COMPARATIVE CHARACTERISTICS OF RECENT AND PROSPECTIVE TAMCOT CULTIVAR RELEASES

Peggy M. Thaxton and Kamal M. El-Zik
Texas A&M University
College Station, TX

Abstract

The main objective is to breed, develop and release superior multi-adversity resistance (MAR) cotton strains and cultivars. Our approach is genetic resistance to insects and diseases, and extreme climatic conditions. The MAR program recently has released five Tamcot cultivars from four MAR gene pools. These cultivars include the MAR-4 Tamcot CAB-CS, MAR-5 Tamcot HQ95, MAR-6 Tamcot Sphinx, and MAR-7A Tamcot Luxor. The MAR-7B Tamcot Pyramid is a new cultivar that will be made available to growers in 2001. Levels of resistance to insects and diseases are extensively evaluated in field nurseries. Substantial progress in developing new MAR cultivars with improved levels of resistance to insects and pathogens, and drought tolerance continues to be made in these cultivars. Genetic gains in resistance to seven insects and eight pathogens paralleled the improvements in high yield potential, earliness, and fiber quality.

Introduction

The main focus of the MAR program is genetic improvement of cotton; to breed, develop and release adapted cottons (strains and cultivars) for the Southwest US Cotton Belt (Texas and Oklahoma) with higher levels of resistance to pests, increased yield potential, earliness, drought tolerance, and improved fiber and seed quality. Genetic resistance is recognized as the most effective, economical and reliable means of maintaining healthy plants and reducing crop losses. Recently, the multi-adversity resistance (MAR) program has released five Tamcot cultivars. These cultivars include Tamcot CAB-CS (MAR-4) released in 1986 (Bird et al., 1986), Tamcot HQ95 (MAR-5) in 1990 (El-Zik and Thaxton 1990), Tamcot Sphinx (MAR-6) in 1996 (El-Zik and Thaxton 1996), and Tamcot Luxor (MAR-7A) in 1999 (El-Zik and Thaxton 2000). Tamcot Pyramid (MAR-7B) (Thaxton and El-Zik 1996, 1999) is a new cultivar that will be made available to growers in 2001. The MAR cultivars have varying degrees of hairiness with the exception of Tamcot CAB-CS which is glabrous. The cotton plants developed in the MAR program are compact, have short internodes, and fruit and mature bolls early. The objective of this paper is to compare the performance characteristics of these recent and future MAR cultivars.

Materials and Methods

The procedures for testing the MAR germplasm have been described in several publications (Bird 1982; El-Zik and Thaxton 1989, 2000). The MAR germplasm is evaluated in a four-stage MAR field testing procedure which includes the Strains Test, Early Field Planting (EFP), Uniform MAR (UMAR), and Variety and Demonstration Tests at ten locations throughout Texas. Five locations: Corpus Christi, Temple, McGregor, Hillsboro and Chillicothe are dryland-rainfed nurseries. MAR cultivars and non-MAR cultivars are used as checks in field testing.

Disease Resistance

Extensive evaluations for resistance to pathogens are made in naturally infested disease field nurseries in Texas to identify and select MAR germplasm with resistance to pathogens causing seed-seedling diseases (*Pythium ultimum, Rhizoctonia solani, Thielaviopsis basicola, Fusarium spp.*), bacterial blight [*Xanthomonas campestris* pv. *malvacearum* (Xcm)], Phymatotrichum root rot (*Phymatotrichum omnivorum*), Verticillium wilt (*Verticillium dahliae*), Fusarium wilt (*Fusarium oxysporum* f. *vasinfectum*), root-knot nematode (*Meloidogyne incognita*), reniform nematode (*Rotylenchulus reniformis*), and leaf spots (*Alternaria, Cercospora,* and other species). Evaluations for resistance to these pathogens are made each year to the most advanced MAR germplasm (F_5 to F_8) in the disease nurseries. Each of the tests includes resistant and susceptible checks for the specific pathogen.

