ENY-057

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Root-Knot Nematode Resistance in Peanut[1]

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The domesticated peanut, *Arachis hypogaea* (L.), is widely used as an oilseed crop around the world and is a major agronomic crop in the southeastern United States. Peanut is produced on about 130,000 acres in Florida each year, and the state is the 4th largest producer in the USA. Production is concentrated in three areas of the state - the panhandle in and around Jackson County, the western panhandle in and around Santa Rosa County, and the central peninsular area in and around Levy and Gilchrist Counties. In Florida, about 90% of all peanut production is of the runner market types (small to medium-seeded). Several thousand acres of Valencia and Virginia market types are produced for the boiling trade.

Root-Knot Disease of Peanut

The peanut crop is subjected to numerous viral, fungal and nematode diseases, which are constant constraints to production faced by Florida farmers. Among the most serious include early and late leaf spot (*Cercospora arachidicola* and *Cercosporidium personatum*), southern stem rot (*Sclerotium rolfsii*), Cylindrocladium blackrot (*Cylindrocladium parsiticum*), tomato spotted wilt virus (Tospovirus, family Bunyaviridae) and root-knot (*Meloidogyne arenaria* race 1).

The peanut root-knot nematode is the most serious nematode pest of the crop and arguably the most serious soil-borne disease problem. For example, the nematode is present in almost all fields where the crop is grown in the state and economic damage is estimated to occur in greater than 50% of these fields. Individual peanut fields heavily infested with the root-knot nematode have sustained yield losses greater than 75%. In addition to causing considerable damage alone, it also increases the severity and incidence of other soil-borne diseases such as southern stem rot and Cylindrocladium blackrot.

Symptoms of Root-Knot Disease

Foliar symptoms of root-knot disease may be expressed at anytime during the growing season. These symptoms of nematode damage on peanut plants range from stunting, yellowing, wilting and even plant death (Figure 1). Generally, however, root-knot nematode damage symptoms are most evident in a peanut crop beginning about 100 days after planting and during or after periods of hot, dry

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weather. Areas of root-knot nematode damaged peanut are usually round to oblong in shape, and rows of infected plants may never overlap as those of healthy plants. It is not uncommon for plants to wilt and eventually die in areas where nematode populations are high. Root symptoms are similar to that caused by all nematodes including a reduction in number of feeder roots and root stunting, but root-knot nematodes cause unique symptoms on roots and pods. Nematodes cause galls (knots) to form on both roots and pods of the peanut, and these galls are highly diagnostic for root-knot nematode presence compared to other nematodes affecting peanut. The presence of galls on roots, pegs and pods appears as single or multiple wart-like growths that may or may not be discolored (Figure 2). As root-knot nematode infection progresses, and generally later in the season, secondary root and pod rots cause further damage and eventual death of the plants.

Figure 1. Peanut plants stunted by root-knot nematodes shown late in the growing season. The plants should fully cover the ground (click on photo to enlarge).

Root-Knot Nematode Resistance in Peanut

In the United States, considerable success has been achieved by plant breeders and plant pathologists in identifying and incorporating varying levels of resistance to diseases in commercial peanut varieties. Breeding cultivars with resistance to root-knot nematode, however, has been slower because no meaningful resistance has been found in the peanut germplasm collection of *Arachis hypogaea.* Also, the occurrence of the devastating tomato spotted wilt disease beginning in the early

Figure 2. Damage to the lower roots and pods of peanut caused by peanut root-knot nematode (click on photo to enlarge).

Figure 3. Severe galling on peanut pods. Most of the pegs and pods were destroyed; these are the surviving pods (click on photo to enlarge).

1990s diverted considerable attention away from breeding for resistance to other diseases including nematodes.

Only one root-knot nematode, *M. arenaria* race 1, is a major nematode pest of peanut, and unlike most plants, peanut is a poor host or a non-host to other commonly found root-knot nematodes in Florida (*M. incognita* and *M. javanica*). Genes conferring resistance to peanut root knot nematode have not been found in cultivated peanut, but a number of other *Arachis* spp. have been identified that are highly resistant or immune to the peanut root-knot nematode. Simpson and Starr (1991) and Garcia *et al.* (1996) reported successful crosses to transfer a high level of nematode resistance into *A. hypogaea.* The resistance was obtained from a wild

species, *Arachis cardenasii*. A germplasm line TxAG-6 was generated by interspecific hybridization [*A. batizocoi* x (*A. cardenasii* x *A. diogoi*)]. Resistance was then introgressed into *A. hypogaea* by a backcross program with a component line of the variety Florunner (UF 439-16-10-3-2) as the recurrent parent. As a result, the first of the two root-knot nematode-resistant peanut cultivars (COAN) was released by the Texas Agricultural Experiment Station in 1999 (Simpson and Starr, 2001). The resistance in COAN is controlled by a single dominant gene and is expressed as a reduction in nematode reproduction. Although nematodes invade the roots of COAN, most emigrate from the roots, but the few that remain in the roots develop to reproductive adults (Bendezu and Starr, 2003).

The second peanut cultivar with resistance to the peanut root-knot nematode was released by the Texas Agriculture Experiment Station in 2002 and named NemaTAM. (Simpson *et al.*, 2003). NemaTAM has greater yield potential than COAN and possesses the same level of resistance to the peanut root-knot nematode. It was derived from the same backcross introgression pathway as COAN but was selected from the seventh backcross generation whereas COAN was selected from the fifth backcross generation. Both COAN and NemaTAM have been proven resistant to the peanut root-knot nematode in a number of trials in the southeastern USA including in Florida. Unfortunately, neither peanut variety can be successful grown in Florida or the southeastern USA because they are highly susceptible to tomato spotted wilt virus and prevalent fungal diseases.

In 2008, however, the USDA released a cultivar, Tifguard, which has resistance to both tomato spotted wilt virus and root-knot nematode (Holbrook et al., 2008). The root-knot nematode resistance present in Tifguard is derived from the single dominant gene in COAN, and limited quantities of seed were made available to growers in 2009. However, good supplies of Tifguard seed should be available in subsequent years. To date, University of Georgia and University of Florida field trials have found excellent root-knot nematode resistance with this cultivar and good final peanut yields in root-knot infested fields.

Peanut Grower Options

For years, the standard recommendations for Florida peanut producers to minimize losses from root-knot nematode were rotation with crops that are poor or non-hosts of the nematode and use of nematicides as needed. While good crop rotation should be continued to reduce all peanut diseases, the advent of resistant peanut varieties will help reduce the need for costly nematicides in peanut production.

Figure 4. Left two rows showing a root-knot nematode tolerant peanut, right two rows are not tolerant to the nematodes (click on photo to enlarge).

Promising Near Term Research

Plant breeders and nematologists are actively pursuing the incorporation of the root-knot nematode resistance into varieties adapted to the disease situation in the southeastern U.S. Tifguard is the first of many future varieties that will be released from peanut breeding programs including the UF/IFAS peanut breeding program. These resistant varieties will not solve the peanut root-knot nematode problems in peanut production; however, they hold great promise to reduce losses from this disease by more than 50%.

Cautionary Notes

The resistance in Tifguard and other varieties that will soon be released is the same single dominant gene. Continuous planting of peanut with this gene in the same fields is likely to eventually lead to resistance-breaking nematode biotypes. This can be

delayed or prevented by utilizing proper crop rotation and even planting non-resistant peanut in the rotation as well. Secondly, this resistance does not reduce damage from lesion nematodes which are a major problem in peanut production in the central peninsular production area of Florida.

For further information on nematode management in peanut, go to: http://edis.ifas.ufl.edu/NG016

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