PHENOLOGY AND YIELD OF MAR COTTON GENOTYPES WITH AND WITHOUT INSECTICIDE TREATMENTS

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Abstract

Insects cause a substantial loss in cotton productivity and increase production cost. Genetic resistance to insects is essential for successful cotton production and profitability. The MAR-7 germplasm was evaluated at 10 locations throughout Texas. The strains test was evaluated at 10 locations, the Early Field Planting (EFP) test at 4 locations, and the Uniform MAR test (UMAR) at ten locations. In addition to grades and yield data, progressive increases in levels of resistance to insects in the MAR germplasm were measured and quantified by mapping mature plants from the tests conducted in Corpus Christi and Hillsboro under insecticide and no-insecticide treatments. Results included yield and earliness from the UMAR and EFP tests and the insecticide treated and non-treated tests, and boll retention.

Averaged over genotypes in the Corpus Christi test, the insecticide treated plots had significantly more bolls set (29%) compared to the non-treated plots (16%). Boll retention ranged from 22% to 35% in the insecticide treated plots compared to 13% to 22% in the non-treated plots. Lint yield averaged 556 lb/acre for the insecticide treated and 284 lb for the non-treated plots. Tamcot Sphinx produced the highest yields under both treatments. Five MAR-7 strains produced high yields similar to Tamcot Sphinx. At Hillsboro, total boll retention was 26% and yield 334 lb/acre for the insecticide treated genotypes compared to 21% retention and 335 lb/acre for the non-treated genotypes, a non-significant difference. The low retention rate is attributed to both insects damage and severe drought.

Averaged over five UMAR tests, lint yield ranged from 444 lb/acre to 653 lb, with a mean of 532 lb. Tamcot Sphinx and four MAR-7A strains produced yields above 575 lb/acre. In the EFP tests averaged over four locations, the new MAR-7B strains performed better than the variety checks, with yield ranging from 347 lb to 595 lb/acre, and a mean of 442 lb. Six MAR-7B strains and Tamcot Sphinx produced more than 490 lb/acre. All six strains have a fiber longer than 1.15 inches and stronger than 30 g/tex.

Superior MAR-7 strains have been identified and selected based on extensive testing for three years. Levels of resistance to six major insects have increased in these strains than previously released MAR germplasm, in both the glabrous and hairy genotypes. Twelve advanced MAR-7A strains, five glabrous (S) and seven hairy (H), combine the many desired traits. The strains are CD3HG2CABS-1-91, CD3HGCBU8S-1-91, LBCBHGDPIS-1-91, CUBQHGRPIS-1-92, PD23CD3HGS-1-93, CBD3HGDPIH-1-91, LBCHUD3HGH-1-91, CD3HGCULBH-1-91, CABU2HGC8H-2-91, CDRCIQCUBH-2-92, CDARCILBCH-1-92, CUBQHGRPIH-1-92. These strains will be released to the cotton industry and commercial cotton breeders. The MAR-7B strains will be further tested to confirm their resistance levels to insects and determine their stability over locations and years.

Introduction

Insects are one of the most costly and limiting factors to cotton productivity and profits in the cotton belt. Genetic resistance is recognized as the most effective, economical, and reliable means of maintaining healthy plants and reducing crop losses. Resistant varieties may not require as many treatments or as high rates of insecticide applications to achieve adequate pest control. This results in reduced production costs and risk, and increase grower's profit.

One of the main goals of the Multi-Adversity Resistance (MAR) program is to develop cotton germplasm resistant to several key insects and to combine increased levels of insect resistance with high yield potential, earliness, and improved fiber quality (1, 3). Previous studies have documented the genetic gains and improvements in resistance to insects and pathogens with the progression of the MAR germplasm from the MAR-1 to MAR-6 gene pools (4, 5). The purpose of this research was to quantify the levels of resistance to insects in the MAR-7 germplasm.

