Influence of Media Components on Efficacy of Paclobutrazol in Inhibiting Growth of Broccoli and Petunia

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Abstract. **Three experiments were conducted to evaluate media component effects on paclobutrazol activity. In Expts. 1 and 2, a broccoli (*Brassica oleracea* var. *botrytis* L.) seedling bioassay was used to compare the activity of paclobutrazol at six concentrations (0–0.32 mg·L⁻¹). Results from Expt. 1 indicated that an average of 4-, 5-, and 10-fold higher concentrations were required in old composted pine bark, fresh pine bark, and composted pine bark samples, respectively, to achieve the same activity observed in sphagnum peatmoss (peat) samples. Activity in coir was similar to that in peat while activity in vermiculite and perlite was greater than that in peat. Activity in a fibrous peat sample was greater than in two less-fibrous peat samples. Results from Expt. 2 indicated that paclobutrazol activity was reduced more in the fine (<2 mm) fraction of fresh and composted bark samples than in medium (2–4 mm) or coarse (>4 mm) fractions. In Expt. 3, petunia (*Petunia hybrida* Vilm. 'Madness Red') was grown in a mixture of either 60% composted pine bark : 0% peat or 0% composted bark : 60% peat. The paclobutrazol concentration required to achieve the same size control was 14 times higher in the former mixture than in the latter. Thus, media components differ greatly in their influence on paclobutrazol activity and the bioassay procedure may serve as a useful tool for predicting media–paclobutrazol interactions. Chemical name used: (±)-(R*,R*)-β-[(4-chlorophenyl)methyl]-α-(1,1-dimethyl)-1H-1,2,4-triazole-1-ethanol (paclobutrazol).**

Media components affect the efficacy of growth retardant drenches. Several-fold higher concentrations of ancymidol were required to provide the same degree of height control for chrysanthemums (*Dendranthema ×grandiflorum* Kitam.) in a pine-bark humus medium as in a medium without bark (Bonaminio and Larson, 1978). Ancymidol activity in a soil–sand mix was about double that in a bark–sand mix (Tschabold et al., 1975). A paclobutrazol drench application on chrysanthemums reduced plant height 31% in a peat-based medium but only 14% in a bark-based medium (Barrett, 1982). However, the effect of a drench of paclobutrazol (250 mg/pot) applied to poinsettias (*Euphorbia pulcherrima* Willd. Klotzsch) grown in bark-based commercial media differed little from that observed in media not containing bark (Newman and Tant, 1995). In this study, untreated plants were considerably shorter when grown in the peat-based media than in the bark-based media, thereby making comparisons between media difficult.

Pine bark is a common component in horticultural media. Although pine bark has a relatively low cellulose content compared with most hardwood barks (5% vs. 25% to 45%), it is typically composted to reduce cellulose content, thereby improving stability and reducing potential N immobilization problems (McElhannon, 1995). Airhart et al. (1978) noted large internal micropore spaces in processed pine bark, which may contribute to water and nutrient retention capacities greater than would be expected from its particle size alone. Adsorption of growth regulators onto the nonpolar, hydrophobic surfaces of bark has been suggested as a reason for reduced activity of these chemicals when media contain bark (Barrett, 1982).

Past research has been limited to establishing that the presence of pine bark in container media reduces the activity of growth retardants. The objective of this study was to evaluate the influence of media component type,

variability within component source, and particle-size fraction of media component on the efficacy of paclobutrazol.

Materials and Methods

Effects of media components and source variability (Expt. 1). Twenty different media component samples were evaluated in this trial (Table 1). Horticultural vermiculite was obtained from Verlite (Tampa, Fla.), and perlite (Aero-soil) from ChemRock (Nashville), while coir, pine bark and peat components were obtained from Fafard (Apopka, Fla.). Coir, which was received as a compressed bale, was soaked overnight in water to break up the bale and then set out to dry for 1 d. Three different sphagnum peatmoss sources (PT) representing three different bog mines in Canada were taken from commercial compressed bales. Peats from the first two sources, PT1 from the Inkerman bog and PT2 from the Lameque bog, were both less fibrous than that from the third source, PT3 from the Milot bog (Bob Steinkamp, personal comm.). Four samples of nondecomposed bark or "fresh bark" (FB), four samples of composted pine bark (CB), and six samples of "old" composted bark (OCB) were collected at the Fafard plant over a 6-week period (Jan. to Mar. 1996). The CB had been composted naturally for 9–12 months, while the OCB was mined from aging 10- to 20-year-old piles of pine bark at a local mill (Bob Steinkamp, personal comm.). The OCB samples contained 40% to 52% sand on a dry mass basis. Density after heating for 24 h at 65 °C and pH 1:2 (v/v) of these components are given in Table 1.

