



# Performance of different varieties/hybrids of black pepper (*Piper nigrum* L.) as mixed crop in coconut garden

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## Abstract

A field experiment was conducted at Central Plantation Crops Research Institute, Kasaragod during 2001 to 2010 for studying the performance of black pepper varieties/hybrids when grown as mixed crop in 36 years old WCT coconut garden. Varieties such as Panniyur-1, Panniyur-2, Panniyur-3, Panniyur-4, Panniyur-5, Sreekara, Subhakara, Panchami, Kottanadan, OPKM, Collection 1041(Thevam) and hybrids such as HP-780, HP-105, HP-1411, HP-813 and HP-34 were grown in three replications. Among the varieties, Thevam, Panniyur- 4, Panniyur- 5, Sreekara, Subhakara and Panchami produced higher number of laterals with more spread (at five years age) compared to the other varieties. Thevam recorded significantly higher number of spikes (202.5), whereas the lowest was recorded in HP 780 (21.5). The spike length was the highest in Panniyur- 5 (15.4 cm), but was on par with varieties such as Panniyur-1, Panniyur-2, HP-1411 and OPKM. Sreekara recorded the lowest spike length of 8.7 cm. Six years mean dry spike yield indicated that, the yield was significantly higher with Thevam (1.81 kg/vine) followed by Panniyur- 5, which had recorded a yield of 1.12 kg/vine and differed significantly over other varieties. Panchami recorded higher oil (5.6 %) and oleoresin content (12.6%) and was on par with Panniyur-4, Kottanadan and OPKM. Due to the mixed cropping of black pepper in coconut garden an improvement in the coconut yield was noticed (132.2 nuts/palm/yr) during 2009-10 compared to the coconut monocrop (101.3 nuts/palm/yr) during 1999 to 2001.

**Keywords:** Black pepper varieties, coconut, mixed crop, quality, yield

## Introduction

Coconut (*Cocos nucifera* L.) is a versatile crop providing food, medicine, health drink, shelter, fuel, timber and fibre. Being a small holders' crop, as a monocrop, it does not provide adequate income and gainful employment to the dependent families. Studies revealed that, adult palm of sole crop of coconut spaced at 7.5 m x 7.5 m apart effectively uses only 22.3% of land area (Kushwah *et al.*, 1973; Maheswarappa *et al.*, 2000), while the average air space utilization by the canopy is about 30 % and solar radiation interception is 45-50% (Bavappa *et al.*, 1986). Thus, coconut garden 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 utilisation of the basic resources of crop production *viz.* land, solar radiation and water can be achieved by adopting intensive cropping systems (Nelliath, 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 gardens in Kerala and Karnataka, wherein, vines are trained on coconut and arecanut trunks. The review of work done on mixed cropping of black pepper with coconut and arecanut

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plantations in different agro-climatic zones of the country has established its suitability as a remunerative crop in various cropping models (Reddy and Thomas, 2001). As early as 1971-72, Panniyur-1 variety of pepper planted as mixed crop and trailed on palms aged over 60 years in one ha plot at Central Plantation Crops Research Institute (CPCRI), Kasaragod yielded a mean of 2 kg dry pepper per vine per year (CPCRI, 1977). 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 coconut garden is meagre. Hence, a field experiment was undertaken at CPCRI, Kasaragod to evaluate the performance of different black pepper varieties/hybrids as mixed crop in coconut garden under irrigated condition.

### Materials and Methods

#### Experimental site

The experiment was undertaken at CPCRI, Kasaragod, Kerala, which is situated at 12°30' N latitude and 75°00' E longitude at an elevation of 10.7 m above MSL. During the study period (2001 to 2010), the experimental area received an average annual rainfall of 3421.7 mm, and experienced mean maximum temperature ranging between 30.5 and 31.6°C and mean minimum temperature ranging between 21.5 and 22.4°C. The soil was sandy loam with field capacity of 7.4% and 8.4% at 0-25 cm and 25-50 cm depth, respectively. The soil nutrient status was found to be low in available N and K and high in available P. The study was conducted with West Coast Tall variety of coconut palms planted during 1965 spaced at 7.5 x 7.5 m (36 years old).

