SAWDUST FOR GROWING CONTAINERIZED FOREST TREE SEEDLINGS[1]

Old sawdust and peatlite produced seedlings of equal quality, new sawdust reduced growth substantially. Seedlings in greenhouses with organic floors were taller than those over gravel floors.

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Disposal of lumber mill waste products has become a problem in recent years because new laws restrict burning. Disposal of vast quantities of waste materials in New Mexico is a serious problem, especially to small mills (*7*). Wood residues (i.e., sawdust and bark) have been successfully used in containers for growing ornamentals (*6, 8*). Utilization of wood residues in growing containerized tree seedlings would reduce the disposal problem. Nursery production costs might also be reduced, since peat moss is becoming less available and more expensive.

Several studies have compared growth and survival of seedlings produced in various organic media. Mixtures of peat and vermiculite (peatlite) have consistently produced high-quality seedlings with good survival potential (*10, 11*). Unfortunately, peat is expensive and is sometimes difficult to obtain. However, sawdust is readily available to many nurseries and could be used if it were shown to be a suitable growth medium.

Growing seedlings in containers presents watering, fertilizing, and handling problems not common to field production. The following characteristics, therefore, should be considered in selection of a container mixture: Air capacity and drainage, water-holding capacity, cation-exchange capacity (CEC), weight, shrinkage, and freedom from pests and toxic substances. Availability, cost, and variability of the growing media should also be considered.

Although by nature low in mineral nutrients (*3*), bark and sawdust greatly exceed soil in ability to hold and release applied nutrients to growing plants (*3,10*). The CEC of bark is generally less than peat when fresh (*10*), but may exceed peat after composting (*5*).

Micro-organisms involved in decomposition of wood residues are more efficient than higher plants in nitrogen absorption and assimilation (*1*). Large amounts of nitrogen must, therefore, be added to wood residues used as media to grow plants. This problem can be solved, however, by composting residues before using them for potting (*14*). Wood residues contain all the minor elements essential to plant growth (*5*).

Sawdust and bark are heavier than peat, and may hold slightly more available water (*10*). Shrinkage or compaction of organic media in containers may cause problems of aeration (*12*). Most sawdust shrinkage can be eliminated by composting. Peat shrinkage is controlled less easily, since this occurs after it has been fluffed during removal from the bale.

Peat often contains weed seed, pathogens, nematodes, and excess soluble salts (*12*). Wood residues may contain root rot fungi and growth inhibitors (*2, 16*). However, composted wood residues have shown little or no inhibitory effect (*13*). Phytotoxins resulting from both plant excretions and residual decomposition are rapidly metabolized by micro-organisms into non-toxic forms (*15*).

Seedling growth can be increased by raising the CO_2 concentration in the greenhouse above ambient levels (*13*); and many nurseries use commercial CO_2 generators for this purpose. Possibly a greenhouse floor of decomposing wood residue could be used for CO_2 enrichment. This would conserve energy and utilize a waste product.

In New Mexico, sawmill waste comes primarily from ponderosa pine *(Pinus ponderosa* Laws), Douglas-fir *(Pseudotsuga menziesii* (Mirb). Franco), and white fir *(Abies concolor* (Gord. and Glend. Lindl.)) (7). The purpose of this study was to determine the feasibility of using sawdust from these combined species for a container medium and CO_2 generator.

Materials and Methods

White fir seed were sown in Spencer-Lemaire book planters (30 in^3) in the spring of 1975. Five organic substrates were used: 1) Old sawdust; 2) new sawdust; 3) old sawdust and soil, 3:1 v/v; 4) old sawdust and forest duff, 3:1 v/v; 5) peat and vermiculite, 1:1 v/v. All seeds were covered with 1-cm layer of perlite. The study involved three greenhouse compartments, each with one of the following floor coverings: 1) New sawdust, 2) new bark, and 3) 1/2-inch (1.3 cm) washed gravel.

Mixed sawdust was obtained from a sawmill near Mora, N. Mex. New sawdust was about 1 month old and light yellow. Old sawdust had been piled at the mill site for about 15 years. Sawdust used for growing the seedlings was sieved through a 1 /4-inch (0.63 cm) mesh screen

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to obtain particles which ranged in size from 1 mm to 5 mm. New bark for the floor was 1 month old and particles ranged up to 7 cm in length. Bark and sawdust floors were spread to a uniform thickness of 7 cm.

