Cover Crop Management in Vineyards of the Lower Orange River Region, South Africa: 2. Effect on Plant Parasitic Nematodes

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This study was conducted as part of a larger investigation into the effect of management practices on selected sown cover crops and the effects thereof on grapevine performance. The aim of this study was to determine the effect of these cover crops on plant parasitic nematode populations under natural field conditions. The trial site was in an own-rooted Sultanina vineyard situated in the Lower Orange River of the Northern Cape Province. Three management practices were applied selectively to ten cover crop species, with two control treatments consisting of weeds. Nematodes were monitored for a period of four years. 'Saia' oats were indicated as being poor hosts to both root-knot and root-lesion nematodes, while 'Overberg' oats showed poor host status against ring nematodes. 'Midmar' ryegrass and 'Paraggio' medic were also poor hosts for root-knot nematodes, while grazing vetch appeared to be a good host for root-knot nematodes. The most notable result from this study was the relatively high numbers of all three nematodes on the vine row, as opposed to the inter-row where cover crops were established. This indicates that vines were much better hosts for these nematodes than the cover crops. It is recommended that if more definite trends are to be observed, *Brassica* species, which have direct toxic/repellant effects on nematodes, should be tested.

Grapevines are host to a large variety of plant parasitic nematodes in South Africa, the more common genera including *Meloidogyne* spp. (Root-knot), *Xiphinema* spp. (Dagger), *Pratylenchus* spp. (Root-lesion), *Paratrichodorus* (Stubby-root), *Longidorus* spp (Needle), *Tylenchulus* spp. (Citrus), *Criconematinae* spp. (Ring) and spiral nematodes (comprising species in the genera *Rotylenchus*, *Helicotylenchus* and *Scutellonema*) (Smith, 1977; Kleynhans *et al*., 1996). Root-knot and dagger nematodes are amongst the most economically significant. No research has been done on the use of cover crops for nematode management in South African vineyards. In California, *Dactylis glomerata* L. ('Berber' orchardgrass) was found to reduce root-knot nematode numbers in vines interplanted with this cover crop (Wolpert *et al*. 1993). In Australia, McLeod & Warren (1993) found that increases of root-knot nematodes were higher on legume crops than on cereals or *Brassica* species. A summary of the nematode host status of various cover crops and commonly occurring weeds in vineyards is given by Nicol & Heeswijck (1997). Most of the research focus thus far has been on root-knot nematodes.

In South Africa, vineyard production is moving more towards an integrated pest management (IPM) approach, in line with the Scheme for Integrated Production of Wine (promulgated under the Act on Liquor Products [Act 60 of 1998]). Cultural management practices and the biological control of pests form the basis of IPM and should be viewed in the context of all pests and their natural enemies. Addison & Samways (2006) found that ants (a secondary pest of the vine mealybug *Planococcus ficus* Signoret) were not affected significantly by cover crop management with *Vicia dasycarpa* Ten. (grazing vetch), *Triticale* v. Usgen 18 (triticale) or *Festuca arundinacae* L. v. Cochise (dwarf fescue) compared to weeds (no sown cover crop, full surface chemical control from bud break to harvest). Triticale, however, did appear to promote ant foraging, while mealybug natural enemies preferred the natural weed plots. Dust is detrimental for hymenopteran parasitoids and predatory mites in vineyards and orchards (Pettigrew, 1998) and planting cover crops can greatly reduce dust levels. It is apparent from the available South African literature, that nothing is known of the effect of cover crops on the natural enemies of plant parasitic nematodes.

The complexity of trophic interactions in South African vineyards with cover crops or weeds, are still poorly understood as very little information is available. The decision to plant a cover crop with regard to IPM must therefore be balanced to obtain least economic pest damage, yet most benefit for natural enemies.

This study was conducted as part of a larger investigation into the effect of management practices on selected sown cover crops and their effect on the grapevines. The aim was to determine the effect of these cover crops on plant parasitic nematode populations under natural field conditions.

