

RESEARCH ARTICLE

Performance Evaluation of Black Pepper (*Piper nigrum* L.) Varieties for Yield and Quality under the Lower Pulney Hills

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ABSTRACT

Black pepper (*Piper nigrum*, Piperaceae) is an important traditional crop cultivated in the lower Pulney hills of Tamil Nadu. An experiment was conducted at Horticultural Research Station, Thadiyankudisai, with the objective of identifying a suitable high-yielding genotype for the lower Pulney hills conditions. Twenty-four black pepper varieties, viz., IISR-Shakthi, IISR-Thevam, IISR-Girimunda, IISR-Malabar Excel, Coorg Excel, Vellanamban, Thekkan, Panchami, Sreekara, Subhakara, Pournami, Panniyur-1 to Panniyur-9, PLD-2, Vijay, Kottanadan, and Karimunda were collected for this trial and planted at 3m x 3m spacing. The field had been laid out as per RBD with three replications. Growth performance, flowering and yield parameters were recorded and the, and yield parameters were recorded and statistically analyzed. The results revealed that vine length ranged from 1.36 m to 3.48 m. The variety Kottanadan recorded a maximum leaf length of 17.2 cm with a leaf breadth of 6.2 cm. The number of laterals per meter column ranged between 16.2 and 27.3. The variety Karimunda recorded the maximum number of spikes per square meter column (79 Nos.). Maximum spike length and number of berries per spike were observed in Panniyur-1 (15.40 cm & 74.60). The varieties Karimunda, and Pournami had been recorded with 2.21 kg, 2.13 kg, and 2.00 kg fresh berries per vine, respectively. The variety Panniyur-1 recorded a higher dry pepper yield of 0.78 kg per vine, followed by 0.68 kg in Karimunda and 0.62 kg in Pournami. Dry recovery percent of black pepper varieties ranged between 39.00% and 27.80%. The highest dry recovery percent was recorded by the variety Panniyur-8 with 39.00 percent.

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INTRODUCTION

Mother India is blessed with diverse agro-climatic conditions that facilitate the cultivation of a wide range of crops. Western Ghats is one of the important biodiversity hot spots of the world, known as the spices hub of India, offers broader scope for the cultivation of spice and plantation because of its unique climatic

conditions (Vignesh *et al.*, 2024) Spice crops viz., Black pepper, Cardamom, Ginger, Clove, Cinnamon, Nutmeg etc., and plantation crops viz., Coffee, Tea, Rubber are predominantly cultivated in this ecosystem. Lower Pulney Hills is one of the prime coffee-growing regions of India, where coffee is cultivated under evergreen

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shade trees (Namreen & Pankaje 2022). Besides coffee, Black pepper (*Piper nigrum*, Piperaceae), the king of spices, is also an important traditional crop cultivated in the lower Pulney hills of Tamil Nadu as a companion crop in coffee plantations and also in the coconut, arecanut plantations in the plains.

The shade trees in the coffee plantations such as Silveroak, Dadap, Jack, and other wild trees, are used as standards for training black pepper vines (Srinivasan *et al.*, 2011), enabling farmers to generate additional income for a better livelihood. The warm humid sub-tropical condition with well-distributed rainfall prevailing in the lower Pulney hills encourages coffee planters to choose pepper as one of the commercial crops in coffee plantations. Though many varieties of black pepper have been developed by Kerala Agricultural University and Indian Institute of Spices Research, Calicut only three varieties of pepper (Panniyur-1, Karimunda, and Kottanadan) are majorly cultivated among the planters of Lower Pulney hills. Most of the plantations are over 35 years old, and the existing pepper vines also exhibit yield decline due to their age, uneven bearing, and susceptibility to phytophthora foot rot. Besides these genetic causes climate change is also playing a considerable role in the yield decline of black pepper (Kandiannan *et al.*, 2014).

Improved black pepper varieties that are field-tolerant to Phytophthora foot rot and drought-tolerant to root knot nematode, with higher yield potential, viz., Pournami, Panniyur 5, Panniyur-6, Panniyur-8, Panniyur-9, IISR-Thevam, IISR-Shakthi, etc., have been released and are being cultivated in pepper-growing regions. Since these varieties are not popular in lower Pulney hills due to the non-availability of superior planting material and biotic and abiotic stresses (Thomas, 2010), an attempt has been made to evaluate the different black pepper varieties in this region. The objective is to select the best-performing varieties of pepper for commercial cultivation.