Different black pepper varieties/hybrids such as Panniyur-1, Panniyur-2, Panniyur-3, Panniyur-4, Panniyur-5, Sreekara (KS14), Subhakara (KS27), Panchami, Kottanadan, HP-780, HP-105, HP-1411, HP-813 (IISR Malabar Excel), HP-34, OPKM, and Collection 1041 (Thevam) were grown as mixed

crop with three replications in a RBD with the plot size of four black pepper vines trained on individual coconut palm per treatment. The rooted cuttings were planted one meter away from the bole of coconut in North-East direction during May-June 2001 and gap filling was carried out wherever necessary during 2003 and crop stand was maintained from 2003 onwards. The recommended package of practices as per Kerala Agricultural University was followed for black pepper, whereby, 50:50:150 g of NPK per vine was applied in two splits (1/3<sup>rd</sup> during May-June and 2/3<sup>rd</sup> during Sept.-Oct.). Each coconut palm was supplied with 500:320:1200 g of NPK per palm applied in two splits, 1/3<sup>rd</sup> during May-June and 2/3<sup>rd</sup> during Sept.-Oct. months. Integrated disease management approach involving application of fungicide (Redomil @ 2 ml in one litre of water during May and bioagent (*Trichoderma viride*) blended with neem cake during Sept.-Oct. months was practiced to manage the wilt disease of black pepper. The garden was drip irrigated with 27 to 35 litres of water per palm per day during December to May and one dripper was placed near black pepper root zone for proper moisture supply. Coconut basins were mulched with coconut leaves during summer months and common dose of vermicompost was applied to coconut (20 kg/palm) and black pepper (2 kg/vine).

Observations on growth characters were carried out during January 2008 and yield attributing characters were recorded from all the vines during January 2008 and January 2009. 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 threshed and dried in open sun for four days and dry weight was taken as yield per vine. Quality parameters such as essential oil and oleoresin were estimated by ASTA (1968) method, while piperine was estimated by HPLC method (Wood *et al.*, 1988). Individual coconut palm-wise yield of nuts was collected from July to June of each agricultural year. Number of nuts obtained for the years 1999 to 2001 was taken as the pre-treatment yield, 2001 to 2003 was taken as transition period and that of 2004-05 to 2009-10 was considered as the post-treatment yield. Economic analysis of the system was carried out based on the prices of input and output prevailed during the study

period. The establishment cost for black pepper was considered for first three years after planting along with variable cost for coconut and fourth year onwards, the variable cost involved for coconut together with black pepper was considered to work out the cost of production. Average market price for coconut @ Rs.6/- per nut and Black pepper @ Rs.175/- 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 wilt disease incidence was observed in Panniyur-2, Panniyur-3, Kottanadan, OPKM, HP-34 and HP-780. With regard to growth characters recorded at five years age, Thevam had recorded significantly higher number of laterals (58 at one m column) and the spread of the vines in North–South and East–West direction was also higher compared to other varieties (Table 1). Panniyur-4 and Panniyur-5, Sreekara, Subhakara and Panchami also produced higher

**Table 1.** Growth characters of different varieties/hybrids of pepper (during January 2008)

Varieties/Hybrids	Spread (m)		No. of laterals in one m column
	N-S	E-W	
Panniyur-1	0.89	0.91	26.3
Panniyur-2	0.85	0.84	20.6
Panniyur-3	0.74	1.10	22.8
Panniyur-4	0.87	0.85	34.3
Panniyur-5	0.99	0.94	33.7
Sreekara	1.20	1.28	40.0
Subhakara	0.97	0.92	36.0
Panchami	0.95	0.98	40.0
Kottanadan	0.89	0.87	23.0
HP-780	0.76	0.93	21.0
HP-105	0.96	0.95	34.0
HP-1411	0.87	0.88	36.0
HP-813 (IISR)	1.08	1.08	38.0
Malabar Excel)			
HP-34	0.75	0.73	16.0
OPKM	0.68	0.72	27.5
Collection 1041	1.42	1.31	58.0
(Thevam)			
SEm (±)	0.03	0.04	1.27
CD (P=0.05)	0.05	0.07	2.13

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

number of laterals and their spread was also higher. Hybrid HP-34, Panniyur-2 and Panniyur-3 recorded significantly lower growth characters. All the varieties/hybrids started flowering from third year onwards.

#### Yield attributing characters

The mean yield attributing characters recorded during January 2008 and 2009 are presented in Table 2. Among the varieties/hybrids, Panniyur-5 recorded significantly higher number of spikes (238 in one metre column height) and was on par with Thevam (202.5) and OPKM (186.6) compared to other varieties/hybrids. The number of spikes was significantly the lowest in HP-780 (21.5).

