PRESENCE OF A GROWTH INHIBITOR IN THE TUBERS OF NUTGRASS (*CYPERUS ROTUNDUS* L.)

BY S. P. SINGH

(*Department of Agronomy, Punjab Agricultural University, Hissar*)

Received November 16, 1967

(Communicated by Dr. L. D. Kapoor, F.A.Sc.)

Nutgrass (*Cyperus rotundus* L.), a perennial weed of Cyperaceae, is of wide occurrence throughout the temperate and tropical regions. This weed possesses a high potentiality of propagation by tubers (Baker, 1964). Aerial growth of this weed, observed under favourable conditions of moisture and temperature, is not as important as the underground structures that generally weigh 4 to 5 times more than the foliage (Hauser, 1962). This weed seldom attains a height of more than one-and-a-half feet or so, but the decline in the productivity and vigour of crops, infested with nutgrass, is so severe that it can never be overlooked under field conditions. These deleterious effects may not be solely attributed to the rob of available moisture and nutrients, and competition for light and space by such a short statured plant that produces not more than about 2 tons of aerial vegetation (Baker, 1964) rather to the antagonistic effects of exudates from its sub-aerial parts which keep the growth and vigour of competing vegetation suppressed.

As early as 1882, de Candole pointed out the specific inhibition of flax by spurge (*Euphorbia* sp.) and of oats by thistle (*Cnicus* sp.), and postulated the production of specific toxic substances by these weeds. Evenari (1949) and Bentley (1958) have summarized the work on naturally-occurring inhibitors. Numerous reports attest to the deleterious effects of quack-grass (*Agropyron repens* L.) on other plant species (Kommedahl, *et al.*, 1959; Kacarava, 1961; Welbank, 1959). The roots and other underground organs of quack-grass (Le Tourneau *et al.*, 1957; Ohman *et al.*, 1964; Osvald, 1948), *Cnicus arvensis* (Kacarava, 1961), *Setaria glauca* (Yakum *et al.*, 1961), and several others (Lawrence and Kilcher, 1962) contain phytotoxic substances. Plants liberating such substances, either as exudate and/or leachate of decomposing dead organs, become victors in the struggle for existence in the plant community primarily by inhibiting the germination and growth of susceptible species.
**Presence of a Growth Inhibitor in Tubers of Nutgrass (C. rotundus L.)**

Eventually, in September 1966, the aqueous extract of nutgrass tubers, involved in an experiment on the antagonism and synergism of auxin herbicides, drew the attention as it inhibited the seed germination and growth of some crop seedlings. This observation led to some systematic work to demonstrate the presence of some water-soluble substance(s) inhibitory for germination in nutgrass tubers, the crop species affected by it, and the degree of such inhibition.

**MATERIALS AND METHODS**

Nutgrass tubers were collected from the fallow lands of Punjab Agricultural University, Hissar Farm. Water extract of tubers was obtained by soaking 50 gm. of slightly crushed tubers in a litre of distilled water for a period of 50 hours at 30 °C. The filtrate, obtained from it, was taken as the water extract. Seeds of 10 crops, viz., Bajra (Pennisetum typhoides), var. S.530; cowpeas, No. 1; sorghum (Sorghum vulgare), var. J.S. 163; maize (Zea mays), Hybrid Ganga 101; black gram (Phaseolus mungo), var. 1-1; cotton, H-14, and local variety of paddy, sesame, sunnhemp and groundnut were tested. Only rainy season crops were included in this experiment, as nutgrass flourishes well in this season. This experiment consisted of 20 treatments, each replicated 4 times. The experiment was repeated twice, first in sand and the other on filter-paper. Fifteen seeds were placed, equally apart, in 6 in. glass Petri dishes. Seeds were covered with 400 gm. of well-washed coarse sand, later moistened with either 50 ml. of distilled water or tuber extract. Petri dishes were held at 30 ± 2 °C. Number of seedlings emerged out of sand, and their length were recorded for 8 subsequent days. In the other set, planned to observe the characteristic inhibition, seeds were put over single circles of Whatman filter-paper No. 1, 150 mm. dia., in place of sand. The volume of water or tuber extract, added to each Petri dish, was reduced to 5 ml. for proper and sufficient wetting of filter-papers. Petri dishes were kept in the germination chamber, held at 30 ± 2 °C. On subsequent days, the number of germinated seeds were recorded and the characteristic inhibitory effects were marked.

**RESULTS AND DISCUSSION**

Table I represents the data on the percentage of seedlings emerged from the sand medium. It is obvious that the aqueous extract of nutgrass tubers inhibited the emergence of crop seedlings. Except maize, all crop species were affected to varying degrees. The length (Text-Fig. 1) and vigour of seedlings, in general, observed from the very beginning, were greatly
TABLE I

Per cent seedling emergence of crops with and without nutgrass tuber extract; as recorded on 25-8-1967 (8 days after sowing)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dajra</th>
<th>Sunnhemp</th>
<th>Paddy</th>
<th>Sorghum</th>
<th>Maize</th>
<th>Black-gram</th>
<th>Cotton</th>
<th>G. nut</th>
<th>Sesame</th>
<th>Cow peas</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>86.6</td>
<td>100</td>
<td>76.6</td>
<td>43.3</td>
<td>85.0</td>
<td>96.6</td>
<td>85.3</td>
<td>56.6</td>
<td>55.0</td>
<td>93.3</td>
<td>78.1</td>
</tr>
<tr>
<td>Tuber extract</td>
<td>23.3</td>
<td>45.0</td>
<td>60.0</td>
<td>40.0</td>
<td>85.0</td>
<td>76.6</td>
<td>65.0</td>
<td>20.0</td>
<td>10.0</td>
<td>40.0</td>
<td>46.4</td>
</tr>
<tr>
<td>Average</td>
<td>55.0</td>
<td>72.5</td>
<td>68.3</td>
<td>41.6</td>
<td>85.0</td>
<td>86.6</td>
<td>75.6</td>
<td>38.3</td>
<td>32.5</td>
<td>66.6</td>
<td></td>
</tr>
</tbody>
</table>

C.D. at 5% probability = 8.17% (for seed treatment)

hampered by the tuber extract. Radicals emerging from groundnut seeds, which received tuber extract, were observed coming upwards, as against their usual downward movement (Plate II, Fig. 1).