Batches (8 L) of each component were limed to pH 6 with Ca(OH)₂ in amounts listed in Table 1. Each batch was moistened with 400 mL of water containing 600 mg·L⁻¹ of the wetting agent AquaGro 2000L (Aquatrols, Cherry Hill, N.J.). Because of differences in initial moisture content, additional predetermined volumes of water were added to moisten each component. After 3 d, each component was mixed 1:1 (v/v) with vermiculite in six 2-L batches. Six concentrations of paclobutrazol ranging from 0 to 3.2 mg·L⁻¹ were applied in 200-mL volumes to 2-L batches of component samples.

After mixing in polyethylene bags, the treated samples were added to 7.6-cm (220-mL) pots. 'Waltham 29' broccoli seeds (15 seeds per pot) were sown and covered with 30 mL of vermiculite (≈0.4-cm layer). The pots

Table 1. Selected characteristics of components evaluated in Expt. 1.

Component	No. samples	Unlimed pHᶻ	Lime requirement (g·L⁻¹)ᶻ	Densityʸ (g·L⁻¹)ᶻ	Percentʸ sand
Vermiculite	1	6.2	0.0	130	---
Perlite	1	7.1	0.0	120	---
Coir	1	6.0	0.0	70	---
Sphagnum peatmoss	1	4.1	2.4	60	---
Fresh pine bark	4	4.9	0.9	170	---
Composted pine bark	4	5.3	1.0	220	---
Old composted pine bark	6	7.1	0.0	260	45

ᶻCa(OH)₂ required to raise the component pH to 6.0.
ʸDry mass basis.

were misted lightly to moisten the surface and placed in trays containing 1–2 cm of nutrient solution (20N–4.4P–16.6K with minor elements; O.M. Scott, Marysville, Ohio), with N at 150 mg·L⁻¹. Average minimum and maximum daily temperatures were 19 and 26 °C with average maximum light levels of 400 μmol·m⁻²·s⁻¹. Seedlings were thinned to nine per pot 5 d after planting. After 14 d, seedlings were cut at the surface of the media and the length of the hypocotyl was measured to the nearest 0.1 cm. Hypocotyl length was calculated as a percentage of the control. The experimental design was a randomized complete-block design with four blocks and nine seedlings per block (pot). Nonlinear regression using PROC NLIN (Statistical Analysis System Institute, 1987) was used to fit exponential decay curve equations to the data. By reparameterizing the nonlinear model, predicted paclobutrazol concentrations resulting in 50% reduction in hypocotyl length (PC50) were determined, along with upper and lower 50% confidence levels.

Effect of particle size (Expt. 2). Component samples PT2, FB1, and CB1 from Expt. 1 were separated into fine, medium, and coarse fractions. The fine fraction was any material that passed through a 2-mm screen after 1 min of vigorous shaking by hand. The medium fraction passed through a 4-mm screen, but was retained on a 2-mm screen. The coarse fraction was retained on a 4-mm screen. The percentage distribution of sample dry mass into the fine, medium, and coarse fractions, respectively, was 30%, 28%, and 42% for FB1; 54%, 22%, and 24% for PT2; and 34%, 21%, and 45% for CB1.

To compare the activity of paclobutrazol in each of the different fractions, the bioassay procedure described in Expt. 1 was followed except that a sixth concentration of paclobutrazol (0.01 mg·L⁻¹) was added. The bioassay was arranged in three blocks with 10 seedlings per block. Average minimum and maximum temperatures were 18 and 23 °C. Growth relative to the control was calculated separately for each screen fraction. Nonlinear regression analysis was performed as described in Expt. 1.

Effects of peat–bark mixtures on drench efficacy (Expt. 3) The following four media treatments were mixed on a volume basis: 1) 60%PT : 0%CB, 2) 40PT : 20%CB, 3) 20%PT : 40%CB, 4) 0%PT : 60%CB. The remaining 40% of each medium consisted of 20% vermiculite and 20% perlite. Sphagnum peatmoss PT2 and composted pine bark CB1 were used. Both components were limed prior to preparing the four media, which were placed in 10.1-cm (220-mL) pots and watered-in with a 600 mg·L⁻¹ solution of AquaGro 2000L wetting agent.