**Table 2.** Yield attributing characters of different varieties of black pepper (Mean of 2008 and 2009)

Varieties/ Hybrids	No. of spikes (in one m column height)	Spike length (cm)	No. of berries/ spike
Panniyur-1	147.4	14.0	80.5
Panniyur-2	56.2	15.1	87.0
Panniyur-3	73.8	11.6	85.6
Panniyur-4	112.6	11.4	76.3
Panniyur-5	238.0	15.4	88.1
Sreekara	83.5	8.7	46.6
Subhakara	92.3	8.9	46.3
Panchami	172.2	11.3	85.3
Kottanadan	118.6	11.5	76.2
HP-780	21.5	11.7	64.7
HP-105	119.9	10.4	50.9
HP-1411	160.3	13.2	76.1
HP-813(IISR)	83.5	11.3	62.0
Malabar Excel)			
HP-34	70.5	9.6	50.1
OPKM	186.6	13.5	57.2
Collection 1041	202.5	9.5	60.6
(Thevam)			
CD (P=0.05)	59.7	2.2	17.3

The spike length was the highest in Panniyur-5 (15.4 cm) and was on par with Panniyur-1 and Panniyur-2, HP-1411 and OPKM varieties. The spike length was the lowest in Sreekara (8.7 cm) and was on par with Subhakara (8.8 cm) and HP-34 (9.6 cm).

The number of berries per spike was significantly higher in Panniyur-5 (88.1) and was on par with Panniyur-1 to 4 (76.3 to 87.0) and Panchami (85.3). The lowest number of berries recorded was in Subhakara (45.3) and Sreekara (46.5) varieties (Table 2).

### Yield of black pepper

Data on average dry berry yield for five years (2006 to 2010) indicated that Thevam had recorded significantly higher yield (1.81 kg/vine) compared to other varieties (Table 3) which was mainly attributed to higher number of laterals bearing capacity and production of more spikes. The next best performing variety was Panniyur- 5, which had recorded 1.12 kg/vine and differed significantly over other varieties. Panniyur-1 (0.98), Panniyur- 4 (0.80), Sreekara (0.75) and Panchami (0.86) were also recorded higher dry spike yield compared to other varieties. Among the hybrids, HP-813 (Malabar Excel) has performed well and yielded significantly higher berry yield (0.75 kg/vine) compared to other hybrids. HP-780, HP-105 and HP-34 gave significantly lower dry spike yield which ranged between 0.38 to 0.49 kg/vine.

**Table 3. Yield of different varieties/hybrids of black pepper when grown as mixed crop in coconut garden**

Varieties/Hybrids	Yield (kg/vine) (Average of 2006 to 2010)
Panniyur-1	0.98
Panniyur-2	0.45
Panniyur-3	0.48
Panniyur-4	0.80
Panniyur-5	1.12
Sreekara	0.75
Subhakara	0.56
Panchami	0.86
Kottanadan	0.49
HP-780	0.39
HP-105	0.46
HP-1411	0.55
HP-813 (IISR Malabar Excel)	0.75
HP-34	0.38
OPKM	0.48
Collection 1041 (Thevam)	1.81
CD (P=0.05)	0.23

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) have reported the superior performance of Panniyur-1 variety compared to other varieties in farmers' field.

### Qualitative characters

Panchami variety recorded higher oil (5.6%) and oleoresin content (12.6%) and was on par with Panniyur-4, Kottanadan and OPKM (Table 4). The piperine content did not differ significantly among the pepper varieties/hybrids and was found to range between 2.68 to 4.97%.

**Table 4. Quality of black pepper varieties/hybrids when grown as mixed crop in coconut garden (2009)**

Varieties/ Hybrids	Essential oil content (%)	Oleoresin content (%)	Piperine content (%)
Panniyur-1	4.07	11.43	3.97
Panniyur-2	3.77	8.63	3.77
Panniyur-3	2.93	8.57	2.67
Panniyur-4	4.93	11.47	3.40
Panniyur-5	4.13	10.47	3.70
Sreekara	3.77	9.27	3.57
Subhakara	4.08	8.13	3.43
Panchami	5.60	12.60	3.80
Kottanadan	4.80	12.30	3.73
HP-780	3.13	10.47	2.90
HP-105	3.20	8.57	2.40
HP-1411	5.03	11.50	3.93
HP-813 (IISR Malabar Excel)	4.00	8.70	3.03
HP-34	3.27	8.87	3.10
OPKM	4.53	11.63	4.97
Collection 1041 (Thevam)	4.00	11.17	3.90
CD (P=0.05)	1.06	1.79	NS