Acid-delinted non-treated seed (100 seeds/plot) of the strains and cultivars included in the EFP and the UMAR tests was field planted at ten locations throughout Texas to evaluate for seedling disease. Data was collected and percent emergence, damping-off, seed rot, and final stand were determined. Progress achieved in resistance to seed-seedling diseases, final stand establishment, and seedling vigor is based on the field stand data from the UMAR and EFP Tests.

Germplasm in the MAR program is screened from the F_1 to F_4 generations for resistance to bacterial blight. A mixed inoculum of four races of the bacterial blight pathogen (*Xcm*) is used to evaluate and identify resistant individual plant selections and progeny rows in the greenhouse and in the field.

Resistance to Phymatotrichum root rot is field tested in the McGregor disease nursery. Plants killed by *Phymatotrichum omnivorum* were counted weekly from square initiation to maturity and percentage of dead plants calculated. Evaluation of MAR germplasm for Verticillium wilt resistance is field tested at Chillicothe in the Rolling Plains and at Halfway on the High Plains. Plants with foliar disease symptoms were counted four times during the season for each plot. Resistance to Fusarium wilt is tested at the National Fusarium Wilt nursery in Tallassee, Alabama which included the resistant check M-315 and the susceptible check Rowden. Data is collected on nematode populations and resistance levels in Weslaco for reniform nematodes, and at College Station for root-knot nematodes.

Insect Resistance

Cotton management programs of the future will depend less on pesticides to control insects. Cultivars will be required to have higher levels of resistance (both intrinsic and transgenic) to insects. Levels of resistance to seven insects: thrips, aphids, fleahopper, boll weevil, budworm, bollworm and whitefly in the germplasm were quantified in the MAR Strains, EFP and UMAR tests in addition to specific insect resistance tests in Hillsboro and Chillicothe. Levels of field resistance to insects are based on grades and observations that are made at each of the 10 test locations by monitoring insect presence and damage, and based on lint yield and earliness.

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A grade is assigned to each genotype with 1 representing severe damage to 5 with minimal damage four times during the growing season. Levels of resistance to pests are determined in comparison with cotton strains and cultivars having known levels of resistance and susceptibility to those insects. In addition, progressive increases in levels of resistance to insects in the MAR germplasm were measured and quantified in a test at Chillicothe (Parajulee et. al. 1997). No insecticides were applied in this test throughout the season. Sampling consisted of weekly monitoring of plots from plant emergence to late August.

Drought Tolerance
Drought tolerance for the MAR cultivars was evaluated in the UMAR tests at locations with only rain-fed production in Corpus Christi, Thrall, McGregor Hillsboro, and Chillicothe. In addition, a dryland test was planted at Chillicothe consisting of 32 entries and four replications.

Lint Yield and Fiber Quality
Performance data of the Tamcot cultivars were collected on agronomic traits, drought tolerance, resistance to insects and pathogens, lint yield and fiber quality traits. All tests were harvested to determine lint yield. Fiber samples were tested utilizing the High Volume Instrument (HVI) double line at the International Textile Center, Texas Tech University, Lubbock, TX.

Results and Discussion

Disease Resistance
Data presented for the Tamcot cultivars are abstracted from replicated EFP and UMAR tests where the Tamcot cultivars were used as checks for comparison with advanced MAR germplasm. The ability of seed and seedlings to perform in cool soil with minimal damage to soil fungi is a key trait of MAR cultivars. Tamcot cultivars had similar field stand ability and vigor, and produced stands from 62% for Tamcot Luxor to 73% for Tamcot Sphinx, compared to 42% stand for the susceptible genotype (Table 1). Progressive improvements in resistance to the seed-seedling pathogens, stand establishment, and seedling vigor have been achieved in the Tamcot cultivars.

Resistant cultivars offer the most economical and practical means of controlling bacterial blight. All the Tamcot cultivars have high levels of resistance to the 19 USA races of the bacterial blight pathogen (Table 1).
Based on data averaged over 1998 and 1999 from the McGregor nursery, the Tamcot cultivars have similar levels of resistance to Phymatotrichum root rot. Percent root rot symptoms for the Tamcot cultivars ranged from 26.1% for Tamcot CAB-CS to 33.7% for Tamcot Sphinx compared to 54.1% for the susceptible genotype check (Table 1).

