sities that were lower than initial densities (Fig. 2, Table 1). Assuming a similar extraction efficiency for the Washington State population, the general nature of the relationship between initial and final nematode densities on Washoe was similar to the Italian population. The final densities of J2 of the Italian population were lower than the initial densities at all inoculum levels in the resistant Nevada Syn XX (Fig. 2, Table 1). Only a few eggs in the American final population were detected on the resistant Nevada Syn XX (Table 1).

The results of these experiments confirm a low tolerance limit for Washoe seedlings to the Washington State M. hapla population. The tolerance limit to the Italian population was slightly higher than previously reported (6), perhaps because of more uniform distribution of inoculum about root systems. The data confirm the resistance of Nevada Syn XX to other M. hapla populations in addition to that reported by Griffin (4). However, early growth of the resistant Nevada Syn XX was inhibited by high numbers of the Italian and American M. hapla populations, even though nematodes reproduced poorly or not at all (Fig. 1 A-B, Table 1). The highest nematode densities used in these studies, although generally greater than those under field conditions, caused growth suppression of both cultivars in the seedling stage. Consequently, stand establishment of the resistant cultivar is a potential problem at high population densities of M. hapla.

Suppressed plant growth is usually of limited duration in the field, because nematode damage is greater in small seedlings than in older plants and the value of m increases with plant age (2). Yield loss is usually the result of stand loss in the seedling stage and increased weed competition.

LITERATURE CITED


Root Extracts of Pangola Digitgrass Affect Egg Hatch and Larval Survival of Meloidogyne incognita*

SANAA HAROON and GROVER C. SMART, JR.?

Key words: allelopathy, biological control.

Winchester (2) reported that Pangola digitgrass (then called Pangolagrass), Digitaria decumbens Stent., adversely affected the root-knot nematode Meloidogyne incognita acrita Chitwood and Oteifa, 1952. Earlier he reported that extracts from roots of young Pangola digitgrass plants stimulated hatch of eggs and that extracts from roots of old plants killed the larvae (1). He did not define “young” and “old.”

The research reported in this paper was designed to determine 1) the influence of root extract from various age Pangola digitgrass plants on egg hatch and larval survival of M. incognita and 2) whether

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?Graduate student and professor, Department of Entomology and Nematology, University of Florida, Gainesville, FL 32611.

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larvae hatched in extract from roots of old plants had been irreversibly harmed or whether they would survive if transferred into root extract from young plants.

Pangola digitgrass cuttings were rooted weekly for 14 weeks. Then 10 grams of roots were taken from plants 3–14 weeks old. The roots were surface sterilized in 0.5% NaOCl for 3 minutes and rinsed in three separate changes of sterile water. The roots from each age plant were comminuted separately in a food blender for 30 seconds in 100 ml of sterilized water, and the solution passed through a sterile 0.45-μm micropore filter to provide root extract. The pH was determined. Extract not used immediately was stored at 4.4 C and used in all subsequent tests.

Three replicates of root extract were prepared for each plant age. Ten milliliters of the extract were placed in a 5.5-cm-d. petri dish and 250 eggs of *M. incognita* added. Sterilized water was used as a control. The number of eggs that hatched each 24 hours for 10 days was recorded, and the larvae were transferred to another dish which contained 10 ml of the same root extract. These larvae were examined daily for 10 days after they hatched to determine the number living and dead. The experiment was conducted under room temperature.

After 2 days a few eggs hatched only in root extract from plants 3, 4, and 5 weeks old (Table 1). In general, the older the plants from which root extracts were made, the later egg hatch began. The first 5 days seemed to be a natural dividing point for hatch in extracts from plants 3–10 weeks old versus plants 11–14 weeks old. These plants will be referred to hereafter as young (3–10 weeks) and old (11–14 weeks). During the first 5 days the mean percentage of eggs hatched in root extracts from young plants was 29%, while in root extracts from old plants the average was 0.3%; 36% hatched in controls. During the second 5 days, hatch in extracts from young plants was 68% and in old plants 87%; 54% hatched in the controls. Differences in hatch between young and old plant root extracts were statistically significant ($P = 0.05$). At the end of 10 days the mean percentage of total egg hatch was 91% in the root extract from young plants, 87% from old plants, and 90% in the controls; differences were not significant. In root extract from 14-week-old plants, only 60% of the eggs hatched; that was less ($P = 0.05$) than the controls.

Table 1. The influence of root extracts from various age Pangola digitgrass plants on hatch of *Meloidogyne incognita* eggs.*

<table>
<thead>
<tr>
<th>Age of plants used to make root extracts (weeks)</th>
<th>No. of eggs hatched per day†</th>
<th>Cumulative egg hatch†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8 9 10</td>
<td>First 5 days Next 5 days Total</td>
</tr>
<tr>
<td>3</td>
<td>15 42 20 11 23 11 26 10 34</td>
<td>88 104 192</td>
</tr>
<tr>
<td>4</td>
<td>7 40 36 36 0 19 9 28 51</td>
<td>119 107 226</td>
</tr>
<tr>
<td>5</td>
<td>4 18 21 37 10 17 12 36 61</td>
<td>80 136 216</td>
</tr>
<tr>
<td>6</td>
<td>6 4 40 23 13 45 67 50</td>
<td>50 198 248</td>
</tr>
<tr>
<td>7</td>
<td>1 17 43 12 13 15 34 48</td>
<td>61 122 183</td>
</tr>
<tr>
<td>8</td>
<td>36 17 5 12 38 31 49 43</td>
<td>58 173 231</td>
</tr>
<tr>
<td>9</td>
<td>25 13 33 12 28 18 30 87</td>
<td>71 175 246</td>
</tr>
<tr>
<td>10</td>
<td>6 7 36 2 15 45 124 50</td>
<td>49 236 285</td>
</tr>
<tr>
<td>11</td>
<td>12 10 52 78 90</td>
<td>242 242</td>
</tr>
<tr>
<td>12</td>
<td>16 50 38 120</td>
<td>224 224</td>
</tr>
<tr>
<td>13</td>
<td>3 6 32 39 78 94</td>
<td>3 249 252</td>
</tr>
<tr>
<td>14 (water control)</td>
<td>18 28 40 65</td>
<td>151 151</td>
</tr>
</tbody>
</table>

