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Humate-Based Biostimulants Do Not Consistently Increase Growth of Container-Grown Turkish Hazelnut

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Abstract

Humate-based products have been aggressively marketed to nursery producers as biostimulants which increase plant growth. Reports of their effect on container-grown trees in organic substrate are few. We tested four distinct types of biostimulants on top and root growth of Turkish hazelnut (*Corylus colurna* L.), grown in containers with pine-bark substrate. Treatments included: 1) an untreated control; 2) humate, applied as a dry topdress; 3) humate, formulated as a wettable powder and applied as a substrate drench; 4) humate, applied as a pre-plant root soak; 5) humate, to which various purported root growth-promoting additives had been added, also applied as a root soak. All treatments were tested within low, medium, and high fertilizer application regimes. No treatment increased top growth compared to untreated trees, and the root-soak treatments had the lowest top growth. At high and low fertilizer application rates, root length was similar for all treatments except for root-soak treatments, which had lower root lengths. At the medium fertilizer rate, root length was greatest for trees treated with granular humate applied as a dry topdressing and lowest for trees treated with root soaks.

Index words: *Corylus colurna* L., humic acid, nursery production, root length, shoot growth.

Significance to the Nursery Industry

Applications of biostimulants, humate-based materials marketed as aids to plant growth, can potentially shorten nursery production cycles. We tested the effect of several types of biostimulants on the growth of Turkish hazelnut (*Corylus colurna* L.) seedlings grown in 3.8 liter (#1) containers in pine-bark substrate under low (9 g Osmocote™ 18-6-12 per container), medium (14 g), and high (19 g) fertilizer application regimes under greenhouse conditions. No treatment improved top growth after 16 weeks compared to not-treated controls, and top growth was reduced by liquid products applied as root soaks. Root length was greatest for granular-humate-treated trees, but only for those fertilized at the medium rate. This study indicates that growth response differs according to the type of biostimulant applied and the fertility program employed. General recommendations therefore cannot be made. Biostimulants should not be applied to container-grown trees during production without prior trials, consisting of different application rates and fertilizer regimes.

Introduction

Biostimulants have been described as ‘non-nutritional products that may reduce fertilizer use and increase yield and resistance to water and temperature stresses’ (12). Major components of commercially available biostimulants may include: humic materials (humin, humic acid, fulvic acid), plant growth hormones (e.g. cytokinins), vitamins (e.g. thiamine), and various other additions.

Humic materials have been shown by many to increase growth of plants growing in solution or sand culture (6, 7, 8, 10, 11, 15, 16, 18). This increased growth may be a result of increased nutrient absorption (10,11,16). Vaughan (18) proposed that humic acids may primarily increase root growth by increasing root cell elongation. Additions of humic materials can produce root systems with increased branching and numbers of fine roots, and as a result, potentially increase whole-plant nutrient uptake by way of increased root surface area (10). Growth of plants in native mineral soil or in organic substrate is reported to be increased (9, 12, 13, 14, 17) or not increased (1, 2, 3, 4, 5) with the application of biostimulants.

Little information is available on the effects of biostimulants on growth of container-grown trees. Therefore, the purpose of this study was to determine the effects of several types of biostimulants on the growth of Turkish hazelnut (*Corylus colurna* L.), transplanted bare-root into containers and grown under greenhouse conditions. In addition, we tested for an interaction between biostimulant treatment and fertilizer rate.

Materials and Methods

This experiment was conducted at the Virginia Tech greenhouse complex from February 28, 1996, to June 17, 1996, under natural light. One-hundred-and-fifty bare-root *Corylus colurna* L. (Turkish hazelnut) seedlings from Heritage Seedlings, Inc., Salem, OR (mean height = 33.8 cm (13.3 in), and mean stem diameter = 5.8 mm (0.23 in)) were planted in 3.8 liter (#1) plastic nursery containers filled with pine bark substrate, amended with 4.0 kg (8.8 lb) dolomite, and 1 kg (2.2 lb) Micromax™ (The Scotts Co., Maryville, OH) per m³ (1.3 yd³). After planting, seedlings were pruned to a central leader, and initial height and stem diameter were measured. Plants were watered as needed throughout the experiment so as to assure a drought-free condition.

The following soil treatments were applied at planting: 1) control (no biostimulant); 2) granular humate (Earthgreen Products, Dallas, TX), applied at 2 g/container as a dry topdress; 3) wettable powder humate (Menefee WSPTM, Earthgreen Products, Dallas, TX), applied at 2.5 mg dissolved in 180 ml of H₂O and applied to containers which had been previously irrigated to container capacity; 4) liquid humate (Growplex™, Earthgreen Products, Dallas, TX), applied as a 30-minute root soak (30 ml Growplex™ mixed with 4 liters of H₂O) immediately prior to planting; and 5) liquid humate + (Roots™, Roots, Inc., New Haven, CT), a propri-
Table 1. Effects of biostimulant and fertilizer treatments on height growth, stem diameter growth, and leaf/shoot dry mass of Turkish hazelnut (Corylus colurna L.).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Height growth (cm)</th>
<th>Stem diameter growth (mm)</th>
<th>Leaf dry mass (g)</th>
<th>Shoot dry mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>37.2a†</td>
<td>3.0a</td>
<td>8.3a</td>
<td>10.5a</td>
</tr>
<tr>
<td>Granular humate</td>
<td>35.8a</td>
<td>2.8a</td>
<td>7.9a</td>
<td>10.1a</td>
</tr>
<tr>
<td>Wettable powder humate</td>
<td>33.6a</td>
<td>2.6a</td>
<td>7.6a</td>
<td>10.0a</td>
</tr>
<tr>
<td>Liquid humate</td>
<td>20.1b</td>
<td>1.7b</td>
<td>5.0b</td>
<td>7.1b</td>
</tr>
<tr>
<td>Liquid humate +</td>
<td>8.9b</td>
<td>0.8c</td>
<td>2.2c</td>
<td>4.8c</td>
</tr>
<tr>
<td>Treatment</td>
<td>0.0001†</td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.0001</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>0.1258</td>
<td>0.0052</td>
<td>0.0146</td>
<td>0.0142</td>
</tr>
<tr>
<td>T x F</td>
<td>0.2284</td>
<td>0.1685</td>
<td>0.1756</td>
<td>0.1988</td>
</tr>
</tbody>
</table>

