THE EXUDATION OF GLUTAMINE FROM LAWN GRASS

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(WITH TWO FIGURES)

In 1934 Greenhill and Chibnall (3) reported the exudation of glutamine from perennial rye grass when treated with nutrient solutions high in ammonia. This is the first recorded observation of glutamine being exuded from a plant.

FIG. 1. Lawn grass, showing exuded salt, composed largely of glutamine. This salt was confined to the area fertilized, and the paths of the fertilizer spreader are clearly seen.

In April, 1942, a similar phenomenon occurred on a lawn in Hamden, Connecticut. On April 11 an undetermined amount of a 10–5–5 fertilizer, high in ammonium sulphate and potassium chloride was applied to a poor uncut area of a lawn and immediately irrigated with a hose. The weather conditions at the time were cloudless, the nights were cool and no rain fell.
In addition to a heavy dew every night, the grass guttated profusely, and this water remained on the plants well into the middle of the morning. On the day following the fertilizer application, the color of the fertilized area took on a whitish cast which became increasingly more conspicuous for three days. At that time detailed observation showed that a small white deposit was attached to the tip and side of almost every grass blade. The owner of the lawn, thinking that the fertilizer that he had applied had been harmful, asked the Experiment Station for an explanation of this unusual phenomenon.

The lawn was indeed an unusual sight when the writer saw it on April 15. Figure 1 clearly shows that the white area corresponded to that part of the lawn where the fertilizer had been applied. The path of the fertilizer spreader is clearly seen. Figure 2 shows individual grass blades, together with specimens of two other species of plants, *Achillea millefolium*, and sorrel, *Rumex acetosella*, bearing the deposits. Two other plant species not included in the picture but which also bore deposits at the leaf margins were clover, *Trifolium repens*, and hawk weed, *Hieracium pratense*.

Identification of material

Samples of the grass with the adhering deposit were brought to the laboratory for identification. Doctors H. B. Vickery and G. H. Pucher
of the Biochemical Laboratory of this Station were able, by chemical means, to identify the greater part of the white deposit as glutamine. In a solution prepared by rinsing the sample of cut grass blades with warm water, the equivalent of 6.7 grams of glutamine per kilo of fresh material were found, while the washed clippings contained the equivalent of 5.1 grams per kilo, most of which was located within the blades.

Attempts to reproduce the phenomenon of glutamine exudation have failed. Only traces of glutamine were found in guttation water collected from grass plots which had been treated with a similar fertilizer in an attempt to duplicate the observation. Apparently the delicate balance between the combination of atmospheric conditions, the soil solution as influenced by a suitable nitrogenous fertilizer, and the condition of the plants favorable for the evaporation of the guttation drops are not commonly encountered.

**Discussion**

Plant physiologists have long recognized the natural process by which water is excreted by the plant—a process called guttation. WILSON (5, 6) studied guttation water and listed some of the compounds which he found dissolved in it. He stated his conviction that these compounds came from within the plant by means of a normal physiological process.

The present observation of glutamine formation in plants and its exudation in the guttation water confirms that of GREENHILL and CHIBNALL (3), and indicates that this phenomenon is perhaps much more common than has been generally supposed.

It is interesting to note that the plants absorbed large quantities of ammonia, as is evidenced by the amounts of glutamine produced (VICKERY et al., 4), and such large quantities of potassium and chlorides as are shown in table I. The fact that such small amounts of calcium and other elements

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**TABLE I**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Amount p.p.m.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrate nitrogen</td>
<td>Trace</td>
</tr>
<tr>
<td>Nitrite nitrogen</td>
<td>Trace</td>
</tr>
<tr>
<td>Ammonia nitrogen</td>
<td>5</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>4</td>
</tr>
<tr>
<td>Potassium</td>
<td>40</td>
</tr>
<tr>
<td>Calcium</td>
<td>Trace</td>
</tr>
<tr>
<td>Mg</td>
<td>4</td>
</tr>
<tr>
<td>Al</td>
<td>0.3</td>
</tr>
<tr>
<td>Mn</td>
<td>Trace</td>
</tr>
<tr>
<td>Sulphate sulphur</td>
<td>Trace</td>
</tr>
<tr>
<td>Chloride</td>
<td>40</td>
</tr>
<tr>
<td>pH</td>
<td>4.30</td>
</tr>
</tbody>
</table>

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1 It was found possible to collect large samples of guttation water from grass blades by "mopping" the area with cheese cloth and wringing the cloth into a vessel.
were found in the dried exudate also indicates that these ions must have been present in low concentration in the soil solution.

It is significant that materials absorbed or elaborated by the plant are at times eliminated from the plant in the guttation process. This suggests that perhaps one function of guttation is to eliminate materials that may be temporarily in excess of the requirements of the plant. This does not imply that these materials are responsible for guttation although they may contribute to the process.

The general belief among botanists is that plants do not need an excretory system, comparable to that of animals, to rid themselves of unwanted or unnecessary products of respiration or of synthetic processes (elaboration), or indeed of an excess of substances absorbed from the soil solution by the roots.

The writer contends that most plants apparently do need such a system, and that water absorbed by the roots is the most important material that the plant needs to excrete. There is no delicate balance between the immediate water requirements of the aerial portion of the plant and the amounts absorbed. On bright sunny days the leaves of a plant may wilt because transpiration exceeds absorption and at night the same leaf may lose water in liquid form because the supply exceeds the requirement. The function of guttation seems to be to regulate the turgor pressure within the plant. Any materials present in the guttation water, whether necessary or unnecessary or even toxic to the plant, would be eliminated only because they were present in the vascular system at the particular time that guttation takes place. GREENHILL and CHINNALL have expressed the belief that possibly the elaborated glutamine might even exercise some selective action on the permeability of the cells and thereby diffuse to the vascular system and eventually to the outside of the leaf. If this assumption be true, then perhaps toxic materials produced by bacteria and fungi in an infected plant might also find their way to the outside of a plant in the same manner.

The fact that chemical compounds reach the outside of the leaf and remain there for varying periods of time is of some importance to those who work with living plants. CURTIS (1, 2) has shown that exuded materials may injure the plant leaf directly, as these deposits did these grass blades, and that they may react or combine with spray and dust materials when applied as insecticides or fungicides to increase or decrease their effectiveness or to increase their injury to the host plant.

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LITERATURE CITED

2. ———. The influence of guttated fluid on pesticides. Phytopath. (In press.)
5. Wilson, J. K. The nature and reaction of water from hydathodes.