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## Technical Memorandum

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### Evaluation of Phytotoxic Effects of Gro-Bark Media Feedstocks

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#### BACKGROUND

The purpose of this trial was to examine the potential presence of phytotoxic compounds in Gro-Bark's growing media feedstocks. Phytotoxicity is defined as the delay in seed germination, inhibition of plant growth or any adverse effect on plants caused by phytotoxins. Phytotoxins can include a variety of compounds such as trace metals, pesticides and phenolic compounds which can sometimes reside in growing media. However, it is practically impossible to screen growing media for all substances which may cause phytotoxicity, due to the overabundance of potential phytotoxic compounds and the varying rates of sensitivity of different species and cultivars. Thus, in order to assess whether there are harmful substances in a material, growth and germination tests are practical. For the purpose of this trial, five of Gro-Bark's most commonly used growing media feedstocks were evaluated for potential phytotoxic effects on water cress and cucumber seeds. Water cress and cucumber were chosen as they are the recommended species noted in *Guidelines for compost quality* and *Test Method of the Examination of Composting and Compost (TMECC) 0.5-0.5 – Biological Assays* (CCME, 1996; TMECC, 2001).

#### METHODOLOGY

Five primary feedstock materials, examined in replica, were tested to evaluate in-vitro germination and radical elongation as well as seedling emergence and relative growth. Those feedstocks included:

1. Blend A;
2. Composted Pine Mulch (CPM) 1";
3. ½" Leaf & Yard Compost;
4. Aged Bark Fines; and,
5. Peat Moss.

The pH and EC of each feedstock tested is provided in Table 1 for comparison.

**Table 1:** The average pH and electrical conductivity (EC) (mS/cm) of each feedstock

Feedstock	Average pH *	Average EC (mS/cm) *
Blend A	5.9	0.22
Composted Pine Mulch (CPM) 1"	4.3	0.33
½" Leaf & Yard Compost	8.3	1.26
Aged Bark Fines	5.3	0.07
Peat Moss	3.3	0.07

\*Determined using the 1:2 dilution method for soilless media

### **Test 1: In-vitro Seed Germination and Radical Elongation**

The test for in-vitro germination and radical elongation was adapted from *TMECC 0.5-0.5 – Biological Assays* (TMECC, 2001), under Method B – In-vitro seed germination and root elongation. Each feedstock was soaked in distilled water at a rate of two (2) parts distilled water to one (1) part feedstock for three (3) hours. Aliquots of the extract were then taken and added to filter paper which had been placed into petri-dishes. Five (5) water cress seeds and three (3) cucumber seeds were then placed into separate petri-dishes which were subsequently sealed in plastic sandwich bags to preserve moisture. This process was repeated twice for each feedstock. Distilled water was used as a control. On day seven, seed germination and root elongation were measured and recorded on all treatments.

The germination and radical elongation rates were calculated by averaging five (5) repetitions that were completed between July and November, 2020. The seed germination and radical elongation measurements of all treatments were compared to the control to calculate germination rates and root elongation rates. This produced calculated rates that were relative to the control, such that the control had a germination and radical elongation rate of 100%. Any feedstock that performed better than the control produced a rate above 100%, materials that performed worse had a rate below 100%, and materials that performed the same as the control had a rate equal to 100%.

### **Test 2: Seedling Emergence and Relative Growth**

This test was adapted from *TMECC 0.5-0.5 – Biological Assays* (TMECC, 2001) under Method A – Seedling Emergence and Relative Growth. This test was completed in addition to the in-vitro germination test to better mimic a nursery setting. Cucumber seeds were potted in a mixture containing 50% of each test feedstock and 50% perlite, with no additional amendments added. Plastic sandwich bags were then placed over the pots to retain moisture and the seeds were watered on an as needed basis with distilled water. A mixture of 100% perlite was used as the control. The seedling emergence and relative growth was measured 14-days post-seeding and all feedstock measurements were then compared to the control. This process was repeated during two trials that were performed in August and December 2020. Both trials contained four repetitions for each feedstock. Watercress seeds were not used in this study due to their fragility and small size.