When filter-paper was used as the germination medium, percentage of seed germination (Table II) was less with tuber extract as compared to controls. Maize and cotton resisted the toxic effects in germination; less adverse effects were observed in case of sunnhemp and black-gram, while all the rest crops, so far as their germination is concerned, were severely affected.

From these two experiments, the presence of some phytotoxic substance(s) in nutgrass tubers is evident. Seedling emergence, an ultimate
Presence of a Growth Inhibitor in Tubers of Nutgrass (C. rctundus L.)

TABLE II

Germination percentage of different crop seeds treated with nutgrass tuber extract and water; as recorded on 31-8-1967 (7 days after sowing)

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Bajra</th>
<th>Sunnhemp</th>
<th>Paddy</th>
<th>Sorghum</th>
<th>Maize</th>
<th>Black gram</th>
<th>Cotton</th>
<th>G. nut</th>
<th>Sesame</th>
<th>Cow peas</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>100</td>
<td>100</td>
<td>73.3</td>
<td>80.0</td>
<td>100</td>
<td>100</td>
<td>70.0</td>
<td>83.3</td>
<td>95.0</td>
<td>91.6</td>
<td>89.3</td>
</tr>
<tr>
<td>Tuber extract</td>
<td>35.0</td>
<td>93.3</td>
<td>41.6</td>
<td>55.0</td>
<td>100</td>
<td>93.3</td>
<td>70.0</td>
<td>70.0</td>
<td>85.0</td>
<td>40.0</td>
<td>68.3</td>
</tr>
<tr>
<td>Average</td>
<td>67.5</td>
<td>96.6</td>
<td>67.5</td>
<td>67.5</td>
<td>100</td>
<td>96.0</td>
<td>76.6</td>
<td>90.0</td>
<td>85.8</td>
<td>..</td>
<td>..</td>
</tr>
</tbody>
</table>

C.D. at 5% probability = 7.66% (for seed treatment)

result of germination and early growth of seedlings, is reduced by tuber extract. Text-Figure 2 shows that inhibition of germination in cowpeas, paddy and sorghum; inhibition of both germination and post-germination seedlings’ growth in Bajra, groundnut, sesame, black-gram and sunnhemp, and only retardation of growth of germinated cotton seedlings contributed towards this large reduction in seedling emergence. Maize was totally indifferent to nutgrass tuber extract during germination and early stages of growth but its height and vigour were always brought down in later stages (Plate II, Fig. 2). The inhibitory effects of nutgrass tuber extract on the shoot height

Text-Fig. 2. Per cent. inhibition of germination and seedling emergence of crops by aqueous extract of nutgrass tubers.
and vigour of almost all crops were quite identical to the root extracts of quackgrass (Kommedahl et al., 1959; Osvald, 1948) that was observed with several crop species.

Post-germination inhibition of growth, which was very clear in groundnut and sesame, was primarily confined to radical and root hairs that ultimately govern the growth of aerial shoot. In sesame (Plate II, Fig. 3) root hairs completely degenerate by the tuber extract. Upward movement of radical in groundnut might result due to upset of internal auxin balance.

CONCLUSION

Tuber extract of nutgrass, when applied to the growing medium, inhibited the germination and growth of 10 crop species under the laboratory conditions. On the basis of above findings, the presence of some phytotoxic substance(s), however, in nutgrass tubers has been confirmed. Although the germination and growth of all the crops, included in this experiment, was inhibited by the phytotoxins present in nutgrass tubers yet the degree of such inhibition varied with different crop species.

ACKNOWLEDGEMENT

My sincere thanks are due to Dr. M. K. Moolani, Professor and Head of Agronomy Department, P.A.U., Hissar, for providing the necessary facilities and to Dr. L. D. Kapoor, F.A.SC., Assistant Director, National Botanical Gardens, Lucknow, for going through the paper critically.

REFERENCES

FIGS. 1–3
**Presence of a Growth Inhibitor in Tubers of Nutgrass (C. rotundus L.)**

8. Lawrence, T. and Kilcher, M. R.  
   “The effects of fourteen root extracts upon germination and 
   seedling length of fifteen plant species,” *Canad. J. Plant 

9. Lo Toumeau, D. and Heggeness, H. G.  
   “Germination and growth inhibitors in the leafy spurge foliage 

10. Ohman, J. H. and Kommedahl, T.  
     “Plant extracts, residues, and soil minerals in relation to com-
     petition of quack grass with oats and alfalfa,” *Ibid.*, 1964, 
     12 (3), 222-32.

11. Osvald, H.  
     “Toxic exudates from the roots of Agropyron repens,” *J. Ecol.*, 
     1948, 36, 192-93.

12. Welbank, P. J.  
     “Competitive effects of Agropyron repens (couch grass), 

     “Preliminary investigations of a germination and growth 
     inhibitor produced by yellow fox-tail (*Setaria glauca* L.), 