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Standardization of soil-less nursery mixture for black pepper (*Piper nigrum* L.) multiplication using plug-trays

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Abstract

Availability of quality planting material of high yielding varieties is a major production constraint in all black pepper (*Piper nigrum* L.) growing countries, and hence there is a need for technology that boosts production of quality planting material. An investigation was carried out to study the effect of different combinations of soil-less coir pith based nursery mixtures on rooting and growth of black pepper cuttings in the nursery. Among the different nursery media combinations, coir pith with *Trichoderma* and vermicompost recorded significantly higher growth parameters. The study confirmed that composted coir pith with vermicompost and *Trichoderma* is an ideal potting medium for black pepper nursery. In the second experiment, among the single node cuttings with three different maturities (collected from the serpentine method runners), maximum nursery grwoth, was recorded in the terminal portion of the runners (11-15th nodes). Similarly, higher growth parameters were recorded in the cuttings planted with full leaf compared to half-leaf cuttings. The study indicated that the rooted cuttings with full leaf from middle and top portions recorded higher growth parameters. Use of *Trichoderma* and vermicompost enriched coir pith in black pepper nurseries minimizes chemical fungicides besides *Trichoderma* that colonizes the root system of seedlings will help in preventing the infection by pathogens in the main field. Since there is no high additional cost involved, the use of *Trichoderma* enriched coir pith can also be adopted by commercial nurseries.

Keywords: black pepper, coir pith, rooting, soil-less nursery mixture, trichoderma, vermicompost

Introduction

Black pepper (*Piper nigrum* L.), the 'King of Spices', is an important member in the family Piperaceae cultivated for its green and dried fruits. Considering its economic importance, area under black pepper is increasing both in traditional and non-traditional areas. But, availability of quality planting material of high yielding varieties is a major production constraint in all growing countries. The conventional propagation methods have limitations due to low success rate, poor rooting, spread of soil borne pathogens, nematodes and poor survival of transplanted cuttings. Transportation of cuttings in nursery bags containing conventional potting mixture to distant places is difficult due to its bulky nature. Coconut coir dust, commercially known as coco-peat, is an easily affordable growth medium for raising vegetable seedlings in the tropics. Coco-peat is an agricultural by-product obtained after extraction of fiber from the coconut husk (Abad *et al*. 2002; Yahaya *et al*. 1999 & 2009). Coco-peat has good water-holding capacity, acceptable electrical conductivity and other chemical attributes. It has a pH of 5.2–6.8 which is neutral to slightly acidic. Coco-peat has the ability to store and release nutrients to plants for extended periods of time. It also has great oxygenation properties which is important for healthy root development. The coco-peat is reusable and hence preferred by nursery growers for raising seedlings. It can be combined with any of the normal ingredients and used as a mixer or a stand-alone product. It is available at an affordable price. Decomposed coir pith can also substitute soil or sand in conventional nursery mixture for raising black pepper cuttings (Srinivasan & Hamza 2000). Nursery mixture containing granite powder and coir pith compost was reported as a successful potting mixture for raising black pepper cuttings in the nursery (Thankamani *et al*. 2007 & 2008).

Vermicompost is finely divided peat-like material with high porosity, aeration, drainage and water-holding capacity (Edwards & Burrows 1988). They have a vast surface area, providing strong absorbability and retention of nutrients (Shi-wei & Fu-zhen 1991). Vermicompost contain nutrients in forms that are readily taken up by the plants such as nitrates, exchangeable phosphorus, soluble potassium, calcium, and magnesium (Edwards & Burrows 1988; Orozco *et al*. 1996). Accordingly, vermicompost has a great potential in the horticultural and agricultural industries as media for plant growth.

Beneficial soil micro-organisms are destined to play an important role in nursery management systems that minimize the application of synthetic chemicals. There are many reports on the use of coir pith as a substrate for the mass production of *Trichoderma* (Saju *et al*. 2002; Usharani *et al*. 2008). Combined application of *Trichoderma* sp. and vesicular arbuscular mycorrhiza is reported to produce robust disease-free rooted black pepper cuttings in the nursery (Sarma 2000). Application of rhizobacteria and *T. harzianum* was also reported to significantly enhance growth of black pepper plants in the nursery (Anandaraj & Sarma 2003).

