

Host Status of Five Weed Species and Their Effects on *Pratylenchus zeae* Infestation of Maize

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Abstract: The host suitability of five of the most common weed species occurring in maize (*Zea mays* L.) fields in South Africa to *Pratylenchus zeae* was tested. Based on the number of nematodes per root unit, mealie crotalaria (*Crotalaria sphaerocarpa*) was a good host; goose grass (*Eleusine indica*), common pigweed (*Amaranthus hybridus*), and thorn apple (*Datura stramonium*) were moderate hosts; and khaki weed (*Tagetes minuta*) was a poor host. Only the root residues of khaki weed suppressed the *P. zeae* infestation of subsequently grown maize. When goose grass, khaki weed, and mealie crotalaria were grown in association with maize in soil infested with *P. zeae*, goose grass and khaki weed severely suppressed maize root development; this resulted in a low number of nematodes per maize root system and a high number of nematodes per maize root unit. Mealie crotalaria did not restrict maize root growth and did not affect nematode densities per maize root system or maize root unit. Special attention should be given to the control of mealie crotalaria, which is a good host for *P. zeae*, and goose grass, which, in addition to its ability to compete with maize, is also a suitable host for *P. zeae*.

Key words: *Amaranthus hybridus*, common pigweed, competition, *Crotalaria sphaerocarpa*, *Datura stramonium*, *Eleusine indica*, goose grass, host status, khaki weed, maize, mealie crotalaria, *Pratylenchus zeae*, root exudate, *Tagetes minuta*, thorn apple, *Zea mays*.

Maize (*Zea mays* L.) is grown on about 4.5 million ha annually in South Africa. Although weeds may be a major problem in maize production, most weed species are successfully controlled by herbicide application and cultivation. Certain weeds, however, such as mealie crotalaria (*Crotalaria sphaerocarpa* Perr. ex DC.), thorn apple (*Datura stramonium* L.), and khaki weed (*Tagetes minuta* L.) are difficult to control by normal practices. Seeds of these weed species continue to germinate throughout the growing season after the herbicides are inactivated (9-11). Common pigweed (*Amaranthus hybridus* L.) and goose grass (*Eleusine indica* (L.) Gaertn.) also are frequently found in maize fields.

Weeds can have positive or negative effects on populations of plant-parasitic nematodes. If the weeds are good hosts, nematode population numbers will increase (5,6,12). Weeds may support nematode populations when crops are not grown. On the other hand, root exudates from

some weeds such as *Tagetes* spp. possess nematicidal activity (14-16).

Pratylenchus zeae Graham is the most common plant-parasitic nematode species associated with maize in South Africa (2). The suitability of some local weeds as hosts for *P. zeae* is unknown. The objectives of our study were 1) to establish the host suitability of five of the most common weed species to *P. zeae*, 2) to study the effects of their crop residues on the parasitism of maize by *P. zeae*, and 3) to investigate the effects of weed competition with maize on *P. zeae* infestation.

MATERIALS AND METHODS

Mealie crotalaria, thorn apple, khaki weed, common pigweed, and goose grass were included in this study.

Seeds of weeds and maize (*Z. mays* L. inbred line K64R) were planted in 15-cm-d plastic pots filled with 4 dm³ steam sterilized sandy soil (93% sand, 4% silt, 3% clay). Seedlings were thinned to 1 maize and 10 weeds per pot after emergence. Plants were fertilized by irrigation with tap water in which Chemcult (6.5% N, 2.7% P, 13% K), a hydroponic nutrient powder, was dissolved. Day:night temperature regimes were 27:17 C with a 13:11-hour light:dark ratio. *P. zeae* obtained from a maize field

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TABLE 1. Root population densities and reproduction rate of *Pratylenchus zae* on five weed species and maize, measured 6 weeks after planting.

Host	Nematodes/ root system†	Nematodes/ 5 g roots	Reproduction rate‡	Fresh root weight (g)
<i>Eleusine indica</i>	2,181 c	413 b	0.66 c	27.97 c
<i>Crotalaria sphaerocarpa</i>	464 b	3,213 c	0.14 b	0.99 a
<i>Amaranthus hybridus</i>	620 b	324 b	0.23 b	9.08 b
<i>Datura stramonium</i>	504 b	361 b	0.17 b	7.07 b
<i>Tagetes minuta</i>	65 a	42 a	0.02 a	13.57 bc
<i>Zea mays</i>	13,016 d	2,307 c	3.79 d	28.81 c

Numbers are the means of eight replicates. Column means followed by the same letter do not differ significantly ($P = 0.01$) according to the Student-Newman-Keuls range test.

† Mean number of nematodes per root system calculated according to the formula $\sum_{i=1}^g (X_i Y_i) / 8$ (X_i = fresh root weight, Y_i = no. nematodes/g roots).

