Research Article

Journal of Plantation Crops, 2008, 36 (2): 123-126

Granite powder as a substitute for sand in nursery mixture for black pepper (*Piper nigrum* L)

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(Manuscript Received: 24-05-07, Revised: 03-10-07, Accepted: 28-05-08)

Abstract

Black pepper is commonly propagated through rooting of cuttings using potting mixture consisting of soil, sand, and farmyard manure in 2:1:1 proportion. Use of sand in potting mixture is uneconomical due to non-availability and cost of the material. Substituting sand with granite powder, a waste material obtained from stone quarries, is more economical. Rate of leaf production (4.6), leaf area (136.8 cm^2), and biomass (3.9 g) of black pepper rooted cuttings were higher for combinations of soil (S), granite powder (G) and farmyard manure (F) (SGF 2:1:1), followed by (SGF 1:1:1), soil, granite powder and coir pith compost (CPC) (SG CPC 1:1:1) and soil, granite powder, *Azospirillum* and *Phosphobacteria* (SG A+P 1:1:1). Production cost of rooted cuttings was less for SGF 2:1:1 and SGF 1:1:1 compared to control.

Keywords: Black pepper, granite powder, potting mixture, rooting

Introduction

Lack of quality planting material of black pepper is one of the major reasons for the low productivity in India (Sadanandan *et al.,* 1998). In order to meet the heavy demands of planting materials, rooted cuttings are being produced rapidly using bamboo method (Kandiannan *et al*., 1998; Thankamani *et al.,* 2004). Whatever may be the method of propagation; cuttings should be planted in good quality nursery mixture for better rooting, vigorous growth and for the production of pest and disease free plants.

Terra care (decomposed coir pith compost) can be successfully substituted for soil or sand in conventional nursery mixtures (soil, sand, FYM in 1:1:1 ratio) (Srinivasan and Hamza, 2000). But growth of the cuttings would be poor if the coir pith is not decomposed properly. Nowadays, use of sand in potting mixture is increasingly becoming difficult due to its non-availability and high cost. Granite powder, one of the waste materials that can be easily obtained from stone quarries, is more economical and can be a good substitute. An experiment was, therefore, carried out at Indian Institute of Spices Research (IISR) to find out whether sand can be replaced with granite powder in the potting mixture and its effect on the growth of rooted black pepper cuttings in polythene bags under nursery conditions.

Materials and Methods

The study was conducted at Indian Institute of Spices Research Experimental farm, Peruvannamuzhi during April- June and October-December, 2004 using an improved black pepper variety, Sreekara. The granite powder was obtained from Koovapoil, Perambra, Calicut, a local source. Nine treatments (Table 1) were included in the study laid out in completely randomized design (CRD) with three replications. Potting mixture as per the treatments was filled in polythene bags of 20 x 10 cm size, with 200-gauge thickness, which had a perforation at the bottom (10-12 holes). Physico chemical properties of potting mixture are listed in Table 1.

Healthy rooted single noded cuttings obtained from bamboo method of multiplication were used for planting in the polythene bags. In conventional method, (control) nutrient solution as per package of practice recommendation of IISR was added to the polythene bags at 1st, 2nd and 3rd month after planting. In the bio- fertilizer treatment, *Azospirillum* and *Phosphobacteria* (10^8cfu/ml) were applied @ 50 ml per bag at one month after planting in the polythene bags. Observations on height, number of leaves per plant and leaf area per plant were recorded at three months after planting in polythene bags. Destructive sampling was done at the end of the experiment to record the length of roots and total biomass. Leaf area per plant was estimated using the method suggested by Ibrahim *et al.* (1985). Areas of individual leaves were added together and average was worked out. Gas exchange parameters were monitored using LCA 4 photosynthesis system from ADC, England after three months growth. After the growth measurements, plants were cut at the basal portion and separated into roots, leaves and stem and dried in an oven at 60^0 C for 72 hours. The dry weight of stem, leaves and roots were recorded separately and added together to record total biomass. Nutrient status of potting mixtures and leaves three months after planting was estimated using standard procedures. The data was subjected to statistical analysis using the procedure of Panse and Sukhatme (1985).