MATERIALS AND METHODS

The detailed experimental procedures and layout were previously described by Fourie (2005). The trial was carried out in Keimoes

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(28°40'S, 20°54'E), which is situated in the semi-arid Lower Orange River region of the Northern Cape Province, with an annual rainfall of 150 mm. The trial site was in a commercial, own-rooted Sultanina vineyard established during 1989 on a sandy soil (4.5 % clay, 0.12% organic matter, pH 7.2) . The grapevines were spaced 2.25 m in the row and 3.25 m between rows.

Irrigation was applied using micro-sprinklers with a 360° wetting pattern, delivering 20 L/h and mounted in the inverted position. Before the advent of the 1997/98 season, the micro-sprinklers were mounted on top of the irrigation line to deliver more water into the working row. During the 1995/96 and 1996/97 seasons, an irrigation of 16 mm per week was applied during the first six weeks after the cover crops were sown. This was followed by fortnightly irrigations of 16 mm each. During the 1997/98 and 1998/99 seasons, an irrigation of 8 mm was applied twice a week for the first four weeks following the seeding date. This was followed by four weekly irrigations of 16 mm each. Thereafter fortnightly irrigations of 16 mm each were applied.

Cover crops

The cover crops and the different soil cultivation practices applied are detailed in Table 1. These cover crops were chosen as they showed promise for establishment on sandy soils in semi-arid conditions (Fourie *et al.*, 2001). Cover crops were compared to two treatments in which weeds were managed according to two management practices which were being applied by producers in the region. Weed control actions were applied four times during the growing season (Fourie, 2005). The cover crops were sown on 28 March in 1995 and during the second week of March the following seasons. These cover crop treatments were compared with two treatments in which 1) weeds were slashed (SL) and controlled chemically from véraison to harvest (AV) and 2) weeds were controlled mechanically from bud break to harvest (MC). The seeding rates and further details of how cover crops were managed can be found in Fourie (2005).

Trial layout

Cover crop treatments were randomly allocated within each of three blocks (replicates) in a factorial design. The experiment was carried out over four seasons (years). The size of each experimental (unit) plot was 114.5 m^2 (eight vines by two rows). No re-randomization took place after the first year so that perennial cover crops could be given the opportunity to establish.

Nematode sampling

Soil samples were taken during August of each year, shortly before bud break. This is when active root growth starts taking place and soil populations of root-knot nematodes peak in vineyards of the Northern Cape Province (Loubser & Meyer, 1987). Five soil cores were extracted from each of three vines per plot using a soil auger, 30 cm from the vine stem and approximately 30 cm deep. Five soil cores were also extracted from within the inter-row next to cover crop plants in the same manner. Vine and cover crop samples were then mixed for each plot during the first three seasons, while during the final season (1998) vine and cover crop samples

TABLE 1

Cover crop treatments established in a sultanina vineyard in the Lower Orange River region during four years.

Cover crop treatments
Grass species
Secale cereale L. v. Henog (rye), BB[1], SA[2]
Secale cereale L. v. Henog (rye), AV[3], SB[4]
Avena sativa L. v. Overberg ('Overberg' oats), BB, SA
Avena sativa L. v. Overberg ('Overberg' oats), AV, SB
Avena strigosa L. v. Saia ('Saia' oats), BB, SA
Avena strigosa L. v. Saia ('Saia' oats), AV, SB
Lolium multiflorum Lam. v. Midmar ('Midmar' ryegrass), BB, SA
Lolium multiflorum Lam. v. Midmar ('Midmar' ryegrass), AV, SI[5]
Lolium perenne v. Derby Supreme (perennial ryegrass), SL[6]
Festuca arundinacae v. Cochise (dwarf fescue, a perennial), SL
Broadleaf species
Vicia dasycarpa Ten. (grazing vetch), BB, SA
Vicia dasycarpa Ten. (grazing vetch), AV, SI
Trifolium subterraneum L. v. Woogenellup ('Woogenellup' subterranean clover), BB, SA
Trifolium subterraneum v. L. Woogenellup ('Woogenellup' subterranean clover), AV, SB
Medicago truncatula Gaertn. v. Paraggio (medic), BB, SA
Medicago truncatula Gaertn. v. Paraggio (medic), AV, SB
Ornithopus sativus L. v. Emena (pink Seradella), BB, SA
Ornithopus sativus L. v. Emena (pink Seradella), AV, SB
Controls
Weeds, MC[7]
Weeds, SL, AV