Improvement in the conventional method is essential, and hence there is a need for a technology that boosts production of quality planting material. The present investigation was carried out to study the effect of different combinations of soil less coir pith based nursery mixtures on rooting and growth of black pepper cuttings in the nursery.

Materials and methods

Two greenhouse (temperature 27±2^{o}C) studies were conducted to compare different nursery mixtures and rooted cuttings of different maturity on growth of black pepper in pro-trays. The experiments were conducted at Indian Institute of Spices Research, Kozhikode, during January 2012 to September 2013.

Preparation of planting material

Four high yielding black pepper varieties namely, Panchami, Sreekara, IISR Shakti and IISR Thevam were used for the experiment. Single node rooted cuttings collected from serpentine method of multiplication were used for planting in pro-trays.

Experiment I: Standardization of soil-less nursery mixture

For the trial on influence of soil-less nursery mixture on growth of the cuttings, single node rooted cuttings of four black pepper varieties were planted in 25 cell plug trays (Fig. 1) filled with various mixtures and compared for the growth characteristics. The eight different nursery mediums substituted with coir pith, potting mixture, vermicompost and *Trichoderma* were: Coir pith (CP), coir pith + *Trichoderma* (CP + T), coir pith + vermicompost

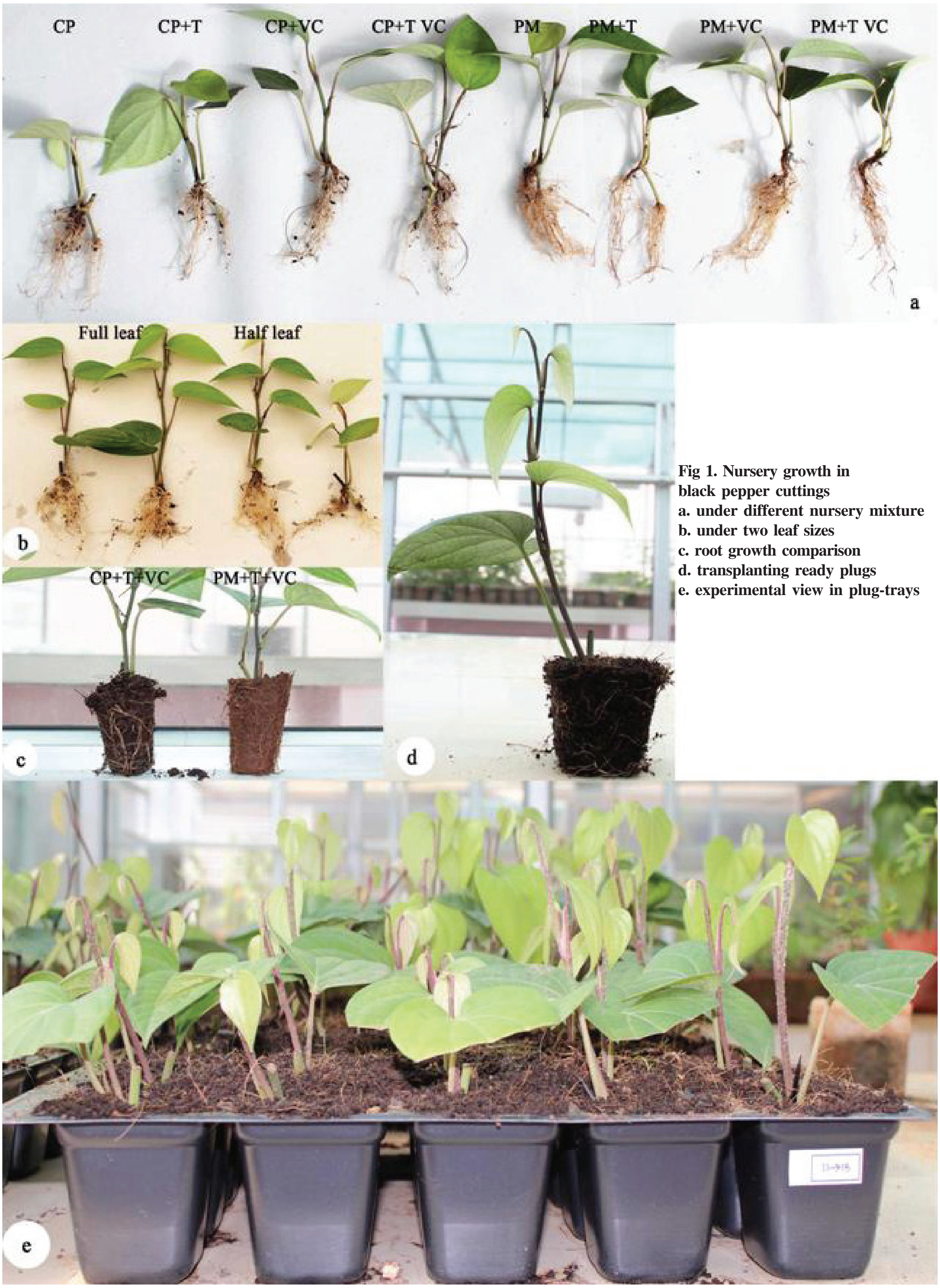

Fig 1. Nursery growth in black pepper cuttings
a. under different nursery mixture
b. under two leaf sizes
c. root growth comparison
d. transplanting ready plugs
e. experimental view in plug-trays

(CP + VC), coir pith + *Trichoderma* + vermicompost (CP + T + VC), potting mixture (PM), potting mixture + *Trichoderma* (PM + T), potting mixture + vermicompost (PM + VC), potting mixture + *Trichoderma* + vermicompost (PM + T + VC). The experiment was conducted in a two factor randomized block design. The total number of replications was four and number of plants per treatment was 15. The coir pith and vermicompost mixture was prepared in 3:1 proportion and used for filling pro-trays. The potting mixture was prepared by mixing garden soil, farmyard manure and sand in 1:1:1 proportion and used for filling pro-trays. Similarly, potting mixture and vermicompost mixture was prepared by potting mixture and vermicompost in 3:1 proportion and used for filling pro-trays. *T. harzianum* in talc formulation (10^7 cfu g^{-1}) was mixed at the rate of 10 g kg^{-1} of potting or coir pith based mixtures.

