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Influence of root trainer and rooting media on root and shoot growth of black pepper (*Piper nigrum* L.)

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Abstract
Black pepper is one of the major spices of India earning huge foreign exchange to the country through exports. In this study the effect of root trainers on various root and shoot parameters is studied over the conventional method of raising cuttings in polybags using thirteen different media combinations. Most of the root parameters were observed to be superior in the cuttings raised in root trainers compared to that of polybags. The treatment T_{13} (Soil + perlite + vermicompost - 2:1:2) recorded highest rooting percentage (80.50 %) in root trainer compared to polybag (78.00%). Root volume was found to be maximum in the root trainer (6.25cm^3) compared to the polybag (5.5cm^3) in the treatment T_{12} (Soil + perlite + FYM in 2:1:2). The treatment T13 (Soil + perlite + vermicompost - 2:1:2) recorded early sprouting of cuttings (20.90 days) and maximum sprouting percentage (84.00) in root trainers.

Keywords: Black pepper, Root, Trainer, Media, Nursery, *Piper nigrum*

Introduction
Black pepper (*Piper nigrum* L.) - the versatile spice of India is a major foreign exchange earner to the nation among the spices exports. On account of its economic importance it is also called as 'Black gold' (Devasahayam *et al.*, 2010) [1]. Being an indigenous spice crop of India the diversity is more in Western Ghat regions *i.e.* in parts comprising Kerala, Karnataka and Tamil Nadu.

Quality planting material is the key to success in agriculture/ horticulture crop production. Poor crop establishment and deadly soil borne diseases are the major constraints in black pepper industry. Improving the rooting pattern may help to overcome the problems to a greater extent. Though pepper can be propagated both by sexual as well as asexual means, vegetative propagation through cuttings is commercially practiced, as the seedlings won't breed true to type. The conventional methods adopted for establishment of pepper have the disadvantage of false sprouting and poor root development, coupled with high disease incidence which eventually leads to poor establishment. Many factors like type of cuttings, season of propagation, rooting media, type of containers etc. have known to influence the rooting of cuttings in plants (Thankamani *et al*. 1996; Sharangi *et al*., 2010) [2, 3]. Good rooting media along with a suitable container play vital role in rooting and success of nursery plants (Agbo and Omaliko, 2006) [4]. Availability of quality planting materials and in sufficient quantity is a major constraint faced by the pepper industry in India. Hence the present investigation was carried out at to study the influence of different media and containers on nursery rising of black pepper cuttings.

Materials and methods
The present investigation was carried out in a naturally ventilated polyhouse during the year 2015-16 at Mudigere which is situated in hilly zone of Karnataka state. It is considered to be mild tropical rainy region. The mean maximum temperature during the period of experimentation ranged from 27.0^0 to 36.6^0 C whereas, the mean minimum temperature ranged from 15.0^0 to 16.1^{0}C. The mean relative humidity ranged from 45-92 per cent.

The experiment was laid out in a Completely Randomized Design (CRD) with twenty-three treatments including control which were replicated twice with 60 cuttings per replication. Two different containers used were Polybag (10cmx15cm) and the plastic root trainers of 160 cc.

Root trainers made up of polypropylene with the size of 160cc which is having perforated holes at the bottom. The colour of the root trainer used is black and having the durability of 8-10 years.

The media combinations used for the study are as follows: T1 (Control): Soil + Sand + FYM - 2:1:1; T2: Soil + FYM - 2:1; T3: Soil + Sand + Vermicompost - 2:1:1, T4: Soil + Vermicompost - 2:1, T5: Soil + Cocopeat + FYM - 2:1:1, T6: Soil + Cocopeat + Vermicompost - 2:1:1, T7: Soil + Burnt paddy husk - 2:1, T8: Soil + Burnt Paddy Husk + FYM - 2:1:1, T9: Soil + Burnt Paddy Husk + Vermicompost - 2:1:1, T10: Soil + Vermiculite + FYM - 2:1:1, T11: Soil + Vermiculite + Vermicompost - 2:1:1, T12: Soil + Perlite + FYM - 2:1:2, T13: Soil + Perlite + Vermicompost - 2:1:2, T14: Soil + FYM + Vermicompost – 2:1:1, T15: Soil + Cocopeat - 2:1, T16: Soil + Sawdust - 2:1, T17: Soil + Sawdust + FYM - 2:1:1, T18: Soil + Sawdust + Vermicompost - 2:1:1, T19: Cocopeat + Vermiculite + FYM - 1:1:2, T20: Cocopeat + Perlite + FYM - 1:1:2, T21: Cocopeat, T22: Cocopeat + FYM - 1:1, T23: Cocopeat + Vermicompost - 1:1