The Tamcot cultivars had similar levels of resistance to Verticillium wilt based on three-year data (1997-1999). Tamcot Pyramid had 21.3% plants with foliar symptoms, Tamcot CAB-CS 22.8%, Tamcot Sphinx 25.4%, Tamcot Luxor 26.9% and Tamcot HQ95 28.4%, compared to 52.6% for the susceptible genotype (Table 2).

In the Tallassee, Alabama Fusarium wilt test in 1997, Tamcot Luxor had 29.3% wilt compared to the susceptible genotype of 65.0% and 6.6% for the resistant genotype. In the 1999 test, Tamcot Pyramid had 58% plants with symptoms compared to 89% for the susceptible genotype and 21% for the resistant genotype (Table 2). The Tamcot cultivars have intermediate resistance levels to Fusarium wilt. Progressive improvements in resistance to root pathogens have been made in MAR cultivars, even though no direct selection was practiced for these pathogens. Testing in disease nurseries over years is essential to identify the genetic gains obtained in the MAR germplasm.

Insect Resistance
Extensive field monitoring, grading and evaluation of the MAR germplasm indicated that Tamcot cultivars have improved levels of resistance to aphids, thrips, fleahopper, and whitefly. Tamcot CAB-CS, a glabrous cultivar, is more sensitive to fleahopper than the other cultivars, and Tamcot Luxor, a very hairy cultivar is sensitive to whiteflies (Table 3). The cultivars also have improved levels of resistance to boll weevil, budworm, and bollworm (Table 4). Tamcot Sphinx and Tamcot Pyramid have the highest levels of resistance to seven insects of the released MAR germplasm.

In the insect test at Chillicothe, number of thrips/plant ranged from 0.47 to 0.76, fleahoppers from 0.15 to 0.46, and number of aphids per leaf from 28.4 to 53.6 (Table 5). Tamcot Pyramid harbored less thrips and aphids than the other strains and Tamcot SP37 harbored the highest.

Percent punctured squares by boll weevil ranged from 29.9% for Tamcot Luxor to 41.1% for the MAR strain HGPIHQPIH-2-94 (Table 6). Boll weevil punctured bolls ranged from 4.2% for Tamcot Pyramid to 17.8% for Tamcot SP37. Worms caused 2.3% to 4.1% damage to squares and 0% to 5% damage to bolls. Plots were harvested to estimate yield. Lint yield ranged from 191 lb/acre for Tamcot SP37, 279 lb/acre for Tamcot Pyramid, to 380 lb/acre for SPNXCHGLBH-1-94. Tamcot Pyramid had the highest levels of resistance to insects in the released MAR germplasm.

Drought Tolerance
Water is a limiting resource to cotton productivity in Texas where over 65% of the acreage are dryland-rainfed. The new cultivars Tamcot Luxor and Tamcot Pyramid produced higher yields under drought conditions than the previous released cultivars. Averaged over two years and four dryland locations, yield ranged from 681 lb/acre for Tamcot Luxor and Tamcot Sphinx to 787 lb/acre for Tamcot Pyramid (Table 7). In the Chillicothe dryland test averaged over two years, lint yield ranged from 650 lb/acre for Tamcot CAB-CS to 855 lb/acre for Tamcot Luxor. Tamcot Pyramid averaged 784 lb/acre, Tamcot Sphinx 743 lb/acre and Tamcot HQ95 733 lb/acre.

Lint Yield
Lint yield is a major objective in the MAR program. The program emphasizes the simultaneous improvement of yield and fiber quality in addition to resistance to pests and abiotic stresses. The progressive genetic gains for the past 28 years in lint yield and fiber strength is shown in Figure 1. The incremental increase in yield paralleled the increase in fiber strength through Tamcot Sphinx where it has remained in the premium range at 28.4 for Tamcot Luxor and Tamcot Pyramid. Tamcot SP37 averaged 530 lb/acre, Tamcot CAB-CS 645 lb/acre, Tamcot HQ95 702 lb/acre, Tamcot Sphinx 769 lb/acre, and Tamcot Luxor 810 lb/acre progressing to Tamcot Pyramid 871 lb/acre. Lint yield increased 64% from

the MAR-1 Tamcot SP37 to the MAR-8 Tamcot Pyramid, and fiber strength increased 22% from Tamcot SP37 to Tamcot Sphinx.

