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Effect of solarized potting mixture on growth of black pepper (*Piper nigrum* L.) rooted cuttings in the nursery

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Abstract

Solarized potting mixture in combination with nutrients and biocontrol agents was evaluated for production of vigorous disease free rooted cuttings of black pepper. Plants raised in solarized potting mixture had better growth than plants raised in nonsolarized potting mixture (soil, sand, and farm yard manure 2:1:1proportion). Among the various treatments, plants raised in solarized potting mixture with recommended nutrients (urea, superphosphate, potash and magnesium sulphate 4:3:2:1) showed significant increase in number of leaves(5.3), length of roots (20cm), leaf area (177cm2), nutrient contents and biomass (3.7g pl-1). The results indicated the superiority of solarized potting mixture for reducing the incidence of diseases besides yielding vigorous planting material. Cost of production of rooted cuttings with biocontrol agents was found to be cheaper in the case of rooted black pepper cuttings raised in solarized potting mixture. Bio control agents or bio fertilizers can be mixed with solarized potting mixture.

Key words: black pepper, cost, potting mixture, solarization, disease.

Introduction

Black pepper known as 'king of spices' is one of the most important spices in the world. In India, the productivity of this spice is low owing to several constraints associated with production. Among them non availability of vigorous, disease free rooted cutting is of prime importance. Foot rot disease caused by *Phytophthora capsici*, nematodes and viruses are common problems in black pepper nurseries. Use of chemicals for disease management is not advisable due to their hazardous nature, cost and need to alpply frequently. Soil disinfection mediated by solarization is an environmentally friendly technology for the management of soil borne diseases. It is a process of hydro-thermal dis-infestation accomplished by covering moist soil or potting mixture with transparent polythene film during hot weather period. Solarization is a safe method of pest control as it is environment friendly and it depends on renewable source of energy (Katan 1981, Yaduraj & Karma 1997). Raising the cuttings in solarized mixture fortified with *Trichoderma harzianum* and VAM is reported to produce robust disease free rooted black pepper cuttings (Sarma 2000; Anandaraj et al. 2001). Solarization mediated favourable effects were observed in bhindi (Bawazir et al.1995), onion (Adelunji 1994), coriander (Herrera & Ramirez 1996), lime (Stapleton & Devay 1986), chillies (Haripriya & Manivannan 2000) and black pepper (Sainamol *et al.* 2003).

Use of biofertilizer to supply nutrients such as nitrogen and phosphorus and use of biocontrol agents for disease management have attracted interest among farmers. Use of bio-control agent is an ideal technology in IPM programme and bio-control agents such as *Trichoderma harzianum* and Pseudomonas fluorescens increased vigour of black pepper cuttings (Thankamani *et al*. 2005). Disease free vigorous planting material is a prerequisite for establishing a healthy plantation. Hence, the present investigation was under taken to evaluate solarized potting mixture in combination with nutrients and biocontrol agents on growth promotion and disease management in black pepper.

Materials and methods

The trial was conducted during 2005 and 2006 at experimental Farm Peruvannamuzhi, Indian Institute of Spices Research, Calicut. Potting mixture was prepared by mixing soil, sand and FYM in 2:1:1 proportion. For solarization, the mixture was spread in beds of 3 m width, 15 m length and 30 cm height from February to March. The beds were leveled, sprinkled with water and covered with transparent polythene sheet (200) micron for 60 days. The edges were tucked inside the soil to make it airtight. After solarization, the mixture was used for filling polythene bags of size 20 x 10 cm. Similarly non solarized soil, sand and FYM mixed in the same proportion was used as a check. The potting mixture was amended with nutrient sources such as chemical fertilizer, coir pith compost, *Azospirillum* and *Phosphobacteria* and biocontrol agents. Nitrogen, phosphorus and potash content of solarised potting media was 166, 42 and 474 ppm respectively whereas nonsolarized potting mixture had lesser nitrogen, phosphorus and potash 153, 34 and 435 ppm respectively. Healthy rooted single node cuttings of black pepper variety IISR Sreekara were used in the experiment. Nutrient solution as per package of practice recommendations of IISR was added to polythene bags at 1st and 2nd month after planting (Devasahayam *et al.* 2006).