MATERIALS AND METHODS

This experiment was conducted from 2022 to 2025 at Horticultural Research Station, Tamil Nadu Agricultural University, Thadiyankudisai, which is located in the Kodaikanal hills (Pulney hills) of Western Ghats, located at 1100 m above MSL. Twenty-four black pepper varieties, viz., Panniyur-1, Panniyur-2, Panniyur-3, Panniyur-4, Panniyur-5, Panniyur-6,

Panniyur-7, Panniyur-8, Panniyur-9, IISR-Shakthi, IISR-Thevam, IISR-Girimunda, IISR-Malabar Excel, Coorg Excel, Vellanamban a local type from Kuzhathupuzha, Thekkan, Panchami, Sreekara, Pournami, PLD-2, Subhakara, Vijay, Kottanadan and Karimunda were collected from State vegetable farm, Vandiperiyar, Kerala. The special features of black pepper varieties are furnished in Table 1. The collected varieties were hardened under a 50 percent shade net house. The area identified for planting was cleared, and 50 cubic centimeters of soil were taken at a spacing of 3m x 3m (Praveena *et al.*, 2019). Perforated PVC pipes of 5 m length and 3" diameter filled with partly decomposed coir pith and wrapped with 50 per cent green shade net were used as standard for planting the rooted cuttings of black pepper. The PVC pipes were compactly fixed in the prepared pits, with 0.5m of the pipe length inside the soil.

One foot away from the fixed PVC standard, one cubic foot pits were taken and filled with topsoil, 5 kg FYM, and 150 g of rock phosphate. Along with the microbial consortia containing *Azospirillum*, Phosphobacteria, Potash solubilizing bacteria, and VAM, each at 10 g, were also added. The rooted cuttings were planted in the prepared pits during October 2022. All cultural practices prescribed by ICAR-IISR Kozhikode were followed as per the schedule. Biometrical observation of floral and yield parameters was recorded periodically, and the data collected were statistically analyzed as explained by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

The vine length of black pepper varieties cultivated under the Lower Pulney Hills showed significant variations among them. At the third year after planting, the vine length varied from 1.36 m to 3.48 m, and the maximum vine length was observed in the variety Panniyur-5. The varieties Panniyur-6, Panniyur-4, Panniyur-3, Sreekara and Pournami were recorded with vine lengths over 3 meters. The least vine length of 1.36 m was observed in the variety PLD-2. This finding confirmed the genetic character of a particular variety and its vigour as reported earlier by Anand *et al.*, 2024 in black pepper. Substantial variation could also be noticed with leaf size. The variety Kottanadan recorded maximum leaf length of 17.2 cm with a leaf breadth of 6.2 cm. This was followed by Panniyur-3, which recorded a leaf length of 15.30 cm and a leaf breadth of 6.7 cm. The lowest leaf length was observed

Table 1. Details of black pepper varieties collected for evaluation under Lower Pulney Hills