Table 1. Physicochemical properties of nursery mixture (Pretreatment)

Treatments	Bulk Density (gm/cc)	Particle density (gm/cc)	WHC (%)	Pore space (%)	N (ppm)	P (ppm)	K (ppm)	C: N ratio
SSAF (control) 2:1:1	1.08	1.05	46.9	49.32	160.0	26.5	609	11.8
SGF 2:1:1	1.19	1.16	42.4	49.21	177.5	26.8	277	12.5
SGF 1:1:1	1.23	1.20	44.8	53.91	169.5	53.1	504	15.5
SGVC 2:1:1	1.12	1.09	50.4	55.10	189	16.4	403	16.9
SGCPC 2:1:1	1.09	1.07	46.9	50.06	140	12.6	492	10.9
SGCPC 1:1:1	1.13	1.11	43.6	48.58	143	12.4	319	15.4
SG (VC+CPC) 2:1:1	1.17	1.14	45.0	51.47	180	14.8	390	10.8
SG (A+P) 2:1	1.36	1.33	37.4	49.83	148.5	12.4	437	16.6
SG (A+P) 1:1	1.19	1.17	43.9	51.47	145.5	11.3	221	13.7
Granite powder	1.63	1.63	21.6	35.05	Traces	Traces	0.2	>40

S-Soil, G-Granite powder, F-Farmyard manure, VC-Vermicompost, CPC-Coir pith compost, A-*Azospirillum*, P-*Phosphobacteria*, SA-Sand, WHC- Water holding capacity.

Results and Discussion

The nursery mixtures tested significantly influenced the growth of black pepper cuttings except height and number of roots per cutting (Table 2). Leaf production was higher in all the treatments except SGVC 2:1:1. There was significant difference in leaf area due to the application of different nursery mixtures, maximum being in SGF 2:1:1 (136.8 cm^2), and was on par with SGF 1:1:1 and the least was recorded by SG CPC 2:1:1 (75.2 cm^2). The treatment SG CPC 1:1:1 recorded maximum root length (26 cm) and was on par with the SGVC 2:1:1, SG (VC +CPC) 2:1:1, SG (A+P) 1:1, SG (A+P) 2:1, SG CPC 2:1:1 and the least was recorded in control. Among the treatments, average root length was significantly higher for SG (A+P) 1:1, that was on par with SG (A+P) 2:1, SGF 1:1:1, SGF 2:1:1 and was the least in SG CPC 2:1:1.

Table 2. Effect of media involving granite powder as a nursery medium on growth parameters of black pepper cuttings (Mean of 2 experiments)

Treatments	Height (cm)	No. of Leaves	Leaf area (cm^2)/ plant	No. of roots	Length of roots (cm) Maximum	Average
SSAF (control)	27.5	4.1	107.2	9.17	18.17	17.17
SGF 2:1:1	32.1	4.6	136.8	11.58	22.90	17.93
SGF 1:1:1	31.2	4.5	133.7	10.79	21.08	18.17
SGVC 2:1:1	28.9	3.8	109.7	10.6	24.83	15.40
SGCPC 2:1:1	27.5	4.2	75.2	10.00	24.00	15.67
SGCPC 1:1:1	29.1	4.2	96.7	10.83	26.00	13.53
SG(VC+CPC) 2:1:1	27.4	4.6	101.0	10.00	25.67	14.17
SG(A+P) 2:1	29.9	4.6	94.0	12.00	22.92	18.67
SG (A+P) 1:1	27	4.2	108.2	11.0	23.33	18.83
CD (P = 0.05)	NS	0.64	22.95	NS	3.41	2.57

S-Soil, G-Granite powder, F-Farmyard manure, VC-Vermicompost, CPC-Coir pith compost, A-*Azospirillum*, P-*Phosphobacteria*. SA-Sand. NS – Not Significant

Total biomass was significantly higher for all the treatments compared to control (Figure 1). Among the treatments, SGF 2:1:1 recorded maximum biomass (3.9 g) and was on par with SGF 1:1:1, SG (VC + CPC) 2:1:1 and SG (A + P) 2:1.