'Madness Red' petunia was planted, one plug per pot, on 9 Apr. 1996. Plants were fertilized at every watering with a nutrient solution (20N–4.4P–16.6K with minor elements; O.M. Scott) containing N at 150 mg·L⁻¹. Average daily minimum and maximum temperatures were 19 and 27 °C. On 18 Apr., 9 d after planting, pots were drenched with 60-mL

of paclobutrazol at concentrations of 0, 0.2, 0.4, 0.8, 1.6, or 3.2 mg·L⁻¹. Plant height and width (average of two perpendicular diameters) were measured at the time of treatment and 2 weeks later. Size was calculated as (width + height)/2. The experiment was a randomized complete-block design with three blocks and four plants per block.

Results

Effects of media components and source variability (Expt. 1). Media components greatly affected the response of broccoli seedlings to paclobutrazol (Table 2). Interaction between media component and paclobutrazol concentration was significant at $P < 0.0001$. Therefore, the response to concentration is presented for each media component.

Growth of control (no paclobutrazol) seedlings was not greatly affected by the organic media components tested. In contrast, seedlings grown in nontreated vermiculite and perlite were significantly shorter than those grown in the organic components, making a dose : response comparison between these two inorganic components and the rest of the organic components more difficult to interpret.

The decay constant in the exponential decay curves used to describe the dose : response of each media component to paclobutrazol (Table 3) is a measure of the rate at which seedling growth declined as paclobutrazol concentration increased. The decay constants for vermiculite and perlite were significantly greater than those for all organic components except PT3. Greater decay constants indicate that vermiculite and perlite exhibited relatively little capacity for reducing paclobutrazol activity.

Of the organic materials, sphagnum

peatmoss and coir reduced paclobutrazol activity less than did the bark components. The decay constants for PT1 and PT2 were smaller than that for PT3. Therefore, PT1 and PT2 were more effective than the more fibrous peat PT3 in reducing the bioassay activity of paclobutrazol. According to PC50 values (Table 3), paclobutrazol in PT3 was twice as effective as in PT2 and three times as effective as in PT1. The dose : response in coir was similar to that in PT2.

Bark components reduced the activity of paclobutrazol more than did sphagnum peatmoss or coir (Fig. 1). Of the bark types, CB reduced paclobutrazol activity most. Fresh pine bark samples produced a dose : response that was between CB and OCB. The PC50 values (Table 3) averaged 0.016, 0.060, 0.078, and 0.164 mg·L⁻¹ for PT, OCB, FB, and CB, respectively. Thus an average of ≈4-, 5-, and 10-fold higher media paclobutrazol concentrations were required in OCB, FB, and CB, respectively, than in PT to achieve 50% inhibition of growth.

Variation in response existed within samples of bark types. Among the fresh bark samples, paclobutrazol was more active in FB3 than in the other three sources tested. The PC50 value for FB3 was 41% lower than the average for the other three fresh bark samples. Response curves for OCB samples exhibited somewhat less variation. Of the six samples, OCB1 had the lowest PC50 and OCB3 the highest, but the difference was only 28%. Among the four CB samples, CB1 and CB3 reduced paclobutrazol activity more than did CB2 and CB4. The average PC50 for CB2 and CB4 was 30% less than the average PC50 for CB1 and CB3.

Effect of particle size (Expt. 2). The activity of paclobutrazol was influenced by the

Table 2. Effect of selected media components mixed 1:1 with vermiculite on the activity of paclobutrazol in inhibiting the elongation of broccoli hypocotyls. (Expt. 1).

Component[z]	Media paclobutrazol concn (mg·L⁻¹)					
	0.00	0.02	0.04	0.08	0.16	0.32
	Hypoctyl length					
	(cm)	├——————— (% of control) ———————┤				
Vermiculite	2.1	0.29	0.21	0.14	0.10	0.09
Perlite	1.8	0.29	0.25	0.19	0.12	0.10
Coir	2.8	0.39	0.32	0.21	0.16	0.10
PT1	3.2	0.49	0.37	0.26	0.18	0.13
PT2	3.0	0.40	0.28	0.24	0.14	0.10
PT3	2.8	0.22	0.20	0.14	0.14	0.09
FB1	2.9	0.73	0.71	0.50	0.40	0.27
FB2	2.7	0.75	0.69	0.54	0.35	0.23
FB3	3.1	0.70	0.55	0.41	0.32	0.21
FB4	3.2	0.72	0.76	0.52	0.39	0.30
CB1	2.8	0.94	0.86	0.69	0.56	0.41
CB2	3.3	0.81	0.75	0.67	0.45	0.33
CB3	3.3	0.83	0.82	0.72	0.55	0.37
CB4	3.2	0.77	0.82	0.58	0.49	0.37
OCB1	2.9	0.68	0.51	0.50	0.36	0.22
OCB2	3.1	0.77	0.66	0.41	0.29	0.21
OCB3	3.0	0.70	0.60	0.45	0.30	0.21
OCB4	2.7	0.72	0.61	0.44	0.27	0.21
OCB5	3.0	0.68	0.54	0.38	0.26	0.18
OCB6	2.9	0.67	0.56	0.38	0.31	0.19
LSD₀.₀₅	0.2[y]	---	---	---	---	---