S. No	Pepper Variety /genotype	Special Features
1	Panniyur-1	- Hybrid, Uthirankotta × Cheriyaaniakadan - High-yielding, not suited to heavily shaded areas
2	Panniyur-2	- Selection (Cul. 141) from CV. Balancotta - Shade-tolerant
3	Panniyur-3	- Hybrid of Uthirankotta × Cheriyaaniakadan - Late maturing
4	Panniyur-4	- Selection from Kuthiravally Type - Stable yielder
5	Panniyur-5	- Open pollinated progeny selection from Perumkodi - Tolerant of shade
6	Panniyur-6	- Clonal selection from Karimunda - Suited to all black pepper tracts
7	Panniyur-7	- Open-pollinated progeny selection from Kuthiravally - Suited to all black pepper tracts
8	Panniyur -8	- Hybrid (HB 20052), Panniyur-6 × Panniyur-5 - Field tolerant to Phytophthora foot rot and drought
9	Panniyur-9	- Well-suited to all the pepper growing tracts with better performance in high altitude/ hilly areas - tolerant to drought stress
10	Sreekara	- Selection from Karimunda (KS-14) - Suited to all black pepper tracts
11	Subhakara	- Selection from Karimunda (KS-27) - Suited to all black pepper tracts
12	Panchami	- Selection from Aimpiryan (Coll. 856) - Late maturing
13	Pournami	- Selection from Ottaplackal (Coll. 812) - Tolerant to root knot nematode
14	IISR-Thevam	- Clonal selection of Thevamundi - Suited to high altitudes & plains - Tolerant to Phytophthora foot rot
15	IISR-Shakthi	- Open pollinated progeny of Perambamundi - Tolerant to Phytophthora foot rot.
16	IISR-Girimunda	- Hybrid, Narayakodi x Neelamundi - Suited to high altitudes
17	IISR-Malabar excel	- Hybrid, Choramundi x Panniyur-1 - Suited to high altitudes; Rich in oleoresin
18	Arka Coorg Excel	- Seedling selection - Suited to Kodagu district and similar areas
19	Thekkan	High-yielding pepper variety with highly branched spikes resistant to quick wilt disease.
20	Vellanamban	- High yielder - High dry recovery rate of around 40%
21	Vijay	- Hybrid, Panniyur-2 X Neelamundi. - High-yielding variety, tolerant to Phytophthora foot rot
22	PLD 2	- Clonal selection from Kottanadan - Suited to Thiruvananthapuram and Kollam regions
23	Karimunda	- Suitable for allpepper-growing areas - High-yielding, shade-tolerant.
24	Kottanadan	- High-yielding, - Drought-tolerant

in the variety Karimunda, measuring 11.3 cm in length and 6.1 cm in breadth. The inherited nature of a variety and its adaptability to specific ecological conditions might explain the differences in leaf size, as supported by Hussain *et al.*, (2017) in black pepper.

The number of laterals per meter column is an essential morphological character in black pepper for better yield. Notable variations were observed among the black pepper varieties evaluated, and they ranged between 16.2 (in IISR Girimunda) to 27.3 (in Karimunda) laterals per meter column. The varieties Panchami, Subhakara, Panniyur-5, and Pournami recorded 25 or above number of laterals

per column, followed by the varieties Sreekara (24.6), Panniyur-1 (23.4), Kottanadan, Panniyur -6, Panniyur-4 (22.3), Panniyur - 7 (21.8), and Thekkan with 21.3 spikes per meter column. Similar reports were affirmed by Deka *et al.*, (2016) in black pepper varieties evaluated under an arecanut-based mixed cropping system in Assam.

The number of spikes per square meter column is one of the main yield-contributing parameters in black pepper. In the present experiment, the number of spikes per square meter column ranged between 32 and 79. The maximum number of spikes was observed in the variety Karimunda (79 Nos.), followed by the

