Development of a Peanut Cultivar with Resistance to the Peanut Root-knot Nematode and Tomato Spotted Wilt Virus

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Abstract

The peanut root-knot nematode and tomato spotted wilt virus are pathogens of peanut that result in large yield losses in the southeastern United States. Peanut cultivars are available that have resistance to either the peanut root-knot nematode or tomato spotted wilt virus, however, no cultivars are available that have resistance to both pathogens. Our objective was to combine resistance to both pathogens in a single genotypes with high yield and grade. Breeding populations were developed by hybridizing the TSWV resistance cultivar, C-99R with the nematode resistant cultivar, COAN. Selection for nematode resistance was conducted using standard greenhouse screening techniques. Selection for TSWV resistance was conducted in the field with natural virus infection. Because of its high resistance to both pathogens, the breeding line C724-19-15 was selected for further evaluation. In subsequent studies, this line exhibited higher yield and higher resistance to TSWV than standard check cultivars when grown in fields with little or no nematode pressure. Because of its high level of resistance to both TSWV and *M. arenaria*, this breeding line had almost twice the yield of standard cultivars when grown in two locations with high pressure from both pathogens. This breeding line has recently been released as the cultivar, Tifguard. Tifguard is the first peanut cultivar with resistance to both the peanut root-knot nematode and tomato spotted wilt virus.

Introduction

The peanut root-knot nematode, *Meloidogyne arenaria*, causes 5-15% annual yield losses to peanut in the southeast. In Georgia, this nematode is responsible for $16.4 million in yield losses and costs $8 million to control (1998 Georgia Plant Disease Loss Estimates). Crop rotation and nematicides are the primary management tactics available to growers. However, because of the extensive host range of *M. arenaria*, growers have few non-host crops to include in rotation with peanut. Nematicides reduce early season nematode populations, but frequently, nematode densities at the end of the growing season are similar in nematicide-treated and untreated soils. The development of nematode-resistant peanut cultivars would eliminate the cost of nematicide application and would allow growers greater flexibility in their choice of rotation crops.

The first nematode resistant peanut cultivar, COAN, was developed by introgressing resistance from wild peanut species (Simpson and Starr, 2001). Although this line has a very high level of resistance to the peanut root-knot nematode, it is not a viable peanut cultivar in the southeast due to its susceptibility to TSWV (Holbrook, et al., 2003).

Since 1985, tomato spotted wilt virus (TSWV) has become a major problem in peanut production areas of the southern United States. The disease is now common in most peanut-growing areas, including Georgia, Florida, Alabama, Texas, and North Carolina, and has become the most important disease problem for many peanut growers (Culbreath et al., 1997a). Several sources of resistance to TSWV are available in peanut, however, they are all susceptible to the peanut root-knot nematode. The objective of this research was to develop a peanut cultivar adapted to the Southeastern U.S. with resistance to the both the peanut root-knot nematode and TSWV.

Methods and Materials

The original population was developed by crossing C-99R (Gorbet and Shokes, 2002), a cultivar with good field resistance to TSWV with COAN, a cultivar with near immunity to the peanut root-knot nematode. The population was advance to the F_4 using single seed descent. Individual F_4 plants were harvested.

A few seed from each plant were used to evaluate the population for resistance to *M. arenaria* using the greenhouse screening technique described by Holbrook et al. (1983) with three replications. The remaining F_{4-5} seeds were planted the following year in single replicate plots at the Gibbs farm in Tift County, GA. Spotted wilt intensity was evaluated in each plot using a disease intensity rating that represents a combination of incidence and severity as described by Culbreath et al. (1997b).

Plot C724-19 was selected based on resistance to TSWV and visual observation of yield after digging. We harvested 30 individual plants from this plot because the nematode screening data indicated that this family might still be segregating for nematode resistance. These 30 lines were evaluated in additional greenhouse and field screens, and a nematode resistant line (C724-19-15) was selected for more intensive study.

This breeding line, along with nematode resistant and susceptible check cultivars were tested for resistance to *M. arenaria* using the greenhouse technique described above with six replications. After the plants were indexed for root-galls and egg-masses, roots were blotted dry and weighed, and nematode eggs were collected with 1.0% (v/v) NaOCl and counted.

The same genotypes were also planted in 2004 and 2005 in fields with little or no *M. arenaria* at the Gibbs Farm in Tift County, GA. Spotted wilt intensity was evaluated in each plot using the disease intensity rating as previously described. Plots were dug, picked, and pods were dried with forced air.

C724-19-15 and check genotypes were also tested in two fields that were heavily infested with *M. arenaria*. One field was at the Bowen Farm in Tift County, GA. The other field was at the Gibbs Farm. Immediately after digging the roots from 10 randomly selected plants were clipped and bagged for each plot. These root were taken to the laboratory were they were visually rated for the amount of root galling using a 0 (no galling) to 9 (severe galling) scale.

Results and Discussion

Root-gall index, egg-mass index, and eggs per gram of fresh root all clearly indicated that Tifguard is resistant to *M. arenaria* (Table 1). Results for Tifguard were very similar to COAN and NemaTAM (Simpson et al., 2003), the two nematode resistant peanut cultivars.