[1]BB = controlled chemically before bud break and thereafter. [2]SA = sown annually. [3]AV = controlled chemically after véraison. [4]SB = sown biennially.
[5]SI = sown initially (only during 1995). [6]SL = slashed. [7]MC = controlled mechanically from bud break.

were separated. Separation of vine and cover crop samples was not done in previous seasons due to technical constraints. However, the data was used nonetheless as it was felt that long-term trends would become apparent during the final year of sampling. In the laboratory, nematodes were extracted from 250 cc soil using a modified sieving-sedimentation technique (Loubser, 1985). During the first three seasons, samples were taken from all the treatments except the treatments in which the annual cover crops were sown biennially (SB) or initially (SI) and controlled chemically after véraison (AV). This was because the cover crops performed better and produced more consistently in the treatments in which the cover crops were sown annually (SA) and controlled chemically from bud break (BB). During the last season (1998), samples were taken from both SA/BB and SB/AV treatments in order to compare the two cover crop management practices.

Statistical analysis

Data were transformed (log{x+1}) to stabilise variance. Analyses of variance were performed separately for each season using STATISTICA for windows, version 7. Treatment means were separated using the Fisher LSD test ($p \leq 0.05$). The 1998 data were also analyzed as a factorial design with the two sampling areas (vine row and vine inter-row), two management practices (SA/BB and SB/AV) and 12 cover crop species as main effects. Cumulative counts were obtained for each nematode species by summing counts across years for each treatment.

RESULTS

During the four seasons sampling, the following nematode species were monitored: Root-knot nematodes, root-lesion nematodes, ring nematodes, dagger nematodes, stubby-root nematodes, citrus nematodes and the spiral nematodes. However, only the first three were found in significant numbers and will be discussed further.

Root-knot nematodes

The F-statistic for treatment differences was significant during each season (1995: $F_{(12;24)}=3.62$, $p \leq 0.05$; 1996: $F_{(12;24)}=16.14$, $p \leq 0.001$; 1997: $F_{(12;24)}=19.90$, $p \leq 0.001$; 1998: $F_{(12;24)}=20.76$, $p \leq 0.001$). Grapevines with grazing vetch as a cover crop supported the highest number of root-knot nematodes during 1996 and 1997 (Table 2). Only during 1997, were numbers in the grazing vetch SA/BB treatment significantly higher than that of the SA/BB treatments in which *Avena strigosa* L. v. Saia (‘Saia’ oats), *Lolium multiflorum* Lam. V. Midmar (‘Midmar’ ryegrass) and *Ornithopus sativus* L. v. Emena (pink Seradella) were employed as cover crops. Mean cumulative numbers over four years, however, indicated significantly higher numbers in the subterranean clover treatment compared to that of ‘Midmar’ ryegrass and *Lolium perenne* L. v. Derby Supreme (perennial ryegrass). Differences in sampling area (vine row or inter-row) measured during 1998 were highly significant ($F_{(1;80)}=32.34$, $p \leq 0.001$) with more nematodes occurring on the vine row (Fig. 1). This was the case for all cover crops except for the treatment in which dwarf fescue was employed as cover crop, where there tended to be more nematodes in the inter row than in the vine row

TABLE 2

Mean numbers (log {x+1}) of root-knot nematodes *Meloidogyne* spp. per 250 cc soil found in various cover crop treatments established in a Sultanina vineyard in the Lower Orange River region during four years.

