COTTON VARIETY TESTS FOR DISEASE AND ROOT-KNOT NEMATODE TOLERANCE

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Abstract

Cotton varieties vary significantly in their tolerances to seedling diseases and nematodes and this paper examines several commercial San Joaquin Valley Acala varieties and selected experimental lines for their reactions to these pests. Results with Acala NemX, a newly released Acala variety, and experimental lines N-901 and N-903 are presented for their significant seedling disease survival potentials and for their root-knot nematode tolerance. Acala's Maxxa, Royale, and Prema have demonstrated a tolerance to Pythium ultumum seedling disease, but Maxxa's performance in seedling survival decreases when nematodes are present. Evidence suggests that nematodes may aggravate some seedling diseases and nematode tolerance improves a variety's tolerance to these diseases. The reaction of these lines in soils where seedling diseases, fusarium wilt, and root-knot nematodes are present demonstrate the value of selecting for increased tolerances to all three problems in cotton breeding programs. Cotton lint yields showed how, when acting in concert, fusarium-wilt, root-knot nematodes, and seedling diseases can exacerbate the combined effects of these diseases and pests.

Introduction

Cotton breeding efforts have often concentrated on the grower's need for higher lint production and higher fiber quality. Breeders have not neglected traits such as insect, seedling disease, or nematode tolerance, but these characteristics do not frequently find their way into commercial cotton cultivars. However, Verticillium-wilt disease, a serious problem in California, has received a lot of research attention and several tolerant varieties have been released. Important contributions to lint yield have been made through improving Verticillium-wilt tolerance and this has encouraged research efforts with other disease problems. This paper reviews research conducted during 1994 and 1995 in California to evaluate the tolerance of several commercial and experimental lines to seedling disease and root-knot nematodes, the apparent relationship between these traits, and how Fusarium-wilt effects the seedling disease/root-knot nematode relationship.

Materials and Methods

In 1994 and 1995 seeds of several San Joaquin Valley Cotton Board (SJVCB) approved Acala cotton varieties were planted in replicated trials in the San Joaquin Valley. Seedling disease tolerances of these varieties were compared at northern and southern locations. The varieties in these tests included Acala SJ-2, Acala GC-510, Acala GC-702, Acala Maxxa, Acala NemX, Acala Eldorado, Acala Prema, or Acala Royale. In the small tests at least 4 replications of each variety were planted with 120 seeds per 30 ft of row for each replication. In several trials half of the plots were planted with seeds treated with a fungicide coating of Apron plus Nu-Flow ND (1 1/2 oz. + 14.5 oz). All trials were evaluated for seedling disease problems by counting seedling emergence and seedling survival percentages.

Several experimental root-knot nematode tolerant lines were compared with the approved varieties, however, only the performance of N-901 and N-903 has been reported. These comparisons were made in larger trials at several grower locations with known root-knot nematode problems. In one trial two approved varieties, Maxxa and NemX, were compared with and without the insecticideTemik (Table 8.). Temik was applied incorporated into the soil as a granule (10%) at 10 Lbs per acre at planting time. In 1995 root-knot nematode severity was determined. The nematode galls on plants dug from each variety were evaluated and given a weighted nematode rating (WNR). Lint yields were taken each year on all tests by either hand harvest (small plots), or machine harvest (larger trials). In 1994 a test was conducted at the Shafter Cotton Research Station on soil heavily infested with root-knot nematodes (Meloidogyne incognita) and the fusarium wilt fungus (Fusarium oxysporum f. sp. vasinfectum). Eight replications of each variety were planted in single row plots 30 ft in length. Four of the approved varieties, Maxxa, Prema, Royale, and NemX, were compared with two experimental lines, N-901 and N-903. All seeds were treated with fungicides and the six cottons were evaluated for surviving seedling percentages, fusarium wilt and lint yield.

Results and Discussion

Six approved varieties were tested for seedling disease survival. (Table 1). Two varieties, Royale and NemX, significantly exceeded the other four in seedling survival. When planted without seed treatments 90% of the untreated NemX seed and 81% of the Royale seedlings survived and these two varieties significantly exceeded the other four. However, when the varieties were treated with fungicides, only NemX produced significantly higher surviving stands. Fungicide treatments did not improve

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stands of either Royale or NemX, although Acala NemX was consistently superior to the all other varieties. These results would support previous studies demonstrating the superior seedling disease tolerance of Acala Royale and Acala NemX. Acala NemX was selected for its high root-knot nematode tolerance.