[z]PT = sphagnum peat moss; FB = fresh pine bark; CB = composted pine bark; OCB = old composted pine bark. Numbers indicate sources.
[y]LSD₀.₀₅ for comparing media component means for the 0 mg·L⁻¹ concentration only.

Table 3. Exponential decay curves to model the elongation response of broccoli hypocotyls to paclobutrazol in twenty different media components mixed 1:1 (v/v) with vermiculite (Expt. 1).

| Component[z] | Regression equation | r^2 | Decay constant[y] | | PC50[x] | | |
			LL	UL	Pred.	LL	UL
Vermiculite	$y = 0.155 + 0.839e^{-115.6x}$	0.86	99.2	132.0	0.015	0.014	0.017
Perlite	$y = 0.175 + 0.822e^{-97.3x}$	0.82	81.9	112.7	0.019	0.017	0.022
Coir	$y = 0.162 + 0.829e^{-54.6x}$	0.88	47.5	61.8	0.016	0.015	0.018
PT1	$y = 0.175 + 0.813e^{-40.1x}$	0.89	35.6	44.7	0.023	0.021	0.025
PT2	$y = 0.158 + 0.836e^{-56.9x}$	0.89	50.1	63.7	0.016	0.014	0.017
PT3	$y = 0.138 + 0.861e^{-110.0x}$	0.94	93.8	126.2	0.008	0.007	0.009
FB1	$y = 0.288 + 0.673e^{-13.8x}$	0.74	10.7	17.0	0.084	0.073	0.094
FB2	$y = 0.227 + 0.735e^{-11.7x}$	0.73	8.9	14.6	0.085	0.074	0.096
FB3	$y = 0.249 + 0.731e^{-20.9x}$	0.80	17.3	24.5	0.051	0.044	0.058
FB4	$y = 0.292 + 0.678e^{-12.8x}$	0.77	10.1	15.5	0.092	0.081	0.103
CB1	$y = 0.349 + 0.670e^{-7.5x}$	0.69	5.0	10.1	0.198	0.170	0.224
CB2	$y = 0.289 + 0.677e^{-8.7x}$	0.72	6.2	11.2	0.134	0.118	0.152
CB3	$y = 0.243 + 0.716e^{-5.4x}$	0.72	3.3	7.5	0.190	0.169	0.211
CB4	$y = 0.363 + 0.609e^{-11.1x}$	0.70	8.2	14.0	0.135	0.116	0.153
OCB1	$y = 0.294 + 0.677e^{-22.8x}$	0.67	17.3	28.3	0.052	0.044	0.060
OCB2	$y = 0.206 + 0.793e^{-15.6x}$	0.83	13.0	18.1	0.064	0.058	0.070
OCB3	$y = 0.233 + 0.736e^{-17.4x}$	0.83	14.6	20.2	0.072	0.053	0.064
OCB4	$y = 0.212 + 0.768e^{-16.7x}$	0.84	14.1	19.3	0.059	0.053	0.064
OCB5	$y = 0.209 + 0.769e^{-20.9x}$	0.85	17.9	23.9	0.054	0.042	0.051
OCB6	$y = 0.239 + 0.741e^{-21.6x}$	0.82	18.1	25.1	0.058	0.043	0.053

[z]PT = sphagnum peatmoss; FB = fresh pine bark; CB = composted pine bark; OCB = old composted pine bark
[y]95% confidence limits (LL = lower limit, UL = upper limit) for the exponential decay constant (c) in the regression equation: $y = a + be^{-cx}$ where y = seedling hypocotyl length as a fraction of the control and x = media paclobutrazol concentration in $mg \cdot L^{-1}$.
[x]Predicted media paclobutrazol concentration $(mg \cdot L^{-1})$ and associated 95% confidence limits (LL = lower limit, UL = upper limit) resulting in 50% growth reduction relative to the control.

particle size of the CB and the FB but not the PT sample (Fig. 2). According to the decay constants and associated 95% confidence limits (Table 4), paclobutrazol activity in CB was greater in the coarse than in the fine fraction. According to PC50 values, almost a 4-fold higher paclobutrazol concentration would be required in the fine fraction than in the coarse fraction of CB to achieve the same activity. Mean seedling hypocotyl length in nontreated CB was 1.9, 2.1, and 2.1 cm for the fine, medium, and coarse fractions, respectively.