Cover crop treatment	Year[1]				
	1995	1996	1997	1998	CUM[2]
Secale cereale L. v. Henog (rye), BB[3], SA[4]	0.74 ab (53)	1.14 a (33)	1.51 ab (40)	1.71 a (58)	**2.26 abc (185)**
Avena sativa L. v. Overberg (oats), BB, SA	0.67 ab (33)	1.72 a (52)	1.68 ab (63)	1.65 a (55)	**2.26 abc (203)**
Avena strigosa L. v. Saia (Saia oats), BB, SA	0.54 ab (13)	1.79 a (85)	0.98 b(20)	1.91 a (90)	**2.25 abc (208)**
Lolium multiflorum Lam. v. Midmar (annual ryegrass), BB, SA	1.01 ab (23)	1.70 a (50)	1.01 b (23)	1.28 a (27)	**2.07 bc (123)**
Lolium perenne v. Derby Supreme (perennial ryegrass), SL[5]	0.00 b (0)	1.16 a (37)	1.40 ab (33)	1.08 a (35)	**1.96 c (105)**
Festuca arundinacae v. Cochise (fescue, a perennial), SL	1.32 ab (77)	1.70 a (73)	1.67 ab (53)	1.39 a (37)	**2.37 abc (240)**
Vicia dasycarpa Ten. (grazing vetch), BB, SA	0.44 b (7)	1.90 a (132)	2.11 a (170)	1.83 a (73)	**2.58 ab (382)**
Trifolium subterraneum L. v. Woogenellup (‘Woogenellup’ subterranean clover), BB, SA	2.08 a (147)	1.63 a (122)	1.92 ab (87)	1.57 a (45)	**2.59 a (400)**
Medicago truncatula Gaertn. v. Paraggio (medic), BB, SA	1.30 ab (60)	1.41 a (53)	1.13 ab (36)	1.43 a (40)	**2.19 abc (190)**
Ornithopus sativus L. v. Emena (pink Seradella), BB, SA	0.44 ab (7)	1.83 a (118)	1.94 b (17)	1.68 a (141)	**2.22 abc (283)**
Weeds, MC[6]	1.54 ab (246)	1.29 a (73)	1.64 ab (43)	1.22 a (20)	**2.35 abc (382)**
Weeds, SL, AV[7]	0.00 b (0)	1.48 a (33)	1.73 ab (67)	1.10 a (32)	**2.12 abc (132)**

[1]Numbers in columns followed by different letters differ significantly on the 5% level. [2]CUM = mean cumulative counts. [3]BB = controlled chemically before bud break and thereafter. [4]SA = sown annually. [5]SL = slashed. [6]MC = controlled mechanically from bud break. [7]AV = controlled chemically after véraison. Numbers in brackets indicate actual numbers of nematodes.