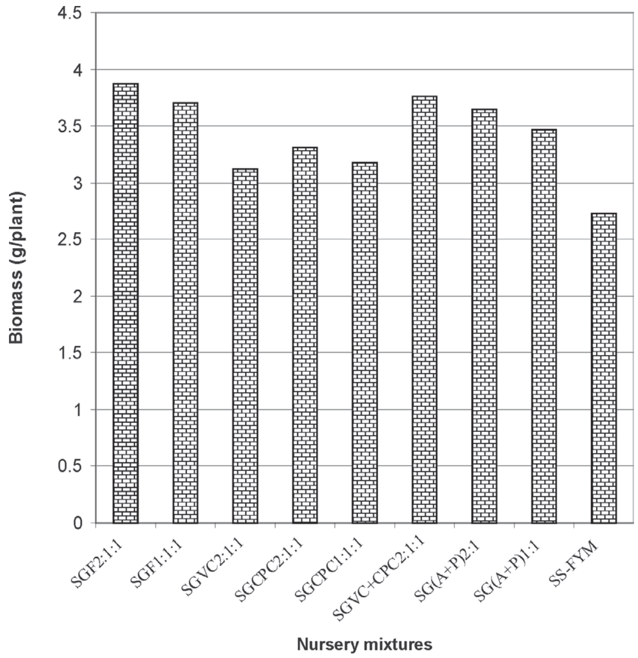

Fig. 1. Effect of media involving granite powder on biomass of black pepper cuttings.

The data on gas exchange parameters of rooted black pepper cuttings revealed significant increase in photosynthetic rate of cuttings for the treatment in which SGF was applied in 2:1:1 proportion, and was on par with SG (VC + CPC) 2:1:1, and the least was recorded in control. Effect of granite powder application on stomata conductance was not significant. The treatment, SGF 2:1:1 recorded maximum transpiration rate (2.43 µ moles), and was on par with SG VC 2:1:1; SGF 1:1:1 and SSAF. The least was recorded by SGCPC 2: 1:1. Maximum photosynthetic rate and stomatal conductance were associated with maximum growth of wheat seedlings (Fisher *et al.* 1998). Photosynthetic rate exhibited significant correlations with seedling dry matter in four tree species (Rawat and Singh, 2000).

Table 3. Effect of media involving granite powder on gas exchange parameters of black pepper rooted cuttings

Treatments	Photosynthetic rate (µ moles m^{-2} s^{-1})	Stomatal conductance (µ mol m^{-2} s^{-1})	Transpiration (m moles) (µ g cm^{-2} s^{-1})
SSAF (control)	2.47	0.07	1.82
SGF 2:1:1	3.83	0.08	2.43
SGF 1:1:1	3.10	0.07	2.01
SGVC 2:1:1	2.30	0.04	2.18
SGCPC 2:1:1	2.87	0.06	1.15
SGCPC 1:1:1	2.90	0.07	1.42
SG(VC+CPC) 2:1:1	3.67	0.07	1.72
SG (A+P) 2:1	3.00	0.07	1.69
SG (A+P) 1:1	2.87	0.06	1.40
CD (P=0.05)	0.59	NS	0.62

S-Soil, G-Granite powder, F-Farmyard manure, VC-Vermicompost, CPC- Coir pith compost, A-*Azospirillum*, P-*Phosphobacteria*. SA- Sand.

Results on plant nutrient composition (Table 4) showed that leaf phosphorus content was higher in SG (VC+CPC), and was on par with SG CPC 1:1:1. The highest potash concentration was observed for the treatment SGF 2:1:1 (4.2%), and was on par with SGF 1:1:1, SG VC 2:1:1, SG (A+P) 2:1, SG (A+P) 1:1 and control. Better performance of the seedlings grown in the medium SGF 2:1:1, SGF 1:1:1; SG (VC + CPC) 2:1:1, SG (A+P) 2:1:1 could be the result of higher nutrients in the leaf especially P and K. This was reflected in better growth of the crop. Regarding the soil nutrient availability, nitrogen content was significantly higher for all the treatments except SG (A+P) 1:1 (Table 4). Regarding the phosphorous content,

Table 4. Nutrient status of Leaf and potting media of black pepper rooted cuttings (3MAP)

Treatment	Leaf N%	Leaf P%	Leaf K%	Soil N(ppm)	Soil P(ppm)	Soil K(ppm)
SSAF	2.34	0.21	3.97	189.0	33.08	483.5
SGF 2:1:1	2.55	0.26	4.17	163.8	27.57	427.2
SGF 1:1:1	2.35	0.21	3.98	164.2	43.19	543.5
SGVC 2:1:1	2.48	0.22	3.97	213.5	39.69	542.5
SGCPC 2:1:1	2.37	0.21	3.66	200.0	42.48	415.2
SGCPC 1:1:1	2.47	0.34	3.95	167.7	19.05	251.2
SGVC+CPC 2:1:1	2.32	0.35	3.87	219.8	36.44	555.0
SG (A +P) 2:1	2.45	0.23	4.05	150.5	19.46	164.5
SG (A+P) 1:1	2.52	0.26	4.14	135.5	21.92	144.2
CD (P=0.05)	NS	0.09	0.21	71.41	7.37	175

S-Soil, G-Granite powder, F-Farmyard manure, VC-Vermicompost, CPC-Coir pith compost, A-*Azospirillum*, P-*Phosphobacteria*. SA-Sand, MAP - Month after planting

treatments SGF 1:1:1 and SG CPC 2:1:1, SG (VC+CPC) 2:1:1 were on par. Maximum potassium content was observed for the treatment SG (VC+CPC) 2:1:1. The production cost for 1000 rooted black pepper cuttings was calculated and shown in (Table 5).