‡ Mean reproduction rate calculated according to the formula $\sum_{i=1}^g (P F_i / P I) / 8$ ($P F_i$ = no. nematodes/root system, $P I$ = initial nematode population density).

were increased in monoxenic cultures on excised maize roots. Inoculum was obtained from 2-month-old cultures and consisted of nematodes of mixed life stages. Nematodes were pipetted in 10-ml aqueous suspensions into holes in the soil around the roots.

For the host suitability test, seeds of each of the five weed species and maize were planted in eight pots. Each pot was infested at planting with 3,500 *P. zae*.

For the crop residue test, maize seeds were planted in the same soils in which the five weed species and maize had been grown during the host suitability test. After emergence of the maize seedlings, each pot was re-infested with 2,000 *P. zae*.

For the competition test, maize seeds were planted with either mealie crotalaria, goose grass, or khaki weed. In each pot one maize seed was surrounded by 10 weed seeds. After emergence of the maize and weed seedlings, each pot was infested with 6,500 *P. zae*. The nematodes were added to shallow depressions in the soil situated midway between the maize and weed seedlings.

In all tests, plants were harvested and fresh root weights determined 6 weeks after planting. Nematodes were extracted from 200-cm³ soil subsamples by a modified decanting and sieving method (3) using 710- μ m-pore and 45- μ m-pore sieves,

followed by the centrifugal-flotation method (8) and from 5 g fresh roots using the centrifugal-flotation method (1) and counted.

The experimental design was a randomized block for all tests, and treatments were replicated eight times. Population data were transformed to \log_e before analyses of variance were calculated.

RESULTS

Very few *P. zae* ($< 5/200$ cm³) were extracted from the soil subsamples and were therefore not included in the calculations of final nematode densities.

Host suitability test: Final population densities per root system and reproduction rates of *P. zae* were significantly ($P = 0.01$) lower in all weed species than in maize (Table 1). Among the weed species, goose grass supported the highest and khaki weed the lowest number of nematodes ($P = 0.01$). No differences in nematode densities were observed among mealie crotalaria, pigweed, and thorn apple. When expressed per 5 g roots, mealie crotalaria supported as many nematodes as maize and significantly ($P = 0.01$) more nematodes than any other weed species. Khaki weed supported the lowest number of nematodes per 5 g roots ($P = 0.01$). Fresh root weight of mealie crotalaria was very low ($P = 0.01$) relative to the other weed species and maize.

TABLE 2. Root population densities and reproduction rate of *Pratylenchus zeae* on maize growing in soil in which weeds or maize had grown, measured 6 weeks after planting.

Previous host plant	Nematodes/ root system†	Nematodes/ 5 g roots	Reproduction rate‡	Fresh root weight (g)
<i>Eleusine indica</i>	3,635 bc	1,066 c	1.82 bc	17.22 b
<i>Crotalaria sphaerocarpa</i>	3,472 bc	998 abc	1.72 bc	17.85 b
<i>Amaranthus hybridus</i>	5,908 c	2,068 cd	2.95 c	15.82 b
<i>Datura stramonium</i>	3,182 b	953 ab	1.95 b	16.44 b
<i>Tagetes minuta</i>	1,849 a	591 a	0.93 a	15.66 b
<i>Zea mays</i>	4,633 bc	2,203 d	2.32 bc	11.22 a

Numbers are the means of eight replicates. Column means followed by the same letter do not differ significantly ($P = 0.01$) according to the Student-Newman-Keuls range test.

† Mean number of nematodes per root system calculated according to the formula $\sum_{i=1}^8 (X_i Y_i) / 8$ (X_i = fresh root weight, Y_i = no. nematodes/g roots).

‡ Mean reproduction rate calculated according to the formula $\sum_{i=1}^8 (P F_i / P I) / 8$ ($P F_i$ = no. nematodes/root system, $P I$ = initial nematode population density).

Crop residue test: Final population density per root system and reproduction rate of *P. zeae* were significantly ($P = 0.01$) suppressed in maize grown after khaki weed (Table 2). Population densities and reproduction rates of *P. zeae* in maize grown after maize and all the other weed species were comparable. The number of *P. zeae* per 5 g roots of maize grown after khaki weed, thorn apple, goose grass, and mealie crotalaria was significantly ($P = 0.01$) lower than in maize grown after maize but was also significantly ($P = 0.01$) lower in maize grown after any other weed species. Fresh root weight of maize grown after maize was significantly ($P = 0.01$) lower than for maize grown after any of the weed species.

Competition test: Numbers of *P. zeae* per root system were significantly ($P = 0.01$) lower in maize grown in competition with goose grass and khaki weed than in maize grown alone (Table 3). Among the weed species, the highest numbers of *P. zeae* per root system were recovered from goose grass and the lowest numbers from mealie crotalaria ($P = 0.01$). The number of *P. zeae* per 5 g roots was highest in mealie crotalaria and lowest in khaki weed ($P = 0.01$). The total numbers of *P. zeae* and the reproduction rates in the roots of maize and weeds grown together were significantly ($P = 0.01$) smaller on maize grown in the presence of either goose grass or

khaki weed compared with maize grown alone. Fresh root weight of maize grown with goose grass or khaki weed was significantly ($P = 0.01$) suppressed. Fresh root weight of goose grass was significantly ($P = 0.01$) greater than those of khaki weed and mealie crotalaria.