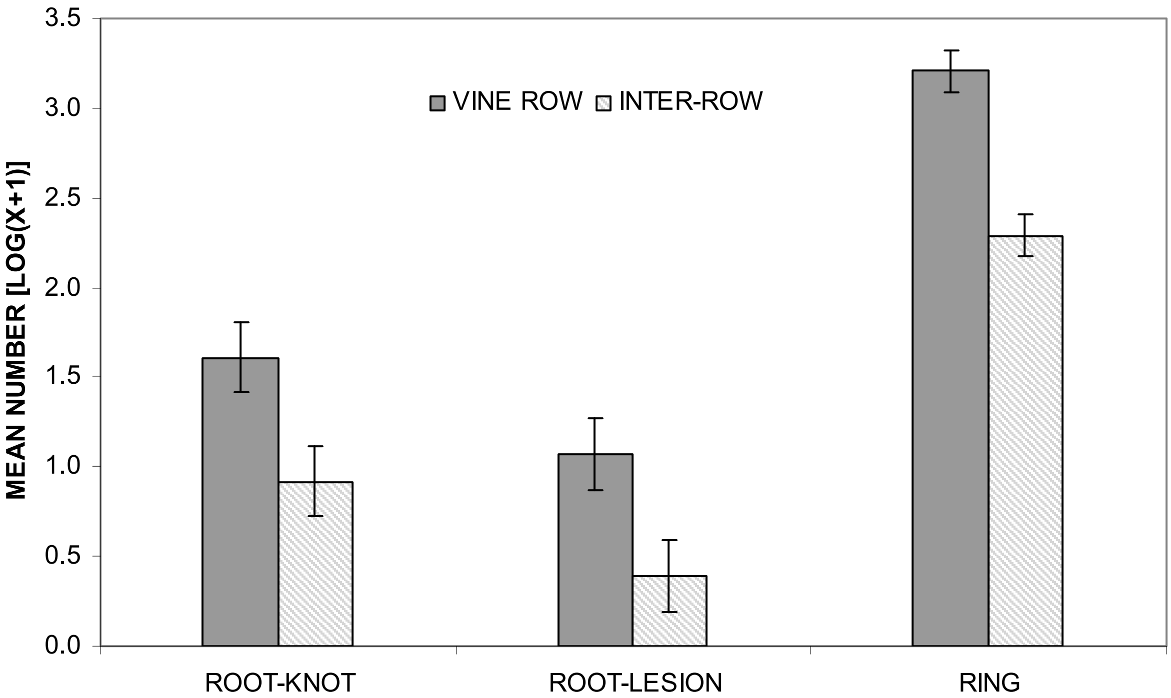

FIGURE 1

Mean number of nematodes per 250 cc soil occurring on the vine row and in the inter-row during 1998 in a Sultanina vineyard in the Lower Orange River region. Error bars denote 95% confidence intervals.

(data not shown). Management practices (SA/BB and SB/AV or SI/AV, compared during 1998), did not influence nematode numbers significantly ($F_{(2;80)}$=2.89, p≤0.06).

Root-lesion nematodes

The F-statistic for treatments was highly significant for 1996 ($F_{(12;24)}$=10.46, p≤0.001), 1997 ($F_{(12;24)}$=5.11, p≤0.001) and 1998 ($F_{(12;24)}$=10.17, p≤0.001) and significant treatment differences were found during these years (Table 3). Results were very variable from year to year, but numbers were generally low and no clear trends could be detected. Differences in sampling area were highly significant ($F_{(1;80)}$=32.07, p≤0.001) with more nematodes occurring on the vine row (Fig. 1). This was the case for all cover crops except for perennial ryegrass, where there were slightly, but not significantly more nematodes in the inter-row (data not shown). Significantly less nematodes were found in the treatments in which SB or SI/AV management practices were applied to the annual cover crops than treatments in which other management practices were applied (i.e. the perennial grasses SL, weeds SL/AV and weeds MC) ($F_{(2;80)}$= 6.34, p≤0.05), measured during 1998 only (Fig. 2).

Ring nematodes

The F-statistic for treatments was significant during each season (1995: $F_{(12;24)}$=2.71, p≤0.05; 1996: $F_{(12;24)}$=31.43, p≤0.001; 1997: $F_{(12;24)}$=281.80, p≤0.001; 1998: $F_{(12;24)}$=271.39, p≤0.001). Significant treatment differences were found during 1995, 1996 and 1998 (Table 4). Nematode numbers in the 'Overberg' oats SA/BB treatment were significantly lower than most other treatments during 1996 and during 1998 numbers were again significantly lower in the 'Overberg' oats SA/BB treatment than in grazing vetch, subterranean clover and weeds, MC treatments (Table 4). No significant differences were found in cumulative counts over four years between treatments (Table 4). There was a drastic increase in nematode numbers in all treatments from 1996. Differences in sampling area were highly significant ($F_{(1;80)}$=70.20, p≤0.001) with more nematodes occurring on the vine row (Fig. 1). This was the case for all cover crops, the difference being very distinct when compared with the other nematodes. Management practices (SA/BB and SB/AV or SI/AV) did not influence nematode numbers significantly ($F_{(2;80)}$=0.99, p≤0.37).

