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Management of Nematodes with Cowpea Cover Crops[1]

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This article is intended to guide agricultural professionals in the use of cowpea cover crops for managing plant-parasitic nematodes.

Advantages

Cover crops are grown between cash crop cycles, or intercropped with cash crops to cover the ground, such as in vegetable fields, orchards, groves, and agricultural sites. If used appropriately, cover crops can improve soil structure and fertility, decrease soil erosion, provide foliage and animal feed, and suppress crop pests such as weeds, insects, nematodes, and other plant pathogens. Residues from cover crops can be incorporated as green manure to supply nutrients and improve fertility for the next crop. Using cover crops can increase on-farm crop diversity, may enhance many beneficial organisms, and could possibly even contribute to carbon sequestration. One good example of a summer cover crop is cowpea, *Vigna unguiculata* (L.) Walp, due to its fast establishment, abiotic and biotic stress tolerance, and biomass production (Figure 1).

Cowpea is a resilient crop critical for the nutrition and income of millions of families in the tropical and subtropical world. It has a rich history in the southeastern United States, where it has been grown for centuries. Cowpea is one of the most tolerant legumes to high temperature and drought, and it can be a significant contributor to sustainable cropping systems. Therefore, it is well-adapted to Florida's hot and humid climate as well as sandy soils.

Figure 1. Cowpea breeding trial at the University of Florida.
Credits: E. Rios, UF/IFAS

For more information on cover crop production in Florida, see Wright et al. (2017). One advantage of using cowpea as a cover crop is its ability to associate with nitrogen-fixing bacteria and thus provide nitrogen for itself and the following crop (Figure 2). Besides fixing nitrogen, cowpea provides other ecosystem services such as weed and nematode suppression, but not all cowpea cultivars perform the same. Some cowpea cultivars can be damaged by several pests and diseases (Figure 3), including root-knot nematodes (*Meloidogyne* spp.), the key nematode pest in many cropping systems in north central Florida (Harrison et al. 2014; Dareus et al. 2021). Using susceptible cultivars

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as cover crops could result in severe root galling (Figure 4). When nematodes build up on cowpea or other cover crops, they can cause damage and yield loss to the next crop planted, which could be a valuable cash crop.

Figure 2. Cowpea root system showing large, round nodules that are fixing nitrogen.
Credits: E. Rios, UF/IFAS

Figure 3. Differential cultivar performance for biotic stresses in Florida. Healthy cowpea cultivar (left) grown next to a pest- and disease-susceptible cultivar (right).
Credits: E. Rios, UF/IFAS

Figure 4. Severe root galling from root-knot nematode on soybean. Galls are irregularly shaped swellings of the root. This distinguishes them from nodules, which are regular, rounded, and easily detached from the root.
Credits: Mace Bauer, UF/IFAS

Host Status of Cultivars of Cowpea to Plant-Parasitic Nematodes

Fortunately, some common cultivars have resistance to one or more species of root-knot nematodes. In particular, resistance to the most common root-knot nematode species, *M. incognita* (southern root-knot nematode) and the invasive *M. enterolobii* (guava root-knot nematode) has been characterized for a number of cowpea cultivars (Table 1; Figure 5). The host status is grouped into 3 categories based on their susceptibility to the nematodes: poor, intermediate, and good hosts. Growers should avoid using good or intermediate hosts in their crop rotation if the specific nematode species are present in the field because the nematode populations will increase on these host plants. A poor host does not support reproduction of the corresponding root-knot nematode species and will be useful in managing that pest. This combination of nematode and nitrogen management could be especially useful in organic production systems where neither nematicides nor synthetic nitrogen fertilizers could be used. For example, 'Iron Clay' is a commonly used cowpea cultivar for summer cover cropping. It has the advantage of being resistant to *M. incognita* (McSorley et al. 1999; Dareus et al. 2021), although it is susceptible to *M. enterolobii* (Table 2; Dareus et al. 2021), an emerging pest in Florida. Harrison et al. (2014) released three cowpea germplasm lines for use as cover crops: US-1136, US-1137, and US-1138. These germplasm lines are not only softseeded, but are also resistant to certain root-knot nematodes (Table 1). The three germplasm lines were found to be as effective at suppressing weeds and root-knot nematodes as 'Iron Clay' (Zambon et al. 2013), and US-1136 was the only resistant cultivar to *M. enterolobii* in the study conducted by Dareus et al., 2021.