### Yield of coconut

Coconut yield recorded during the experimental period indicated no significant difference among the treatments. However, there was an improvement in the nut yield compared to the pre-experimental yield under all the treatments (Table 5). The general mean yield of coconut in the plot was 132.2 nuts/palm/year during 2009-10 compared to the pre-experimental yield of 101.3 nuts/palm/year (1999 to 2001). Six years mean yield of coconut also indicated improvement in the yield (113.1 nuts/palm/year) compared with pre-experimental yield. This clearly indicates positive influence of mixed cropping of black pepper in coconut garden. Sadanandan *et al.*, (1993) have also reported increase in yield of coconut to an extent of 53% due to mixed cropping of black pepper in farmers' field. Under high density multi-species

**Table 5. Coconut yield as influenced by mixed cropping of different varieties/hybrids of black pepper (Nuts/palm/year)**

Varieties	(1999-2001)	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	Mean
Panniyur-1	88.8	72.7	135.7	91.0	95.2	101.0	133.5	104.9
Panniyur-2	94.1	102.0	115.7	115.3	115.6	117.0	154.2	120.8
Panniyur-3	107.9	97.3	121.7	111.7	126.6	111.3	117.7	114.4
Panniyur-4	102.3	64.3	119.7	99.0	93.7	113.0	118.5	101.4
Panniyur-5	105.8	85.0	125.0	101.7	98.1	86.0	163.0	109.8
Sreekara	95.6	95.0	132.3	92.3	136.3	109.3	200.4	127.6
Subakara	111.8	88.3	128.3	134.3	117.0	142.3	122.0	122.0
Panchami	110.7	92.7	126.0	117.7	115.9	124.0	125.7	117.0
Kottanadan	105.2	91.0	124.3	119.0	111.4	109.0	194.2	124.8
HP-780	93.8	90.3	138.3	115.0	114.7	122.0	116.0	116.1
HP-105	96.0	81.7	135.3	101.7	94.9	108.0	98.7	103.4
HP-1411	107.7	92.0	148.0	120.3	111.2	123.0	97.7	115.4
HP-813 (IISR Malabar Excel)	108.5	89.3	134.0	115.7	98.7	119.3	160.2	119.5
HP-34	91.2	81.3	117.3	91.7	79.9	91.3	90.0	91.9
OPKM	104.4	90.3	114.7	113.7	108.4	111.0	118.2	109.4
Collection 1041 (Thevam)	97.8	93.7	134.3	105.7	107.7	113.0	104.6	109.8
F test	NS	NS	NS	NS	NS	NS	NS	NS
Overall Mean	101.3	87.9	128.2	109.1	107.8	112.5	132.2	113.1

NS - Not significant

cropping system, black pepper provided additional yield and there was improvement in the yield of coconut as reported earlier (Maheswarappa and Anithakumari; 2005; Palaniswami *et al.*, 2007; Krishnakumar *et al.*, 2010).

### Economic analysis of coconut + black pepper mixed cropping system

Data on cost of production, gross return and net return is presented in Table 6. The initial establishment cost (first three years) was to the tune of Rs. 57,350/- per ha of coconut garden out of which Rs. 14,000/- was spent towards establishment of black pepper. The cost of production for coconut + black pepper system from 4<sup>th</sup> year onwards was Rs. 60,300/- to 63,800/- per ha. The net return was the highest under Thevam cultivation (Rs. 1,04,981/-) followed by Sreekara (Rs. 91,252/-), Panniyur-5 (Rs. 83,935/-) and Panchami (Rs. 83,535/-). The lowest net return was in HP-34 (Rs. 42,732/-) and HP105 (Rs. 50,179/-) hybrids owing to their very low yield. Under coconut based high density multi species cropping system, black pepper provided additional income when trailed on coconut under Kasaragod condition as reported by Palaniswami *et al.* (2007) and Krishnakumar *et al.* (2010).

