Short communication

Effects of growing media on seedlings characteristics of patula pine (*Pinus patula* Schlecht. et Cham.) in Swaziland

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Abstract

Pinus patula Schlecht. et Cham. seedlings were grown in six growth media in Swaziland to assess the effects of growing media on seedling characteristics. The experiment was laid out in a randomized complete block design with four replications and six treatments (pine bark compost; Super medium, a commercial nursery medium; pine sawdust; topsoil; cattle manure; and bagasse). Pine-bark compost (seedling height, 18.7 cm), Super medium (height, 18.6 cm), and topsoil (height, 13.4 cm) produced significantly ($p < 0.05$) taller seedlings than other growth media. Owing to their superior performance, pine bark compost and Super medium are recommended as growing medium in the pine nurseries of Swaziland.

Keywords: Nursery media, Organic media, Pine-bark compost.

Pinus patula Schlecht. et Cham., commonly known as Mexican yellow pine, *jelecote* pine, patula pine, *pinheiro de jelecote*, *pinheiro patula*, is native to central and eastern Mexico, where it is found at elevations of 1,400 to 3,200 m. It is a moderately frost-resistant pine, reaching a height of 20 to 30 m, usually with straight and cylindrical boles, but sometimes forked. In Swaziland, *P. patula* is used for the production of both timber and pulp (for local sawmills as well as for export). As a result, area under *P. patula* plantations is expanding, which calls for production of good quality planting stock. Soil-less growing media have long been recognized as superior to soil-based alternatives, which are generally peat moss-based or bark-based. The advantages of soil-less growing media include its low cost, consistency, uniformity, transportation efficiency, and a more suitable air-water relationship, which facilitate optimal plant growth (Anonymous, 2010). Although several locally available organic substances are used as growing media in pine nurseries, only composted pine bark has been widely accepted in Swaziland. It is, however, not clear what effects different growing media could have on growth and development of pine seedlings in Swaziland. Therefore, an experiment was conducted to determine the effects of locally available organic substances on the seedlings characteristics of *P. patula*, and thus determine the best growing medium for use in pine nurseries.

The experiment was carried out in a shade house (3.0 m long, 3.0 m wide, and 2.0 m high) at the Crop Production Department Farm in Luyengo Campus (26.57°S; 31.02°E; 732.5 m altitude; and 800 to 1,000 mm annual rainfall) of the University of Swaziland, in the Middleveld ecological zone. Six growing media were used: pine-bark compost (Vickery Company in Malkerns, Luyengo); Super medium (prepared by mixing poultry manure with composted pine-bark in ratios of 1:23); pine sawdust (from Bhunya where SAPPI Usuthu has a wood and pulp mill); topsoil (from pine forest at Mtimane, 1.0 m^2 and up to 25-30 cm depth); cattle manure (from Dairy Farm, Luyengo Campus); and bagasse (Simunye Sugar mill).

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Representative samples of the growing medium were analyzed for bulk density, particle density, and porosity (Table 1). White SAPPI polyvinyl chloride (PVC) trays (340 mm long, 340 mm wide, and 80 mm high) were used to hold the growing media in which the pine seeds were sown. Each PVC tray had 49 round cavities of 40 mm diameter, 80 mm depth, and a volume of 80 ml. Twenty four trays (one tray per treatment) were used and were placed on a 1.2 m high surface. The experimental design was a randomized complete block design with four replications and was conducted for 16 weeks (November 2009 to March 2010), consistent with the duration of raising nursery seedlings at SAPPI nursery during the summer months. After seedling emergence, five seedlings per tray excluding the border rows were randomly selected and tagged for periodic biometric observations. Starting from four weeks after planting (WAP), seedling height, stem diameter, number of branches per seedling, number of primary needles per seedling, leaf colour, root-shoot ratio of seedlings, and dry mass (DM). Differences in needle leaf colour were ascertained using a leaf colour score range of 1 to 5 (Edje and Ossom, 2009). On this scale, the descriptions of the colour scores were: 1, yellow; 2, yellow-green; 3, light-green; 4, green; and 5, very green. Length-based root-shoot ratio was determined at 16 WAP (Anonymous, 2009). To measure DM at 16 WAP, seedlings were removed from the growing media and oven-dried (75°C) overnight and weighed (Anonymous, 2009). Routine management practices carried out included watering, fertilizer application, and management of weeds, insect pests, and diseases. Watering was done on a daily basis, using a 5 L watering can, fitted with a sprinkler funnel, during mid-day to avoid continuous wet conditions, as this could encourage susceptibility of the seedlings to fungal diseases. On each occasion, the growing media were watered to field capacity. A compound fertilizer [2:3:2 (22)] containing 0.5% zinc was applied at a rate of 8 g per tray, once a week during the first three months, and thereafter, once every two weeks, as recommended. Data were analyzed using MSTAT-C statistical program, version 1.3 (Nissen, 1983) and the means were separated using Duncan's Multiple Range Test ($p < 0.05$).