In the bio fertilizer treatment, *Azospirillum sp*. and *Phosphobacteria* sp. (109 cfu ml-1) were applied @ 50 ml per bag at the time of planting and a month after planting in polythene bags. Decomposed coconut coir pith prepared using *Pleurotus* sp. was used in the experiment. *Trichoderma harzianum*, VAM and bacterial consortia consisting of IISR 6, IISR 151, IISR 853, IISR 859, BP-35 were used as biocontrol agents in this experiment. Regarding bacterial consortia, inoculums were diluted twenty times and 109 cfu of inoculums was added to the polythene bags twice in1st and 2nd month after planting @ 50 ml per plant. Trichoderma @1g/plant and VAM 10cc/plant respectively were added to the concerned treatments. Plant protection chemicals were given 1st and 2nd months after planting for plants raised in unsolarized potting mixture. The trial was laid out in CRD with three replications, eight treatments with fifteen plants in each treatment. All nutrients as per the treatment were added to bags filled with potting mixture.

Treatments : 1. Solarized potting mixture (SPM) + recommended nutrients, 2. SPM + *Azospirillum* + *Phosphobacteria* (A+P), 3. SPM + Coir Pith Compost (CPC), 4. SPM + Biocontrol Agents (BA,) 5. Potting Mixture (PM) + recommended nutrients, 6. PM+ *Azospirillum* + *Phosphobacteria* (A+P), 7. PM+ Coir Pith Compost (CPC), 8. PM+ Biocontrol Agents (BA).

Observations on height, number of leaves, root length and total biomass per plant were recorded 3 months after planting. Leaf area per plant was estimated using the equation LA = L x W x 0.61 where LA=Leaf area, L=Length of leaves and W= width of leaves (Ibrahim *et al*. 1985). Areas of individual leaves were added together and average was calculated. The dry weight of stem, leaves and roots of ten plants was recorded randomly replication wise and added together to record total biomass. Nutrient status of leaves after 3 months of planting was estimated using standard procedures (Jackson 1973). After three month of growth 5 plants in each treatment were uprooted, roots were washed in water, plants were examined for rotting and lesions covered by Phythophtora and nematode infections. Severity of damage and number of plants infected were recorded. The data was subjected to statistical analysis after appropriate transformations (Panse & Sukhatme 1985).

Results and discussion

Response of rooted black pepper cuttings in different potting media indicated that solarized potting mixture registered more numbers of leaves, increased root length, leaf area and dry matter compared to plants raised in non solarized potting mixture (Table 1). There was a significant increase in number of leaves and length of roots in solarized potting mixture with recommended nutrients that was on par with plants raised in SPM with *Azospirillum* + *Phosphobacteria* and biocontrol agents. In the case of plants raised in nonsolarized potting mixture, application of biocontrol agents recorded maximum number of leaves, length of roots and leaf area that was on par with application *Azospirillum* +*Phosphobacteria.*

There was significant difference in leaf area due to application of different nursery mixtures, maximum being in SPM with recommended nutrients followed by SPM with (*Azospirillum* + *Phosphobacteria*). In the nonsolarized potting mixture, plants raised with application of bio control agents recorded maximum leaf area that was on par with the application of followed by the application of *Azospirillum* + *Phospho-bacteria*.

Total biomass was significantly higher in plants raised in solarized potting mixture compared to nonsolarized potting mixture (Fig. 1). Maximum dry matter (3.7g pl -1) was recorded by SPM with recommended nutrients treatment that was on par with SPM + (A+P) and SPM +BA.

