Using puffed rice hulls to improve water-use efficiency of greenhouse soil

Improving water-use efficiency of agricultural soils, particularly those in PE film houses where water is precious, is an important concern in Korea. Hence, the use of rice hulls to improve water-use efficiency and the physical properties of greenhouse soils was investigated. However, the soil physical properties, particularly the water preservation capacity of greenhouse soils, barely improved with the use of rice hulls basically because it is hydrophobic and disintegrates slowly in soils due to its surface wax layer. Thus, the rice hulls needed to be puffed to become hydrophilic. Puffed rice hulls was studied as a substitute for rice hulls and were found to have good effects on soil water conservation and physico-chemical properties (Fig. 1 and Table 1).

Preparation of puffed rice hull and its characteristics

Puffed rice hull is a hydrophilic material made from hydrophobic rice hulls. It can be produced under high temperature and pressure by the mechanical processing of crushing rice hulls through a narrow space between special compound metal housing and crushing balls. In the process, the surface wax layer of rice hull is destroyed and its texture becomes similar to that of sawdust. Puffed rice hull can absorb water over six times of its weight, and precipitate immediately in the water due to its broken wax layer and enlarged surface area. It can also work effectively as a soil improvement agent with its high content of organic matter (about 46%) and C/N ratio (about 100).

Advantages of puffed rice hull use

Precisely controlled drip irrigation system (Fig. 2), which started at -33 kPa and was adjusted to -10 kPa of soil water potential for lettuce cultivations, was adopted for the experiment carried out on a sandy loam soil in a PE film house to find out the application effect of 5 mg·ha⁻¹ of puffed rice hull. The effects of puffed rice hull on soil water preservation and soil physico-chemical properties were as follows:

- Irrigation water was saved by 17% with puffed rice hull. The water requirement of the control plot...
was 1,800 MT·ha⁻¹, while that of puffed rice hull plot was 1,500 MT·ha⁻¹ for lettuce cultivation due to the high water absorbing and holding capacity of bulked rice hull.

- The formation of soil aggregates with puffed rice hull increased from 8.3% (control) to 14.1%, and the soil pore phase from 55% (control) to 56%, giving more space for soil water preservation. The results seem to be from the effect of enhanced microbial activity by puffed rice hull providing the energy and carbon for soil microorganisms.

In addition to the above direct effect, the application of puffed rice hull showed other beneficial effects on soils:

- The use of puffed rice hull softened the soil. Soil hardness was measured from 6.4 kg·cm⁻² for the control to 3.6 kg·cm⁻² with puffed rice hull, providing a better condition for root growth.

- It also improved soil buffering capacity, especially in salt accumulated soil by excessive fertilization. The soil EC dropped to 2.9 dS/m⁻¹ with puffed rice hull from 3.8 dS/m⁻¹ for the control.

**Precautions**

Farmers must be aware that the high water holding capacity of puffed rice hull is sometimes harmful for crops that require small amount of water. The application rate of puffed rice hull and water irrigation should be adjusted based on the plant requirements. Nitrogen deficiency can occur by the high C/N ratio of rice hulls. Hence, nitrogen fertilization rate should also be adjusted based on soil fertility.

<table>
<thead>
<tr>
<th>Organic materials</th>
<th>Water absorption rate by soaking time [%]</th>
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<tbody>
<tr>
<td></td>
<td>after 1 hour</td>
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<tr>
<td>Puffed rice hull</td>
<td>445</td>
</tr>
<tr>
<td>Rice hull</td>
<td>248</td>
</tr>
<tr>
<td>Sawdust</td>
<td>420</td>
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</tbody>
</table>

![Fig. 2. PE film house experiment using drip irrigation system and tensiometers](image)