Materials and Methods

The MAR procedures utilize seed, seedling, and plant screening and selection in the laboratory and greenhouse in the fall and winter, and in the field (F_1- F_4), followed by extensive four stage field testing at 10 locations throughout Texas. These procedures and data base make it possible to identify superior cotton strains with genetic gains to many traits (3). In 1996, MAR germplasm (F_5 - F_6) was evaluated at the 10 Texas locations. The tests included the strains test at 10 locations with 80 strains and 15 check varieties in 2 replications, Early Field Planting (EFP) test at 4 locations with 28 advanced MAR-7B strains and 4 check varieties, and Uniform MAR test (UMAR) at 10 locations with 20 advanced MAR-7A strains and 4 check varieties. The

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common locations for both the UMAR and EFP tests were Weslaco, Corpus Christi, College Station, and Temple. The Strains and UMAR tests were also grown at Temple, McGregor, Halfway and Chillicothe. These locations represent a wide range of diverse environments including moderate to severe water stress, and insect and disease pressures. In addition many tests were conducted in cooperation with Extension County Agents in growers fields. Entries were arranged in a randomized complete block design with four replications. Plots were harvested at two dates to estimate earliness and determine lint yield. Fiber quality was analyzed by the International Textile Center, Texas Tech University, Lubbock, utilizing the High Volume Instrument (HVI) double line. Analysis of variance was performed to determine differences among strains for each test and combined over locations. When measured traits had a significant F value ($P < 0.05$), means were separated using Fisher's least significant difference (LSD) procedure.

Levels of resistance to insects are based on grades and observations that are made at each of the 10 test locations several times during the season for the Strains, EFP and UMAR tests, knowing insect pressures and damage, and based on lint yield and earliness. Levels of resistance to pests were determined in comparison with cotton lines and varieties having known levels of resistance and susceptibility to those pests. In addition, progressive increases in levels of resistance to insects in the MAR germplasm were measured and quantified by plant mapping at tests conducted in Corpus Christi and Hillsboro under no-insecticide and insecticide treatments. The tests included nine advanced MAR-7A strains and two checks: Tamcot CAB-CS and Tamcot Sphinx. In addition to grades, insect counts and yield, plants were mapped at the end of the season to determine boll retention and distribution of bolls on fruiting branches and nodes. Plant height, number of main stem nodes and fruiting branches, and bolls developed at the first, second and third fruiting positions were recorded from a 3.3 feet per plot from four replications at maturity (2).

Insect pressures at the Corpus Christi location were light for thrips and fleahoppers but were moderate for boll weevil and the budworm/bollworm complex, and over 20 applications of insecticides were made on the treated plots, mostly to control the boll weevil. In Hillsboro, insect populations were light throughtout the season, and the insecticide-treated plots received three applications.

Results and Discussion

Uniform MAR (UMAR) Test

Average lint yield and range for eight UMAR test locations is shown in Table 1 for 1995 and 1996. In 1996, average yield for five UMAR tests at Weslaco, Corpus Christi, and College Station was 562 lb/acre compared to 665 lb in 1995, a reduction of 103 lb, with a range of 222 to 829 lb/acre. Yield was higher in 1996 at Weslaco even though moisture availability was a factor, but not the beet-army worm. Yield was lower in 1996 at Corpus Christi and College Station than in 1995. A significant decrease in yield occured in the Blackland tests due to the drought; 163 lb in 1996 compared to 569 lb/acre in 1995 at Temple. Reduction in yield in the Coastal Bend Region (Corpus Christi) and Central Blacklands (Temple, McGregor, Hillsboro) was due to the severe drought in 1996.

Table 2 shows lint yield and earliness of MAR-7A strains, in the 1996 UMAR tests averaged over five locations. Yield ranged from 444 lb/acre for CDARCILBCH-1-92 to 653 lb for Tamcot Sphinx, with a test mean of 532 lb. Two of the top yielding strains are smooth (S) and two are hairy (H). The OSIKRHQWIH-2-94 strain is an okra-leaf type. Earliness in maturity ranged from 55% for Deltapine 50 to 84% for Tamcot HQ95.

