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ENY063

Cover Crops for Managing Root-Knot Nematodes[1]

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Nematodes are unsegmented roundworms belonging to the to the Phylum Nematoda. Nematodes are found in almost all habitats, but they are often overlooked due to their microscopic size. Many different kinds of nematodes are present in soil (http://entnemdept.ifas.ufl.edu/creatures/nematode/soil_nematode.htm). These include plant parasites, decomposers, predators, insect parasites, and animal parasites. Some nematodes are aquatic and do not affect terrestrial plants. In farming systems, nematode predators and nematodes that are parasites of insects are beneficial, while nematode parasites of plants and animals are pests. Entomopathogenic nematodes (nematodes harmful to insects) may help to reduce the number of insect pests by infecting them with bacteria. Plant-parasitic nematodes will mainly feed on plant roots, and they can seriously damage or even kill crops, turf, and ornamental plants. Plant-parasitic nematodes are difficult to control because they live underground or inside the plant roots. One of the most damaging groups of plant-parasitic nematodes is the root-knot nematodes (*Meloidogyne* spp.). These nematodes are widespread and are pests of almost all major crops. Damage by root-knot nematodes can seen as galls or knot-like swellings produced along the plant roots (Figure 1). These galls cannot be easily removed because they are part of the plant root tissue. The juvenile root-knot nematode is the infective stage that can freely move through the soil and enter the root of a suitable host plant. Root-knot nematodes establish feeding sites within plant roots and cause enlargement of root cells, so only the females are capable of establishing feeding sites, and presence of root-knot nematodes can be detected by the presence of their galls on plant roots.

Several different species of root-knot nematodes occur in Florida (http://edis.ifas.ufl.edu/in846), and a few of these occur as different host races that may feed on different crops. It is extremely difficult to identify or tell apart different species or races of root-knot nematodes.

Figure 1. Galling on roots is a distinctive symptom caused by root-knot nematodes.

Cover Crops

Cover crops are crops grown between cash crop cycles or incorporated with cash crops to cover the ground in vegetable fields, orchards, and agricultural sites. Cover crops are mainly planted to improve soil fertility, soil structure, decrease soil erosion, and suppress weeds, insects,

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nematodes, and other plant pathogens. Residues from cover crops can be incorporated as "green manure" to supply macro and micronutrients for increasing the soil fertility for the next crop. Cover crops also help to enhance many beneficial organisms, and also possibly contribute to carbon sequestration. Cover crops are used to manage nematodes because nematodes can move only very short distances on their own. Nematodes cannot migrate to another field if a cover crop is not a host to the nematodes. Instead, some of them may starve, which helps to manage their population. Fallow soil also helps to keep nematodes populations at lower levels, but it may lead to soil erosion and other problems. Many different types of cover crops are adapted for cultivation in the southern United States. Popular cover crops are cowpea (*Vigna unguiculata*), sorghum-sudangrass (*Sorghum bicolor* × *S. sudanense*), sunn hemp (*Crotalaria juncea*), marigolds (*Tagetes* spp.), jointvetch (*Aeschynomene americana*), velvetbean (*Mucuna* spp.), sesame (*Sesamum indicum*), grasses, rye (*Secale cereale*), wheat (*Triticum aestivum*), oats (*Avena sativa*), crimson clover (*Trifolium incarnatum*), vetch (*Vicia* spp.), and lupine (*Lupinus angustifolius*). Today, there is an interesting trend toward using legumes as cover crops, because they supply nitrogen to subsequent crops or can be used as high-quality forage in silage production (Hartwig and Ammon 2002).

Summer Cover Crops

Cowpea, sunn hemp, sorghum-sudangrass, marigold, jointvetch, velvetbean, hairy indigo (*Indigofera hirsuta*), castor (*Ricinus communis*), sesame, and some grasses have most commonly been used as summer cover crops to keep root-knot populations at lower levels.

COWPEA

Cowpea is well adapted for cultivation in the tropics and southern United States. Cowpea is a leguminous summer cover crop (Figure 2) and helps to fix free atmosphere nitrogen with the help of nitrogen-fixing bacteria. Nematode management using a cowpea cover crop is dependent on the type of cowpea cultivar used and the type of nematode present. Cultivars such as 'Mississippi Silver' and 'Iron Clay' were found effective against different species of *Meloidogyne incognita*. Some cultivars are susceptible and may increase nematode populations. For more information on cowpea cover crops for root-knot nematode management, see http://edis.ifas.ufl.edu/in516.

SUNN HEMP

Sunn hemp is being used more and more often as a summer legume cover crop in the southern United States (Figure 3). This versatile crop helps to suppress weeds, reduce soil erosion, and reduce populations of root-knot nematodes and reniform nematodes (*Rotylenchulus reniformis*). Besides suppressing nematodes, crop residues from sunn hemp also help to improve soil organic matter and crop vigor and health. For more information on sunn hemp cover crops for root-knot nematode management, see http://edis.ifas.ufl.edu/ng043.

Figure 2. Cowpea (*Vigna unguiculata*).