Experiment II: Standardization of maturity of the cutting

In the second trial, growth parameters of single node rooted cuttings of two black pepper varieties (Panchami and IISR Thevam) at three different maturity stages (grown on serpentine method) with a full or half leaf were compared. The three stages of maturity *viz*., basal (1-5th node), middle (6-10th node) and terminal (11-15th node) were distinctly different in appearance and differed in age by about 15-20 days. The experiment was conducted in a three factor randomized block design with four replications. The growth parameters were compared by growing them on the best medium identified from the Experiment I, filled in 25 cell pro-trays (Fig1 e) under green house conditions.

Observations recorded

The plants were allowed to grow for 90 days after which observations were recorded on nursery growth parameters such as rooting per cent, days to first leaf emergence, plant height, number of leaves, number of roots, root length and root-shoot ratio (dry weight). At the end of the experimental period, five plants per replication were destructively sampled and the number of roots and the dry weights of stem, leaves and roots were recorded to estimate the total biomass. Nutrient status of different nursery mixtures at 90 days after planting was estimated using standard procedures (Jackson 1973).

Data analysis

Data were analyzed statistically using the procedure of Panse & Sukhatme (1985). Significance was defined at $P<0.05$.

Results and discussion

The basic physicochemical properties of the media used are summarized in Table 1. Coir pith based mixtures had higher moisture (77%-83%) and acidic pH (3.5-4.69) than conventional potting mixtures (22%-28%) which were neutral in pH. The coir pith based mixtures also had higher organic carbon, available iron, zinc, manganese and copper contents as compared to conventional potting mixtures. The addition of vermicompost in the mixture contributed to increase in organic carbon content, phosphorus, magnesium, iron, manganese and zinc availability of potting mixture based medium and increased phosphorus and magnesium contents in coir pith based medium. Saravanan & Bhaskar (1997) also found improvement in physicochemical properties of