.Table 5. Production cost of 1000 (nos) of rooted black pepper cuttings (Rs.)

ItemCost (Rs)	SSAF 2:1:1 (Control)	SGF 2:1:1	SGF 1:1:1	SGVC 2:1:1	SGCPC 2: 1:1	SGCPC 1:1:1	SGCPC+ VC 2:1:1 2:1	SG (A+P) 1:1	SG (A+P)
Potting mixture & Nutrients	681	414	502	1258	835	1051	1047	693	699
Polythene bags	330	330	330	330	330	330	330	330	330
Filling & planting	350	350	350	350	350	350	350	350	350
Irrigation	250	250	250	250	250	250	250	250	250
Cost of cuttings	2000	2000	2000	2000	2000	2000	2000	2000	2000
Total	3611	3344	3432	4188	3765	3981	3987	3523	3629

S-Soil, G-Granite powder, F-Farmyard manure, VC-Vermicompost, CPC-Coir pith compost, A-*Azospirillum*, P-*Phosphobacteria*. SA-Sand.

From the table, it is evident that production cost is less for the treatments SGF 2:1:1, SGF 1:1:1, SG (A +P) 2:1:1 compared to control (SSAF 2:1:1). The maximum production cost was observed for the treatment in which vermicompost was applied.

Biomass production was higher for the treatments SGF 2:1:1, SGF 1:1:1, SG (A+P), 2:1 and SG (VC+CPC) 2:1:1. The combination of granite powder with potting media, as is evident from Table 1 produced better porosity, has resulted in production of roots which reflected on more number of leaves and leaf area. It is possible that greater biomass accumulation has resulted from both greater leaf area and higher rate of carbon assimilation. Increased vigor of seedlings of *Casurina obesa* and *Eucalyptus gomphocephala* were observed due to application of granite powder compared to ordinary potting mixture (Oldfield, 2002). Significant increase in biomass of wheat was observed due to granite powder application (Hinsinger *et al*., 1995). Nutrient content in granite powder is more comparable to sand as is evident from the Table 2.Use of granite powder as ingredient in potting mixture has not been reported in Indian literature. Based on the available literature, granite powder contains SiO_2, MgO, FeO_2, Na_2O, Al_2O_3, K_2O, CaO, TiO_2 (Oldfield, 2002) but in the present experiment, only nitrogen, phosphorous and potash were analysed.

Biomass production of black pepper plants was high in medium consisting of SGF 2:1:1. Horwath *et al.* (2002) reported that Farmyard manure (FYM) contains significant amount of ammonium and nitrate that are readily available to crops. It is possible that FYM contained in SGF supplied these nutrients in readily available form resulting in better growth. It is also reported that FYM supported higher density of microbial biomass, soil aggregation, organic carbon, and total nitrogen and improve the quality and growth of crops (Agele *et al*., 2005).

Biofertilizer enhanced the growth, biomass and nutrient uptake of black pepper (Bopaiah and Khader 1989; Kandiannan *et al*., 2000). In the present investigation also, increased growth parameters observed in (SG A+P) 2:1:1. Biofertilizers are known to increase the uptake of nitrogen, phosphorus and potassium along with production of growth hormones and cytokinins by microbes which enhance the growth and vigour of plants (Baliah *et al*., 2003; Paul *et al*., 2003).

The growth in general was less for the treatments consisted of conventional potting mixture. This may be due to less number of roots, height and leaf area. Regarding the production cost and biomass, SGF 2:1:1, SGF 1:1:1, are better for producing healthy rooted black pepper cuttings at a low cost of production. Since SGF 2:1:1 gives better output both in terms of seedlings biomass production and production cost, it may be considered for commercial adoption.

The results showed that granite powder could be successfully substituted for sand in conventional nursery mixture and can be used in areas where availability of sand is scarce and uneconomical. Use of granite powder alone in polythene bags will cause hardening of the mixture due to depletion of moisture, resulting in less anchorage of plants to the medium and hence its use singly is not advisable.

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