Title: Leonardite: A mined source of humic acid

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Abstract: Many blueberry growers in South Georgia have expressed interest about using humate as a soil amendment and its effect on fruit production. Presently, pine bark is used to amend soils to increase organic matter and lower pH. Pine bark, generally, is applied at a rate of 100 cubic yards per acre, with a cost from $800.00 to $1,200.00/A. To alleviate establishment costs, some growers incorporate Leonardite and/or its extracts, humic and fulvic acids, to increase organic matter. To extract humic and fulvic acid, the Leonardite is processed in a strongly basic aqueous solution, e.g. KOH. To precipitate the humic acid, the solution is adjusted to pH 1 with a mineral acid, e.g. H\textsubscript{2}SO\textsubscript{4}. Three Leonardite products, two humic acids and one unextracted Leonardite, were analyzed for nutrient content. Calcium levels were 5000 ppm in both extracted samples and 2070 ppm in the unextracted Leonardite. Potassium levels were 977 and 800 ppm in the extracted samples and 125 ppm in the unextracted Leonardite, suggesting humic acid reacted with KOH. Research on Leonardite products and the effect on blueberry production are limited.
Rates of humate in ornamental horticulture suggest using 3% – 12% v/v% in potting media. This equates to 30 – 120 t for equivalent additions on a per acre basis. At these rates, the application of calcium will be 124 – 1200 lb/A. Establishing blueberry at levels of 900 lb/A calcium is not recommended. The analysis of these Leonardite products is insightful as soil nutritional amendments to blueberry.

**Index words:** Leonardite, humic acid, plant nutrients

**Introduction:**
Organic matter, as pine bark, in blueberry production is essential for lowering pH, increasing cation exchange capacity (CEC), and improving water retention. Generally, southeastern U.S. blueberry production depends on amendments of up to 20t/A of pine bark to successfully grow southern highbush (*V. corymbosum* interspecific hybrids) (Williamson et al 2006). At $40 – 60 a ton, the per acre price is $800 – $1200 (Fonsah et al., 2013). Recently, blueberry growers in Georgia began amending their soils with humic acid and humate products derived from Leonardite to improve CEC and water retention. However, product labels are generally only expressing the concentration as % humic acid and % inert compounds.

For humic acid extraction from Leonardite, the material is processed with a strong industrial caustic [e.g. NaOH, KOH, Ca (OH)$_2$] so that humic acid is taken into solution and a strong mineral acid (e.g. HCl or H$_2$SO$_4$) to precipitate humic acid (Aitken et al., 1964). Considering the salt formation from the acid/base reaction and blueberry sensitivity to salt and calcium, a study to identify the mineral inputs from humic acid extracted form Leonardite was conducted. This study evaluates two commercially available products (Anderson’s Humic DG and Helena’s Humate) and an unprocessed source of Leonardite (Alma Sunbelt Blueberries).

**Methods and Materials:**
Three commercially available products were analyzed at the UGA soils lab: Anderson’s Humic DG, Helena’s Hydra-Hume DG, and an unprocessed Leonardite (Alma Sunbelt Blueberry). Samples were extracted by Mehlich I (0.05N HCl + 0.025N H₂SO₄). The inductively coupled plasma (ICP) method was used to analyze mineral content according to UGA’s soil lab methodology (http://aesl.ces.uga.edu/protected/methods/stl-soil.html).

**Results and Discussion:**

Regular additions of organic matter to the soil are a common agricultural practice that has been utilized for more than 10K yrs. However, the function and chemistry of organic matter has been the focus of much research since Liebig’s discoveries that inorganic compounds are utilized by plants for fertility. General consensus associates humic acid with enhancing CEC through organic functional groups such as phenolics, carboxylic acid, phthalate and nitrogen bearing groups (e.g. indole) (Aitken et al., 1964; Ricca et al., 1993; Ricca et al., 2000). Leonardite, a low grade coal, is mined to extract humic acid, which in turn is processed to be used as a soil amendment to be utilized for heavy metal remediation and to increase soil CEC (Soler-Rovira et al., 2010; Pertuit, et al, 2001). In this study, identifying the elemental nature of the products shows that Ca is 0.5% and 0.2% of processed and unprocessed Leonardite, respectively. At recommended rates of 40 – 400 lb/A, Ca additions would be 0.2 – 2lbs/A. Further, the K values of processed Leonardite are 977 – 800 ppm whereas the unprocessed material is 125 ppm (Table 1) suggesting KOH was used as the caustic extractant.

In three studies, humic acid from Leonardite was analyzed to determine effect on growth: tomato (*Lycopersicon esculentum* L. Mill. ‘Mountain Pride’) (Pertuit, et al, 2001), zinnia (*Zinnia elegans* Jacq. ‘Small World Pink’) (Dudley et al., 2004), and turnip (*Brassica rapa* L. ‘Purple Top White Globe’) (Duval et al., 1998). Tomato and zinnia where potted studies (sand or 1 sand - 1 peat)
where response was noted at 1/64% and 3.125% humic acid additions; this equates to 15.6 t/A and 31 t/A, respectively. Further, turnip grown in fine sandy loam soil in the field elicited no response to treatments of up to 400 lb/A. In each study, authors warned that Leonardite sources are variable, suggesting consumer awareness. If a grower were to apply humic products at the suggested rate for response, there is a 4 -10 lb/t addition of Ca from unprocessed to processed Leonardite. *Blueberry soil analysis recommendation (UGA Soils Lab) suggests not planting in soils greater than 900 lb/A Ca*. Further, research of humic products and blueberry is limited and needs to be more thoroughly explored.

**Conclusion**

The relationship between blueberry and Leonardite products is not well defined. It is well established that blueberry growth is enhanced with organic matter amendments to the soil, especially pine bark (Williamson et al., 2006). However, humic products add non-organic, potentially undesirable, elements from the parent material and processing. In addition, studies reveal that rates greater than what is suggested on the label are needed to elicit a response. Considering levels of Ca in both the processed and unprocessed material, caution is advised in the use of Leonardite without thorough knowledge of the minerals being applied.

**References**

Aitken, J.B., Acock, B. and Senn, T.L. 1964. The characteristics and effects of humic acids derived from Leonardite. South Carolina Agricultural Experiment Station Technical Bulletin 1015 pp1-28


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Table 1. ICP analysis of Leonardite unprocessed (Alma Sunbelt Blueberry) and commercially processed Leonardite Anderson’s Humic DG and Helena’s Humate. All elements are reported as parts per million (ppm) as well as pH.

<table>
<thead>
<tr>
<th>Source</th>
<th>P</th>
<th>K</th>
<th>Ca</th>
<th>Mg</th>
<th>Mn</th>
<th>Fe</th>
<th>Al</th>
<th>Cu</th>
<th>Na</th>
<th>Ni</th>
<th>Zn</th>
<th>Mo</th>
<th>pH</th>
</tr>
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<tr>
<td>Anderson</td>
<td>117.5</td>
<td>977</td>
<td>4999.5</td>
<td>671</td>
<td>207</td>
<td>432.5</td>
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<td>261</td>
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<td>0.5</td>
<td>0.45</td>
<td>105</td>
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<tr>
<td>Helena</td>
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<td>800</td>
<td>4999.5</td>
<td>481.5</td>
<td>131.5</td>
<td>205.5</td>
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<td>279</td>
<td>0.95</td>
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<td>0.3</td>
<td>114</td>
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<tr>
<td>Sunbelt</td>
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<td>125</td>
<td>2070</td>
<td>2041</td>
<td>103</td>
<td>262.5</td>
<td>0.15</td>
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