Fiber Quality

Fiber quality traits are based on results from the 1998 and 1999 Uniform MAR tests. Generally, fiber quality of Tamcot Pyramid is similar to that of recent Tamcot cultivar releases. Fiber length averages 1.07 inches for Tamcot Pyramid and Tamcot Luxor, and 1.10 for Tamcot Sphinx, HQ95 and CAB-CS (Table 8). Tamcot Sphinx has the highest fiber quality, with high strength and length. However, the fiber of Tamcot Pyramid is finer (0.5 micronaire units) than Tamcot Sphinx. Fiber uniformity and elongation are similar among cultivars.

Conclusion

Substantial progress in developing new MAR cultivars with improved levels of resistance to insects and pathogens continues to be made. Genetic gains in resistance to seven insects and eight pathogens paralleled the improvements in yield potential, earliness, and fiber quality. Tamcot Luxor was released in 1999. Documentation for the release of Tamcot Pyramid has been prepared and is expected to be released in 2000/2001. The MAR-7A and MAR-7B strains have been released. MAR-8 strains will be further tested to confirm their resistance levels to insects and pathogens, and further determine their yield potential and stability over the diverse Texas cotton growing regions and environments.

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Table 1. Mean percent field stand, bacterial blight disease grade and percent plants with Phymatotrichum root rot disease symptoms for Tamcot cultivars and reference genotypes.

Cultivar	Field Stand	Bacterial Blight	Phymatotrichum Root Rot
	%		%
Tamcot Pyramid	66.7	1.1†	27.1
Tamcot Luxor	62.3	1.1	28.5
Tamcot Sphinx	73.3	1.1	33.7
Tamcot HQ95	66.3	1.2	28.0
Tamcot CAB-CS	64.0	1.2	26.1
Susceptible genotype	42.2	7.2	54.1
Resistance genotype	73.3	1.1	24.2
Mean	63.6	---	32.4

† Reaction of US races of the bacterial blight pathogen, on a scale of 1 (immunity) to 10 (fully susceptible).

Table 2. Mean percent of plants showing Verticillium and Fusarium wilts disease symptoms for Tamcot cultivars and reference genotypes.

Cultivar	Verticillium Wilt	Fusarium Wilt	
		1997	1999
	%	%	%
Tamcot Pyramid	21.3		58
Tamcot Luxor	26.9	29.3	
Tamcot Sphinx	25.4		
Tamcot HQ95	28.4		
Tamcot CAB-CS	22.8		
Susceptible genotype	52.6	65.0	89
Resistant genotype	19.7	6.6	21
Mean	27.6	33.6	56

Table 3. Response of Tamcot cultivars and susceptible genotypes to aphids, thrips, fleahopper, and whitefly.

Cultivar	Aphids	Thrips	Fleahopper	Whitefly
Tamcot Pyramid	2.2	1.8	1.5	1.9
Tamcot Luxor	2.2	2.0	1.5	2.7
Tamcot Sphinx	2.0	2.0	1.6	2.1
Tamcot HQ95	2.1	2.2	1.7	1.9
Tamcot CAB-CS	2.9	2.8	2.5	1.9
Susceptible genotype	4.2	4.4	4.4	4.8

Table 4. Response of Tamcot cultivars and susceptible genotypes to boll weevil, budworm, and bollworm.

Cultivar	Boll Weevil	Budworm	Bollworm
Tamcot Pyramid	2.3	2.4	2.5
Tamcot Luxor	2.3	2.6	2.5
Tamcot Sphinx	2.4	2.6	2.5
Tamcot HQ95	2.5	2.8	2.8
Tamcot CAB-CS	2.9	3.1	3.0
Susceptible genotype	4.5	4.7	4.7

Table 5. Mean lint yield and abundance of thrips, fleahoppers, and aphids for MAR strains and cultivars in the 1997 insect resistance test at Chillicothe, Texas.

