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Biochar-ammonium phosphate as an uncoated-slow release fertilizer in sandy soil

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Biochar-Ammonium Phosphate as an uncoated-slow release fertilizer in sandy soil

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Biochar: Production, Characterization and Applications, August 20-25, 2017 Hotel Calissano Alba, ITALY
Loss of 78 Gt (78 billion tonnes) of carbon (C) from soil since 1850 = 10 x annual fossil fuel emissions
Agriculture Residues

Cotton stalks

Corn stalks

Rice straw & husk

Corn cob
Objectives

1. Manufacturing of a new effective uncoated eco-friendly N, P fertilizer using agriculture residues
2. Characterize, and determine the agronomic value of the BAP
BioChar device in Egypt
Thermochemical Conversion

Syngas
H2, Co, Co2

Waste Biomass
Pyrolysis

Bio-oil

Biochar
Ammonia reaction with Biochar

Biochar + Phosphoric acid → Biochar-Ammonium Phosphate (BAP) + Ammonia Gas

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Eq. 1: $1.5 \text{mol NH}_3 + (0.76 \text{mol H}_3\text{PO}_4 + 150 \text{g Biochar}) \rightarrow 248 \text{g Biochar} (\text{NH}_4)_2\text{HPO}_4 \rightarrow \text{BAP1}$

Eq. 2: $1.5 \text{mol NH}_3 + (0.76 \text{mol H}_3\text{PO}_4 + 220 \text{g Biochar}) \rightarrow 320 \text{g Biochar} (\text{NH}_4)_2\text{HPO}_4 \rightarrow \text{BAP2}$
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Process flow diagram for BAP manufacturing

1. Biochar production at 420 °C
2. Screening of Crushing, Grinding Biochar
3. Washing & purification
4. Mixed Biochar with $\text{H}_3\text{PO}_4$ (Mixture)
5. Reaction mixture + $\text{NH}_3$
6. Drum Granulation
7. Draying
SEM micrograph of Rice husk Biochar, (a) BAP1 & (b) BAP2
Biochar-ammonium phosphate (BAP2)
Biochar-ammonium phosphate (BAP 1)
FTIR spectrum of Rice husk Biochar&BAP2
Release patterns of N-NH$_4$ + from BAP1, BAP2 and AP by water solution.
Greenhouse experiment (. Japanese mustard spinach (*Komatsuna Brassica*))
**Effect of N fertilizer sources on some vegetative characteristics of Japanese mustard spinach plants.**

<table>
<thead>
<tr>
<th></th>
<th>Leave area (cm²)</th>
<th>Chlorophyll SPAD</th>
<th>Fresh weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BAP 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BAP 2</td>
<td>75.00</td>
<td>68.50</td>
<td>48.70</td>
</tr>
<tr>
<td>NH4H2PO4</td>
<td>103.40</td>
<td>97.64</td>
<td>49.20</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>54.60</td>
<td>52.08</td>
<td>47.80</td>
</tr>
<tr>
<td></td>
<td>8.50</td>
<td>7.86</td>
<td>0.50</td>
</tr>
</tbody>
</table>
Nitrogen remained in soil and losses in leachate water.

<table>
<thead>
<tr>
<th></th>
<th>Nitrogen remained in soil (% of N applied)</th>
<th>available nitrogen (NH₄ and NO₃) in leachate (mg L⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2014</td>
<td>2015</td>
</tr>
<tr>
<td>BAP 1</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>BAP 2</td>
<td>22</td>
<td>25</td>
</tr>
<tr>
<td>NH₄H₂PO₄</td>
<td>12</td>
<td>10</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td>2.5</td>
<td>3.6</td>
</tr>
</tbody>
</table>
Nitrogen uptake as affected by uncoated slow release fertilizer and traditional fertilizer

![Bar chart showing nitrogen uptake in mg N plant\(^{-1}\) for BAP 1 (36.6), BAP 2 (37.6), and NH\(_4\)H\(_2\)PO\(_4\) (28.0).](chart.png)
Nitrogen use efficiency as affected by uncoated slow release fertilizer and traditional fertilizer.

<table>
<thead>
<tr>
<th>Nutrient sources</th>
<th>BAP 1</th>
<th>BAP 2</th>
<th>NH4H2PO4</th>
</tr>
</thead>
<tbody>
<tr>
<td>NUE (%)</td>
<td>17.96</td>
<td>18.81</td>
<td>14</td>
</tr>
</tbody>
</table>

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Conclusion

• BAP could function as an uncoated-slow release fertilizer that permits maximum uptake and utilization of nitrogen. Fertilizer impregnated into the Biochar does not contain any harmful coating materials that deteriorate the soil properties. Besides, the Biochar material adds organic carbon to the soil in addition of its benefit of economic impact.
Thanks for your attention