Semi hard wood cuttings of pencil thickness (0.8-1.0 cm diameter) were selected from healthy vines and cuttings of 10 cm length with 2 nodes were prepared by giving a slant cut at the bottom. The planted cuttings were observed daily under each treatment and the number of days required for sprouting was recorded and their mean was used to calculate the days taken for first sprout to appear. The per cent sprouting was counted at 30, 60 and 75 days after planting by taking the ratio of number of cuttings sprouted to the number of cuttings planted and multiplied by 100.

Five cuttings per treatment per replication were carefully removed from the container after 120 DAP and dipped in water to remove the sand particles adhering to roots to record the observations pertaining to roots. Root volume was recorded using water displacement method and the values are expressed in cubic centimetres.

The experimental data were analyzed statistically by adopting Fischer's method of analysis of variance as outlined by Gomez and Gomez (1976) [5]. The interpretation of data was done by using the critical difference value calculated at 0.01 probability level.

Results and Discussion

It is evident that the shoot and root parameters exhibited significant differences for the treatments. Among different combinations tried the media comprising of Soil + Perlite +Vermicompost in 2:1:2 ratio (T_{13}) was found to be best in promoting shoot growth. The cuttings planted in this media combination were earliest to sprout (20.20 days in polybag and 20.90 days in root trainer) and recorded maximum sprouting percentage (78.20 and 84.00 in polybag and root trainer respectively). This might be attributed to ready availability of nutrients to the cuttings (Table 1 & 2).

Table 1: Effect of different rooting media and containers on days to sprout in black pepper cuttings.

Treatments	Days to sprout	
	Polybag	Root trainer
T_1 - Soil + sand + FYM - 2:1:1	24.40	23.60
T_2 - Soil + FYM - 2:1	24.20	25.00
T_3 - Soil + sand +Vermicompost- 2:1:1	23.40	23.90
T_4 - Soil +Vermicompost- 2:1	23.60	23.90
T_5 - Soil + Cocopeat + FYM - 2:1:1	24.70	23.40
T_6 - Soil + Cocopeat +Vermicompost- 2:1:1	25.40	23.10
T_7 - Soil + Burnt paddy husk - 2:1	26.30	23.40
T_8 - Soil + Burnt paddy husk + FYM - 2:1:1	27.00	23.00
T_9 - Soil + Burnt paddy husk +Vermicompost- 2:1:1	25.50	24.40
T_{10} - Soil + Vermiculite + FYM - 2:1:1	24.20	23.70
T_{11} - Soil + Vermiculite +Vermicompost- 2:1:1	21.30	23.0
T_{12}- Soil + Perlite + FYM - 2:1:2	22.50	23.70
T_{13} - Soil + Perlite +Vermicompost- 2:1:2	20.20	20.90
T_{14} - Soil + FYM +Vermicompost– 2:1:1	25.50	23.70
T_{15} - Soil + Cocopeat - 2:1	26.60	24.80
T_{16} - Soil + sawdust - 2:1	27.00	25.70
T_{17} - Soil + sawdust + FYM - 2:1:1	24.90	23.70
T_{18} - Soil + sawdust +Vermicompost- 2:1:1	24.40	23.60
T_{19} - Cocopeat + Vermiculite + FYM - 1:1:2	26.10	24.40
T_{20} - Cocopeat + Perlite + FYM - 1:1:2	24.20	24.20
T_{21} –Cocopeat	25.10	25.00
T_{22} - Cocopeat + FYM - 1:1	25.10	25.00
T_{23} - Cocopeat +Vermicompost- 1:1	25.50	24.40
F- test	*	*
C D @ 1%	2.25	1.56

Maximum per cent of rooting (78% in polybag and 84.0 % in root trainer) (Table 3) and was observed in T13 (Table 5). Vermicompost is known to have many growth promoting substances that might have helped the better root development. These results are in conformity with Gavrilov (1963) [6] who reported that vermicompost could be a definitive source of plant growth regulators produced by interactions between microorganisms and earthworms, which could contribute significantly to enhancement of plant growth. Similar results were also reported by Shirol *et al*. (2001) [7] in dwarf poinsettia cuttings.