DISCUSSION

The results indicate a differential host suitability among the five weed species for *P. zeae* under greenhouse conditions. Based on the numbers of *P. zeae* per root system and reproduction rate, goose grass can be considered a moderate host; mealie crotalaria, pigweed, and thorn apple are poor hosts; and khaki weed is a nonhost for *P. zeae*. Based on the numbers of *P. zeae* per root unit, mealie crotalaria can be considered a good host; goose grass, pigweed, and thorn apple moderate hosts; and khaki weed a poor host. Gast et al. (5) also mentioned that the classification of host suitability of a given plant on the basis of nematodes per root system and nematodes per root unit can differ. A classification based on nematode density per root system can be misleading because the size of the root system can vary in two given hosts equally suitable to the nematode but with a different tolerance to nematode damage. In such a case, the host that is tolerant to nematode damage will be considered a good host,

whereas the susceptible host will be considered a poor host. Since no information on the susceptibility of the weeds studied to *P. zae* is available, we prefer to classify the weeds on the basis of nematode densities per root unit. Khaki weed was reported to suppress populations of *Pratylenchus brachyurus* (6), and *Tagetes patula* was reported to suppress *Pratylenchus penetrans* populations (12,13,17). *Crotalaria mucronata* maintained populations of *P. brachyurus* but suppressed numbers of *P. zae* (3). *Crotalaria spectabilis* maintained populations of both *P. brachyurus* and *P. penetrans* (6,12). *Amaranthus retroflexus* was a good host for *P. penetrans* (13), but a poor host for *Pratylenchus neglectus* and *Pratylenchus scribneri* (5).

Khaki weed, *T. patula*, and *C. spectabilis* enhanced subsequent crop growth due to suppression of nematodes in soil and roots (6,17). In the present study, root development in maize grown after any of the weeds was greater than when maize was grown after maize. This increase in growth was not due to nematode control, since only the crop residues of khaki weed caused a suppression of *P. zae* infestation in subsequently grown maize.

Goose grass and khaki weed grown in the presence of maize severely suppressed maize root development, and this resulted in a low number of nematodes per maize root system. Expressed on a per root unit basis, however, maize was infested with significantly higher numbers of nematodes when grown in the presence of these two weeds than when grown with mealie crotalaria or alone. The increased population densities of the nematodes expressed per root unit may be due to the concentration of the nematodes in smaller root systems, or it may be that plants subjected to stresses other than nematodes are more susceptible to nematode penetration. Similar competitive effects were also observed between *Amaranthus* and fieldbeans (5). If not for the competitive effects on root growth, khaki weed would probably have a negative and goose grass a positive effect on nematode density in maize. Thus root biomass

TABLE 3. Root population densities and reproduction rate of *Pratylenchus zae* on maize and five weed species when maize was grown in competition with each weed and alone, measured 6 weeks after planting.

Host	Nematodes/root system†			Nematodes/5 g roots			Reproduction rate‡			Fresh root weight (g)		
	Maize	Weed	Total	Maize	Weed	Total	Maize	Weed	Total	Maize	Weed	Total
<i>Eleusine indica</i> + <i>Zea mays</i>	181 a	532 c	713 b	3,485 c	77 ab	1,798 a	0.03 a	0.08 b	0.11 a	1.65 a	34.49 c	36.14 c
<i>Crotalaria sphaerocarpa</i> + <i>Zea mays</i>	3,693 b	47 a	3,740 c	1,215 a	96 b	713 a	0.57 b	0.01 a	0.58 b	17.71 b	2.45 a	20.16 b
<i>Tagetes minuta</i> + <i>Zea mays</i>	132 a	82 b	214 a	2,628 b	47 a	1,065 a	0.02 a	0.01 a	0.03 a	1.78 a	8.72 b	10.65 a
<i>Zea mays</i>	7,679 b		7,679 c	1,790 a		1,790 a	1.18 c		1.18 c	25.84 b		25.84 b

Numbers are the means of eight replicates. Column means followed by the same letter do not differ significantly ($P = 0.01$) according to the Student-Newman-Keuls range test.

† Mean number of nematodes per root system calculated according to the formula $\sum_{i=1}^8 (X_i Y_i) / 8$ (X_i = fresh root weight, Y_i = no. nematodes/g roots).

‡ Mean reproduction rate calculated according to the formula $\sum_{i=1}^8 (P F_i / P I) / 8$ ($P F_i$ = no. nematodes/root system, $P I$ = initial nematode population density).

plays a significant role, as shown by Jaffee (6).

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