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Response of ten cultivars of Lolium perenne to the ectoparasitic nematode Tylenchorhynchus dubius

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Abstract

The interaction between 10 cultivars of *Lolium perenne* and *Tylenchorhynchus dubius* was studied to investigate the incidence of tolerance and resistance to ectoparasitic nematodes in *L. perenne*.

Differences in tolerance were small; the nematode treatments yielded 67 to 76% of the dry shoot mass of the controls. Cultivars with a low leaf weight ratio and a low transpiration coefficient tended to have a somewhat better tolerance. Differences in resistance occurred, but resistance is of minor importance to reduce damage in the *L. perenne/T. dubius* host-parasite system.

Additional keywords: tolerance, resistance, perennial ryegrass.

Introduction

Nematodes contribute to reseeding problems of pastures (Van Bezooijen, 1979). The major part of the population of plant-parasitic nematodes in pastures consists of ectoparasitic species. It is not known whether cultivars of the predominant grass species *Lolium perenne* differ in tolerance and resistance to ectoparasitic nematodes. To ascertain the incidence of tolerance and resistance in *L. perenne*, the interaction between the ectoparasite *Tylenchorhynchus dubius* and ten cultivars of *L. perenne* was studied. *T. dubius* is one of the commonnest and most numerous nematode species in Dutch pastures.

The reaction of dry matter production of the host on nematode infestation determines the degree of tolerance, and the reaction of the nematode to its host (as measured by the multiplication of the nematode population) determines the degree of resistance (Oostenbrink, 1972). Degree of tolerance and degree of resistance usually do not correlate, and a different experimental design is needed to assess both characteristics accurately. To measure tolerance, the population density must be sufficiently high to cause measurable damage, whereas resistance can be determined best when initial density is low in relation to the available root mass and the duration of the experiment is long enough to permit the formation of several generations. In a previous paper (Den Toom, 1988) it was shown that *L. perenne* is most susceptible to damage by *T. dubius* during the first weeks of growth. Multiplication of the population during this period is small. So, susceptibility of the plant seems to be more determinant for the amount of damage than the nematode's ability to reproduce on the plant. Therefore, the experiment described in this paper concentrated on tolerance and its correlation with other plant characteristics.

Table 1. Name, type and ploidy of the cultivars of *L. perenne* in the experiment.

Cultivar	Type	Ploidy
Gremie	production	2n
Hora	production	2n
Perma	production	2n
Pelo	production	2n
Meltra	production	4n
Artal	production	4n
Royal	turf	2n
Manhattan	turf	2n
Ensporta	turf	2n
Idole	turf	2n

Materials and methods

Table 1 gives an overview of the cultivars of *L. perenne* used. In a pot experiment under controlled conditions each cultivar was grown in soil containing *T. dubius* and in non-infested soil (control). The experiment contained eight replications and was carried out as described by Den Toom (1988). Per pot, 25 seeds were sown and the number of plants was reduced to 16 after emergence. Daylength was 16 h, temperature 25 °C (day and night), irradiance 92 W m^{-2} and relative humidity 70%. At watering, the moisture content of the soil was adjusted to 25%. The method of watering was comparable with the method described by Den Toom (1988), but generally the water need of each cultivar/nematode treatment combination was determined by measuring water loss in two replicate pots; each third time of watering all pots were weighed.

In the period from 29 to 31 days after seeding, destructive sampling took place. The aboveground parts were severed at the soil surface. Fresh mass was determined and in four replicates a subsample was taken to measure leaf area. The rest of the shoot was dried in an oven at 100 °C for 24 hours. In the other replicates total dry mass of the shoot was determined. The soil was washed off the underground parts and they were then dried.

Initial density of the nematode population was determined on the day after the start of the experiment by elutriating four pots with an Oostenbrink elutriator. Final density in the nematode treatments was determined in three pots of each cultivar. Both times, adults and juveniles were counted separately.

Results

Nematodes. Initial density was 5.9 × 10^3 nematodes per pot. Ninety % of the population were adults. Final density ranged from 6.1 × 10^3 tot 13.8 × 10^3 nematodes per pot with a mean of 10.7 × 10^3. For 'Ensporta' and 'Idole' final population density was significantly smaller than the mean, and for 'Pelo', 'Artal' and 'Manhattan' it was significantly larger. The percentage juveniles increased in all cultivars, although less so in 'Ensporta' and 'Idole'. Since the growth of the nematode population was found

Table 2. Effect of 10 cultivars on final density, relative growth rate and composition of the population of *T. dubius*. Initial density was 5.9×10^3 *T. dubius* per pot for all cultivars and initial percentage of juveniles was 10.