Table 1. Physicochemical properties of potting mixtures

Treatments	Moisture (%)	pH	EC (dSm^{-1})	OC (%)	P	K	Ca	Mg	Fe	Mn	Zn	Cu
					($mg\ kg^{-1}$)							
CP	81	4.09	0.34	9.24	52.0	660	2250	365	168	122	48.3	12.5
CP + T	79	3.51	0.69	8.70	48.0	610	1950	343	153	102	24.8	6.10
CP + VC	83	4.54	0.15	8.90	110	229	2295	415	162	98.0	25.2	6.50
CP + T + VC	77	4.69	0.17	8.40	106	263	2300	405	163	103	24.2	4.40
PM	22	7.38	0.78	1.15	15.0	754	2000	318	19.8	26.3	3.20	2.40
PM + T	22	7.44	0.57	1.40	45.0	723	2250	310	17.8	26.0	5.20	2.30
PM + VC	28	7.09	0.45	3.72	125	423	2260	350	42.6	36.0	9.80	3.50
PM + T + VC	22	7.13	0.36	2.88	110	313	2255	360	45.2	35.2	12.4	3.40

potting medium due to incorporation of coir pith in cowpea. Warrier *et al*. (1998) reported that composted coir pith could be successfully used as rooting medium for *Eucalyptus* sp. Savithri & Khan (1994) suggested that coir pith could serve as important source of organic manure for agricultural crops.

The growth parameters observed are shown in Table 2. In the first study, the growth of black pepper plants differed significantly among the nursery mixtures used. The effect of different treatments on rooting per cent, days to first leaf emergence, plant height, number of leaves, number of roots, root length, and root-shoot ratio were significant. Rooting per cent was highest in CP + T + VC than the other treatments. The minimum days to first leaf emergence was 30.75 in CP + T + VC followed by PM + T + VC with 33.38 days. Among the varieties, Panchami recorded minimum number of days to leaf emergence (23.50) in CP + T + VC and PM + T + VC followed by 24.50 in CP + VC. All the treatments with T and VC combinations showed better growth than the control sets (CP and PM alone). Maximum plant growth (plant height 13.28 cm; number of leaves 3.50, number of roots 20.88, root length 18.28 cm and root shoot ratio 0.42) was recorded in plants grown in coir pith, *Trichoderma* and vermicompost. The variety, Panchami recorded maximum plant height, number of leaves and root shoot ratio in the treatment CP + T + VC, whereas number of roots and root length was maximum in IISR Thevam under the same treatment. The treatment and variety interaction was also significant for all the characters.

The growth parameters recorded in various treatments differed according to the nursery mixture used with the best in the treatment CP + VC + T (Fig 1a). This may be attributed to higher moisture retention capacity, porosity and nutrient status of coir pith (Nagarajan *et al*. 1985). Similar results were reported by Siddagangaiah *et al*. (1996) in vanilla and Singh *et al*. (2003) in jojoba. Increased dry matter production in black pepper due to application of decomposed coir pith, sand and farmyard manure was reported by Srinivasan & Hamza (2000) and Thankamani *et al*. (2007).

Root system of the plant is the system by which water and nutrients are absorbed by the plants, so a plant with better root system obviously will give a better growth of the plant. The application of vermicompost and *Trichoderma* to coir pith enhanced root initiation, root elongation, root biomass and rooting percentage. This may be due to the better texture and porosity of coco-peat (Singh *et al*. 2002) which facilitated easy penetration of roots in vanilla (Siddagangaiah *et al*. 1996) and also being a well drained media it promoted better root characters (Singh *et al*. 2002). *T. harzianum* is also capable of increasing the uptake of nutrients by secreting enzymes that solubilise insoluble nutrients (Altomare *et al*. 1999; Harman *et al*. 2004).

The improvements in nursery growth of black pepper cuttings under CP + VC + T (Fig 1 c & d) could also be due to vermicompost. Vermicompost, which is produced by the fragmentation of organic wastes by earthworms, have a fine particulate structure and contain nutrients in forms that are readily available for plant uptake. Siddagangaiah *et al*. (1996) on evaluating various rooting media, indicated that vermicompost and decomposed coir pith were ideal for rooting and multiplication of vanilla. Black pepper cuttings raised in vermicompost were significantly taller and had more number of leaves than in conventional potting mixture (Thankamani *et al*. 1996).