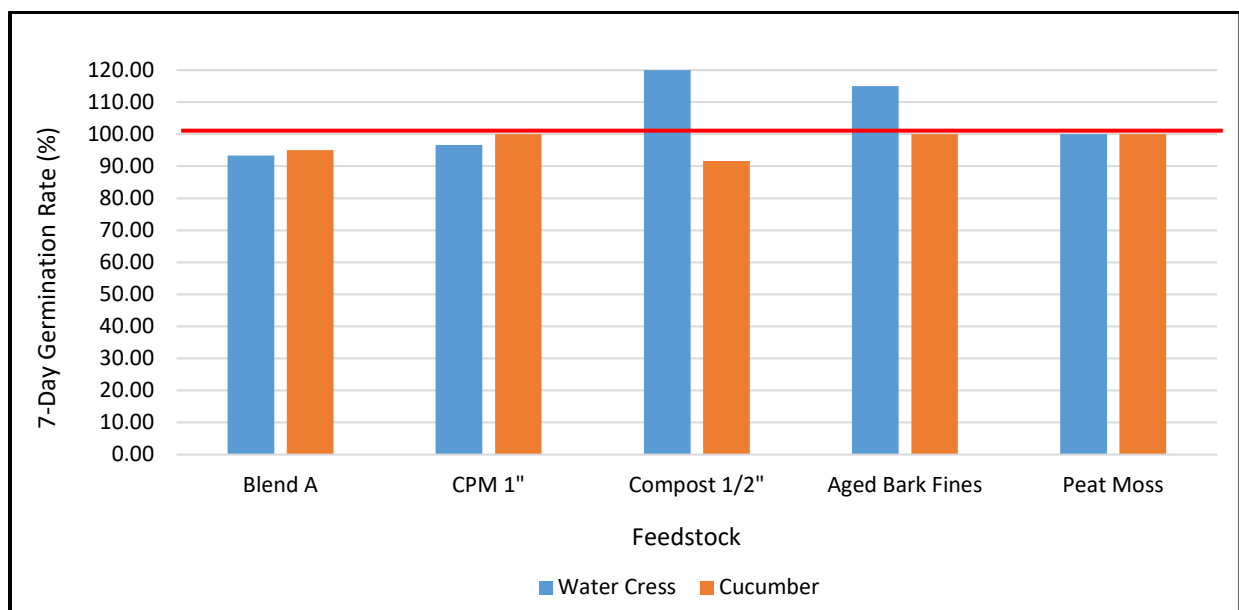
Similar to Test 1, seedling emergence and growth measurements for all treatments were compared to the control. Feedstock that had greater growth or seedling emergence than the control had a rate above 100%, where feedstock that performed worse had a rate less than 100%.

## RESULTS AND DISCUSSION

### In-vitro Seed Germination

Figure 1 and Figure 2 depict the 7-day germination and radical elongation rates of water cress and cucumber for each feedstock tested. As noted above, the control has a germination and radical elongation rate of 100%, which is indicated by the red line on Figure 1 and 2.

All the growing media feedstocks tested had a germination rate of 90% or greater at 7-days post seeding (Figure 1). Tiquia et al (1996) noted that a germination rate of 80% or higher typically suggests that the material in question is not phytotoxic. Therefore, these results indicate that none of the growing media feedstocks tested resulted in the appearance of phytotoxic symptoms in the cucumber and water cress seedlings.