Paclobutrazol activity in FB was greater in the coarse fraction than in either the fine or medium fractions; the response in fine and coarse fractions did not differ. The response for the medium fraction of FB was similar to that observed for the coarse fraction of CB. According to PC50 values, a 2-fold higher concentration was required in the fine and medium fractions of FB than in the coarse fraction to achieve the same activity. Hypocotyl lengths in nontreated fresh pine bark were 2.0, 2.1, and 2.2 cm for the fine, medium, and coarse fractions, respectively.

Particle size had no effect on the growth of seedlings in sphagnum peat moss treated with paclobutrazol. Hypocotyl lengths of seedlings grown in nontreated sphagnum peatmoss were 2.1, 2.0, and 2.1 cm, for fine, medium, and coarse fractions, respectively.

Effects of peat–bark mixtures on drench efficacy (Expt. 3). Paclobutrazol activity decreased as the percentage of composted bark in the media increased from 0% to 60% (Table 5). Change in plant size 2 weeks after applying a 3.2 mg·L⁻¹ paclobutrazol drench was 19% of the control in the 0% CB mix and 60% of the control in the 60% CB mix. The 40% and 20% CB mixes behaved similarly but were more like the 60% CB mix than the mix with no bark (Fig. 3). Because the growth of nontreated petunias in the 60% CB mix was ≈10% less
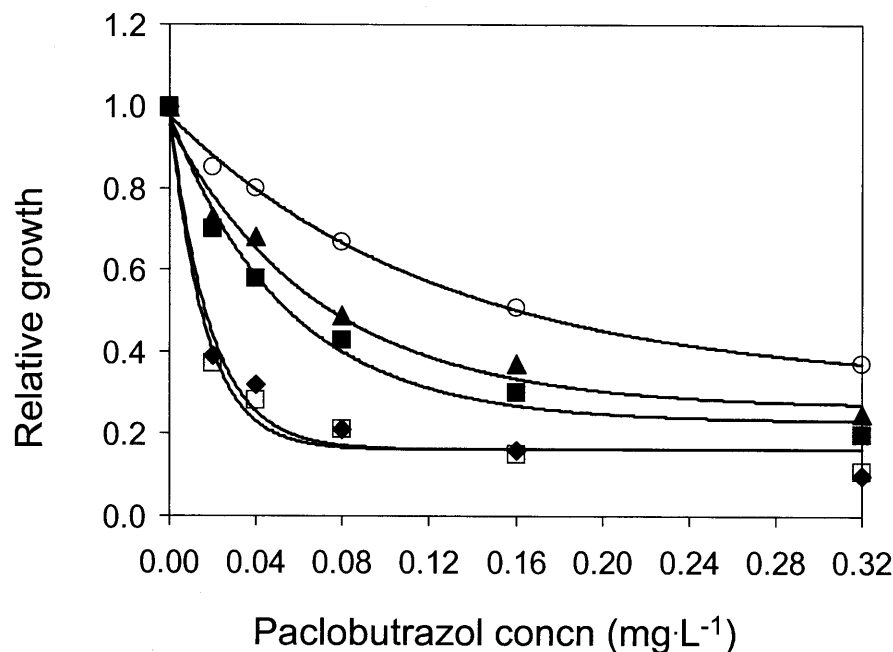

Fig. 1. Effect of media components on the activity of paclobutrazol as measured by a broccoli seedling bioassay. Regression equations are: sphagnum peatmoss (▢), $y = 0.16 + 0.83e^{-62.3x}$, $r^2 = 0.87$; coir (◆), $y = 0.16 + 0.83e^{-54.6x}$, $r^2 = 0.88$; old composted pine bark (■), $y = 0.23 + 0.75e^{-18.6x}$, $r^2 = 0.80$; fresh pine bark (▲), $y = 0.27 + 0.70e^{-14.4x}$, $r^2 = 0.75$; composted pine bark (○), $y = 0.32 + 0.66e^{-8.0x}$, $r^2 = 0.69$. Data were pooled over three samples of peat, four samples each of fresh pine bark and composted pine bark, and six samples of old composted pine bark.