Figure 3. Sunn hemp (*Crotalaria juncea*).

SORGHUM-SUDANGRASS

Although sorghum-sudangrass is a summer cover crop (Figure 4), it can be planted year round in central and south Florida. Populations of root-knot nematodes are best suppressed when sorghum or sorghum-sudangrass are used as rotation crops. In Florida, 'SX-17' sorghum-sudangrass did not support populations of *Meloidogyne incognita*

(races 1 and 3), *M. arenaria* (race1), and *M. javanica*. Thus it was effective against a wide range of root-knot nematodes that are common in Florida. Some varieties of sorghum-sudangrass are not only poor hosts for root-knot nematodes but may be resistant to some plant diseases and insect pests. As with cowpea, cultivar choice can be critical. For more information on sorghum-sudangrass cover crops for root-knot nematode management, see http://edis.ifas.ufl.edu/in531.

Figure 4. Sorghum-sudangrass (*Sorghum bicolor* × *S. sudanense*).

MARIGOLD

Marigold (*Tagetes* spp.) can be used as a cover crop (Figure 5) and it also produces an allelochemical called alpha-terthienyl, which helps to reduce populations of root-knot nematodes and may have activity against other plant pests such as fungi, bacteria, and insects (Hooks et al. 2010). Marigold can suppress 14 genera of plant-parasitic nematodes, especially root-knot nematodes (*Meloidogyne* spp.) and lesion nematodes (*Pratylenchus* spp.). Different species and cultivars of marigold vary in their ability to suppress nematode populations. For more information on marigold cover crops for root-knot nematode management, see http://edis.ifas.ufl.edu/ng045.

Figure 5. Marigold (*Tagetes* spp.).

OTHER SUMMER COVER CROPS

Some other crops such as jointvetch (Figure 6), velvetbean (Figure 7), horsebean (*Canavalia ensiformis*) (Figure 8), sesame (Figure 9), and some grasses can be also used as cover crops to manage populations of root-knot nematodes (Table 1). Weeds such as hairy indigo (*Indigofera hirsuta*), castor (*Ricinus communis*) (Figure 10), partridge pea (*Cassia fasciculata*), and showy crotalaria (*Crotalaria spectabilis*) (Figure 11) have also been used (Table 1). Several of the cover crops, including velvetbean, cowpea, sorghum-sudangrass, jointvetch, and castor were found effective to reduce more than one species or race of root-knot nematodes in Florida, but results depend on crop cultivars and nematodes species or races (McSorley et al. 1994). Recently a strip-tillage system with bahiagrass (*Paspalum notatum*) was developed, and it may be helpful for managing root-knot nematodes. For more details see (http://edis.ifas.ufl.edu/ep128).

Table 1. Response of some cover crops to Florida populations of *Meloidogyne* spp. based on five in greenhouse tests (McSorley et al. 1994)

Cover Crop[a]	M. arenaria race 1	M. javanica	M. incognita race 3	M. incognita race 1
Sesame	-[b]	-	?	+
Jointvetch	+	+	-	+
Velvetbean	?	?	+	+
Sorghum-sudangrass	+	+	+	+
Cowpea	N	N	+	+
Horsebean	+	-	-	N
Hairy indigo	?	N	N	N
Castor	+	+	+	+
Partridge pea	+	+	+	N
Showy crolataria	+	+	+	N

[a] Response may vary with cultivars of crops.
[b] Dash (-) = nematode reproduction likely/crop not effective. (+) = unclear; low levels of nematodes reproduction possible, N = not tested.

Figure 6. Jointvetch (*Aeschynomene americana*).

Figure 7. Velvetbean (*Mucuna* spp.).

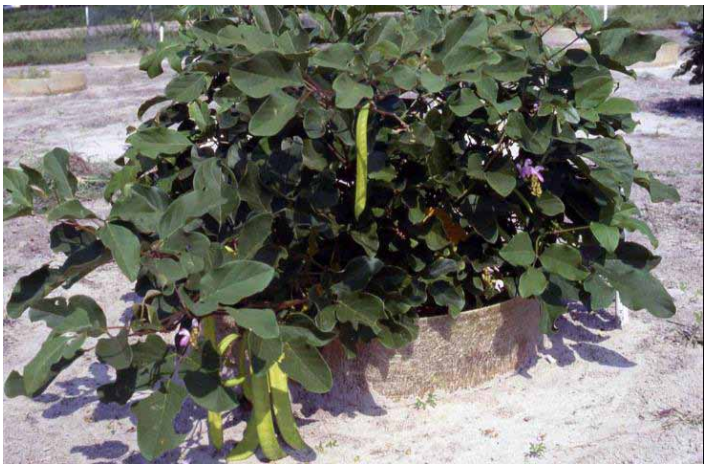

Figure 8. Horsebean (*Canavalia ensiformis*).

Figure 9. Sesame (*Sesamum indicum*).

Figure 10. Castor (*Ricinus communis*).

Figure 11. Showy crotalaria (*Crotalaria spectabilis*).