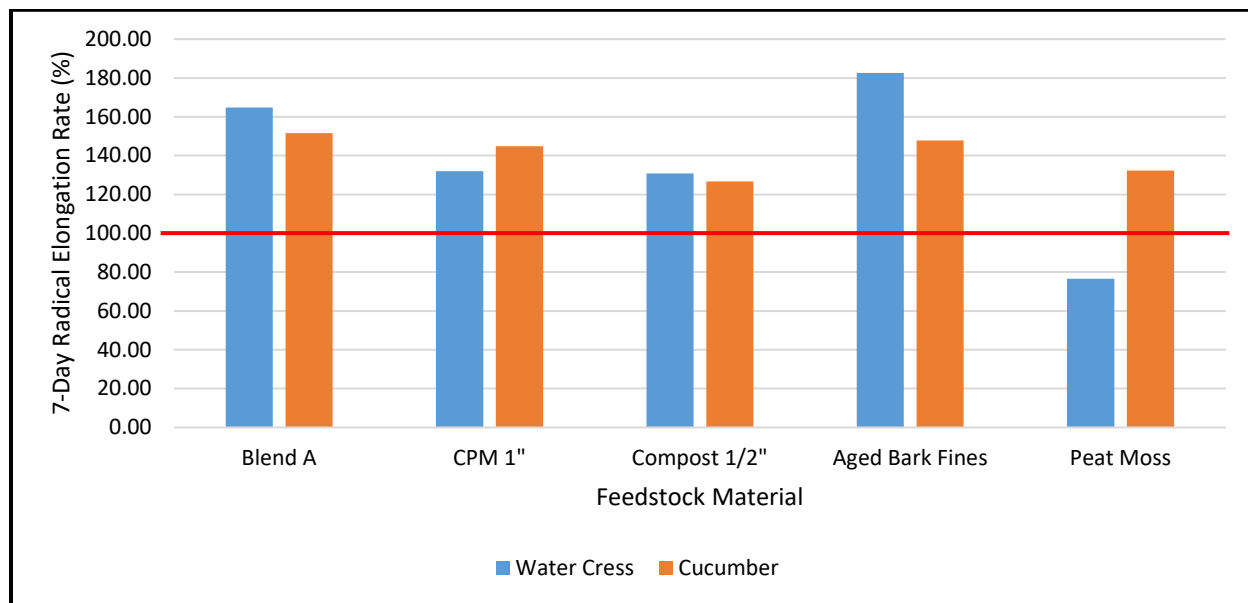
**Figure 1:** The average 7-day in-vitro germination rate (%) of water cress and cucumber. All feedstock materials were compared to a control which had a germination rate of 100%, indicated by the red line.

### Radical Elongation

All feedstocks tested had an elongation rate greater than 120% except for peat moss, which produced a lower radical elongation in the water cress than the control (Figure 2). Interestingly, the radical elongation of the cucumber seedling in peat moss did not appear to be impacted.

It is possible that the discrepancy in the peat moss radical elongation between the water cress and cucumber is due to differences in susceptibility to low pH, as cucumber has been shown to tolerate acidic environments slightly better than water cress (TMECC, 2001). Peat Moss is a considerably acidic media that has a typical pH lower than all other feedstocks tested (Table 1).

Additionally, other feedstocks tested that had similar inherent nutrient content/electrical conductivity in comparison to peat moss, such as aged bark fines, did not show similar reductions in radical elongation (Table 1, Figure 2). Thus, it is likely that the decreased root elongation observed was due to the low pH and not due to low electrical conductivity or the presence of phytotoxic compounds.



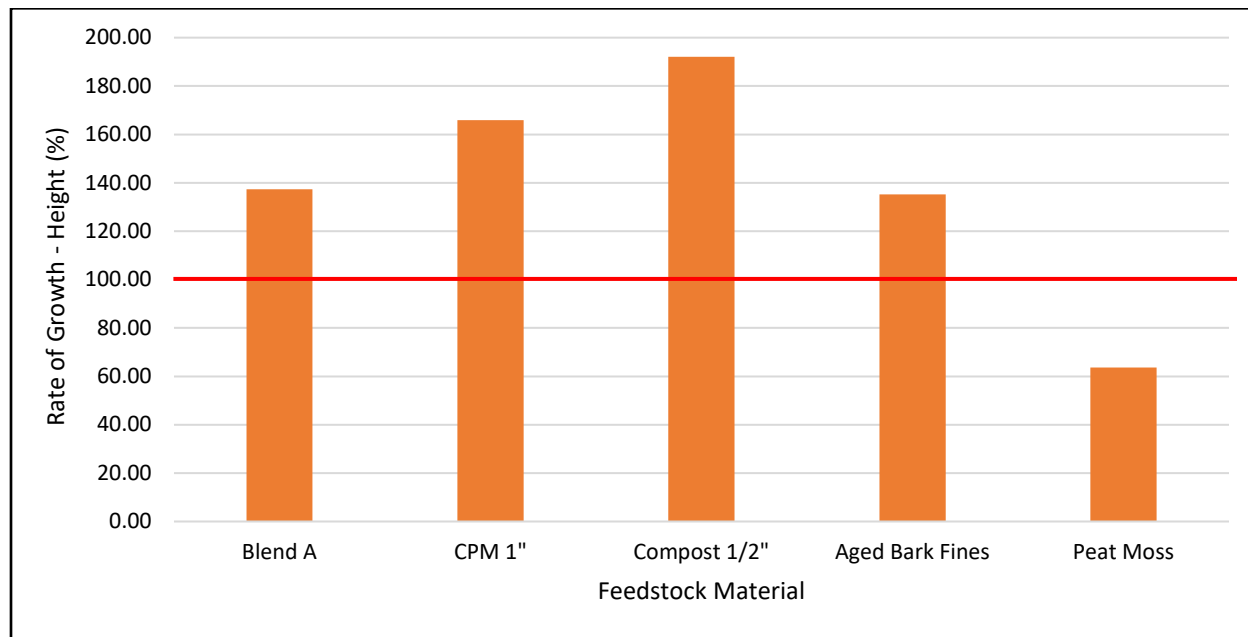
**Figure 2:** The average 7-day radical elongation rate (%) of water cress and cucumber. All feedstock materials were compared to a control which had a germination rate of 100%, indicated by the red line.

