oplolaimus [illegible]*robustus*
[illegible]*odera* [illegible]
[illegible]
[illegible]
atelloroma brachyurus
atelloroma [illegible]
[illegible] *sp.*
[illegible]*orhynchus* [illegible]

[illegible]*nchus* [illegible]
[illegible]*enchus* [illegible]
[illegible]*lonchus* [illegible]
[illegible]*lenchus neglectu*

[illegible]	[illegible]	0	[illegible]	40	[illegible]	[illegible]	30	[illegible]	[illegible]	60	97	[illegible]	50	[illegible]	[illegible]	[illegible]	0	
[illegible]	[illegible]	107	[illegible]	[illegible]	[illegible]	[illegible]	0	0	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
[illegible]	[illegible]	98	[illegible]	0	[illegible]	[illegible]	0	0	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	0	0	
[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]
pinghe[illegible]	[illegible]	[illegible]	[illegible]	0	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	109
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	21	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	80	[illegible]	[illegible]	[illegible]	20	0

[illegible]	0	[illegible]	[illegible]	0	[illegible]	30	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0
[illegible]	0	[illegible]	[illegible]	0	[illegible]	0	0
[illegible]	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	0	0
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	60	476
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	194

0.01	[illegible]	0.01	0.0001

Table 5. Canonical correlation between population densities of plant-parasitic nematodes recovered from soil and roots of wheat in the wheat-producing areas of South Africa, and 4 environmental factors.

Canonical variable	Canonical correlation	Chi-square	Standardized canonical coefficients																			
			Left hand variables												Right hand variables							
			Pz	*Pb*	*Pp*	*Pn*	*Pt*	*H*	*Ty*	*Rp*	*Pm*	*Sb*	*Mb*	*Dd*	sand	clay	Av. ann. rainfall (mm)	Altitude (m)	Temperature (°C)*** TnAv.	TnN	TxAv.	TxX
C1	0.899	429.32**	0.1	0.0	0.1	– 0.6	– 0.3	– 0.1	0.0	– 0.0	0.0	0.1	– 0.1	0.0	0.1	0.2	0.1	0.9	– 0.2	0.3	0.1	0.1
C2	0.558	156.64**	0.3	0.0	– 0.2	0.4	– 0.2	0.0	– 0.0	– 0.6	0.1	0.3	– 0.1	0.0	0.4	– 0.2	– 0.4	– 0.4	– 0.4	– 0.4	– 0.5	– [illegible]
C3	0.428	95.15**	0.1	– 0.0	0.0	0.3	0.0	– 0.0	0.1	0.2	0.2	– 0.1	– 0.2	0.1	– 0.0	– 0.1	0.1	– 0.4	0.5	– 0.8	0.0	0.0
C4	0.396	61.81**	0.4	0.1	0.3	– 0.1	0.3	0.1	0.1	– 0.1	0.1	0.1	0.0	0.2	0.8	– 0.0	0.4	0.0	0.1	0.4	0.0	0.2
C5	0.301	33.77*	0.1	0.3	– 0.0	0.0	– 0.0	0.3	– 0.3	0.2	– 0.1	0.2	– 0.1	0.0	0.3	0.5	0.2	– 0.0	– 0.3	– 0.3	– 0.3	0.3
C6	0.223	18.12	0.1	– 0.1	– 0.1	0.0	0.0	0.1	0.0	0.0	– 0.2	– 0.2	– 0.1	0.0	– 0.0	0.1	0.1	0.6	– 0.1	0.5	– 0.2	0.6

Pratylenchus zeae (*Pz*), *P. brachyurus* (*Pb*), *P. penetrans* (*Pp*), *P. neglectus* (*Pn*), *P. thornei* (*Pt*), *Heterodera* sp. (*H*), *Tylenchorhynchus* sp. (*Ty*), *Rotylenchus parvus* (*Rp*), *Paratrichodorus minor* (*P*), *Scutellonema brachyurum* (*Sb*), *Merlinius brevidens* (*Mb*), *Ditylenchus destructor* (*Dd*).

Significant at * P = 0.05, ** P = 0.01.

*** TnAv. = average minimum temperature, TnN = absolute minimum temperature, TxAv. = average maximum temperature, TxX = absolute maximum temperature.

Vaalharts. In the Central Orange Free State only two species, *P. minor* and *P. zeae* were present.

The seven wheat-producing areas could be ranked on the basis of the frequency of occurrence and average population density of the most predominant ecto- and endoparasitic nematode species (Table 4). In Vaalharts, high population densities of three ectoparasitic species, *P. minor*, *M. brevidens* and *Tylenchorhynchus* sp., were recovered (on average 791, 452 and 432 individuals/100 ml soil, respectively). In the Rûens and Swartland areas, high population densities of two endoparasitic species, *P. neglectus* and *P. thornei*, respectively, were found (on average 1441 and 1406 individuals/5 g fresh roots, respectively).

Three of the canonical correlations between nematode species and environmental factors were significant (Table 5). The first canonical variable was interpreted as a negative correlation (P = 0.01) of the incidence of *P. neglectus* with the altitude. The second canonical variable was interpreted as a positive correlation (P = 0.01) of the incidence of *R. parvus* with the average annual rainfall, altitude, average minimum and maximum and absolute minimum temperature. The fourth canonical variable was interpreted as a positive correlation (P = 0.01) of the incidence of *P. zeae* with percentage sand, average annual rainfall and absolute minimum temperature.

Discussion

Only five of the eighteen plant-parasitic nematode species identified during the present survey have previously been reported from wheat in South Africa. Among these are the two predominant ectoparasitic species, *M. brevidens* and *P. minor*, and two other ectoparasitic species, *S. brachyurum* and *R. unisexus* (Keetch & Buckley, 1984). Both *M. brevidens* and *P. minor* are considered potentially important pathogens of wheat (Swarup & Sosa-Moss, 1990).

The two predominant endoparasitic species, *P. neglectus* and *P. thornei*, and all other endoparasitic species, except *P. brachyurus*, have not previously been reported from wheat in South Africa (Keetch & Buckley, 1984). *P. thornei* is considered an important pathogen of wheat in North America, Mexico, Israel and Australia (Baxter & Blake, 1968; Van Gundy *et al.*, 1974; O'Brien, 1983; Orion *et al.*, 1984) causing significant yield losses. Parasitism of wheat by other *Pratylenchus* species, including *P. neglectus*, was reported (Griffin, 1984) but their status as pathogens of wheat is unknown. Several *Tylenchorhynchus* species caused poor growth of wheat in North America and India (Griffin, 1984) and are considered potentially important pathogens of wheat (Swarup & Sosa-Moss, 1990). Wheat apparently is not a good host for *R. parvus* which occurred in only 6 % of the fields sampled. In contrast, in sorghum and maize fields *R. parvus* was found in 100 and 93 %, respectively, of all fields sampled (De Waele & Jordaan, 1988*a*, *b*). The data of the present study confirm that wheat is also a poor host for *D. destructor* (Basson *et al.*, 1990). *D. destructor* was only found in irrigated fields where wheat is cultivated in rotation with groundnut. The absence of *Meloidogyne* species in the wheat fields investigated is surprising since *M. incognita* and *M. javanica* have been found on many crops in South Africa including maize,

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