Early Field Planting (EFP) Test

In the EFP tests averaged over four locations, the new MAR-7B strains performed better than the variety checks, with yield ranging from 347 lb to 595 lb/acre, and a mean of 442 lb (Table 3). Six strains and Tamcot Sphinx produced the highest yields, more than 490 lb/acre. Four strains are glabrous and two are hairy. All six strains have a fiber longer than 1.15 inches and stronger than 30 g/tex.

Insecticides Treated and Non-Treated Tests

Corpus Christi

Results of the mapping data showed that differences were obtained between treatments and among strains for boll retention at Corpus Christi (Table 4). Boll retention ranged from 22% to 35% in the insecticide treated plots compared to a range of 13 to 22% retention in the non-treated plots. The low retention rate is due to both insects damage and severe drought. Five strains and Tamcot Sphinx had high boll retention under both insecticide and no-insecticide treatments.

Averaged over genotypes, the insecticide treated plots had significantly more bolls set (29%) compared to the non-treated plots (16%). More bolls were set on fruiting branch positions 1 and 2 of the treated compared to the non-treated plots, 40% vs 17% for position one, and 29% vs 13% for position 2 (Figure 1). There was no difference between treatments at position 3. In the non-treated plots, there was no difference in fruit set among the three fruiting branch postions.

Figure 2 illustrates that more bolls were produced at the first five fruiting branches for both treated and non-treated plots, and significantly more bolls were produced on the treated plots in comparison to the non-treated on all the branch zones. Boll retention was 39% in the insecticide treated plots compared to 26% in the non-treated plots, for fruiting branches 1 to 5. On branches 6 to 10, retention was 19% for the treated and 9% for the non-treated plots.

Lint yield averaged 556 lb/acre for the insecticide treated and 284 lb for the non-treated plots (Table 5). Tamcot Sphinx produced the highest lint yield under both treatments. The range was 450 lb for Tamcot CAB-CS to 715 lb for Tamcot Sphinx in the insecticide treated plots, and 169 lb for SPNXSV506H-1-94 to 360 lb for Tamcot Sphinx in the non-treated plots. Five new MAR-7 strains produced high yields similar to Tamcot Sphinx, two are smooth and three are hairy.

Hillsboro

Differences were obtained between treatments and among strains for boll retention in the Hillsboro test (Table 6). Boll retention ranged from 21% to 33% in the insecticide treated plots with a mean of 26%, compared to 21% in the non-treated plots with a range of 19 to 26% retention, the same pattern as obtained in Corpus Christi. Severe drought was again a factor in the low boll retention rate. Seven strains and Tamcot Sphinx had high boll retention under both insecticide and no-insecticide treatments.

Fruiting position 1 produced more bolls in the treated than the non-treated plots, 32% vs 23% (Figure 3). However, there were small differences between treatments at postion 2. At postion 3, more bolls were produced in the non-treated than the treated plots (Figure 3).

More bolls were produced on the first five fruiting branches (Figure 4). Boll retention on fruiting branches 1-5 was 33% for the insecticide treated and 25% for the non-treated plots. The non-treated plots produced slightly more bolls on branches 6 to 10 and 11 to 15. Insects pressure were minimal this year at the Hillsboro test and late rains favored the non-treated test to produce late bolls.

The yields in the insecticide treated and non-treated plots were not significantly different, average yield was 344 lb/acre in the treated and 335 lb in the non-treated plots (Table 7). Lint yield ranged from 289 lb for Tamcot CAB-CS to 404 lb/acre for Tamcot Sphinx in the treated plots and 299 to 383 lb/acre in the non-treated plots.

Figure 5 illustrates boll retention under optimum growing condition in the the Brazos Valley test near College Station. This test had the same entries as those in the Corpus Christi and Hillsboro tests, but was treated with insecticides and received three irrigations. Total boll retention was 64%, with 55% retention at fruiting branch position 1, 33% at position 2, and 10% at postion 3.