DISCUSSION

Various Vicia species studied previously in combination with root-knot nematodes indicated variable results, from being poor hosts, such as *Vicia sativa* L. x *Vicia cordata* L. to some being good hosts, such as *Vicia sativa* (Nicol & Heeswijck, 1997). The results of the present study indicated a trend towards grazing vetch supporting higher populations of root-knot nematodes than the other cover crops. Root-lesion nematodes significantly preferred perennial cover crops and weeds over the annual cover crops which were sown biennially or initially. Being an endoparasitic nematode, this was to be expected. The lack of any definite trends in the data on root-knot and root-lesion nematodes can be ascribed to sampling having taken place only from soil and not from roots. This is ,indeed, a drawback of this study and could not be addressed due to technical constraints. 'Overberg' oats could have a suppressive effect on ring nematodes. The sudden increase in ring

TABLE 3

Mean numbers (log {x+1}) of root-lesion nematodes *Pratylenchus* spp. per 250 cc soil found in various cover crop treatments established in a Sultanina vineyard in the Lower Orange River region during four years.

Cover crop treatment	**Year[1]**				
	1995	**1996**	**1997**	**1998**	**CUM[2]**
Secale cereale L. v. Henog (rye), BB[3], SA[4]	0.53 a (13)	0.97 ab (22)	1.14 a (13)	0.99 abc (25)	**1.69 a (73)**
Avena sativa L. v. Overberg (oats), BB, SA	0.00 a (0)	1.77 a (63)	0.35 bc (3)	1.57 a (36)	**2.00 a (103)**
Avena strigosa L. v. Saia (Saia oats), BB, SA	0.00 a (0)	0.92 abc (8)	0.00 c (0)	1.06 abc (11)	**1.28 a (20)**
Lolium multiflorum Lam. v. Midmar (annual ryegrass), BB, SA	0.00 a (0)	1.54 a (45)	0.00 c (0)	0.80 abc (10)	**1.61 a (55)**
Lolium perenne v. Derby Supreme (perennial ryegrass), SL[5]	0.00 a (0)	0.00 c (0)	0.35 bc (3)	1.25 ab (23)	**1.31 a (27)**
Festuca arundinacae v. Cochise (fescue, a perennial), SL	0.66 a (33)	1.26 ab (18)	0.98 ab (20)	0.89 abc (15)	**1.79 a (87)**
Vicia dasycarpa Ten. (grazing vetch), BB, SA	0.53 a (13)	0.61 bc (5)	0.79 abc (10)	0.61 bc (5)	**1.38 a (33)**
Trifolium subterraneum L. v. Woogenellup ('Woogenellup' subterranean clover), BB, SA	0.73 a (53)	1.10 ab (15)	0.69 abc (7)	1.04 abc (11)	**1.81 a (87)**
Medicago truncatula Gaertn. v. Paraggio (medic), BB, SA	0.44 a (7)	0.35 bc (3)	1.38 a (23)	0.25 c (1)	**1.55 a (35)**
Ornithopus sativus L. v. Emena (pink Seradella), BB, SA	0.80 a (87)	0.93 ab (22)	0.35 bc (3)	1.15 abc (16)	**1.84 a (128)**
Weeds, MC[6]	0.87 a (140)	0.87 abc (15)	0.35 bc (3)	1.25 abc (16)	**1.92 a (175)**
Weeds, slashed, AV[7]	0.00 a (0)	0.61 bc (5)	0.35 bc (3)	0.94 abc (16)	**1.39 a (25)**

[1]Numbers in columns followed by different letters differ significantly on the 5% level. [2]CUM = mean cumulative counts. [3]BB = controlled chemically before bud break and thereafter. [4]SA = sown annually. [5]SL = slashed. [6]MC = controlled mechanically from bud break. [7]AV = controlled chemically after véraison. Numbers in brackets indicate actual numbers of nematodes.