Strain/Cultivar	Lint Yield lb/acre	Thrips/ Plant	Fleahopper/ Plant	Aphids/ leaf
SPNXCHGLBH-1-94	380	0.53	0.15	30.2
Tamcot Pyramid	279	0.47	0.25	28.4
HQCULHQPIH-1-95	270	0.70	0.25	53.6
Tamcot Luxor	247	0.62	0.36	33.9
Tamcot Sphinx ck	241	0.65	0.27	28.4
HGPIHQBPIH-2-94	239	0.75	0.35	26.8
PD24BLPD9H-1-93	232	0.57	0.25	34.4
Tamcot SP37 ck	191	0.76	0.46	49.9
Mean	260	0.63	0.29	35.8

Table 6. Mean damage caused by tobacco budworm, bollworm, and boll weevil to MAR strains and cultivars in the 1997 insect resistance test at Chillicothe, Texas.

Strain/Cultivar	Punctured Squares		Punctured Bolls	
	Weevil	Worm	Weevil	Worm
	%	%	%	%
SPNXCHGLBH-1-94	38.9	3.0	6.2	0.0
Tamcot Pyramid	36.5	2.3	4.2	1.0
HQCULHQPIH-1-95	33.2	3.5	5.3	5.0
Tamcot Luxor	29.9	4.1	5.8	0.0
Tamcot Sphinx ck	32.6	2.8	6.1	0.4
HGPIHQBPIH-2-94	41.1	2.8	8.4	0.8
PD24BLPD9H-1-93	34.2	2.9	7.9	3.2
Tamcot SP37 ck	39.5	2.5	17.8	3.0
Mean	35.7	3.0	7.7	1.7

Table 7. Mean lint yield of Tamcot cultivars in the Uniform MAR Test over three years and the Chillicothe Dryland Test over two years.

Cultivar	UMAR[1]	Chillicothe[2]
	lb/acre	Lb/acre
Tamcot Pyramid	787	784
Tamcot Luxor	681	855
Tamcot Sphinx	681	743
Tamcot HQ95	---	733
Tamcot CAB-CS	---	650
Mean	716	752
LSD (*P*=0.05)†	107	102
C. V. %	6.6	5

[1]1997-1999
[2]1997-1998
† Least significant difference between two means within a column

Table 8. Mean fiber quality traits of Tamcot cultivars in the Uniform MAR Test over two years.

Tamcot Cultivar	Length U.H.M.	Uniformity	Strength	Elongation	Micronaire
	inches		g/tex		units
Pyramid	1.07	83.2	28.4	6.2	4.1
Luxor	1.07	82.9	28.5	6.0	4.2
Sphinx	1.10	83.4	30.6	6.1	4.6
HQ95	1.10	83.1	27.8	6.0	4.0
CAB-CS	1.10	82.8	26.6	6.2	4.0
Mean	1.09	83.1	28.4	6.1	4.2

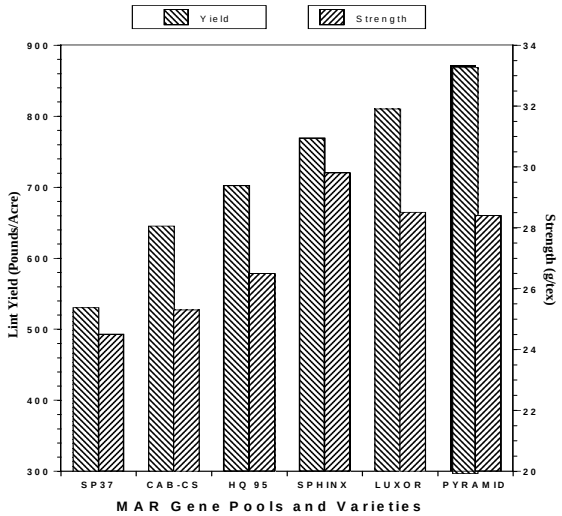

Figure 1. Mean lint yield and fiber strength of Tamcot cultivars representing MAR-1 to MAR-7 gene pools averaged over 45 tests and five years (1994-1998).