As can be seen from Table 2, seedlings grown in pine bark compost, Super medium and topsoil were significantly ($p < 0.05$) taller than seedlings established on other growth media. Both pine-bark compost and Super medium had a significantly ($p < 0.05$) higher number of branches per seedling compared to other growing media. Seedlings established on Super medium also had significantly ($p < 0.05$) higher number of primary needles, although the number of needles did not significantly differ from those of seedlings grown on pine bark. Pine bark compost (mean leaf colour score, 4.3 out of 5.0), Super medium (score, 4.2 out of 5.0), and topsoil (score, 4.2 out of 5.0) produced significantly ($p < 0.05$) greener leaves on seedlings than other treatments. Seedlings established on pine-bark compost and Super medium had significantly ($p < 0.05$) greater DM than those on other growing media.

The seedlings established in the different media (except for those in cattle manure), were suitable for transplanting. The mean seedling height attained in this experiment was consistent with the pine industry recommendations. Mean root-shoot ratios (0.4 to 0.6) also conformed to the recommended range of 0.4 to 1.0 for pine seedlings. Among the substrates, pine-bark compost and Super medium produced robust and greener seedlings, with well developed primary needles, presumably because of their favourable physical properties (Table 1). Jones et al. (2002) observed that pine seedlings, which developed primary needles, had a greater shoot growth potential after planting because of increased stem units in their buds. Topsoil and cattle manure had the highest bulk density (topsoil, 0.26 $g \cdot cm^{-3}$; cattle manure 0.19 $g \cdot cm^{-3}$), which may be a negative factor in the widespread use of these materials. Super medium is a more nutritive (though slightly more expensive) alternative to pine bark compost in commercially produced pine seedlings because chicken manure is incorporated in it. It is recommended that pine nurseries use Super medium or pine-bark compost as the growing medium.

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Table 1. Physical properties of the growing media.

Growing medium	Physical properties at start of experiment		
	Bulk density ($g cm^{-3}$)	Particle density ($g cm^{-3}$)	Porosity (%)
Pine bark compost	0.16	1.0	84.0
Super medium	0.17	0.7	75.0
Pine sawdust	0.11	1.0	89.0
Topsoil	0.26	2.5	89.6
Cattle manure	0.19	1.6	88.1
Bagasse	0.04	0.4	90.0

Table 2. Mean data per pine seedling at 16 weeks after planting in Swaziland.

Growing media	Plant height (cm)	Number of branches	Number of primary needles	Leaf colour	Root-shoot ratio	Dry mass (g)
Pine bark compost	9.3^{c}	3.9^{b}	17.0^{cd}	4.3^{c}	0.4^{a}	7.3^{d}
Super medium	9.7^{c}	4.8^{b}	18.7^{d}	4.2^{bc}	0.4^{a}	7.0^{d}
Pine sawdust	6.9^{ab}	2.1^{a}	7.7^{ab}	3.8^{b}	0.6^{a}	4.2^{b}
Topsoil	7.7^{b}	2.1^{a}	11.7^{bc}	4.2^{bc}	0.5^{a}	4.7^{bc}
Cattle manure	5.9^{a}	0.8^{a}	3.2^{a}	2.9^{a}	0.5^{a}	2.4^{a}
Bagasse	6.6^{a}	2.1^{a}	6.4^{ab}	3.8^{b}	0.5^{a}	3.1^{ab}

Numbers followed by the same letters in the same column are not significant at $p > 0.05$.

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