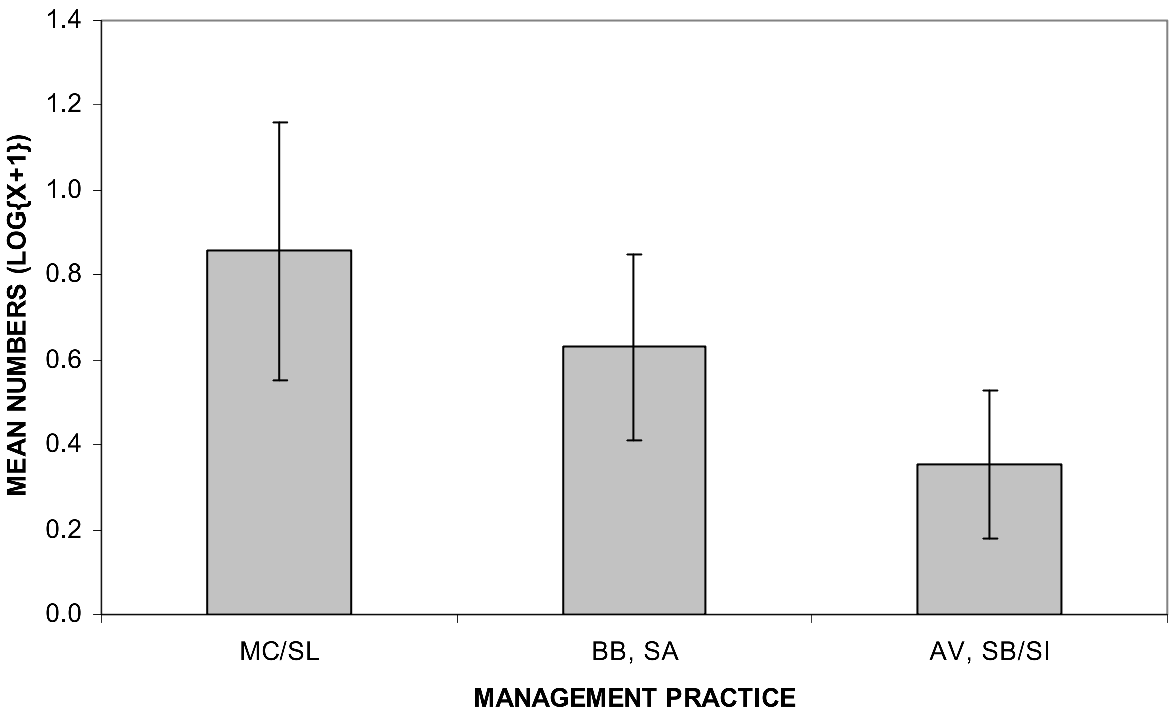

FIGURE 2

Mean numbers of *Pratylenchus* spp. (root-lesion) per 250 cc soil during 1998 in three management practices: MC/SL grouping: perennial grasses slashed, weeds slashed and controlled chemically after véraison and weeds controlled mechanically from bud break. BB,SA grouping: cover crops sown annually and controlled chemically before bud break and thereafter. AV, SB/SI grouping: cover crops sown biennially or initially and controlled chemically after véraison.
Error bars denote 95% confidence intervals.

TABLE 4

Mean numbers (log {x+1}) of ring nematodes *Mesocriconema xenoplax* per 250 cc soil found in various cover crop treatments established in a Sultanina vineyard in the Lower Orange River region during four years.