Cowpea cultivars have not tested as extensively against other root-knot nematode species or other plant-parasitic nematodes important in Florida (Table 2). Based on research in older cultivars, most cultivars with resistance to *M. incognita* are also resistant to common isolates of *M. arenaria*and *M. javanica* (Roberts et al. 2005), although many modern cultivars have not been tested against these nematodes (Table 2). Cowpea is susceptible to reniform nematode (*Rotylenchulus reniformis*), a major pest of cotton. In limited testing on *Belonolaimus longicaudatu s*(sting nematode) and *Paratrichodorus minor* (stubby-root nematode), cowpea was detrimental for sting nematode management and was beneficial for stubby-root nematode management in Florida.

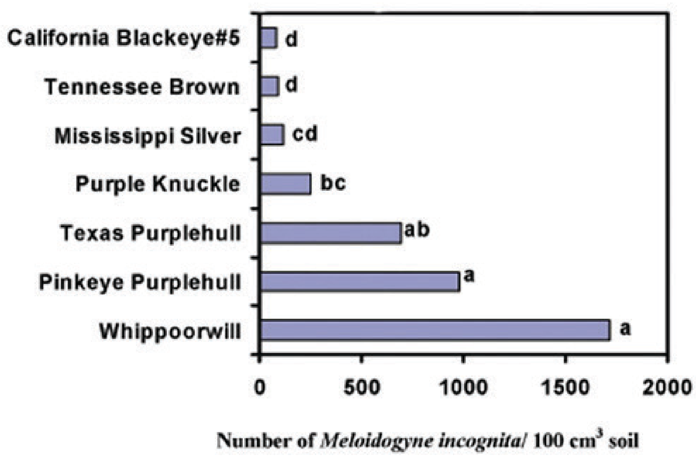

Figure 5. Population densities of the root-knot nematode, *Meloidogyne incognita*, following seven cowpea cultivars in Alachua County, FL, 1991. Bars followed by the same letter are not different (P is less than or equal to 0.05), according to Duncan's multiple range test performed on log-transformed data.
Credits: Gallaher and McSorley 1993

Challenges in Managing Nematode with Cowpea

In central Florida research, initial beneficial effects of cowpea rotation on root-knot nematode populations were lost once a susceptible vegetable crop like tomato or pepper was grown (McSorley et al. 1999). Combining cowpea cover cropping with solarization, anematode-resistant vegetable cultivar, or other strategies may provide the organic vegetable grower with a viable means for root-knot nematode management (McSorley et al. 1999).

Determining the nematode species in a field and, if available, selecting a suitable resistant cowpea cultivar to manage the nematode(s) present is crucial for successful management. This will be more difficult if mixtures of different plant-parasitic nematode species are present in the field. Ideally, a cowpea cultivar with resistance against all nematodes in a field would be selected. Otherwise, it is critical to focus management options on the key nematode pest. If a suitable cowpea cultivar for key nematode pests in a field is not available, a different cover crop or management strategy would be needed. Additionally, responses of a root-knot nematode species to cowpea may depend on the local nematode isolates, particularly for cultivars that have an intermediate level of resistance. For example, *M. javanica* from Florida may reproduce better on cowpea than an isolate from Hawaii. Therefore, host status of a cultivar may vary somewhat by location. For this reason, it is always prudent to plant a new cultivar in a small area to test performance against local root-knot nematode isolates before it is widely planted. Testing of modern cultivars and breeding for resistance to Florida isolates of *M. enterolobii*- and *M. incognita* is ongoing (Dareus et al. 2021).In addition, behavior (virulence) of root-knot isolates within an area might also change over time. Studies at University of California, Riverside, showed that a local population of the root-knot nematode *M. incognita* consisted of individuals varying in fitness. Although most of these root-knot isolates cannot reproduce on cowpea that contain the root-knot-nematode-resistant gene Rk, present in most commercial resistant cowpea cultivars, some nematode isolates can overcome the resistant gene (Roberts et al. 2005). Currently, no *M. incognita* that overcome root-knot-nematode resistance have been identified in Florida. To discourage development of resistance-breaking root-knot-nematode isolates, root-knot-nematode-resistant cowpea may be rotated with non-host or susceptible crops. Continuous culture of root-knot-nematode-resistant cowpea should be avoided because it will favor the resistant isolates of nematodes.

