HOST PLANT RESISTANCE TO WHITEFLIES, *BEMISIA TABACI* (GENNADIUS), BIOTYPE B, (HOMOPTERA: ALEYRODIDAE) IN COTTON RACE STOCKS FOR BREEDING IMPROVED COTTON CULTIVARS

A Thesis

by

BRANDON WAYNE RIPPLE

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

May 2004

Major Subject: Entomology

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Approved as to style and content by:

Marvin K. Harris (Co-Chair of Committee)	C. Wayne Smith (Co-Chair of Committee)
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ABSTRACT

Host Plant Resistance to Whiteflies, *Bemisia tabaci* (Gennadius), Biotype B, (Homoptera: Aleyrodidae) in Cotton Race Stocks for Breeding Improved Cotton Cultivars. (May 2004)

Brandon Wayne Ripple, B.S., Texas A&M University

Co-Chairs of Advisory Committee: Dr. Marvin K. Harris
Dr. C. Wayne Smith

Whiteflies (*Bemisia tabaci, Biotype B,* Homoptera: Aleyrodidae) are pests of cotton crops, affecting the yield of the crop both indirectly and directly. These pests feed on the leaves of cotton plants and produce "honeydew," a sticky liquid excretion which covers the lint of the open cotton boll creating problems during the processing of the lint. High densities of these pests also can decrease the productivity of the cotton plant by stripping it of vital nutrients. The primary objective of this research was to screen 116 converted cotton race stocks for resistance to sweetpotato whiteflies. Responses of converted race stocks to whiteflies are compared to that of known susceptible commercial cultivars PSC 355 and Delta Pearl.

Screens for antibiosis resistance to whitefly were established using excised leaves placed in a nutrient solution (¼ strength Hoagland's). Cohort populations of whiteflies were established on these leaves and followed daily to determine differences in developmental time as well as percent survival. Resistant candidates were determined using a chi-squared test comparing the ranked sums of leaf averages for the two

selection criteria, whitefly developmental time and percent whitefly survival, of each cotton race stock to that of the putative known susceptibles (KS). These tests showed 6 converted race stocks to be significantly different ($P \leq 0.1$) from the KS for at least one of the two selection criteria. Of these converted race stocks, M-9044-0154 and M-9044-0156 showed to have lower whitefly survival than the KS, while M-9644-0188, M-9644-0195, M-0044-0221, and M-9644-0242 showed whitefly to have an increased developmental time. Retesting of these six converted race stocks along with several others identified another race stock line, M-0044-0171, which was significantly different from the KS. Retesting also indicated that M-9644-0188 was different for survival in addition to developmental time which was determined in the original screening.

Additional tests were conducted in the greenhouse and field to examine these race stock lines. Greenhouse screenings indicated that M-9044-0156 and M-9644-0188 contained possible non-preference resistance characteristics. Field screenings conducted in Weslaco and College Station, TX in 2002 and 2003 failed to provide useful data due to low densities of insects.

DEDICATION

I would like to dedicate this thesis to my family. I am not sure where I would be without their constant support throughout this process. I would like to thank my parents for the faith and resources they provided, my brother for always clearing the path in front of me, and I would especially like to thank my wife Jennifer for being beside me every step of the way.

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I would like to thank everyone who has assisted me in this project during the past two years. The constant encouragement and guidance from Dr. Marvin Harris has been greatly appreciated and the knowledge I have gained during this time with his lab has prepared me for many future endeavors. I would like to thank Dr. C. Wayne Smith for his continuous support during this time. I appreciate being associated with the Cotton Improvement Lab during the past six years, both as a student worker and as a graduate student. I would also like to send thanks to the student workers Brad, Maggie, and Sarah who assisted me throughout this project. While some of the labor may have been tedious, without all of your help and flexibility this study could not have been completed.

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CHAPTER I

INTRODUCTION

Cotton is biologically a perennial plant; however it is grown commercially as an annual due to cultivar selection and management that favor early maturity (Niles 1980). Cotton is also a hardy plant and is capable of growing in areas ranging from tropical and subtropical locations to as far north as 45˚ N in the Peoples Republic of China (Niles 1980, Lee 1984). Cotton was first planted as a commercial crop in the United States in 1621. Prior to this, cotton was grown in limited amounts that only provided enough fiber for home usage. Cotton production has continued to grow and today is used to make everything from baby diapers to NASA space suits (Smith 1995).

Currently there are over 34 million hectares of cotton in cultivation worldwide, with 5.6 million hectares grown in the United States. In 2002, the United States produced 20.3 million of the worlds 98.3 million total bales of cotton and currently ranks second behind The Peoples Republic of China (24.4 million bales) in worldwide cotton production (United States Department of Agriculture 2003, National Cotton Council of America. 2003a). Other countries that contribute significantly to the total worldwide cotton production include India, 12.3 million bales; Pakistan, 8.3 million bales; The Republic of Uzbekistan, 4.9 million bales; Turkey, 3.9 million bales; and Brazil, 3.5 million bales (United States Department of Agriculture 2003).

This thesis conforms to the format of The Journal of Economic Entomology.

Historical Pests in Cotton

> The potential for losses to arthropod pests is greater in cotton than in any other field crop and no other crop has been the target of more entomological attention. (Bradley 1996).