In the second trial, the growth of black pepper plants did not differ significantly among the three different maturity stages of the cuttings, except for plant height and root-shoot ratio. Even though, growth characters showed gradual increase in all the three maturity stages of cuttings, maximum was recorded when terminal shoots were used (11-15th nodes). On comparison of the full and half leaf retained cuttings, the treatment effect was non-significant except for plant height, number of nodes and root-shoot ratio (Table 3). Higher growth parameters were recorded in the single node rooted cuttings retained with full leaf (Fig 1b). Significant differences among the two varieties with higher plant height, number of leaves, number of nodes and root length was

Table 2. Effect of various nursery media on growth various varieties of black pepper rooted cuttings (90 days after planting)

Treatments	Rooting (%)					Days to 1st leaf emergence					Plant height (cm)					No. of leaves				
	Pan chami	Sree kara	IISR Sakthi	IISR Thevam	Mean	Pan chami	Sree kara	IISR Sakthi	IISR Thevam	Mean	Pan chami	Sree kara	IISR Sakthi	IISR Thevam	Mean	Pan chami	Sree kara	IISR Sakthi	IISR Thevam	Mean
CP	60.00	60.00	88.83	60.00	67.21	30.00	50.00	52.00	53.00	46.25	5.35	6.00	3.75	1.50	4.15	1.50	2.00	1.00	0.50	1.25
CP+T	88.83	88.83	88.83	74.14	85.16	26.00	30.50	49.50	54.50	40.13	7.70	6.00	6.35	3.00	5.76	2.00	2.00	2.00	1.50	1.88
CP+VC	88.83	60.00	74.42	74.41	74.42	24.50	32.50	59.50	32.50	37.25	8.95	8.90	5.25	7.70	7.70	2.00	2.50	1.50	2.00	2.00
CP+T+VC	88.83	88.83	88.83	88.83	88.83	23.50	26.00	45.00	28.50	30.75	20.75	9.50	6.75	16.10	13.28	4.50	3.00	2.50	4.00	3.50
PM	88.83	45.00	45.00	60.00	59.71	28.00	33.00	55.50	42.50	39.75	9.00	4.35	4.55	7.90	6.45	2.00	2.00	1.50	2.00	1.88
PM+T	88.83	88.83	88.83	60.00	81.62	26.00	33.50	50.00	43.00	38.13	8.50	8.20	5.15	8.00	7.46	2.00	2.50	2.00	2.00	2.13
PM+VC	88.83	60.00	60.00	60.00	67.21	25.50	35.50	53.00	49.50	40.88	15.65	5.50	6.85	8.55	9.14	4.00	2.00	2.00	2.00	2.50
PM+T+VC	88.83	88.83	74.42	88.83	85.23	23.50	31.50	46.50	32.00	33.38	16.35	8.00	6.45	15.10	11.48	4.00	2.50	2.00	4.00	3.13
Mean	85.22	72.54	76.14	70.81	76.18	25.87	34.06	51.37	41.94	38.31	11.53	7.05	5.63	8.48	8.17	2.75	2.31	1.81	2.25	2.28

Treatments	No. of roots					Root length (cm)					Root: Shoot ratio (dry weight)				
	Panchami	Sreekara	IISR Sakthi	IISR Thevam	Mean	Panchami	Sreekara	IISR Sakthi	IISR Thevam	Mean	Panchami	Sreekara	IISR Sakthi	IISR Thevam	Mean
CP	14.50	22.50	9.00	4.00	12.50	13.65	11.75	7.25	9.75	10.60	0.20	0.19	0.34	0.21	0.24
CP+T	14.50	14.00	11.50	14.50	13.63	12.25	11.50	14.60	13.35	12.93	0.28	0.24	0.41	0.26	0.30
CP+VC	15.50	15.00	9.00	15.50	13.75	16.50	11.00	11.85	17.50	14.21	0.31	0.27	0.46	0.31	0.34
CP+T+VC	16.50	23.00	18.50	25.50	20.88	20.25	16.00	16.00	20.85	18.28	0.41	0.36	0.57	0.35	0.42
PM	12.50	13.00	13.00	14.50	13.25	12.85	10.10	8.50	12.75	11.05	0.13	0.24	0.14	0.17	0.17
PM+T	14.50	16.00	13.00	12.00	13.88	14.10	13.35	12.00	16.50	13.99	0.18	0.26	0.18	0.19	0.20
PM+VC	15.50	10.00	14.00	14.00	13.38	13.70	11.50	10.50	16.60	13.08	0.20	0.20	0.14	0.18	0.18
PM+T+VC	15.50	17.50	14.00	16.50	15.88	15.50	12.60	14.35	16.25	14.68	0.23	0.34	0.51	0.28	0.34
Mean	14.81	16.37	12.75	14.56	14.62	14.85	12.25	11.88	15.44	13.61	0.24	0.26	0.34	0.24	0.27