Root volume was maximum in the treatment combination T12- Soil + Perlite + FYM in 2:1:2 ratio (5.5cm^3 in polybag and 6.25cm^3 in root trainers) (Table 4). This might be due the combined effect of the media components like soil, perlite that gives better porosity to the media and allows good root penetration apart from having good water absorption capacity. The FYM in the media also helped in good root development

in terms of number and length of the roots that together is responsible for increased root volume in the treatment. Shridhar *et al*. (1989) [8] also reported similar results in black pepper cuttings.

Table 2: Effect of different media and container type on sprouting of black pepper cuttings

Treatments	Percent sprouting	
	Polybag	**Root trainer**
T_1 - Soil + sand + FYM - 2:1:1	69.00	67.00
T_2 - Soil + FYM - 2:1	64.00	64.00
T_3 - Soil + sand +Vermicompost- 2:1:1	71.50	70.50
T_4 - Soil +Vermicompost- 2:1	68.00	67.00
T_5 - Soil + Cocopeat + FYM - 2:1:1	66.50	64.00
T_6 - Soil + Cocopeat +Vermicompost- 2:1:1	67.00	67.00
T_7 - Soil + Burnt paddy husk - 2:1	67.00	62.50
T_8 - Soil + Burnt paddy husk + FYM - 2:1:1	64.00	65.00
T_9 - Soil + Burnt paddy husk +Vermicompost- 2:1:1	63.00	67.00
T_{10} - Soil + Vermiculite + FYM - 2:1:1	63.20	68.50
T_{11} - Soil + Vermiculite +Vermicompost- 2:1:1	75.50	77.00
T_{12}- Soil + Perlite + FYM - 2:1:2	78.00	80.50
T_{13} - Soil + Perlite +Vermicompost- 2:1:2	78.20	84.00
T_{14} - Soil + FYM +Vermicompost– 2:1:1	67.00	67.00
T_{15} - Soil + Cocopeat - 2:1	63.50	61.50
T_{16} - Soil + sawdust - 2:1	64.00	61.50
T_{17} - Soil + sawdust + FYM - 2:1:1	65.00	62.50
T_{18} - Soil + sawdust +Vermicompost- 2:1:1	68.00	67.00
T_{19} - Cocopeat + Vermiculite + FYM - 1:1:2	74.00	77.00
T_{20} - Cocopeat + Perlite + FYM - 1:1:2	70.50	70.50
T_{21} –Cocopeat	69.00	75.50
T_{22} - Cocopeat + FYM - 1:1	75.50	73.00
T_{23} - Cocopeat +Vermicompost- 1:1	69.50	74.00
F- test	*	*
C D @ 1%	4.10	3.33

Among the two containers studied, the root trainer proved to be best over polybags. This might be due to the congenial conditions created in the trainers for better root growth and development due to occurrence of the mechanism called air pruning. It leads natural pruning or seizure of root growth at the point of exposure to air *i.e.* in the bottom thereby stimulating the development of more fibrous roots. Increased root number and in turn the root volume might have improved the ability of the plants to absorb more nutrients and water from the media. Further the added advantage of root trainer is its long durability and less space occupancy compared to conventional methods.

Table 3: Effect of different media and containers on rooting percentage of black pepper cuttings.