In fields with little to no nematode pressure, COAN and NemaTAM exhibited yields that were significantly lower than Georgia Green (Branch, 1996) (Figure 1). Similar results were observed for COAN in a previous study (Holbrook et al., 2003). Although NemaTAM was shown to have a higher yield potential than COAN in Texas (Church et al., 2000), the yield difference in our test was not significant. COAN and NemaTAM are not commercially viable cultivars for the southeastern U.S. because of their high susceptibility to TSWV (Figure 2). Tifguard exhibited significantly higher resistance to TSWV than these cultivars in both years of testing. Tifguard also exhibited higher resistance to TSWV than Georgia Green and C-99R, two cultivars with moderate levels of resistance to TSWV.

Tifguard had significantly higher yield than Georgia Green when tested in fields with little to no nematode pressure (Figure 1). Although a previous study had documented competitive yields in breeding lines with moderate resistance to nematodes (Holbrook et al., 2003), this is the first report of competitive pod yield for a peanut genotype with a high level of nematode resistance when grown under severe pressure from TSWV.

In the peanut production region of the Southeastern U.S. peanuts in fields with the peanut root-knot nematode also experience pressure from TSWV. In such a situation the yield of currently available virus resistant cultivars will be reduced by nematode pressure, and the yield of currently available nematode resistant cultivars will be reduced by TSWV. Because of its high level of resistance to both TSWV and *M. arenaria*, Tifguard had significantly higher yield than all other entries when grown in two locations with high pressure from both pathogens (Figure 3). Root gall indices for Tifguard demonstrated a level of nematode resistance similar to NemaTAM and the nematode resistant germplasm lines, NR0812 and NR0817 (Anderson et al., 2006) (Figure 4).

In summary, this is the first report of a high yielding peanut genotype with excellent resistance to both the peanut root-knot nematode and TSWV. Tifguard should be valuable for peanut growers who have to deal with both pathogens.

Table 1. Root galling, egg-mass ratings, and *Meloidogyne arenaria* reproduction on selected peanut genotypes when tested in the greenhouse.

Genotype	Root-gall index†	Egg-mass index†	Eggs per gram fresh root
Georgia Green	4.3‡	3.7	8125
C-99R	4.2	3.2	3563
COAN	1.5	0.7	206
Tifguard	1.3	0.5	134
NemaTAM	1.0	0.5	171
Lsd (P≤0.05)	1.0	1.1	3071

† Root-gall and egg-mass index on 0 to 5 scale: 0, no galls or no egg-masses; 1, 1-2; 2, 3-10; 3, 11-30; 4, 31-100; 5, more than 100 galls or egg masses per root system.

‡ Data are means of 6 replications.

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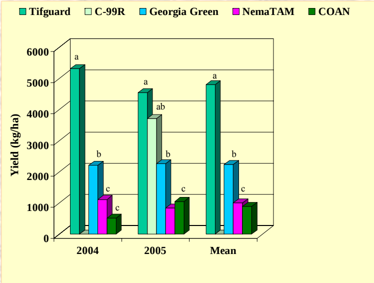

Figure 1. Pod yield of selected peanut genotypes when grown in fields with little or no nematode pressure at Tifton, Georgia in 2004 and 2005. Genotype x year interaction effects were not significant (P>0.05). Therefore, data from the two years were pooled for genotype comparisons.

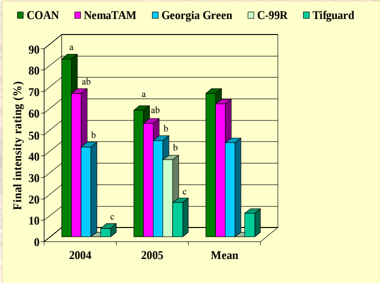

Figure 2. Final intensity of tomato spotted wilt of selected peanut genotypes at Tifton, GA in 2004 and 2005. Percentage of the total row length with plants severely affected by spotted wilt. Genotype x year interaction effects were significant (P≤0.05). Therefore, data were analyzed independently for each year.

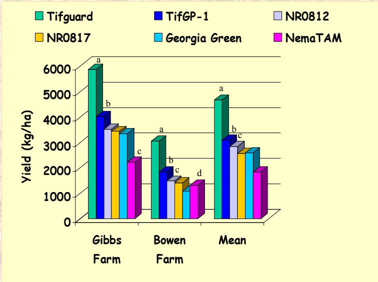

Figure 3. Pod yield of selected peanut genotypes when grown at locations heavily infested with *Meloidogyne arenaria* in 2006. Gall index on a 0 (no galling) to 10 (severe galling) scale. Genotype x year interaction effects were not significant (P>0.05). Therefore, data from the two years were pooled for genotype comparison.

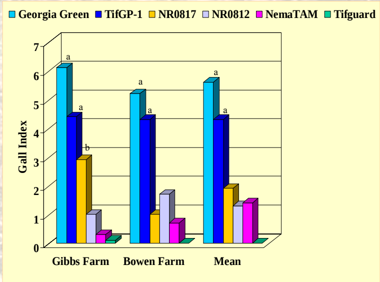

Figure 4. Root gall index of selected peanut genotypes when grown at locations heavily infested with *Meloidogyne arenaria* in 2006. Gall index on a 0 (no galling) to 10 (severe galling) scale. Genotype x year interaction effects were not significant (P>0.05). Therefore, data from two years were pooled for genotype comparison.