Conclusion

Substantial progress in developing new MAR germplasm with improved levels of resistance to insects and pathogens have been made. Genetic gains in resistance to six insects paralleled the improvements in high yield potential, earliness and fiber quality. Resistance levels were increased for thrips, fleahopper, boll weevil, tobacco budworm, bollworm and silverleaf whiteflies. Superior MAR-7 strains have been identified based on extensive testing for three years, 1994-1996. Twelve advanced MAR-7A strains, five glabrous (S) and seven hairy (H), combine the many desired traits. The strains are CD3HG2CABS-1-91, CD3HGCBU8S-1-91, LBCBHGDPIS-1-91, CUBQHGRPIS-1-92, PD23CD3HGS-1-93, CBD3HGDPIH-1-91, LBCHUD3HGH-1-91, CD3HGCULBH-1-91, CABU2HGC8H-2-91, CDRCIQCUBH-2-92, CDARCILBCH-1-92, CUBQHGRPIH-1-92. These strains will be released to the cotton industry and commercial cotton breeders. The MAR-7B strains will be further tested to confirm their resistance levels to insects and determine their stability over locations and years.

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Table 1. Mean lint yield and range of MAR cotton strains and varieties in 1995 and 1996.

Location	Lint Yield		Range
	1995	1996	1996
	lb/acre	lb/acre	lb/acre
Weslaco-TAES	570	670	396 - 829
Weslaco-USDA	522	730	342 - 749
Corpus Christi	781	556	418 - 715
College Station	527	340	222 - 435
Brazos Valley	926	514	385 - 648
Mean	665	562	222 - 829
Temple	569	163	101 - 220
McGregor	279	100	67 - 147
Hillsboro	----	335	239 - 411

Table 2. Mean lint yield and earliness of MAR cotton strains and varieties in the 1996 Uniform MAR (UMAR) test over five locations.

MAR Strain/Variety	Lint Yield	Earliness
	lb/acre	%
Tamcot Sphinx ck	653**	74.3**
OSIKRHQWIH-2-94	609	61.4
SPNXHQBPIS-1-94	604	58.4
CUBQHGRPIS-1-92	597	65.1
CABU2HGC8H-2-91	578	77.8
Deltapine 50 ck	559	54.9
PD23CD3HGS-1-93	555	67.3
CABCSV506S-1-94	550	60.9
SPNXCHGLBH-1-94	546	81.2
HGPICDHGBS-1-94	546	71.7
HGPISV506H-1-94	537	70.4
SPNXHQBPIH-1-94	530	77.9
Tamcot CAB-CS ck	529	68.6
PD24HQBPIH-1-94	528	73.4
PD24BLPD9H-1-93	518	78.3
HGPICG14QH-1-94	516	74.4
SPNXSV506H-1-94	511	80.4
CUBQHGRPIH-1-92	503	76.1
CDULBQSHPS-1-93	487	70.8
BLCG8CP45H-1-93	476	70.7
Tamcot HQ95 ck	475	84.3
CDRCIQCUBH-2-92	463	82.1
HGPIHQBPIH-2-91	458	73.1
CDARCILBCH-1-92	444	81.3
Mean	532	72.3
LSD (*P*=0.05)	61	7.1
C.V. %	18.3	12.2

**Significant at 0.01 probability level.

Table 3. Mean lint yield and earliness of MAR cotton strains and varieties in the 1996 Early Field Planting (EFP) Test over four locations.

MAR Strain/Variety	Lint Yield
	lb/acre
PD22CUBQWS-1-95	595**
SPNXCDUG8H-1-95	556
Tamcot Sphinx ck	519
HQCULHQPIH-1-95	508
PD22QWGPIS-1-95	499
PD22CDGU8S-1-95	495
LGQWILBCGS-1-95	490
HQCULCLBGS-1-95	486
CIQUBCHGBS-1-95	483
Deltapine 50 ck	472
PD22LBCPIS-1-95	461
PD22CDCULH-2-95	457
Tamcot CAB-CS ck	456
CUBQWCGP6H-2-95	455
LGQWCIQABS-1-95	452
CBQ2WI2LGS-1-95	451
LGQWLBCDUS-2-95	448
PD22CBQHGS-2-95	425
PD22CBQHGS-3-95	420
CUB2Q2WHGS-2-95	416
CQPICDGP6H-1-95	414
SPNXQWGPIH-1-95	410
LGQWLBCDUS-1-95	409
Tamcot HQ95 ck	400
SPNXCBGP6H-2-95	391
CUBQWCLBGS-2-95	390
CHGUQWGPIS-1-95	389
CUBQWCGP6S-1-95	383
CUBQWCGP6H-1-95	377
NLBG8LQBUS-1-95	353
LGQWCUQPIS-1-95	347
NLG8CDGP6H-1-95	347
Mean	442
LSD(*P*=0.05)	52
C.V.	16.8

** Significant at the 0.01 level.

Table 4. Mean boll retention for MAR strains and varieties treated with and without insecticides at Corpus Christi.