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Table 1. Host status of cowpea cultivars for southern root-knot nematode (*M. incognita*) and guava root-knot nematode (*M. eneterolobii*).

Cultivar	Target root-knot nematode		References
	M. incognita	***M. enterolobii***	
California Blackeye #5	Poor	-	McSorley and Gallaher 1992; Fassuliotis 1976
Colossus	Poor	-	Fassuliotis 1976
Crimson	Good	-	Kirkpatrick and Morelock 1987
Elite	Good	-	Kirkpatrick and Morelock 1987
Iron Clay	Poor	-	Dareus et al. 2021
Magnolia Blackeye	Poor	-	Fassuliotis 1976
Mississippi Purple	Poor	Good	Fassuliotis 1976 Dareus et al. 2021
Mississippi Silver	Poor	Good	Gallaher and McSorley 1993; McSorley et al. 1999; Kirkpatrick and Morelock 1987; Fassuliotis 1976; Dareus et al. 2021
Pinkeye Purplehull	Good	-	Gallaher and McSorley 1993
Purple Knuckle	Intermediate	-	Gallaher and McSorley 1993
Tennessee Brown	Poor	-	McSorley and Gallaher 1992
Texas Purplehull	Good	-	Gallaher and McSorley 1993
Texas Cream 40	Good	Good	Dareus et al. 2021
US-1136[1]	Poor	Poor	Dareus et al. 2021
US-1137[1]	Poor	Good	Dareus et al. 2021
US-1138[1]	Poor	Good	Dareus et al. 2021
White Acre	Good	-	Dareus et al. 2021
Whippoorwill	Good	-	Gallaher and McSorley 1993
Zippercream	Poor	-	McSorley and Dickson 1995; Fassuliotis 1976
Zipper Pea	Poor	Good	Dareus et al. 2021

"Good" denotes a good host that will increase populations of a particular root-knot nematode species. "Poor" denotes a poor host that will decrease populations of the corresponding root-knot nematode species, aiding in management. "Intermediate" has intermediate host status and management value between "Good" and "Poor."

[1] US-1136, US-1137, and US-1138 are publicly available, but currently supply is very limited.

Table 2. Host status of cowpea cultivars for various plant-parasitic nematodes: *M. javanica* (Javanese root-knot nematode), *M. arenaria* (peanut root-knot nematode), *R. reniformis* (reniform nematode), *B. longicaudatus* (sting nematode), and *P. minor* (stubby-root nematode).

Target Nematode	Good host	Poor host	Reference
M. javanica	California Blackeye #5, Mississippi Silver	Iron Clay	Harris and Ferris 1991; Swanson and Van Gundy 1984; Kokalis-Burelle et al. 2013
M. arenaria	Elite	Mississippi Silver, Iron Clay	Kirkpatrick and Morelock 1987; Kokalis-Burelle et al. 2013
R reniformis	California Blackeye #5, Iron Clay		Inserra et al. 1994; Waisen et al. 2019
B. longicaudatus	Mississippi Silver		McSorley and Dickson 1995;
P. minor	Unknown cultivar	Mississippi Silver, unknown cultivar	Baujard and Martiny 1995; McSorley and Dickson 1995; Wang et al. 2004

A good host will increase populations of the corresponding nematode and should be avoided. A poor host will decrease populations of the corresponding nematode and will aid in management.