Table 2. Growth performance of pepper varieties under the Lower Pulney Hills

S. No	Genotype	Vine Length (3 rd year) (m)	Leaf length (cm)	Leaf breadth (cm)	Plant Spread N-S (m)	Plant Spread E-W (m)	Number of laterals in one column
1.	Panniyur -1	2.68	13.5	7.8	0.72	0.68	23.4
2.	Panniyur -2	2.23	12.8	9.2	0.69	0.61	17.6
3.	Panniyur -3	3.12	15.3	6.7	0.64	0.56	18.6
4.	Panniyur -4	3.30	12.0	8.0	0.66	0.50	22.3
5.	Panniyur -5	3.48	13.0	9.0	0.76	0.62	26.2
6.	Panniyur -6	3.40	14.0	6.0	0.51	0.44	22.3
7.	Panniyur -7	2.85	12.0	7.0	0.56	0.50	21.8
8.	Panniyur -8	2.30	13.0	8.6	0.61	0.40	19.6
9.	Sreekara	3.10	12.1	6.7	0.64	0.50	24.6
10.	Panchami	2.70	13.5	9.1	0.68	0.60	26.8
11.	Pournami	3.10	13.3	7.0	0.58	0.61	25.4
12.	IISR-Thevam	2.62	12.0	6.9	0.66	0.54	19.3
13.	IISR-Shakthi	2.46	13.2	8.0	0.62	0.55	19.8
14.	IISR-Girimunda	1.62	14.5	6.5	0.48	0.32	16.2
15.	IISR-Malabar Excel	2.01	12.5	8.6	0.42	0.36	17.2
16.	Arka Coorg Excel	2.03	13.5	8.9	0.40	0.46	16.6
17.	Thekkan	2.81	13.6	7.2	0.48	0.51	21.3
18.	Vellamban	1.41	13.4	6.9	0.47	0.30	16.8
19.	Panniyur -9	1.84	14.2	7.3	0.52	0.35	17.9
20.	Subhakara	2.12	12.8	6.2	0.62	0.58	26.2
21.	Vijay	1.45	13.3	6.6	0.41	0.28	18.4
22.	PLD 2	1.36	14.6	7.6	0.54	0.49	18.2
23.	Karimunda	2.68	11.3	6.1	0.66	0.58	27.3
24.	Kottanadan	2.65	17.2	6.2	0.72	0.62	22.3
	SED	0.087	0.052	0.040	0.005	0.005	0.146
	CD (5%)	0.165	0.108	0.090	0.010	0.010	0.296

variety Pournami and Subhakara with 71 and 69 spikes per square meter, respectively, and the least number of spikes per square meter was observed in the variety Arka Coorg Excel (32 spikes). The length of the spike is another critical parameter influencing black pepper yield, with significant variations observed among the 24 varieties tested in the lower Pulney hills. The black pepper variety Panniyur-1 produced the longest spikes of 15.40 cm, closely followed by Panniyur-5 with 14.80 cm long spikes. This was followed by the varieties Pournami and Panniyur-7 (13.60 cm). The lowest spike length of 7.80 cm was noticed in the variety Subhakara. The production of more spikes per square

meter and the length of spike directly indicate that the resource-to-sink ratio might be better because of the favourable climatic adaptability nature, combined with the genetic nature of the variety. These results were in line with the findings of Prasannakumari *et al.*, (2001) and Pannaga *et al.*, (2021).

The number of berries per spike has a direct influence on black pepper yield. Irrespective of spike the density of berries within the spikes showed wide variation among the varieties evaluated. The number of berries per spike ranged from 74.60 to 41.20. The maximum number of berries per spike (74.60) was recorded by the variety Panniyur-1 and 64.60 berries

Table 3. Yield performance of pepper varieties under lower Pulney Hills (Third year of planting)

S.No	Genotype	Number of spikes per m ² area	Spike length (cm)	Number of berries per spike	Fresh Pepper yield (kg/vine)	Dry pepper yield (kg/ vine)	Dry recovery %
1.	Panniyur -1	66.00	15.40	74.60	2.21	0.78	35.30
2.	Panniyur -2	42.00	12.10	64.60	1.54	0.55	35.70
3.	Panniyur -3	50.00	12.00	61.30	1.51	0.42	27.80
4.	Panniyur -4	54.00	12.30	56.30	1.41	0.49	34.70
5.	Panniyur -5	58.00	14.80	61.40	1.06	0.38	35.70
6.	Panniyur -6	48.00	8.92	53.00	1.00	0.33	32.90
7.	Panniyur -7	44.00	13.60	64.00	0.92	0.31	33.60
8.	Panniyur -8	43.00	13.20	52.30	0.72	0.28	39.00
9.	Sreekara	59.00	8.60	48.60	1.49	0.52	35.00
10.	Panchami	61.00	11.80	54.20	1.24	0.42	34.00
11.	Pournami	71.00	13.60	63.40	2.00	0.62	31.00
12.	IISR-Thevam	59.00	8.30	44.60	1.76	0.58	33.00
13.	IISR-Shakthi	62.00	12.10	57.50	1.81	0.60	33.20
14.	IISR-Girimunda	33.00	10.30	51.40	0.89	0.28	31.40
15.	IISR-Malabar Excel	38.00	11.60	55.30	0.96	0.31	32.30
16.	Arka Coorg Excel	32.00	12.40	48.60	0.73	0.24	33.00
17.	Thekkan	39.00	12.80	54.30	0.84	0.28	33.20
18.	Vellanamban	38.00	11.30	51.60	1.23	0.38	31.00
19.	Panniyur -9	43.00	11.60	55.00	1.33	0.44	33.00
20.	Subhakara	69.00	7.80	46.20	1.49	0.52	35.00
21.	Vijay	41.00	12.10	41.80	0.85	0.29	34.00
22.	PLD 2	60.00	12.60	44.10	1.70	0.56	33.00
23.	Karimunda	79.00	10.20	54.10	2.13	0.68	32.00
24.	Kottanadan	61.00	11.30	41.20	1.56	0.53	34.00
	CD (5%)	1.702	0.253	1.063	0.058	0.019	0.278
	SED	0.843	0.125	0.526	0.029	0.010	0.138