### Seedling Emergence and Relative Growth

All the growing media feedstocks had a seedling emergence rate of 100% except for peat moss, which produced cucumbers with a smaller height and shorter roots (Figure 3 and 4). Interestingly, unlike the in-vitro seed germination test which indicated the cucumber was tolerant to the acidity of the peat moss (Figure 2), the results of the seedling emergence and relative growth test indicate that in this case, the cucumber was in fact reactive to the peat.

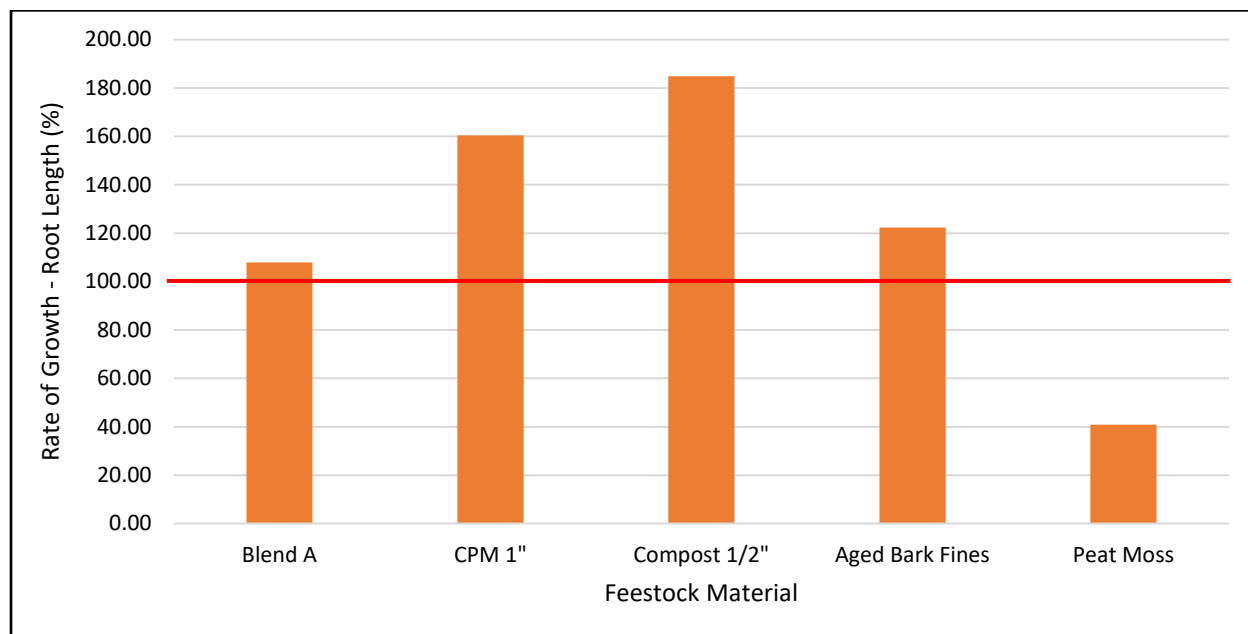
In general, peat is a trusted growing media ingredient used by many nursery and greenhouse growers worldwide and is considered relatively innocuous with little to no concern about phytotoxic compounds being present. However, peat is known to be acidic and has a very low electrical conductivity. Accordingly, additives such as dolomitic lime and fertilizer are typically used to correct these issues when growing in straight peat moss or a mixture of peat, perlite and/or other ingredients. In this trial, no additives were used to amend the peat moss prior to planting which resulted in the negative growth impacts observed in Figures 2, 3 and 4. This illustrates the importance of understanding the physical and chemical properties of growing