†Means in columns followed by the same letter are not significantly different, Tukey’s HSD (P = 0.05; n = 30).

Results and Discussion

Top growth. Top growth of biostimulant-treated trees was similar to controls, except for liquid humate and liquid humate + treated trees, which resulted in the least height growth (Table 1). The root-soak treatments (liquid humate and liquid humate +) reduced stem diameter growth, and leaf and shoot dry mass compared to the other treatments. There were no significant interactive effects of treatments x fertilizer rates for any top growth parameter. Fertilizer rate did not affect height growth, but trees fertilized at the high rate had greater stem diameters and leaf and shoot dry mass than those fertilized at the low rate (data not shown). Many others have demonstrated that as fertilizer rate is increased, top growth will increase (e.g. 19).

These results confirm findings of others who have observed little increase in top growth from biostimulant application. Albrechts et al. (1) found no increase in the fruiting of strawberry after application of several types of biostimulants. Heckman (4) demonstrated that the yield of cabbage was not increased over controls with biostimulants. Elliot and Prevatte (3) showed that seaweed-based biostimulants did not improve turfgrass growth. Laiche (5) found that the use of humic acid can be detrimental to the growth of some container-grown woody plant species.

Results from Table 1 indicate that use of biostimulant root soaks, as applied in this study, can have a negative impact on plant growth. This may be due to supraoptimal concentrations or length of exposure when soaking roots. Others have documented inhibitory effects of high concentrations of humic acid (7, 17).

Root length. At least 90% of total root length was in the 0–1 mm diameter class for all treatments, where liquid humate and liquid humate + treatments resulted in the lowest lengths (Table 2). Reynolds et al. (11) found that liquid-applied humate reduced root dry mass of grapevines as compared to granular humates, which increased root dry mass. They speculated that root damage may have occurred because of high salt concentrations produced by liquid humate treatments. The root-soak solutions in our study had maxi-

Table 2. Effects of biostimulant and fertilizer treatments on root length (m) of Turkish hazelnut (Corylus colurna L.) for four different diameter classes, and total root length.†

<table>
<thead>
<tr>
<th>Diameter Class</th>
<th>0–1 mm</th>
<th>1–3 mm</th>
<th>3–5 mm</th>
<th>5–10 mm</th>
<th>Total (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>176.1ab†</td>
<td>11.7a</td>
<td>1.3a</td>
<td>0.8a</td>
<td>189.9</td>
</tr>
<tr>
<td>Granular humate</td>
<td>216.3a</td>
<td>3.3b</td>
<td>0.6b</td>
<td>0.2b</td>
<td>220.3</td>
</tr>
<tr>
<td>Wettable powder humate</td>
<td>158.4b</td>
<td>9.6a</td>
<td>0.9ab</td>
<td>0.7a</td>
<td>169.7</td>
</tr>
<tr>
<td>Liquid humate</td>
<td>53.5c</td>
<td>3.9b</td>
<td>1.1a</td>
<td>0.8a</td>
<td>59.4</td>
</tr>
<tr>
<td>Liquid humate +</td>
<td>24.1c</td>
<td>1.9b</td>
<td>0.6b</td>
<td>0.2b</td>
<td>26.8</td>
</tr>
<tr>
<td>Treatment</td>
<td>0.0001†</td>
<td>0.0001</td>
<td>0.0002</td>
<td>0.0001</td>
<td>0.0001‡</td>
</tr>
<tr>
<td>Fertilizer</td>
<td>0.8673</td>
<td>0.6982</td>
<td>0.0024</td>
<td>0.7837</td>
<td>0.8598‡</td>
</tr>
<tr>
<td>T x F</td>
<td>0.0601</td>
<td>0.3546</td>
<td>0.1613</td>
<td>0.0028</td>
<td>0.0509‡</td>
</tr>
</tbody>
</table>

†Roots >10 mm in diameter excluded from table. n = 12.
‡Means in columns followed by the same letter are not significantly different, Tukey’s HSD (P = 0.05; n = 12).

P > F.
of biostimulant root soaks, at the concentrations used in this study, had a negative effect on root and shoot growth of container-grown Turkish hazelnut trees. However, total root length of granular humate-treated trees was higher at the medium (2.5 g N/container) fertilizer rate. Increased root length relative to top growth is generally thought to produce a plant with greater potential for post-transplant growth. Although some fertilizer regime:biostimulant combination may increase root growth, the inconsistent results seen in our study suggest that general recommendations cannot be made on the use of biostimulants for the container production of Turkish hazelnut and other species.

**Literature Cited**