Forest duff, amorphous and dark brown to black, was collected from a A_1 horizon of a white fir stand at 7,600 feet. The soil was a clay loam (pH 6.5) containing 2.5 percent organic matter. The peat moss (pH 5.5) and vermiculite were used at fine grind.

Trees were watered daily and fertilized twice a week with a complete nutrient solution. During the fast-growth phase (i.e., May to December) trees were fertilized with high N (225 ppm), low P (30 ppm), and low K (20 ppm). During the hardening-off phase (December to March), trees received low N (42 ppm), high P (80 ppm), and high K (120 ppm). Nitrogen sources were potassium nitrate, calcium nitrate, and ammonium nitrate. Phosphorus was applied as phosphoric acid and iron as Fe-EDTA (Sequestrene 138). Electrical conductivity of container media was measured with a whitestone bridge and maintained at 2.0 milliohms and adjusted to pH 6 with phosphoric acid.

During the fast-growth phase temperatures ranged from 15° to 18° C (day) and 18° to 21° C (night). Hardening-off temperatures ranged from 16° to 21° C (day) and 0° to 7° C (night). Humidity range was 30 to 40 percent. Seedlings received 16 hours of supplementary incandescent light from July to December.

The experimental design was a split-plot with 3 replications. Main plots were the greenhouse compartments and sub-plots were container media. Significant treatment means were separated by Duncan's multiple range test (*4*).

Each sub-plot was comprised of 32 seedlings. After 11 months of growth, 10 trees from each treatment in each replication were randomly selected and measured for height, stem caliper, and dry weight of shoots and roots. Seedlings were washed to remove potting media and oven-dried at 55° C for 24 hours before weighing.

Table 1.—*Height of 11-month-old white fir seedling grown with three different greenhouse floor coverings and growth substrates (mean values of 30 seedlings per treatment)*

	Height		
Substrates	Sawdust floor[1]	Bark floor[1]	Gravel floor[1]
	cm		
3 old sawdust:1 soil	18.25 c	17.58 c	13.87 b
3 old sawdust:1 duff	14.18 b	15.53 b	14.14 b
1 peat:1 vermiculite	19.11 c	17.59 c	14.60 b
Old sawdust	19.19 c	20.77 c	14.69 b
New sawdust	3.61 a	3.46 a	3.88 a
Greenhouse means[2]	14.87 b	14.99 b	12.22 a

[1] Substrate means followed by the same letter within a column are not significantly different at the .01 level of probability.
[2] Greenhouse means followed by the same letter are not significantly different at the .05 level of probability.

Table 2.—*Root collar diameter of 11-month-old white fir seedlings grown with three different greenhouse floor coverings and growth substrates (mean value of 30 seedlings per treatment)*

	Root Collar Diameter		
Substrates	Sawdust floor[1]	Bark floor[1]	Gravel floor[1]
	mm		
3 old sawdust:1 soil	3.8 b	3.7 b	4.0 b
3 old sawdust:1 duff	3.9 b	4.0 b	4.0 b
1 peat:1 vermiculite	4.5 b	4.4 b	4.5 b
Old sawdust	4.2 b	4.4 b	4.2 b
New sawdust	1.3 a	1.3 a	1.6 a
Greenhouse means (N.S.)	3.5	3.6	3.8

[1] Substrate means followed by the same letter within a column are not significantly different at the .01 level of probability.

Results and Discussion

Old sawdust and peatlite substrates produced trees of equal quality (tables 1, 2, and 5). Although dry weight of roots tended to be greater in peatlite, differences were not significant (table 4). Amending old sawdust with soil or forest duff was of no benefit. In fact, trees growing in old sawdust plus duff tended to be smaller (table 1). New sawdust greatly inhibited growth (tables 3 and 4). Observations showed that peatlite root plugs were more easily extracted from the growing medium than were those in old sawdust. Roots of plants grown in new sawdust were insufficient to form a plug.