media ingredients, so that custom blenders, such as Gro-Bark, can formulate a mix that is pH and chemically balanced.



**Figure 3:** The average 14-day height growth rate (%) for cucumber. All feedstocks were compared to a control which had a height growth rate of 100%, indicated by the red-line.

It is also interesting to note that in this case, the adage “the dose makes the poison” was true with the peat moss and the cucumber. In Test 1, the cucumber could tolerate the mild acidity of the aliquots of the peat moss extract, but in Test 2 when the cucumber was planted in straight peat moss, it was too acidic and resulted in stunted growth (Figure 3, 4 and 5). These results indicate that whatever toxic or plant reactive compounds may be present in the feedstocks are amplified in Test 2. Despite this, all other growing media feedstocks performed better than the control in both Test 1 and Test 2, further supporting the conclusion that Gro-Bark’s Blend A, Aged Bark Fines, Compost and CPM 1” contain no phototoxic compounds.



**Figure 4:** The average 14-day root length growth rate (%) for cucumber. All feedstocks were compared to the control, which had a root length growth rate of 100% indicated by the red-line.



**Figure 5:** A comparative photo of cucumber sprouts 14-days post-seeding in December, 2020. From left to right the feedstock treatments are: Control (100% Perlite), Blend A, Compost 1/2\", CPM 1\", Aged Bark Fines and Peat Moss.

## CONCLUSION

Overall, the results of this trial indicate that Gro-Bark's Compost, Aged Bark Fines, Blend A and CPM do not contain phytotoxic compounds at levels which can cause issues to plant germination, growth rate and root elongation. Conversely, peat moss, which is a considered an innocuous growing media component, was the only material to display negative growth impacts on the

watercress and cucumber. It is unlikely that this would be caused by the presence of phototoxic compounds, but instead, is likely caused by the high acidity of the peat.

These results indicate that even with a feedstock like peat (one that is well known and trusted among growers), there is still the possibility of negative growth effects caused by the intrinsic properties of the feedstock. To ensure that the potential negative effects of the growing media feedstocks are decreased or eliminated, several manufacturing, blending and storage requirements must be considered. For peat, it is ensuring that it is blended with both lime and a starter charge to help balance the acidity and add required nutrients. For Gro-Bark feedstocks, it is ensuring that all bark based products have been sufficiently aged in aerobic conditions, stored in windrow-type piles and turned frequently to ensure aeration. Lastly, the completion of weekly, bi-weekly and quarterly quality assurance tests, including germination tests such as the one outlined in this document, continue to verify the safety and efficacy of Gro-Bark's bark-based feedstocks.

Overall, the results of this trial demonstrates the high quality of all Gro-Bark produced growing media feedstocks such as Blend A, Compost, CPM and Aged Bark, and support the fact that they are free of any phytotoxic compounds at levels which can cause issues to plant germination, growth rate and root elongation.

The methodology used within this trial was based off the Test Methods for the Examination of Composting and Compost (TMECC), which provide peer reviewed and standardized methods to determine if compost or similar materials cause plant toxicity.

## REFERENCES

- CCME, 1996. Guidelines for Compost Quality, Canadian Council of Ministers of the Environment, Composting Subcommittee, Winnipeg, MB.
- Tiquia, S.M., Tam, N.F., Hodgkiss, I.J., 1996. Effects of composting on phytotoxicity of spent pig-manure sawdust litter. *Environ. Pollut.* 93, 249-256.
- TMECC 05.05 – 2001. Biological Assays. Test Methods for the Examination of Composting and Compost, USDA and U.S. Composting Council, Raleigh, NC.