MAR Strain/Variety	Boll Retention	
	Treated	Non-Treated
	%	%
Tamcot Sphinx ck	34	19
SPNXHQBPIS-1-94	27	16
SPNXCHGLBH-1-94	35	16
HGPIHQBPIH-2-91	35	18
CUBQHGRPIS-1-92	26	19
CABU2HGC8H-2-91	32	11
CUBQHGRPIH-1-92	33	20
CDARCILBCH-1-92	22	17
SPNXHQBPIH-1-94	31	21
CDRCIQCUBH-2-92	28	17
HGPISV506H-1-94	22	13
SPNXSV506H-1-94	33	14
Tamcot CAB-CS ck	24	22
Mean	29	16

Table 5. Mean lint yield for MAR strains and varieties treated with and without insecticides at Corpus Christi.

MAR Strain/Variety	Lint Yield	
	Treated	Non-Treated
	lb/acre	lb/acre
Tamcot Sphinx ck	715**	360
SPNXHQBPIS-1-94	679	175
SPNXCHGLBH-1-94	656	349
HGPIHQBPIH-2-91	646	335
CUBQHGRPIS-1-92	626	356
CABU2HGC8H-2-91	601	356
CUBQHGRPIH-1-92	544	305
CDARCILBCH-1-92	543	311
SPNXHQBPIH-1-94	508	298
CDRCIQCUBH-2-92	507	306
HGPISV506H-1-94	480	219
SPNXSV506H-1-94	477	169
Tamcot CAB-CS ck	450	305
Mean	556	284
LSD (*P*=0.5)	108	NS

Table 6. Mean boll retention for MAR strains and varieties treated with and without insecticides at Hillsboro.

MAR Strain/Variety	Boll Retention	
	Treated	Non-Treated
	%	%
Tamcot Sphinx ck	28	24
SPNXHQBPIS-1-94	27	24
SPNXCHGLBH-1-94	33	25
HGPIHQBPIH-2-91	24	21
CUBQHGRPIS-1-92	30	19
CABU2HGC8H-2-91	22	20
CUBQHGRPIH-1-92	28	21
CDARCILBCH-1-92	21	18
SPNXHQBPIH-1-94	25	26
CDRCIQCUBH-2-92	26	20
HGPISV506H-1-94	21	19
SPNXSV506H-1-94	26	21
Tamcot CAB-CS ck	22	20
Mean	26	21

Table 7. Mean lint yield for MAR strains and varieties treated with and without insecticides at Hillsboro.

MAR Strain/Variety	Lint Yield	
	Treated	Non-Treated
	lb/acre	lb/acre
Tamcot Sphinx ck	404	383
CABU2HGC8H-2-91	404	343
SPNXCHGLBH-1-94	349	381
SPNXHQBPIH-1-94	345	375
CUBQHGRPIH-1-92	365	349
HGPICDHGBS-1-94	345	339
CDARCILBCH-1-92	349	306
CDRCIQCUBH-2-92	334	317
SPNXHQBPIS-1-94	306	341
CUBQHGRPIS-1-92	337	299
SPNXSV506H-1-94	327	304
HGPISV506H-1-94	319	311
Tamcot CAB-CS ck	289	309
Mean	344	335

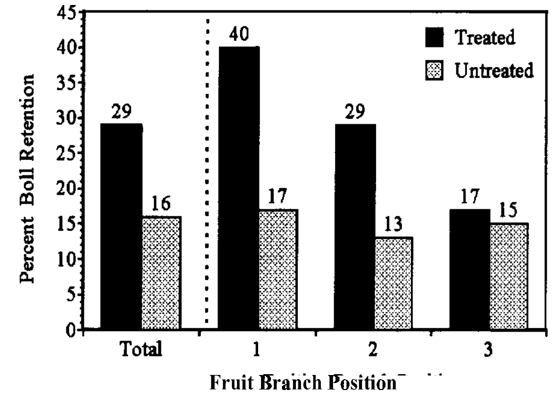

Figure 1 Percent Boll Retention by fruiting branch position average over genotypes at Corpus Christi.

