Population Dynamics of *Criconemoides simile* on Soybean[1]

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Abstract: Custer and Hood soybean cultivars were inoculated with nine levels of *Criconemoides simile* ranging from 300 to 20,600 nematodes per plant. Rate of reproduction decreased as inoculum level was increased beyond 900–2,000 nematodes. Final population density was influenced by both composition and level of inoculum. There was an indication that substance(s), inhibitory to larvae, accumulated in soil in which Hood was grown for 11 months. Significant reduction of fresh weight of roots of Hood, but not Custer, occurred at population densities of 37,000 and 44,700 nematodes per plant. *Key words:* ring nematode, allelopathy.

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In previous greenhouse tests, *Criconemoides simile* ([Cobb 1918] Chitwood 1949) (Cs) reproduced rapidly on soybean when the level of inoculum was low (100 females) and injury to roots was not apparent (6). The rate of reproduction (R) (9) by Cs was significantly greater on the soybean cultivar Custer than it was on the cultivar Hood. A major factor contributing to the significantly different rates of reproduction on the two cultivars was the failure of many of the larvae on Hood to mature. In studies with Cs subsequent to those reported previously, levels of inoculum ranging from 300 to 20,600 individuals per plant were used in order to monitor the effect of inoculum level on the rate of reproduction by Cs and on the growth of Custer and Hood soybeans. Also, a test was conducted to test the hypothesis that some allelopathic substance(s) accumulate in soil in which Hood is cultivated which inhibits development of Cs larvae.

MATERIALS AND METHODS

Unless noted otherwise, the source of plant material, greenhouse conditions, and methods by which Cs populations were maintained, collected for inoculum, and assayed were as previously reported (7). Differences between treatments were evaluated using standard analysis of variance procedures.

Effect of inoculum levels: In one test, inoculum levels of 0, 300, 600, 1,200, and 2,000 Cs per 10-cm-d pot (one plant/pot) at a female-to-larvae ratio (F:L) of 33:67 were established; in a second test, inoculum levels of 0, 900, 2,600, 10,300, and 20,600 Cs at a F:L of 55:45 were established. Inoculum was pipetted into the depression in the center of each pot just prior to transplanting seedlings. There were three replicates of each treatment, and the test was terminated 50 days after infestation.

A third test was conducted to determine whether populations would reach damaging levels under conditions more natural than those established using the pipetting procedure described for tests 1 and 2. Soil was initially infested with 876 Cs per pot, and at intervals of 38, 83, and 129 days the infested soils were removed, combined according to treatment, mixed, repotted, and replanted with 10-day-old Custer and Hood seedlings. At 193 days after initial infestation, the two infested soil lots were each divided into two equal parts. Half the infested soil in which Custer had been growing (Custer-soil) was planted to Hood; the remaining half was replanted to Custer. Likewise, half the infested soil in which Hood had been growing (Hood-soil) was planted to Custer; the remaining half was replanted to Hood. The test was terminated 73 days later, 266 days after initial infestion.

At each planting interval, three 454-g subsamples of soil from each treatment were used to determine population densities, percent soil moisture, and pH. Plant growth was measured only for those plants cultivated during the last interval, 193–266 days, at which time there were five replicates of each treatment. Controls were handled as described above, but contained no nematodes.

Allelopathic effects: Four 20-cm-d pots

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were filled with soil. Five Custer seedlings were transplanted into each of two pots, and five Hood seedlings into each of the remaining two pots. At monthly intervals, for 11 months, the soil from each pot was removed, mixed, replaced, and replanted to the same cultivar. At the end of this period, both pots of Custer-soil were combined. The same was done with Hood-soil. Soil from these two lots was placed into 10-cm-d pots and infested with 100 females of Cs. Custer seedlings (one/pot) were transplanted into four pots of Custer-soil and into four pots of Hood-soil. Similarly, Hood seedlings were transplanted into four pots of Hood-soil and into four pots of Custer-soil. Controls received seedlings and nematodes as described above, but pots contained soil in which soybeans had not previously been cultivated. The test was concluded 62 days after infestation.

RESULTS

Effect of inoculum levels: Final populations of Cs on Custer numbered from 2,900 to 125,600 per plant (Table 1). Values of R decreased steadily as inoculum level was increased beyond 2,000 per plant. At 50 days after inoculation there were no significant differences among weights of Custer roots exposed to nematodes and those exposed to control fluids. Final numbers of Cs on Hood ranged from 900 to 44,700 per plant. Values of R were inversely related to inoculum level. Fresh weights of roots of Hood plants inoculated with 10,300 and 20,600 Cs per plant were significantly less than those of controls. Values of R declined before significant injury to roots occurred. When the F:L in inoculum was 33:67 (400 females and 800 larvae), populations recovered from Custer and Hood averaged 8,400 and 1,200 Cs per pot, respectively; when the F:L was 55:45 (500 females and 400 larvae), recovery was 13,400 and 6,500 Cs per pot from Custer and Hood, respectively.

During the 266-day period of test 3, significantly greater numbers of Cs were recovered from Custer than from Hood at each planting interval between 0 and 193 days (Fig. 1). When the two soil lots were divided, populations had increased to 8,000 per plant on Custer and had decreased to 760 per plant on Hood. Seventy-three days later, populations had increased to 58,100 nematodes per plant on Custer growing in Custer-soil, 37,100 on Hood in Custer-soil, 6,300 on Hood in Hood-soil, and 11,300 on Custer in Hood-soil. Weights of roots of Hood plants growing in Custer-soil were significantly less than those of controls, 8.2 and 14.4 g, respectively. Weights of roots

Table 1. Rate of reproduction (R) and effect of *Criconemoides simile* on growth of Custer and Hood soybean.