Treatments	Rooting percentage	
	Polybag	**Root trainer**
T_1 - Soil + sand + FYM - 2:1:1	58.32	63.04
T_2 - Soil + FYM - 2:1	56.09	59.02
T_3 - Soil + sand +Vermicompost- 2:1:1	62.72	64.28
T_4 - Soil +Vermicompost- 2:1	64.99	62.31
T_5 - Soil + Cocopeat + FYM - 2:1:1	60.63	57.98
T_6 - Soil + Cocopeat +Vermicompost- 2:1:1	62.23	54.32
T_7 - Soil + Burnt paddy husk - 2:1	61.42	55.42
T_8 - Soil + Burnt paddy husk + FYM - 2:1:1	59.56	61.33
T_9 - Soil + Burnt paddy husk +Vermicompost- 2:1:1	61.32	64.42
T_{10} - Soil + Vermiculite + FYM - 2:1:1	59.09	62.31
T_{11} - Soil + Vermiculite +Vermicompost- 2:1:1	71.72	71.20
T_{12}- Soil + Perlite + FYM - 2:1:2	72.08	74.38
T_{13} - Soil + Perlite +Vermicompost- 2:1:2	74.66	77.92
T_{14} - Soil + FYM +Vermicompost– 2:1:1	62.73	62.64
T_{15} - Soil + Cocopeat - 2:1	58.49	57.24
T_{16} - Soil + sawdust - 2:1	62.52	57.08
T_{17} - Soil + sawdust + FYM - 2:1:1	59.02	58.12
T_{18} - Soil + sawdust +Vermicompost- 2:1:1	61.33	62.32
T_{19} - Cocopeat + Vermiculite + FYM - 1:1:2	70.77	69.53
T_{20} - Cocopeat + Perlite + FYM - 1:1:2	63.72	64.66
T_{21} –Cocopeat	61.42	65.72
T_{22} - Cocopeat + FYM - 1:1	69.23	67.32
T_{23} - Cocopeat +Vermicompost- 1:1	63.04	66.68
F- test	*	*
C D @ 1%	4.16	3.39

Table 4: Effect of different media and containers on root volume of the black pepper cuttings

Treatments	Root volume (cm^3)	
	Polybag	Root trainer
T_1 - Soil + sand + FYM - 2:1:1	2.50	3.50
T_2 - Soil + FYM - 2:1	3.00	4.00
T_3 - Soil + sand +Vermicompost- 2:1:1	2.75	2.75
T_4 - Soil +Vermicompost- 2:1	3.25	3.50
T_5 - Soil + Cocopeat + FYM - 2:1:1	3.75	3.75
T_6 - Soil + Cocopeat +Vermicompost- 2:1:1	4.25	4.50
T_7 - Soil + Burnt paddy husk - 2:1	2.75	3.75
T_8 - Soil + Burnt paddy husk + FYM - 2:1:1	4.00	3.75
T_9 - Soil + Burnt paddy husk +Vermicompost- 2:1:1	3.75	3.00
T_{10} - Soil + Vermiculite + FYM - 2:1:1	3.75	5.20
T_{11} - Soil + Vermiculite +Vermicompost- 2:1:1	5.25	4.50
T_{12}- Soil + Perlite + FYM - 2:1:2	5.50	6.25
T_{13} - Soil + Perlite +Vermicompost- 2:1:2	5.25	4.75
T_{14} - Soil + FYM +Vermicompost– 2:1:1	4.00	5.50
T_{15} - Soil + Cocopeat - 2:1	3.75	5.00
T_{16} - Soil + sawdust - 2:1	3.00	2.75
T_{17} - Soil + sawdust + FYM - 2:1:1	4.75	2.75
T_{18} - Soil + sawdust +Vermicompost- 2:1:1	2.25	4.25
T_{19} - Cocopeat + Vermiculite + FYM - 1:1:2	4.25	4.00
T_{20} - Cocopeat + Perlite + FYM - 1:1:2	2.25	3.50
T_{21} –Cocopeat	3.00	3.00
T_{22} - Cocopeat + FYM - 1:1	4.00	2.00
T_{23} - Cocopeat +Vermicompost- 1:1	2.75	3.25
F- test	*	*
C D @ 1%	1.32	1.33

Conclusion

Thus, the present study revealed that Soil, perlite and vermicopmost could be an excellent potting mixture for black pepper and root trainer could be a better container over poly bags for nursery raising of cuttings.

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