Untreated Acala SJ-2 and Acala Prema seeds were planted to evaluate them for seedling tolerances (Table 2.). When treated with fungicides stands of SJ-2 improved to 83 percent seedling survival, compared to 58 percent without fungicides. Acala Prema stands were also improved, 94 percent from 79 percent, with fungicide treatment. Prior research showed that Prema has significant tolerance to Pythium ultimum in comparison with other acala varieties and these results support those conclusions.

In 1995 four approved varieties selected for their tolerances to seedling diseases were planted in a root-knot infested soil (Table 3). Maxxa and NemX seeds planted without fungicides were compared to untreated Eldorado and GC-702 seeds. In this test both Maxxa and NemX had significantly higher seedling survival percentages than GC-702, but they were not significantly greater than Eldorado. After treating all four varieties with fungicides NemX was significantly higher in seedling survival than GC-702. The other varieties were not significantly different. Root-knot nematode levels were fairly high at harvest but apparently nematodes were not a factor at seedling emergence because Maxxa provided survival percentages above 90 percent even when untreated. In addition, Acala NemX, which is root-knot tolerant, did not exceed Acala Maxxa in seedling survivors. It would appear from these data that any differances in this test in seedling stands were probably due to seedling pathogens.

Of interest were results from trials planted to determine how some of these varieties would perform in soils infested with root-knot nematodes. Several trials were located on growers fields, while one was conducted at the CPCSD Research Station. Maxxa, Royale, NemX, N-903, and N-901 were compared, and Prema was added at the CPCSD site (Table 4). Maxxa and Royale were significantly lower in lint yield than NemX, N-901 and N-903 at Kirschenmann Farms, Wilson Farms, and at the CPCSD Station. Acala NemX, N-903 and N-901 were numerically higher in yield at all three locations. The lower yields of Maxxa and Royale at these locations indicates a problem with root-knot nematodes. Prema's higher tolerance to root-knot nematodes helped it out-yield Maxxa and Royale at the CPCSD Station.

Four of the approved varieties, Maxxa, GC-702, Royale, Prema, and NemX were planted in a field trial at the Bidart Brothers Ranch (Table 5.). The field was at the southern end of the San Joaquin Valley, and was known to be infested with root-knot nematodes. This was a large scale field trial with plot having half-mile row lengths. Again Acala NemX was the highest yielding variety followed by Prema , Royale, and GC-702.

The differences in root-knot tolerance in varieties can be illustrated by comparing the amount of galling assigned to each of four varieties using the weighted nematode rating system (WNR). Acala NemX, as expected, had the lowest WNR (Table 6.). The others were significantly different and higher than NemX.

Acala Maxxa and Acala NemX varieties were compared with seeds planted with and without Temik (Table 7.). The trial was at the Hernstedt Farms in Kern County in another field infested with root-knot nematodes. Lint yields of Acala Maxxa were significantly improved by applying Temik granules, and in the process, equaling Acala NemX yields. Acala NemX yields, however, were not significantly increased by Temik treatments. Temik is effective against root-knot nematodes, but is more often applied as an insecticide in California. It is not surprising that Maxxa would be helped by Temik in this root-knot infested soil.

Results from the fusarium-wilt/root-knot nematode trial at the USDA Cotton Research Station, Shafter, demonstrate how the combination of seedling pathogens and the two organisms, F. Oxysporum f. sp. vas infectum and Meloidogyne incognita, effect the severity of this disease complex. The same six cultivars used at the CPCSD Station (Table 5.) were used in this test. Maxxa and Royale had the lowest seedling survival percentages. The four cultivars with the highest nematode tolerances, Prema, NemX, N-901 and N-903 (as demonstrated in Table 4.), again had significantly higher seedling survival percentages. The fusarium-wilt score of these varieties seem to reflect their relative root-knot nematode tolerance. These seedling survival percentages and fusarium-wilt scores, together with their relative root-knot nematode tolerances, reflect how these three types of organisms can interact with one another to influence cotton yields. For example, Maxxa had 42 percent of its plants with serious fusarium wilt symptoms, Royale and Prema had slightly less, but NemX had only 19 percent wilt symptoms. The two experimental lines N-901 and N-903 were also more tolerant of fusarium-wilt. Cotton lint yields were reflective of their performances in the other tests, but the overall yields indicate how these organisms attacking susceptible varieties in concert can exacerbate the problems observed on individual plants. The effects of root-knot nematodes on the expression of fusarium wilt has been well documented, but the mechanism has still not been determined.