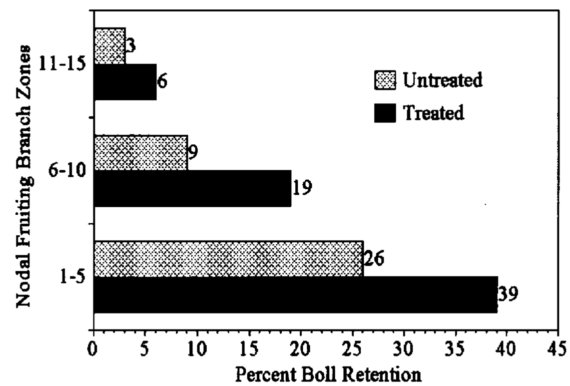

Figure 2. Percent boll retention by nodal fruiting branch zones averaged over genotypes at Corpus Christi.

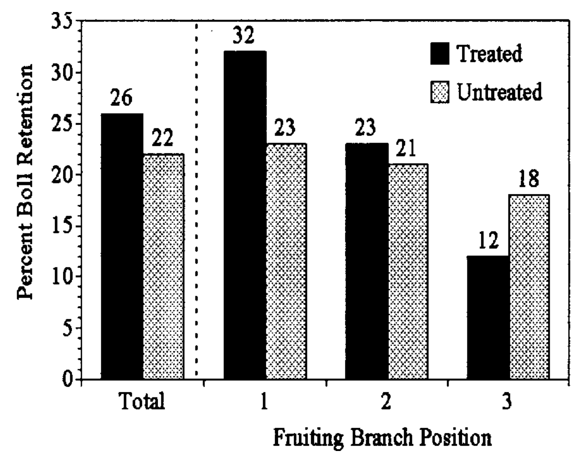

Figure 3. Percent boll retention by fruiting branch position average over genotypes at Hillsboro.

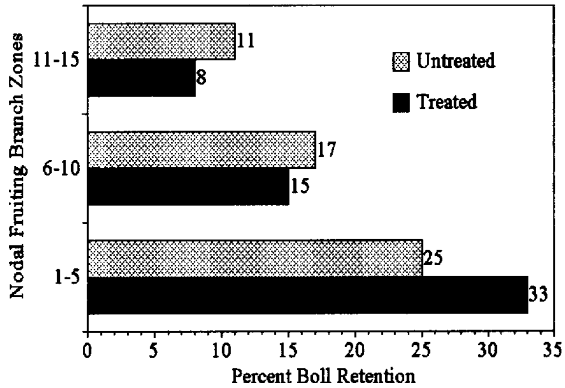

Figure 4. Percent boll retention by nodal fruiting branch zones averaged over genotypes at Hillsoboro.

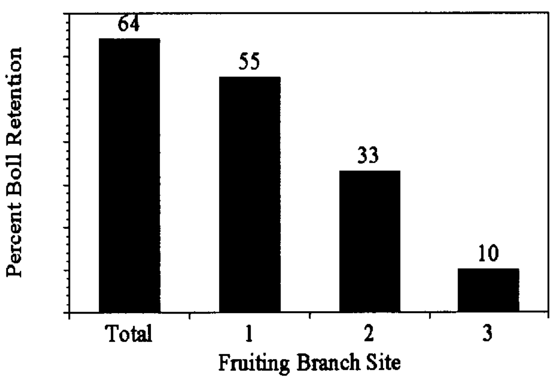

Figure 5. Percent boll retention by fruiting branch site under optimum conditions in Brazos Vallet