Parameters	Rooting (%)	Days to 1st leaf emergence	Plant height (cm)	Number of leaves	Number of roots	Root length (cm)	Root: Shoot ratio
Varieties	5.19**	1.77**	0.64**	0.27**	0.84**	0.71**	0.127**
Treatments	7.34**	2.51**	0.91**	0.38**	1.19**	1.02**	0.179**
G × T	14.68**	5.02**	1.82**	0.76**	2.39**	2.04**	0.359**
CV (%)	8.76	5.59	10.2	16.18	7.18	7.82	6.27

Note: Bottom table is with C D values (P<0.05)

Table 3. Effect of maturity of rooted cutting on growth of black pepper (90 days after planting)

Variety	Maturity of cutting (nodal position)	Leaf size	Plant height (cm)	No. of leaves	No. of nodes	No. of roots	Root length (cm)	Root: Shoot ratio
Panchami	1st-5th	Full leaf	34.25	5.50	5.50	9.50	19.75	0.17
		Half leaf	20.40	4.50	4.50	9.00	16.50	0.18
	6th-10th	Full leaf	34.50	6.00	6.50	16.00	22.00	0.26
		Half leaf	28.50	5.00	5.00	10.00	17.50	0.21
	11th-15th	Full leaf	46.25	6.00	6.00	13.50	21.00	0.28
		Half leaf	33.75	6.00	6.00	13.50	20.50	0.19
IISR Thevam	1st-5th	Full leaf	17.75	2.50	3.00	9.00	17.25	0.19
		Half leaf	12.25	2.00	2.50	8.50	15.00	0.20
	6th-10th	Full leaf	19.25	3.50	4.00	13.00	18.25	0.24
		Half leaf	11.25	2.00	2.00	10.50	14.50	0.25
	11th-15th	Full leaf	23.00	3.50	3.50	15.00	19.35	0.25
		Half leaf	16.00	3.00	3.50	14.00	18.00	0.28
Mean			24.76	4.13	4.33	11.79	18.30	0.23

C D Values (P<0.05)

Parameter	Plant height (cm)	No. of leaves	No. of nodes	No. of roots	Root length (cm)	Root:Shoot ratio
Variety (V)	3.37**	0.75**	0.57**	NS	NS	0.011**
Maturity of cutting (C)	4.13**	NS	NS	NS	NS	0.013**
Leaf size (L)	3.37**	NS	0.57**	NS	NS	0.011**
CV (%)	15.47	20.40	14.90	24.89	13.91	5.43

recorded in Panchami. The interaction effects were non-significant for all the characters recorded. There have been several explanations for the diminishing rooting and growth of cuttings obtained from matured runners like accumulation of rooting inhibitors, decrease in endogenous content of auxin and or root promoters. Similarly, higher nursery growth parameters were recorded in the cuttings planted with full leaf. The study indicated that the rooted cutting with full leaf from middle and top portions recorded higher growth.

Thus, the present study confirmed that composted coir pith with vermicompost and *Trichoderma* is an excellent potting medium for black pepper nursery. Use of *Trichoderma* and vermicompost enriched coir pith in black pepper nurseries minimizes use of chemical fungicides, besides *Trichoderma* that colonizes the root system of seedlings will help in preventing infection by pathogens in the main field. Since there is not much additional cost involved, the use of *Trichoderma* enriched coir pith can also be adopted by commercial nurseries.

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