It seems that breeding new cotton varieties is becoming more complicated with passing years. The cotton industry is receiving pressure to reduce and/or eliminate many of the chemicals used to control the disease and pest problems. It is increasingly important for cotton breeders and plant pathologists to intensify efforts to incorporate disease and pest tolerance in new varieties for release to their growers.

Table 1. Seedling Disease Trial 1994

Cotton Varieties	Percentage Seedling Survival	
	Untreated	Treated*
1. GC-510	67 a	78 cd
2. Acala -SJ-2	68 ab	77 cd
3. Acala Maxxa	70 abc	77 cd
4. GC-702	71 abc	79 cd
5. Acala Royale	81 d	78 cd
6. Acala NemX	90 e	94 e

*Seeds were treated with Apron (1.5 oz.) Nu-Flow ND (14.5 oz)

Table 2. Seedling Disease Trial 1994

Cotton Varieties	Percentage Seedling Survival	
	Untreated	Treated*
1. Acala SJ-2	58 e	83 b
2. Acala Prema	79 c	94 a

* Seeds were treated with Apron (1.5 oz.) Nu-Flow ND (14.5 oz.)

Table 3. Seedling Disease Trial 1995

Cotton Varieties	Percentage Seedling Survival	
	Untreated	Treated*
1. GC-702	78 a	83 ab
2. Eldorado	85 abc	94 bc
3. Acala Maxxa	91 bc	93 bc
4. Acala NemX	92 bc	96 c

*Seeds were treated with Apron (1.5 oz) Nu-Flow ND (14.5 oz.)

Table 4. Root-Knot Nematode Trials 1994

Cotton Varieties*	Lint Yields (Lbs./Acre)		
	Kirschenmann	Wilson	CPCSD
1. Acala Maxxa	592 a	1112 a	458 a
2. Acala Royale	753 a	1251 ab	641 a
3. Acala Prema	---	---	842 b
4. N-903	1012 b	1579 c	1292cd
5. N-901	1054 b	1401 b	1091bc
6. Acala NemX	1056 b	1429 bc	1429d

* Seeds are treated with Apron (1.5 oz.) Nu-Flow ND (14.5 oz.)

Table 5. Root-Knot Nematode Trial 1995, Bidart Brothers Farms

Cotton Varieties	Lint Yields (Lbs./Acre)
1. GC-702	792
2. Acala Royale	856
3. Acala Prema	977
4. Acala NemX	1025

Table 6. Nematode Galling Evaluation 1995

Cotton Varieties	Weighted Nematode Ratings
1. Acala Maxxa	13.0 c
2. GC-702	12.1 c
3. Eldorado	7.8 b
4. Acala NemX	3.2 a

Table 7. Root-Knot Nematode Trial 1995, Hernstedt Farms

Cotton Varieties	Lint Yield (lbs/A)	
	Untreated	Temik Treated*
1. Acala Maxxa	1275 a	1479 b
2. Acala NemX	1425 b	1474 b

*Temik applies as granules 10% (10 Lbs./Acre) in the furrow at planting

Table 8. Wilt / Root-Knot Nematode Trial 1994, USDA Cotton Research Station, Shafter

Cotton Varieties	Seedling Survival %	Fusarium Wilt %	Lint Yield
1. Acala Maxxa	75	42	426
2. Acala Royale	75	35	508
3. Acala Prema	87	35	745
4. Acala NemX	90	19	1436
5. N-901	89	8	978
6. N-903	89	5	1292
LSD.05	6	7	318