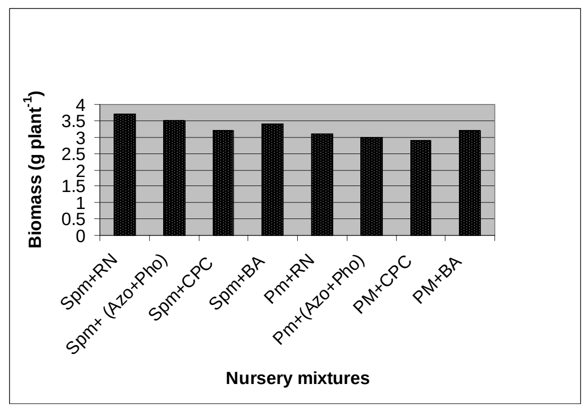

Fig1. Effect of solarized potting mixture on biomass of black pepper rooted cuttings

Table 1. Effect of solarized potting mixture on growth and disease incidence of black pepper rooted cuttings (3MAP)

Treatment	Height (cm)	Number of Leaves	Length of roots (cm)	Leaf Area (cm^2)	Rotting (%)		Lesion (%)	
SPM+ Recommended nutrients	35.93	5.30	20.0	177.0	26.67	(30.80)	20.0	(26.58)
SPM+ (A+P)	34.52	4.70	18.1	151.3	40.0	(38.86)	20.0	(26.58)
SPM + CPC	34.93	4.50	16.9	140.0	40.0	(38.86)	33.3	(35.01)
SPM + BA	35.82	4.70	18.5	138.0	33.3	(35.01)	26.7	(30.80)
PM + Recommended nutrients	30.20	3.90	16.2	125.4	40.0	(38.86)	40.0	(38.86)
PM+ (A+P)	31.46	4.00	15.7	142.6	53.3	(46.92)	46.7	(42.70)
PM+CPC	31.96	4.30	15.0	124.0	60.0	(50.77)	53.3	(46.92)
PM+BA	30.57	4.60	17.0	144.7	46.7	(43.07)	26.7	(30.80)
CD(0.05)	NS	0.68	4.8	18.5	12.45		13.11	

* Numbers in parenthesis indicate transformed values

A - Azospirillum, P- Phospho bacteria, CPC - Coir pith compost, SPM - Solarized potting mixture , BA- Bio control Agent, PM-Potting mixture, MAP-Month after planting.

Disease incidence

Though plants looked apparently healthy, the root region was found to be affected by P. capsici or nematodes. In general the incidence of rotting and lesion was more in ordinary potting mixture than solarized potting mixture. Among the treatments least incidence of rotting and lesions was noticed in plants raised with recommended nutrients. More rotting and nematode lesions were observed in potting mixture amended with CPC and *Azospirillum* + *Phosphobacteria*.

Results on nutrient status of the leaves (Table 2) showed that nutrient status was high for the plants raised in solarised potting mixture. Among the treatments maximum nutrient content (NPK) was observed for the treatment SPM + Recommended nutrients that was on par with SPM + (A+P). In the case of plants raised in nonsolarized potting mixture, maximum NPK content was observed for the treatment PM + Recommended nutrients followed by PM + Bio control agents.

Production cost of rooted black pepper cuttings was worked out for potting mixture with various treatments (Table 3). The highest production cost was observed for the treatment SPM + recommended nutrients whereas lowest production cost was noticed for SPM + bio control agents. Same trend in production cost was observed for the plants raised in potting mixture also.

Table 2. Nutrient status in the leaves of black pepper rooted cuttings.

Treatments	N (%)	P (%)	K (%)
SPM+ Recommended nutrients	3.1	0.21	1.36
SPM +(A+P)	2.8	0.19	1.27
SPM + CPC	2.6	0.19	1.21
SPM + BA	2.8	0.18	1.20
PM + recommended nutrients	2.1	0.17	1.28
PM+(A+P)	2.3	0.13	1.22
PM+CPC	2.0	0.13	1.19
PM+BA	2.2	0.15	1.29
CD (0.05)	0.57	0.06	0.1

A - *Azospirillum*, P- *Phosphobacteria*, CPC - Coir pith compost, SPM - Solarized potting mixture , BA- Biocontrol agent, PM-Potting mixture.