Winter Cover Crops

Winter cover crops such as rye (*Secale cereale*) (Figure 12), hairy vetch (*Vicia villosa*) (Figure 13), wheat (*Triticum aestivum*) (Figure 14), crimson clover (*Trifolium incarnatum*) (Figure 15), and lupine (*Lupinus angustifolius*) (Figure 16) are used where summer is the main cropping season (Wang et al. 2004). Rye is a commonly used winter cover crop in the southeastern United States and a poor host of *Meloidogyne* spp. (McSorley and Dickson, 1989). Population densities of *M. incognita* remained low throughout the winter cover-cropping season on several crops (wheat, rye, oat, lupine, hairy vetch, and crimson clover). However, their numbers increased after a susceptible corn crop was planted in the spring (Table 2), especially following hairy vetch, crimson clover, and lupine (Wang et. al. 2004). Leguminous cover crops are important for providing nitrogen, but most winter legumes can increase population levels of root-knot nematodes, and hairy vetch and crimson clover are particularly troublesome. Some cultivars of winter legumes show promise in nematode management. 'Cahaba' White vetch (*Vicia sativa*) was reported effective in managing *M. incognita* race 3 in a greenhouse experiment conducted

Figure 12. Rye (*Secale cereale*).

Figure 13. Vetch (*Vicia villosa*).

Figure 14. Wheat (*Triticum aestivum*).

Figure 15. Crimson clover (*Trifolium incarnatum*).

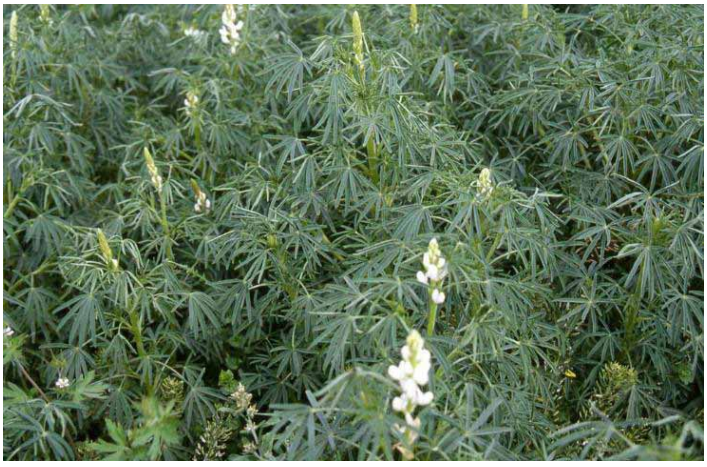

Figure 16. Lupine (*Lupinus angustifolius*).

in Georgia (Timper et al. 2006). 'Cherokee' red clover (*Trifolium pratense*) had reduced root galling and nematode reproduction compared to other germplasm of red clover in response to *M. arenaria*, *M. hapla*, *M. incognita*, and *M. javanica* (Quesenberry et al. 1989). Rye and oat were most effective in keeping nematode numbers low, and in general, cereal cover crops are better than leguminous crops for nematode suppression (Wang et al. 2004) (Table 2).

Table 2. Response of cover crops to *Meloidogyne incognita* in two years of winter cover crop-corn rotation, Citra, FL (Wang et al. 2004).

Winter Crop[a]	**Response to** *M. incognita*
Wheat	-[b]
Rye	+
Oat	+
Vetch	-
Crimson clover	-
Lupine	-

[a]Response may vary with different cultivars of crops.
[b](+) = useful rotation crop. Dash (-) = moderate to high levels of reproduction likely/crop not effective.

Conclusions

Cover crops may be used for many different reasons, and some may be helpful for managing root-knot nematodes. However use of some cover crops may have both advantages and disadvantages. Crops such as hairy vetch and crimson clover are legumes which provide a nitrogen supply but they also encourage populations of root-knot nematodes over the winter time (McSorley and Dickson 1989). Velvetbean can produce dense vines and become hard to manage, and it can also act as a host plant for some insect pests. Some of these plants discussed as "cover crops" such as hairy indigo, crotalaria, and, castor, are considered as weeds in Florida and cannot be recommended, while crotalaria and castor can be toxic to livestock (McSorley et al. 1994). Weed management is also important to discourage root-knot nematode populations in cover crops. Poor stand of velvetbean due to seedling diseases and vulnerability to defoliation of plants by caterpillars led to weed development in velvetbean plots. Some of these weeds were nematode hosts and showed galling from *M. incognita* (Crow et. al. 2001). Presence of these weeds made the velvetbean cover crop ineffective for nematode management. Even when cover crops are used successfully, it is important to know that nematodes can recover after a susceptible host is grown, so crop rotation should be done on a continuing basis to avoid buildup of nematode populations. There are some other management options for nematodes such as solarization (http://edis.ifas.ufl.edu/in824) and resistant plants, which are also effective for managing root-knot nematodes to some extent. For more information on nematode management in organic agriculture, see http://edis.ifas.ufl.edu/ng047.

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