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

Varieties/ Hybrids	Cost of production (4th year onwards)	Gross return (Mean of 2006 to 2010)	Net return (Mean of 2006 to 2010)
Panniyur-1	63550	139304	74504
Panniyur-2	63300	138839	74039
Panniyur-3	62300	134032	69232
Panniyur-4	63550	130187	65387
Panniyur-5	64800	148735	83935
Sreekara	63550	156052	91252
Subhakara	62300	144455	79655
Panchami	63800	148335	83535
Kottanadan	62300	145229	80429
HP-780	61800	133032	68232
HP-105	62300	114979	50179
HP-1411	63050	137190	72390
HP-813(IISR Malabar Excel)	63550	147630	82830
HP-34	60300	107532	42732
OPKM	61050	128812	64012
Collection 1041 (Thevam)	64800	169780	104981

### Conclusion

From the above study, it can be concluded that, under Kasaragod condition, mixed cropping of black pepper with Thevam, Panniyur-1 and Panniyur-5, Sreekara, Panchami, Kottanadan and

Malabar Excel (HP 813) was found to perform well in coconut garden and can be recommended for growing in coconut garden as mixed crop. In addition, coconut together with black pepper mixed cropping resulted in increase in productivity of coconut and thus increase in profitability of the system over a period of time.

### References

- ASTA. 1968. Official Analytical Methods. 2<sup>nd</sup> edn, American Spice Trade Association, New Jersey.
- Bavappa, K. V. A., Abdul Khader, K. B., Biddappa, C. C., Khan, H. H., Kasturi Bai, K. V., Ramadasan, A., Sundararaju, P., Bopaiah, B. M., Thomas, G. V., Misra, L. P., Balasimha, D., Bhat, N. T. and Shama Bhat, K. 1986. Coconut and arecanut based high density multi-species cropping systems. *Journal of Plantation Crops*. **14**(2): 74-87.
- CPCRI, 1977. Annual Report for 1976. Central Plantation Crops Research Institute, Kasaragod, Kerala. 283 p.
- Krishnakumar, V., Nair, C.P.R. and Maheswarappa, H.P. 2010. Integrated management of root (wilt) disease affected coconut gardens through cropping/farming system approach. Technical Bulletin No. 65. CPCRI, Kasaragod. 16 p.
- Kushwah, B. L., Nelliath, E. V., Markose, V. T. and Sunny, A. F. 1973. Rooting pattern of coconut. *Indian Journal of Agronomy*. **18**: 71-74.
- Maheswarappa, H. P. and Anithakumri, P. 2005. Agronomic strategies for managing root (wilt) affected coconut gardens. *Technical Bulletin*, CPCRI, RS, Kayamkulam, Kerala, India. 17 p.
- Maheswarappa, H. P., Subramanian, P. and Dhanapal, R. 2000. Root distribution pattern of coconut (*Cocos nucifera* L.) in littoral sandy soil. *Journal of Plantation Crops*. **28**(2): 164-166.
- Mathew, P.A., Nagabhushanam, S. and Dhandar, D.G. 1993. Multicropping trials in coconut in Goa. In: *Advances in coconut research and development* (Eds.) Nair, M.K., Iyer, R.D., Rajagopal, V. and. Vidyasagar, P.S.P.V. Oxford and IBH pub. Co. Pvt., Ltd., New Delhi. pp:437-439.
- Nelliath, E. V. 1973. Multiple cropping or multi-storeyed cropping in plantation crops. *Journal of Plantation Crops*. **1**(Suppl): 204.
- Palaniswami, C., George V. Thomas., Dhanapal, R., Subramanian, P., Maheswarappa, H. P. and Upadhyay, A. K. 2007. Integrated Nutrient Management in Coconut Based Cropping System. Technical Bulletin No. 49. Central Plantation Crops Research Institute, Kasaragod. 24 p.
- Potty, N. N., Radhakrishnan, T.C. and Ashokan, P.K. 1979. A note on the early growth and performance of six varieties of pepper in the multi-storeyed cropping programme in coconut garden. *Agric. Res. J. Kerala*. **17**: 151-152.
- Reddy, D.V.S. and Thomas George, V. 2001. Mixed Cropping of Black Pepper in Coconut and Arecanut Gardens. Technical Bulletin No. 42, Central Plantation Crops Research Institute, Kasaragod, India. 20p.
- Sadanandan, A.K., Jose Abraham, Anandaraj, M. and Hamza, S. 1993. Effect of coconut-pepper mixed cropping on soil fertility and crop productivity. In: *Advances in coconut research and development* (Eds.) Nair, M.K., Iyer, R.D., Rajagopal, V. and. Vidyasagar, P.S.P.V. Oxford and IBH Pub. Co. Pvt., Ltd., New Delhi. pp:433-435.
- Wood, A.B., Maureen Barrow, L and James D. J. 1988. Piperine determination in black pepper (*Piper nigrum* L.) and its oleoresins- a reversed phase high-performance liquid chromatographic method. *Flavour Frag J*. **3**: 55-64.