than that in the other three mixes, change in plant size was converted into a relative value by dividing by the mean for the nontreated control for each medium (Fig. 3). According to the regression equations, a 15% reduction in petunia growth required a paclobutrazol concentration of 0.19, 0.74, 0.67, and 2.57 mg·L⁻¹ for the 0%, 20%, 40%, and 60% CB mixes, respectively. Thus the paclobutrazol concentration required was 14 times as great in the 60% CB mix than in the 0% CB mix. In the

20% and 40% CB mixes the paclobutrazol concentration required was four times as great as in the 0% CB mix.

Discussion

The type of media component greatly affected the activity of paclobutrazol. Reduced activity of nonionic organic chemicals added to soil are often attributed to adsorption reactions with the soil humus (Helling et al., 1971).

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Table 4. Regression equations describing the elongation response of broccoli hypocytyls to paclobutrazol applied to different fractions of fresh pine bark (FB), sphagnum peatmoss (PT), or composted pine bark (CB). All components were mixed 1:1 (v/v) with vermiculite (Expt. 2).

Component	Fraction[z]	Regression equation	r^2	Decay constant[y]		PC50[x]		
				LL	UL	Pred.	LL	UL
Fresh pine bark	Fine	$y = 0.340 + 0.636e^{-22.8x}$	0.67	17.1	28.4	0.061	0.051	0.071
	Medium	$y = 0.286 + 0.686e^{-23.3x}$	0.77	18.8	27.8	0.050	0.044	0.056
	Coarse	$y = 0.205 + 0.768e^{-36.9x}$	0.83	31.5	42.4	0.026	0.023	0.029
Sphagnum peatmoss	Fine	$y = 0.173 + 0.807e^{-69.7x}$	0.87	61.7	77.7	0.013	0.012	0.014
	Medium	$y = 0.155 + 0.818e^{-73.7x}$	0.85	64.4	82.9	0.012	0.011	0.013
	Coarse	$y = 0.143 + 0.824e^{-70.3x}$	0.84	61.4	79.1	0.012	0.011	0.013
Composted pine bark	Fine	$y = 0.421 + 0.639e^{-10.8x}$	0.63	7.3	14.3	0.194	0.152	0.236
	Medium	$y = 0.367 + 0.633e^{-18.7x}$	0.68	14.0	23.4	0.083	0.070	0.097
	Coarse	$y = 0.280 + 0.656e^{-21.6x}$	0.72	16.8	26.5	0.050	0.043	0.058

[z]Fine (<2 mm), medium (2–4 mm), and coarse (>4 mm)

[y]95% confidence limits (LL = lower limit, UL = upper limit) for the exponential decay constant (c) in the regression equation: $y = a + be^{-cx}$, where y = seedling length as a fraction of the control and x = media paclobutrazol concentration in mg·L^{-1}

[x]Predicted media paclobutrazol concentration (mg·L^{-1}) and associated 95% confidence limits (LL = lower limit, UL = upper limit) resulting in 50% growth reduction relative to the control.
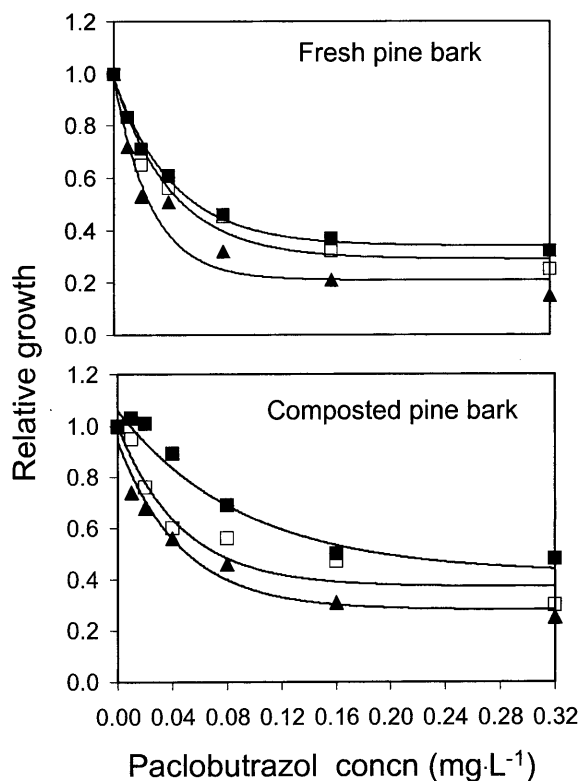

Fig. 2. Effect of particle size of fresh pine bark or composted pine bark on the activity of paclobutrazol as measured by a broccoli seedling bioassay. Particle size fractions were fine (■) <2 mm, medium (□) 2–4 mm, or coarse (▲) >4 mm. Regression equations are given in Table 4.