Inoculum level (in 1,000's)	Final population (in 1,000's)		R†		Fresh root weight (g)	
	Custer	Hood	Custer	Hood	Custer	Hood
Test #1						
0.3	2.9	0.9	9.8	3.0	24.1	21.9
0.6	4.6	2.1	7.7	3.5	23.8	24.1
1.2	8.4	5.0	6.9	4.1	23.3	22.3
2.0	21.3	8.4	10.6	4.2	20.1	21.8
Control	0	0	0	0	24.2	25.1
Test #2						
0.9	13.4	6.5	15.6	7.6	23.1	27.0
2.6	23.0	14.0	8.9	5.4	24.1	26.8
10.3	65.0	43.8	6.3	4.2	23.5	25.2*
20.6	125.6	44.7	6.1	2.2	23.2	23.9**
Control	0	0	0	0	27.0	33.8

*Indicates a difference from control which is significant at the 5% level.
**Indicates a difference from control which is significant at the 1% level.
†R = final population/initial population.

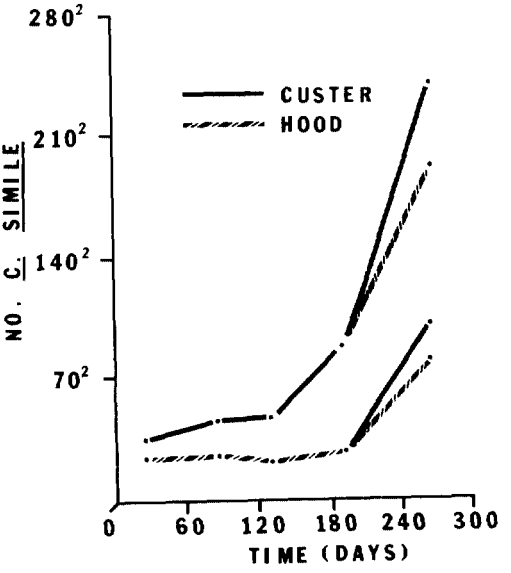

Fig. 1. Development of populations of *Criconemoides simile* on Custer and Hood soybeans. At 193 days soil lots were split and reciprocal planting were made (Hood seedlings into one half of the Hood-soil and Custer seedlings into remaining half; likewise, Custer seedlings into one half of Custer-soil and Hood seedlings into remaining half).

in other plant-soil-neamtode combinations were not significantly different from those of controls. Soil pH and percent moisture ranged from 6.4 to 7.2 and from 15.5% to 18.5%, respectively.

Allelopathic effects: The numbers of Cs recovered from Custer and Hood growing in soil in which Custer and Hood had been previously cultivated for 11 months were significantly different, more being recovered from the former than from the latter (Table 2). Nematodes recovered when Hood was the inoculated cultivar, and either Custer or Hood the previous cultivar, were not significantly different. The numbers of Cs recovered from controls were also significantly different.

Table 2. Reproduction of *Criconemoides simile* on Custer and Hood soybeans growing in soil in which Custer or Hood had previously been cultivated for 11 months.

Previous cultivar	*C. simile* (in 1,000's) recovered from inoculated cultivar	
	Custer	Hood
Custer	24.6b†	9.2a
Hood	10.7a	9.6a
None‡	35.2c	13.3a

†Data analyzed by Duncan's new multiple-range test; numbers within columns followed by different letters are significanty different at the 5% level.

‡Soils in which soybeans had not been cultivated previously.

DISCUSSION

Populations of Cs increased at a greater rate from low P_1 than from high P_1. Reports of Aycock et al. (1), for *C. xenoplax* on Japanese holly (*Ilex crenata* Thumb.), and Braun et al. (2), for *C. xenoplax* and *Paratylenchus neoamblycephalus* on Myrobalan plum, are consistent with this observation. Values of R tended to increase on Hood and fluctuate on Custer between 300 and 900–2,000 nematodes in inoculum and then declined steadily on both cultivars as inoculum levels were increased beyond 2,000. There was no indication that a "ceiling level" (4,8) was being approached nor that significant root injury was occurring on Custer. However, on Hood, final populations that developed from the two highest inoculum levels were essentially the same, indicating that the ceiling level for this cultivar was reached. These points coincided with the points of significant reduction in fresh weight of roots, indicating that root damage was a factor in determining the ceiling level.

Data from the 266-day test suggest that under conditions more natural than those obtained by pipetting large quantities of nematodes around the roots of small plants, populations of Cs might never reach levels at which damage is detectable as reductions in root weight. However, if high populations are artificially introduced (as they were in test 2) or if they are accumulated under a better host (as they were under Custer during the first 193 days), damage can result. Under such conditions, Hood would be regarded as the host less suitable for reproduction, but more susceptible to disease or injury. Similar host-nematode relationships have been described by others (3,9).

It was previously reported (9) that the significant difference in density of Cs populations recovered from the two cultivars 50

days after inoculation was due to failure of many larvae to mature on Hood. This, coupled with observations of differences in final density among populations in test 3 and test 4, provides a possible explanation for the failure of many larvae of Cs to mature on Hood; i.e., the accumulation of a root exudate or chemical substance(s) inhibitory to them. Differences in concentrations or types of root exudates which affect reproduction have been domumented for other phytoparasitic nematodes (5,10). Further investigation into the nature of such substances is in progress.

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