productivity of arecanut and thus increase profitability of the system over a period of time.

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