OPPORTUNITIES FOR DEVELOPING RESISTANCE TO THE RENIFORM NEMATODE IN COTTON

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Abstract

Most research on cotton nematodes has been on the cotton root-knot nematode, *Meloidogyne incognita*. The reniform nematode (*Rotylenchulus reniformis*) is a relatively new and fundamentally different problem. It already has become apparent that the best ways to manage this nematode will be different as well. Root-knot nematode-resistant cultivars have been developed from *G. hirsutum* germplasm but the development of reniform nematode-resistant cultivars probably will require the transfer into Upland cotton of nematode resistance genes from other species of *Gossypium*. The most promising sources of resistance are within the species *G. barbadense*, *G. longicalyx*, and *G. arboreum*.

Background

History

In contrast to the cotton root-knot nematode, which was discovered on cotton in the late 1800s at a time when U.S. cotton acreage was rapidly expanding, the reniform nematode was first reported on cotton in Georgia in 1940 (Smith, 1940) at a time when U.S. cotton acreage was rapidly shrinking, reaching an all time low in 1982. Most research on the reniform nematode has been during the last 10 years during a resurgence of U.S. cotton acreage. Unlike the root-knot nematode, the reniform nematode has not been found in western states, is rare on the High Plains of Texas, and is considered a secondary nematode problem in the Atlantic Coastal Plains. The reniform nematode is considered a primary nematode problem in Louisiana, Mississippi, Alabama, and South Texas.

Biology

The most notable difference between the reniform and the cotton root-knot nematode from a cotton production standpoint, is that the reniform nematode infects differentiated root tissue (Robinson, 1999; Robinson et al., 1997). Consequently it does not cause galls or markedly stunt roots as typically is observed in root-knot nematode infections, does not strongly predispose plants to Fusarium wilt, and rarely kills plants. The primary pathology instead is a dysfunctional pericycle that impedes uptake of water and nutrients. In infected plants the root architecture differs little from that of healthy plants and since plants are rarely killed, nematode feeding sites have a spacially dense distribution that is relatively uniform across the field, deep into the soil profile, and persistent during winter. This etiology and pathology differ strikingly from the more familiar root-knot nematode problem.

Identification and Development of Resistance

Overview

At least seven published and eight unpublished studies have been done to identify sources of resistance to the reniform nematode in cotton. Altogether, more than 1,500 genotypes of 21 species of *Gossypium* and numerous related genera have been examined. It seems unlikely there are any genotypes of *G. hirsutum* with sufficiently high levels of resistance to reduce nematode populations substantially within infested fields. Nonetheless, commercial cultivars do differ in the level of reproduction they support in the field and the potential of these differences for nematode management has not been examined rigorously. One study (Robinson et al., 1999) examined the 55 most widely planted cultivars of *G. hirsutum* between 1950 and 1995, representing approximately 2/3 of the year-acres planted to cotton in the second half of the twentieth century, and no resistance was observed. Most Pima cultivars also have been examined and none were resistant (Robinson et al., 1999; Yik and Birchfield, 1984).

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Resistance and Tolerance in Upland Cotton Breeding Lines

The Louisiana State University Upland cotton breeding lines La. RN 4-4, La. RN 909, La. RN 910, and La. RN 1032, combine good root-knot nematode resistance with some limited resistance to the reniform nematode (Jones et al., 1988; Muhammad and Jones 1990), which in tests in Texas (A. F. Robinson, unpublished data) was seen as a reproducible 52-72% reduction in reproduction when compared to that observed on a susceptible control. This material has been utilized to develop additional breeding lines (N220-1-91, N222-1-91, N320-2-91, N419-1-91) which combine root-knot nematode resistance with field tolerance to the reniform nematode under South Texas growing conditions (Cook et al. 1997a, 1997b).

Relationship to Root-Knot Nematode Resistance

Known sources of root-knot nematode resistance in Upland cotton do not convey reniform nematode resistance. However, the most highly root-knot nematode-resistant breeding lines typically support about 65% of the reniform nematode reproduction observed on susceptible controls (A. F. Robinson, unpublished data), and regression analysis of nematode reproduction data for approximately 300 genotypes of *G. hirsutum* showed a 40% reduction in reniform nematode reproduction across the full range of root-knot nematode resistance (A. F. Robinson, unpublished data).

Transgenic Cotton

Reniform nematode-resistant transgenic cotton apparently is not available. In one study, no commercially available transgenic cultivar of Upland cotton in 1998 showed any resistance to the reniform nematode (Robinson and Bridges, 1999). In another study (A. F. Robinson and M. Oliver, unpublished data), neither root-knot nor reniform nematode resistance was found among numerous transgenic Coker 312 lines carrying constructs designed to interfere with root-knot nematode feeding (Opperman et al., 1994).

Resistance in Primitive Accessions

Moderate to good resistance to the reniform nematode has been detected and confirmed in follow-up experiments usually in other laboratories for at least 10 accessions of *G. barbadense*, 4 of *G. arboreum*, 1 of *G. herbaceum* (Carter, 1981; Robinson and Percival, 1997; Robinson, unpublished data; Yik and Birchfield, 1984). In two independent laboratories, reciprocal crosses between the reniform nematode-resistant primitive accession *G. barbadense* TX110 and the root-knot nematode-resistant breeding line Auburn M315 (or sister line) have been found to produce F1 hybrid progeny which carry resistance to both the reniform and the root-knot nematode (J. L. Starr , unpublished data; J. McD. Stewart, unpublished data).

Immunity

G. longicalyx is immune (Yik and Birchfield, 1984), and this result has been confirmed by several laboratories; it also has been confirmed that nematodes penetrate *G. longicalyx* roots in the same numbers as in susceptible plants but fail to mature (A. F. Robinson, unpublished data). In an ongoing project, triple species hybrids of *G. longicalyx*, *G. hirsutum* and either *G. amourianum* or *G. herbaceum* have been found to carry the *G. longicalyx* immunity and subsequently have been crossed successfully with root-knot nematode-resistant *G. hirsutum* (A. F. Robinson and A. A. Bell, unpublished data).

Untested Accessions

The total number of primitive accessions that have been tested within each species of *Gossypium* is still a small proportion (ca. 2-3% for most species) of the number available for testing within the several thousand accessions of primitive cotton in the U.S. National Cotton Collection, and many geographic origins are unrepresented among tested accessions.

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