Therefore, the observation that the activity of a nonionic organic chemical such as paclobutrazol was not greatly affected by the inorganic materials, vermiculite and perlite, was not surprising.

Of the organic components tested, coir and peat had the least effect in reducing paclobutrazol activity. The average PC50 was 0.016 mg·L^{-1} for coir and peat. Compared with these materials, PC50 values (mg·L^{-1}) increased approximately 5-fold for FB (0.076), 4-fold for OCB (0.060), and 10-fold for CB (0.164). One explanation for coir and peat having less effect in reducing paclobutrazol activity is that these materials have lower densities (Table 1). The average densities of peatmoss and coir

samples were 60 and 70 g·L^{-1}, respectively. Average densities (g·L^{-1}) were 170 for FB, 220 for CB, and 160 for OCB (subtracting the average sand content of 45%). Therefore, the bark components had ≈3-fold higher densities than peat and coir. It follows that bark components would have provided approximately three times as much mass of organic material per volume to react with paclobutrazol.

Differences in density do not account for the greater reduction in paclobutrazol activity observed in CB vs. FB. Average density of CB was ≈30% more than that of FB whereas the PC50 of CB was approximately doubled. Results from Expt. 2 indicated that the major difference between FB and CB was in the fine

fraction. The PC50 of CB was 220% more than that of FB in the fine fraction (0.194 vs. 0.061 mg·L^{-1}) but only 66% (0.083 vs. 0.050 mg·L^{-1}) and 92% (0.050 vs. 0.026 mg·L^{-1}) more in the medium and coarse fractions, respectively. The densities (g·L^{-1}) of the fine, medium, and coarse fractions were 143, 136, and 136, respectively, for FB and 164, 173, and 168, respectively, for CB. Although the density of the fine, medium and coarse fractions was 15%, 28%, and 24% greater for CB than for FB, respectively, this does not account for the much greater reduction in activity of paclobutrazol in CB noted above. If PC50 values are converted from a volume basis to a mass basis, respective averages for CB and FB would be 1.18 and 0.43 mg·kg^{-1} in the fine fraction, 0.48 and 0.37 mg·kg^{-1} in the medium fraction, and 0.30 and 0.19 mg·kg^{-1} in the coarse fraction. Therefore, on a mass basis, the fine fraction of CB required 2.8-times more paclobutrazol to provide the same activity as observed for FB fines, the medium fraction 1.3 times, and the coarse fraction 2.5 times. These results suggest that screening of bark compost will affect the activity of added paclobutrazol.

Coir, a by-product of coconut processing, is a fibrous material that has favorable properties for use in growing media (Meerow, 1995). The lignin content of coir is 70% (Meerow, 1995), pine bark is 95% (McElhannon, 1995), and sphagnum peatmoss is 20% to 30% (Lucas, 1982). The oxidation of lignins during microbial decomposition increases their reactivity, and the modified lignin-like compounds are largely responsible for the adsorption of chemicals in soils (Helling et al., 1971). Coir used in container media is not composted, which may account for its influence on paclobutrazol activity being similar to that of peat and less than that of composted pine bark. However, the influence of coir may increase as the material undergoes microbial decomposition.

If composting increases reactivity with paclobutrazol, the OCB samples should have had an even greater effect than did CB. However, their effects were similar. The reasons for the OCB not having the same or greater effect on paclobutrazol as CB cannot be deter-

Table 5. Response of petunia grown in four different media, containing 20% vermiculite and 20% perlite by volume, as affected by paclobutrazol drench concentration[z] (Expt. 3).