There were no significant measurable differences among seedlings in weight or collar diameter produced in the greenhouse compartments with the three floor coverings (tables 2, 3, and 4). However, at the 0.05 level of probability, seedlings grown over an organic mulched floor were significantly taller than those grown over gravel (table 1). The gain in height from organic floors was most noticeable for seedlings grown in old sawdust or peatlite. For example, seedlings grown in old sawdust were 41 percent taller when grown over bark than when grown over gravel.

No mycorrhizal growth was observed on any of the tree roots. Inoculation with forest duff was of no benefit. It is quite possible the high fertility levels used in the study inhibited development of mycorrhizae. Roots growing rapidly in media having high fertility may actually outgrow their fungal symbionts (*9*).

Table 3.—*Shoot dry weight of 11-monthold white fir seedlings grown with three different greenhouse floor coverings and substrates (mean value of 30 seedlings per treatment)*

	Shoot Dry Weight		
Substrates	Sawdust floor[1]	Bark floor[1]	Gravel floor[1]
	Gms		
3 old sawdust:1 soil	10.88 b	11.38 b	10.48 b
3 old sawdust:1 duff	10.51 b	10.33 b	10.83 b
1 peat:1 fermiculite	11.32 b	11.29 b	10.69 b
Old sawdust	13.67 b	11.26 b	10.83 b
New sawdust	4.89 a	3.51 a	3.90 a
Greenhouse means (N.S.)	10.25	9.55	9.35

[1] Substrate means followed by the same letter within a column are not significantly different at the .01 level of probability.

Table 4.—*Root dry weights of 11-month-old white fir seedlings grown with three different greenhouse floor coverings and growth substrates (mean value of 30 seedlings per treatment)*

	Root Dry Weight		
Substrates	Sawdust floor[1]	Bark floor[1]	Gravel floor[1]
	Gms		
3 old sawdust:1 soil	13.57 b	24.36 b	13.82 b
3 old sawdust:1 duff	12.62 b	20.29 b	16.58 b
1 peat:1 vermiculite	17.82 b	23.27 b	20.91 b
Old sawdust	13.38 b	16.83 b	18.11 b
New sawdust	6.54 a	4.25 a	16.17 a
Greenhouse means (N.S.)	12.12	17.14	15.92

[1] Substrate means followed by the same letter within a column are not significantly different at the .01 level of probability.

Conclusions

Seedlings growing in old sawdust are equal in quality to those produced in peatlite. Nurserymen having access to aged sawdust could consider it a logical alternative to peatlite. Where old sawdust is not available, fresh sawdust could be composted. Use of sawdust for growing seedlings should reduce nursery production costs and help dispose of lumber mill waste products.

Table 5.—*Shoot:root ratio (dry weight) of 11-month-old white fir seedlings grown with three different greenhouse floor coverings and give growth substrates (mean value of 30 seedlings per treatment)*

Substrates	Dry Weight Shoot:Root Ratio		
	Sawdust floor[1]	Bark floor[1]	Gravel floor[1]
	- - - - - - -	*Gms*	- - - - - - -
3 old sawdust:1 soil	2.28 c	2.24 c	1.84 b
3 old sawdust:1 duff	1.59 b	1.87 b	1.68 b
1 peat:1 vermiculite	2.10 bc	2.20 bc	1.81 b
Old sawdust	1.67 b	2.43 c	1.97 b
New sawdust	0.90 a	0.88 a	1.02 a
Greenhouse means (N.S.)	1.71	1.92	1.66

[1] Substrate means followed by the same letter within a column are not significantly different at the .01 level of probability.

Old sawdust does not require sterilization or large quantities of added nitrogen to compensate for microbial action. It is much lighter weight than soil and provides high water-holding capacity and good aeration. Changes in its physical and chemical properties appear negligible over the time required to grow a seedling crop.

Because seedlings grown over decomposing sawdust and bark were taller than those grown over gravel, the labor required to maintain a relatively fresh floor may be justified. While preliminary unpublished results by one author (Donald J . Cotter) has shown that a CO_2 enrichment equal to twice ambient air can occur around tomatoes growing in bark, further study is needed to accurately determine actual CO_2 concentrations over the organic mulched floors.

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