Cultivar	Final density[1]	RGR[2]	J[3]
Gremie	9.9	0.017	79
Hora	8.8	0.013	72
Perma	10.6	0.020	77
Pelo	13.7*	0.028	77
Meltra	12.5	0.025	77
Artal	13.8*	0.028	79
Royal	11.3	0.022	77
Manhattan	13.3*	0.027	73
Ensporta	6.1*	0.001	60
Idole	7.8*	0.009	65
mean	10.7	0.020	

[1] Expressed in thousands per pot (480 g dry soil in a volume of 400 ml). Values followed by * are significantly different from the mean (t-tests, $p < 0.05$).
[2] RGR = relative growth rate (d^{-1}). A period of 30 days was taken to calculate RGR.
[3] J = percentage juveniles in the final population.

to be exponential in comparable experiments with *T. dubius*, the relative growth rate of the population was calculated (Table 2).

Crop observations. *T. dubius* decreased the dry matter yield of all cultivars. Except for 'Gremie' both shoot mass and root mass were decreased (Fig. 1). Because the coefficient of variation for root dry mass was large (about 40%), the effect on root dry mass was not significant in an analysis of variance.

The dry matter yield of the nematode treatment of each cultivar was expressed as a fraction of the dry matter yield of the control of that cultivar. Using t-tests the resulting relative yields were all compared with the mean relative yield. The mean relatie yield was 0.71 for the shoot (Table 3), 0.88 for the roots and 0.76 for total dry mass. 'Gremie' differed significantly from the other cultivars, because of the absence of an effect of nematodes on the root mass of this cultivar. The relative yield of the shoot of 'Gremie' did not differ from the mean.

Transpiration of the plants was calculated from transpiration of the pots by subtracting evaporation, which was assessed from transpiration of the pots before emergence. Leaf weight ratio (LWR), transpiration coefficient (TC) and specific leaf area (SLA) of all cultivar/treatment combinations were calculated (Table 4). An analysis of variance revealed a significant cultivar effect on the magnitude of these characteristics. Nematodes significantly influenced LWR, TC and SLA. To ascertain whether the effect of nematodes on relative yield of the shoot correlated with LWR, TC and SLA, Spearman's correlation test was carried out. The same was done to investigate the relation between the decrease in relative yield of the shoot and the magnitude of the effect of nematodes on LWR, TC and SLA. Nematodes generally decreased LWR. The magnitude of the

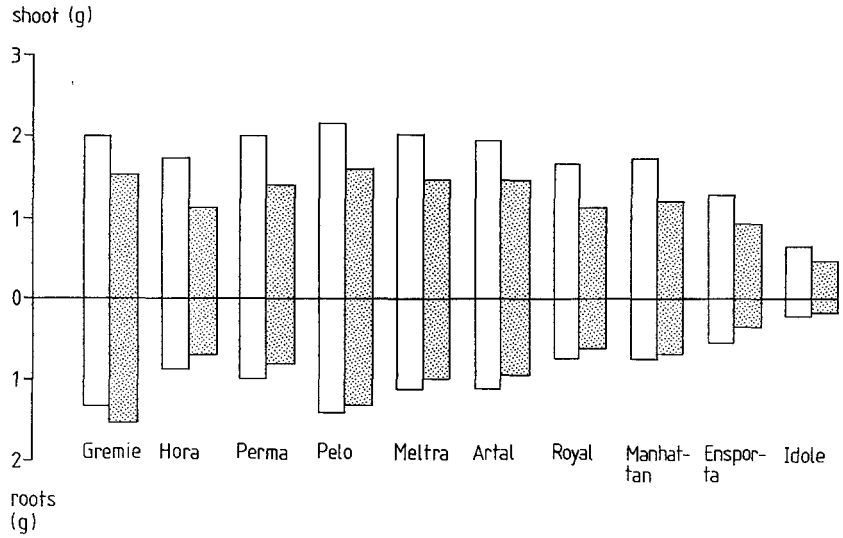

Fig. 1. Shoot dry mass and root dry mass per pot of 10 cultivars of *L. perenne* after 30 days growth in soil containing *T. dubius* (grey bars) and in non-infested soil (white bars).