Cover crop treatment	Year[1]				
	1995	1996	1997	1998	CUM[2]
Secale cereale L. v. Henog (rye), BB[3], SA[4]	0.88 ab (13)	2.04 ab (117)	3.31 a (2727)	2.96 ab (1060)	**3.53 a (3917)**
Avena sativa L. v. Overberg (oats), BB, SA	0.35 ab (3)	1.02 b (37)	3.23 a (1980)	2.49 bc (392)	**3.36 a (2412)**
Avena strigosa L. v. Saia (Saia oats), BB, SA	1.29 ab (73)	1.95 ab (328)	3.12 a (1357)	2.85 ab (710)	**3.38 a (2468)**
Lolium multiflorum Lam. v. Midmar (annual ryegrass), BB, SA	0.96 ab (256)	2.04 ab (898)	3.18 a (1613)	2.79 ab (722)	**3.52 a (3490)**
Lolium perenne v. Derby Supreme (perennial ryegrass), SL[5]	0.00 b (0)	2.53 a (425)	3.06 a (1360)	3.01 ab (1322)	**3.44 a (3107)**
Festuca arundinacae v. Cochise (fescue, a perennial), SL	1.72 a (83)	2.67 a (471)	3.19 a (1940)	2.87 ab (950)	**3.48 a (3445)**
Vicia dasycarpa Ten. (grazing vetch), BB, SA	0.35 ab (3)	2.56 a (592)	2.79 a (797)	3.17 a (1570)	**3.46 a (2962)**
Trifolium subterraneum L. v. Woogenellup ('Woogenellup' subterranean clover), BB, SA	0.44 ab (7)	2.82 a (682)	3.11 a (1413)	3.09 a (1262)	**3.52 a (3363)**
Medicago truncatula Gaertn. v. Paraggio (medic), BB, SA	0.64 ab (27)	2.68 a (811)	3.02 a (1450)	2.74 ab (623)	**3.43 a (2911)**
Ornithopus sativus L. v. Emena (pink Seradella), BB, SA	0.44 ab (7)	2.67 a (533)	2.95 a (967)	2.88 ab (1485)	**3.42 a (2992)**
Weeds, MC[6]	0.00 b (0)	2.77 a (680)	3.25 a (1875)	3.12 a (1348)	**3.58 a (3855)**
Weeds, slashed, AV[7]	0.00 b (0)	2.60 a (667)	2.98 a (1093)	2.77 ab (613)	**3.34 a (3273)**

[1]Numbers in columns followed by different letters differ significantly on the 5% level. [2]CUM = mean cumulative counts. [3]BB = controlled chemically before bud break and thereafter. [4]SA = sown annually. [5]SL = slashed. [6]MC = controlled mechanically from bud break. [7]AV = controlled chemically after véraison. Numbers in brackets indicate actual numbers of nematodes.

nematode numbers after 1996 can be attributed to the fact that the irrigation system was changed from mounted in the inverted position to being mounted on top. This resulted in a change in the irrigation spray pattern, delivering more water into the working row. Other than trends discussed above, it does not appear as if the cover crops had any significant effect on any of the nematode species, as the weed treatments (controls) did not generally differ significantly from any of the cover crop treatments.

Our data supports that of Quader *et al*. (2001) who measured root-knot nematodes on vine rows and cover-cropped inter-rows in a south Australian vineyard. These authors suggested that any suppressive role cover crops may have played against root-knot nematodes were negligible as soil compaction and the distance between vine roots and cover crop roots can make it difficult for nematodes to move laterally. It appears from the present study that this also applies to root-lesion and ring nematodes. Root-knot and root-lesion nematodes are classified as endoparasites, while ring nematodes are classified as sedentary ectoparasites (Kleynhans et al., 1996), although they can move independently over short distances or passively, for example, with irrigation water. Ring nematodes have also been classified as being endomigratory on walnut roots (Ciancio & Grasso, 1998). It would appear that these nematodes are largely dependant on the roots that they find themselves in close proximity to, which indicates that vine roots are, indeed, better hosts for these nematodes than the cover crop roots under investigation here and that any of these cover crops can therefore be recommended without affecting vine root infestations negatively. This is confounded by the fact that, generally, vine roots receive more irrigation water than cover crops, which would assist with nematode reproduction. For more concrete recommendations regarding host status of these cover crops to plant parasitic, vine root samples would have to be analyzed as well.

CONCLUSIONS

If any benefit is to be derived from planting cover crops in vineyards as a management option for nematodes, other plants, such as *Brassica* species, with direct deterrent or toxic effects on plant parasitic nematodes and the concept of biofumigation should be considered, as this could prevent utilization of vine roots by these nematodes. Research investigating the effects of crop yield by plant parasitic nematodes in South African vineyards with cover crops is a further aspect requiring attention before recommendations can be made to grapevine growers.

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