ADDING ROOT-KNOT NEMATODE RESISTANCE TO GEORGIA-ADAPTED COTTON GERMPLASM, 2007

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Introduction

State surveys of the densities of nematodes reveal that the major cotton-producing counties in Georgia have damaging levels of nematodes (state loss of 137,423 bales ... valued at $53,594,970 in 1998) and is increasing from previous years (National Cotton Council, 1998). From 1991 to 1998, almost 98 thousand bales per year valued at a total of $300 million were lost (National Cotton Council, 1998). It is estimated that Georgia producers specifically lose about 77,000 bales of cotton annually from root-knot nematodes (*Meloidogyne incognita,* RKN) damage (Blasingame and Petal, 2001). Crop rotation, while a recommended cultural practice to lessen soil populations of RKN, is not an option for most Georgia growers because of the lack of suitable non-host crops with which to rotate their cotton acreages. Therefore, inherent genetic resistance provides an attractive alternative to pesticides and crop rotation.

Poor profit potential of cotton production from yield stagnation and high pest management costs impels creation of cultivars with inherent genetic resistance to enhance economic returns for cotton producers. Insect, nematode, and weed pest management costs are among the highest expenditures growers face in cotton production (National Cotton Council, 2001), thus their reduction would enhance profitability of cotton production. Since Georgia is the second ranked cotton producing state with 1.4 million acres (NASS, 2006), cotton cultivars adapted for the unique aspects of the environment of Georgia, such as rainfall patterns, soils types and depth, and presence of root-knot nematodes must be developed to give the best available genetics to the GA producer.

Despite the widespread occurrence of RKN in Georgia and most cotton production areas in the Southeast and that genetic resistance to RKN has existed since 1974 (Shepherd, 1974), private cultivar developers have previously exhibited little interest in fulfilling this need. Commonly cited reasons for the slow progress in developing RKN resistant cultivars is that the current screening process is costly, tedious, time consuming and destructive for identifying resistance genotypes. Further, most breeding stations have neither the facilities nor personnel with expertise in nematology to carry out the screening process to identify resistant material. Of those RKN-resistant (CPCSD Acala NemX) or tolerant cultivars (ST LA887 or PM H1560) that have been distributed by commercial cotton seed companies, none are adapted to the Southeast.

Our objective, to develop Georgia-adapted, value-added cotton germplasm with RKN resistance, will benefit the state's producers by providing increased yield and decreased production costs whereas the increased availability of RKN-resistant germplasm will benefit the cotton industry across the belt.

Materials and Methods

In a previous project, Drs. Chee, May, and Davis developed advanced RKN parents from a backcross breeding population using M120RNR and M155RNR root-knot nematode resistant donor parent with the elite breeding line PD94042 (May, 1999). The best resistant BC3F3 lines will be crossed with Georgia adapted, value added lines from our UGA Cotton Breeding program. A ten plant sample of this material was challenged twice with a very high rate of RKN in a pot-based greenhouse test following Shen et al. (2006). Further samples were then grown at the Gibbs Farm, University of Georgia-Tifton campus in an RKN infested field following the procedure of Davis and May (2005). The resistant lines were verified in an additional pot-based greenhouse test. Resistant lines 103-7, 201-A, 506-5, and 506-11 were selected as parents to introgress the RKN resistance into the Georgia-adapted germplasm GA 98028 and GA 2001078. Selection of the resistant offspring will use DNA marker-assisted selection (MAS) with the markers being developed in a companion project (Shen et al., 2006). The chromosomal region bearing the RKN resistance that is indicated by these molecular markers has been already verified independently (Ynturi et al., 2006), although the work in our lab appears to have markers that are, at present, closer to the RKN resistance gene. We have found the markers to be polymorphic between the parental Georgia lines and both parents of the RKN resistance donors. The most current molecular markers will be used in a three-cycle backcrossing program in the greenhouse to insert the RKN resistance gene during 2007 but our crossing schedule was disrupted by inviable seed from the second backcross. We have sent F_1 seed to the winter nursery in Mexico to obtain seed for the 2008 growing season to use our standard breeding approach (Lubbers et al., 2006) as well as testing samples of the F_2 population with the molecular markers for RKN resistance. We are also continuing to follow our backcrossing plan as a two-pronged approach to enhance the likelihood of selecting the RKN resistance in a better genetic background for Georgia-adapted production. After the F_2 yield test and the F_3 selections with fiber quality testing within the standard approach and the single plant selections with fiber quality testing in the BC_2F_1 population of the backcrossing approach, we will plant an unreplicated modified augmented design yield test (with every 5th row in the trial assigned to a conventional check cultivar) in either Tifton or Plains to select for yield and to test/verify the homozygosity of the RKN resistance marker(s). This trial will be machine harvested and the seed-cotton yield of each F4 progeny row compared with seed-cotton yield of the nearest check row. We will then harvest boll samples for lint %, fiber quality, and for seed in a parallel increase field for the rows that significantly out-yield the nearest check plot. The preliminary trial (PT), which is the next step, will be conducted near Tifton or Plains, GA, depending upon land availability. Advanced generation germplasm lines promoted from the PT shall be tested in an advanced yield trial (AT) in Plains and Tifton. Elite germplasm lines from a successful performance in the ATs will be tested in locations throughout the state in both dryland and irrigated fields in the University of Georgia Official Variety Trials.

Interim Results and Discussion

The backcross approach was delayed by failed crosses and/or inviable seeds at BC_1 stage. We are theorizing that this was caused by the high temperatures found in greenhouses in the summer, but we didn't note any excessive afternoon wilting and the plants grew vigorously without any obvious stress or stunting. The backcrossing is continuing; but to increase the likelihood of success, the F_1 seed has been sent to the winter nursery in Mexico to furnish F_2 seed to use in our standard conventional breeding approach as a hedge against any further difficulties in the backcross approach.
Further field research with the PD 94042-derived, parental RKN resistance donors (and related lines) for this project was conducted in 2007 to further verify the field-level effectiveness of the genes that came from M120RNR and M155RNR. This test used fumigated and non-fumigated soil to compare the efficacy of the introgressed RKN resistance genes. The lint yield and fiber quality analyses are expected to be completed in late January 2008 and will be placed in an updated version of this technical report published in the 2007 Georgia Cotton Research and Extension Reports. Seed increase plots were also produced for multi-location agronomic testing upcoming in 2008.
This approach should quickly provide a solid performing release of RKN resistant germplasm/cultivars. But, even though MAS is generally considered a reliable procedure, it is a relatively recent innovation and has not been extensively utilized, and there may be technical problems associated with it.

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