Table 3. Relative yield of the shoot (RS) of 10 cultivars in response to a nematode treatment.

Cultivar	RS[1]	C[1] (g/pot)
Gremie	0.74	(2.03)
Hora	0.67	(1.73)
Perma	0.70	(1.99)
Pelo	0.73	(2.15)
Meltra	0.73	(2.02)
Artal	0.76	(1.92)
Royal	0.67	(1.66)
Manhattan	0.68	(1.76)
Ensporta	0.72	(1.27)
Idole	0.73	(0.66)
mean	0.71	(1.72)

[1] For each cultivar dry matter yield of the nematode treatment is expressed as a fraction of dry matter yield of the corresponding control. Absolute dry matter yield of the controls (C) is given between brackets. None of the relative yields differs significantly from the mean (t-test, $p < 0.05$).

decrease did not correlate with the effect of nematodes on the relative yield of the shoot, but a lower LWR in the control correlated with a smaller effect of nematodes on relative yield. TC was either increased or not influenced by nematodes. When expressed per unit shoot mass, transpiration was increased in all cultivars. A smaller TC in the control correlated with a smaller effect of nematodes on relative yield. Nematodes increased

Table 4. Leaf weight ratio (LWR), transpiration coefficient (TC) and specific leaf area (SLA) of control (C) and nematode (N) treatments of 10 cultivars.

Cultivar	LWR ($g\ g^{-1}$)		TC ($g\ g^{-1}$)		SLA ($cm^2\ g^{-1}$)	
	C	N	C	N	C	N
Gremie	0.62	0.55	178	177	196	202
Hora	0.69	0.66	190	208	204	210
Perma	0.69	0.69	176	193	190	219
Pelo	0.63	0.58	170	180	182	192
Meltra	0.66	0.62	175	198	168	186
Artal	0.66	0.63	170	199	178	199
Royal	0.70	0.69	208	215	189	217
Manhattan	0.71	0.64	193	190	187	208
Ensporta	0.72	0.76	213	248	207	242
Idole	0.74	0.71	218	239	313	361

SLA for al cultivars. No correlation was found between SLA in the control and relative yield.

Discussion

As the effect of nematodes on shoot yield shows, no large differences in tolerance were found between the cultivars. The shoot mass of the nematode treatments was 67 to 76% of that of the controls. Cultivars with a relatively large root system (low LWR) and a low TC tended to have a somewhat greater tolerance.

T. dubius generally decreased LWR and increased the TC and SLA. The magnitude of these effects did not correlate with the degree of tolerance. In experiments with *T. dubius* on *L. perenne* cv. Pelo it was shown that the effect of the nematode on the dry mass of the plant was mainly connected with a decrease in LWR and SLA in the first week of growth. The magnitude of the effects on LWR, SLA and TC varied with time and even changed direction (Den Toom, 1988). So, it is unlikely that there will be a strong correlation between tolerance and the magnitude of the effect of nematodes on the above-mentioned characteristics 30 days after sowing.

Although the experiment was not designed to measure resistance, an indication of differences in resistance was obtained from the figures on final nematode density and RGR (Table 2). 'Pelo', 'Artal' and 'Manhattan' seem to be less resistant than the other cultivars. Nematode reproduction on 'Ensporta' and 'Idole' was small, but the increase of the percentage juveniles showed that it did occur. This small reproduction is not necessarily caused by a high degree of resistance of 'Ensporta' and 'Idole'. From the results of Sharma (1971), it may be concluded that the part of the population that contributes to reproduction is determined more by the expansion of the root system than by the mobility of the nematodes. The root growth of 'Ensporta' and 'Idole' was relatively slow, and this may be why the nematode reproduced poorly on these cultivars.

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Samenvatting

Reactie van tien cultivars van Lolium perenne op de ectoparasitaire nematode Tylenchorhynchus dubius

Om na te gaan of in *Lolium perenne* tolerantie en resistentie t.a.v. ectoparasitaire nematoden voorkomt, werd de interactie tussen 10 cultivars van *L. perenne* en de ectoparasitaire nematode *Tylenchorhynchus dubius* onderzocht.

De verschillen in tolerantie bleken gering. Cultivars met een lage spruit/wortel-verhouding en een lage transpiratiecoëfficiënt waren in het algemeen wat toleranter. Er werden verschillen in resistentie gevonden, maar voor het verminderen van schade in het waardplant/parasiet-systeem *L. perenne/T. dubius* is resistentie van weinig belang.

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