It is apparent that plants grown in solarized potting mixture had shown response and produced more growth namely number of leaves, root length, leaf area and bio mass. In this study temperature under polythene sheet rose up to 55° C compared to 30°C in the non solarized potting mixture. The high temperature along with high moisture content might have killed the soil borne mesophilic pathogens. Majority of the pathogens including P. capsici and nematode fall in the category of mesophilic microorganisms that require temperatures below 35°C for survival in soil. This was supported by the findings of Hrender Raj *et al.* (1997) in vegetables. In addition to control of pathogens and pests, soil solarization helps in increased mineralization of nutrients in soil and shifts the soil micro biota in favour of growth promoting types (Stapleton *et al.* 1985). Solarization has been found effective in controlling nematodes (Vilasini 1996). Plants raised in SPM with recommended nutrients had more dry matter production followed by application of Azospirillum and phosphobacteria. Better nutrition might have improved vigour of the plants and there by less susceptibility to disease. Disease management involves the practices directed to improve plant vigor and induce resistance through nutrition (Singh 1991). Pathogen free media in combination with high nutrient status and less disease incidence resulted in good growth of black pepper plants as evident in the Table 1 & 2. The increased growth parameters observed in SPM + (A+P) may be due to the increased up take of nitrogen, phosphorus and potash along with production of IAA, GA3 and cytokinins. Biofertilizer enhanced the growth, biomass and nutrient up take of black pepper (Bopaiah & Khader 1989; Kandiannan *et al.* 2000; Paul

Table 3. Production cost of 1000 rooted black pepper cuttings.

Media	Planting material (Rs)	Potting mixture& Nutrients /BF/BA (Rs)	Polythene bags (Rs)	Filling & planting (Rs)	Irrigation (Rs)	Solari-zation	Plant protectiom chemicals	Total (Rs)
SPM+RN	2000	780	330	350	300	172	-	3932
SPM+(A+P)	2000	600	330	350	300	172	-	3752
SPM+CPC	2000	675	330	350	300	172	-	3827
SPM+BA	2000	357	330	350	300	172	-	3509
PM+RN	2000	780	330	350	300	-	325	4085
PM+(A+P)	2000	600	330	350	300	-	125	3705
PM+CPC	2000	675	330	350	300	-	325	3980
PM+BA	2000	357	330	350	300	-	125	3462

SPM - Solarized potting mixture, RN - Recommended nutrients, A - Azospirillum,
PM-Potting mixture, CPC - Composted coir pith, BA -Biocontrol aent, BF-Biofertilizer.

et al., 2003). Growth of the plants raised in SPM with coir pith compost was relatively less. Coir pith has high water holding capacity and the medium is favorable for the growth of microorganism (Suharban 2004). This might have resulted in the growth of disease causing organism leading to increased rotting and poor growth as shown in Table 1. Less plant growth observed in non solarized potting mixture may be due to more disease incidence, and poor nutrient absorption as evident in Table No. 1 & 2. However plants raised with recommended nutrients and biocontrol agents had better dry matter due to good root growth resulting from better nutrient availability and due to less disease incidence.

Increase biomass production observed in the solarized potting mixture with recommended nutrients had 20% high compared to the treatment nonsolarized potting mixture + recommended nutrients. Considering the biomass production and less disease incidence, the technology of raising rooted cuttings in solarized potting mixture with recommended nutrients is found to be viable one for the production of vigorous rooted cuttings though the production cost is relatively higher than other treatments.

The utilization of renewable solar energy for disinfesting soil through soil solarization can be popularized among the nurseries. Besides cost effectiveness, the solarization can be easily practiced in pepper nurseries in tropical countries. The multitude of benefits such as improved nutrient status, decreased disease incidence and improved vigour can be achieved through this eco friendly soil disinfestation technology. Mixing of biofertilizer or biocontrol agents with solarized potting mixture may be taken as a technology for the production of vigorous rooted cuttings in organic agriculture.

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