*Approximately 250 eggs per replicate.
†Each figure is the mean of three replicates.
Root extracts from plants 3–8 weeks old had no effect on larval survival, but survival decreased sharply in extracts from older plants (Fig. 1).

The pH, which ranged from 6.2 to 6.5 in the root extracts and was 6.8 in the water control, had no apparent effects on egg hatch and larval survival.

To determine whether larvae which hatched in root extracts from old plants were irreversibly harmed, we placed 100 eggs in petri dishes containing 5 ml of root extract from either young (4 weeks) or old (14 weeks) plants. After five days, hatched larvae were counted. Each treatment was replicated twice. Half of the 16 larvae hatched in root extracts from old plants were transferred to a petri dish containing 10 ml of extract from roots of young plants and half to a dish containing 10 ml of root extract from old plants. The 86 larvae hatched in extracts from young plants were transferred similarly to serve as controls.

Seven of the eight larvae transferred from old to young extract were alive after 10 days, while all eight larvae in old extract died within 1 day. All 43 larvae transferred from young to old extract died within 2 days, while 32 of the 43 transferred from young to young extract survived 10 days and all 43 survived for 3 days.

In conclusion, root extracts from Pangola digitgrass plants, no more than 10 weeks old, stimulated eggs of *M. incognita* to hatch 2–3 days early. Root extracts from plants 11–14 weeks old delayed egg hatch 5–6 days. However, just as many eggs hatched within 10 days in extracts from the older plants as in that from the younger plants, except at 14 weeks where fewer hatched. Larval survival was affected little or none by root extracts from plants 3–8 weeks old, but extracts from plants 9–14 weeks old killed most of the larvae within 10 days. Larvae that hatched in root extract from old plants, but did not remain in it, were not harmed irreversibly.
Effects of Pangola Digitgrass on Meloidogyne arenaria, M. javanica, and M. hapla

SANA HAROON and GROVER C. SMART, JR.

Key words: allelopathy, biological control.

Pangola digitgrass (Digitaria decumbens Stent.) can be used as a pasture grass or it can be harvested as hay. It originated in Africa and has been introduced to other tropical and subtropical areas of the world. Winchester and Hayslip (5) reported that the grass eliminated populations of the root-knot nematode, Meloidogyne incognita acrita Chitwood and Oteifa, 1952. Overman (3) sampled 74 pastures of Pangola digitgrass and found M. incognita Kofoid and White, 1919 in only one. That pasture had been in Pangola digitgrass only one year. Haroon and Smart (1) confirmed that Pangola digitgrass is antagonistic to M. incognita. Other species of Meloidogyne, especially M. javanica (Treub, 1885) Chitwood, 1949 and M. arenaria (Neal, 1889) Chitwood, 1949, are present in regions where Pangola digitgrass may be grown. The three species of Meloidogyne mentioned previously plus M. hapla Chitwood, 1949 are the four most common species of Meloidogyne on a world basis (4). Since the grass is known to be antagonistic to M. incognita, experiments were conducted to determine whether it is antagonistic to the three other most common species of Meloidogyne.

Forty 15-cm-d clay pots were filled with autoclaved Arredondo fine sand. Twenty of the pots were planted with one unrooted Pangola digitgrass cutting and 20 with one tomato (Lycopersicon esculentum Mill. cv. Rutgers) seed to serve as controls. Five weeks later the soil in five pots of digitgrass and five of tomato was infested with 15 egg masses of either M. arenaria, M. hapla, M. javanica, or M. incognita. All pots were placed in a greenhouse at about 25 ± 3 C and watered as needed. The experiment was terminated after 90 days. The plants were removed from the soil, the tops removed and weighed, the roots washed, weighed, and the number of galls and egg masses determined. The roots were stained with acid fuchsin in lactophenol, destained in lactophenol, mounted on slides, and examined for the presence of different life stages of Meloidogyne. The population of second-stage larvae in the soil in each pot was determined by removing larvae from a 100-cm³ aliquot of soil by a centrifugation-flotation technique (2).

After 90 days, soil populations of second-stage larvae of all four species of Meloidogyne on digitgrass were low: 3 M. javanica, 12 M. hapla, 24 M. arenaria, and 36 M. incognita per pot compared to 2,412, 4,609, 12,180, and 7,152 of the same species on tomato (Table 1). Second-stage larvae per root system were 9 M. javanica, 11 M. hapla, 12 M. incognita, and 48 M. arenaria in digitgrass roots compared to 475, 307, 429, and 4,120 of the same species in tomato roots. Thus, Pangola digitgrass should be a suitable crop to use wherever it can be grown for pasture or forage or as an antagonistic plant against the four most common species of Meloidogyne. It is not known if the grass is antagonistic to other species of Meloidogyne.

LITERATURE CITED


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2Graduate student and professor, Department of Entomology and Nematology, University of Florida, Gainesville, FL 32611.