Media components		Paclobutrazol[y] (mg·L⁻¹)					
% Peat	% Bark	0.0	0.2	0.4	0.8	1.6	3.2
		Change in plant size[x] (cm)					
60	0	11.0	8.9	8.3	6.6	5.1	4.4
40	20	11.0	11.4	9.9	8.9	8.3	7.1
20	40	11.2	11.2	10.2	8.8	8.3	7.5
0	60	9.7	9.3	9.4	9.7	8.5	8.0

[z]Medium by concentration interaction was significant ($P < 0.01$). Regression equations are given in Fig. 3.
[y]60 mL per 10-cm pot.
[x]Plant size, (height + average width)/2, was measured at the time of treatment and 2 weeks later.
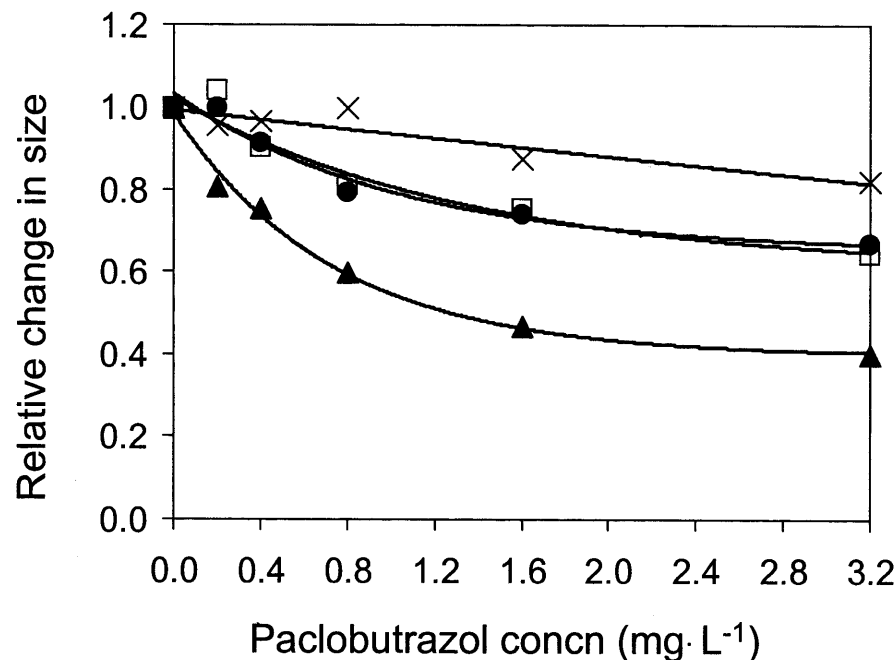

Fig. 3. Effect of varying composted pine bark (CB) and sphagnum peatmoss (PT) percentage in media on the relative growth 2 weeks after drenching 'Madness Red' petunias with paclobutrazol at six concentrations. The drench rate was 60 mL per 10-cm pot applied 9 d after planting. Regression equations were: 60%CB:0%PT (X), $y = -0.62 + 1.6e^{-.04x}$, $r^2 = 0.23$; 40%CB : 20%PT (□), $y = 0.65 + 0.38e^{-0.98x}$, $r^2 = 0.64$; 20%CB : 40%PT (●), $y = 0.61 + 0.41e^{-0.74x}$, $r^2 = 0.60$; 0%CB : 60%PT (▲), $y = 0.40 + 0.59e^{-1.37x}$, $r^2 = 0.85$.

mined from this study. The OCB was of unknown age and its considerable fine sand content (Table 1) is thought to be derived from windblown sources (Bob Steinkamp, Fafard, personal comm.).

The use of the bioassay procedure to compare the different components proved useful for predicting the comparative effect of paclobutrazol treatments on petunia (Expt. 3). The procedure predicted that ≈10 times more

paclobutrazol would be needed in CB1 than in PT2. Although the highest paclobutrazol drench concentration (3.2 mg·L⁻¹) did not reduce growth more than 50%, the concentrations giving 15% reduction in petunia growth were 0.19, 0.73, 0.67, and 2.56 mg·L⁻¹ for the 0%, 20%, 40%, and 60% CB mixes, respectively. Therefore, 14 times more paclobutrazol had to be applied to the 60% CB mix to achieve the same effect as was obtained in the 0% CB mix.

As many label recommendations for drench concentrations are determined on peat-based media, the results of this study hopefully will aid growers in modifying concentrations to be more effective in pine bark-based media. Uniform recommendations for drench rates of paclobutrazol for commercial production will be difficult due to the wide range of components used in mixes and differences among sources of these components. Adding small amounts of composted bark has a significant effect on the amount of paclobutrazol required to achieve desired growth reduction. As composting operations produce a more consistent product for use in growing media, results of a standardized bioassay test could be offered by media producers as a guide for growers who use growth regulator drenches.

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