per spike in Panniyur-2. The variety Panniyur-7 had recorded 64.00 berries per spike. The least berry density per spike was noticed in the variety Kottanadan, 41.20 berries, followed by Vijay (41.80 berries). Previous research conducted on black pepper by Arya *et al.*, (2003) and Tripathi *et al.*, (2018) confirmed these results and supported the idea that the number of berries per spike is mainly influenced by genetic characteristics in black pepper.

Significant variations could be noticed for the fresh pepper yield per vine among the twenty-four varieties evaluated under lower Pulney Hills. The varieties Panniyur-1, Karimunda, and Pournami had been recorded with 2.21 kg, 2.13 kg, and 2.00 kg of fresh berries per vine, respectively, at the age of three years. Secondly, the varieties IISR-Shakthi, IISR-Thevam, and PLD-2 recorded 1.81 kg, 1.76 kg, and 1.70 kg of fresh berries, respectively. A similar trend could be noticed for the dry yield of black pepper. The variety Panniyur-1 recorded a higher dry pepper yield of 0.78 kg per vine, followed by 0.68 kg in Karimunda and 0.62 kg in Pournami. The varieties IISR- Shakthi, IISR-Thevam, and PLD-2 recorded 0.60 kg, 0.58 kg, and 0.56 kg dry berries, respectively. The lowest dry pepper yield of 0.24 kg per vine was observed in Arka Coorg Excel. With respect to dry recovery, the percentage of black pepper ranged between 39.00% and 27.80%. The highest dry recovery percent was recorded by the variety Panniyur-8 with 39.00 percent followed by 35.70 percent in Panniyur-5 and Panniyur-2. The high dry pepper yielder Panniyur- 35.30 percent dry recovery, and the Karimunda recorded 32.00 percent. The least dry recovery of 31.00 percent was noted in the varieties Pournami and Vellanamban. The evaluation of the pepper varieties by previous workers (Matthew *et al.*, 1993) under the multi-stage and mixed-cropping systems showed a better performance for the varieties Karimunda and Panniyur-1. The ability of individual black pepper cultivars to adapt to the environment where they are cultivated and the conversion of accumulated resources into sinks might be the reason for their better yield performance. Sadanandan *et al.*, (1993) reported that the Panniyur-1 variety has a higher yield than other varieties in the farmer's field. Maheswarappa *et al.*, (2012) also reported a similar outcome.

CONCLUSION

It is concluded that among the twenty-four varieties of black pepper evaluated under Lower Pulney Hills,

the traditional varieties Panniyur-1 and Karimunda recorded yields of 2.21 kg and 2.13 kg of green pepper, and 0.78 kg and 0.68 kg of dry pepper per vine in the third year of vine growth. This was closely followed by the variety Pournami which had 2.00 kg of fresh berries and 0.62 kg of dry pepper per vine at the age of three years. Secondly the varieties IISR-Shakthi, IISR-Thevam, and PLD-2 recorded 1.81 kg, 1.76 kg, and 1.70 kg of fresh berries, respectively. A similar trend could be noticed for the dry pepper yield of black pepper. The varieties IISR- Shakthi, IISR- and PLD-2 recorded 0.60 kg, 0.58 kg, and 0.56 kg dry berries, respectively. And these varieties could be a replacement for the traditional varieties of black pepper under the Lower Pulney hills.

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