Cotton supports a diverse arthropod complex. Historically, most economic damage came from boll weevil, *Anthonomus grandis* Boheman, or the bollworm, *Helicoverpa zea* (Boddie), / budworm, *Heliothis virescens* (Fabricius), complex. During the late 1800s and the early 1900s invasions of boll weevil affected cotton crops from the Lower Rio Grande Valley of Texas to Georgia. These devastating insect pests eliminated cotton as a crop in many areas and severely decreased production in all other locations across the United States. During this time, cotton remained to be grown in some areas only due to the determination of farmers to harvest a crop no matter how damaged it was (Harris 2001). Drastic attempts have been made recently to control this major pest in cotton. The Boll Weevil Eradication Program, which was initiated in the late 1970s along the Virginia / North Carolina border (National Cotton Council of America 2003b) uses intensive pheromone-based detection followed by an insecticide program using ultra low volume malathion to eradicate infestations. The Boll Weevil Eradication Program has continued to expand and as of 2003, over 6.1 million hectares across the U.S. are currently under the eradication program with nearly 2.5 million of these hectares considered eradicated (El-Lissy and Grefenstette 2003). Additionally, advances in technology such as Bt cotton have helped to control lepidopteran pests such as bollworm and budworm. Bt cotton was first released in large scale in 1996, with over

800,000 hectares planted across the United States. As of 2001, this number has increased to over 2.3 million hectares (Williams, 2003).

The narrow spectrum management achieved with the Boll Weevil Eradication Program and Bt cotton changed the arthropod pest landscape. Secondary pests previously managed by broad spectrum programs now have the opportunity to increase in importance (Williams 2003). This increase in importance of secondary pests has been seen in the case of certain sucking pests such as the sweetpotato whitefly, *Bemisia tabaci* (Gennadius), Biotype B. Other names used to describe this whitefly include the silverleaf whitefly, *Bemisia argentifolii* Bellows & Perring (Perring et al. 1993).

Whitefly Biology

The sweetpotato whitefly is found generally on the abaxial side of leaves. They puncture the leaf tissue with their piercing sucking mouthparts and feed on the phloem (Byrne and Bellows 1991). All immatures and adults have stylets that are approximately 200 micrometers in length (Freeman et al. 2003). This allows all whitefly stages to feed at a given plant location at the same time.

The biology of this whitefly consists of seven stages (i.e. egg, 1st instar, 2nd instar, 3rd instar, 4th instar, pupa, and adult) (Lopez-Avila, A. 1986). However, some scientists consider the 4th instar and the pupa to be only one stage because there is no molt separating the two (Gill 1990). Eggs are oviposited on the underside of the host leaf, with lifetime production of 71-82 eggs/female reported for cotton (Butler et al. 1983).

Husain and Trehan (1933) found an egg incubation period on cotton that ranged from 3 to 33 days depending on temperature and other environmental factors. Eggs give rise to the 1st instar whitefly, which is also known as the crawler. This stage is mobile for the first couple of hours after hatch while it searches for a location to settle and feed (Leigh et al. 1996). Once the immature has settled, the following instars do not move except for slight movements during their molt into the next instar (Byrne 2003). Butler et al. (1983) showed that developmental time for *Bemisia tabaci* from egg to adult was linked to temperature. Developmental times on cotton ranged from 17 days at 30˚C to 65 days at 14.9˚C.

Whiteflies in Cotton

Whiteflies can cause both direct and indirect damage to cotton plants. High densities of whiteflies can cause direct damage due to feeding activities, which strip the plant of vital nutrients, thus decreasing the productivity and health of the plant. Direct damage such as this is thought to be of secondary importance; therefore, few studies have focused on this type of damage. Indirectly, whiteflies cause damage due to their sticky "honeydew" exudate, which they excrete. This honeydew is produced by all stages of the whitefly, but is produced in higher amounts in the later nymphal instars (Lopez-Avila and Cock 1986). Honeydew sticks to the lint and can cause difficulties during processing. Honeydew also acts as a substrate for fungi that cause sooty mold, which can discolor and therefore decrease lint quality and value (Lopez-Avila 1986). Other damage caused by whiteflies includes the transmission of diseases such as cotton leaf curl virus (Lopez-Avila and Cock 1986). High densities of whiteflies can cause additional damage to cotton by decreasing weight of bolls (seed and lint) as well as by causing leaf and boll shedding (Mound 1965). In 2002, sweetpotato whitefly caused estimated losses of 23,169 bales of cotton in the United States and infested over 400,000 hectares, mostly in California (224,764), Arizona (94,150), and Texas (74,866) (Williams 2003).

Severe whitefly damage in cotton was first observed in 1981. However, sweetpotato whiteflies were present in desert cotton in California for up to 14 years before they became a major pest (Dowell 1990). The sudden explosion of whitefly numbers in 1981 was attributed to two factors. Initially, whiteflies probably were suppressed by highly toxic chemicals such as DDT and organophosphates that were applied together in order to control boll weevil or bollworm. The routine use of organophosphates provided an environment favoring expression of resistant strains of whiteflies (Dittrich et al. 1990). DDT caused stress on whitefly populations, which enhanced egg production and increased frequency of generation cycles (Dittrich et al. 1990 and Basu 1995).

Although chemical control of whiteflies is the most commonly used method today, it does not provide adequate suppression of whiteflies in agricultural systems. Whiteflies currently show resistance to a wide variety of chemical classes that includes but is not limited to organochlorines, organophosphates, carbamates, and pyrethroids (Horowitz et al. 1988). Whiteflies live on the underside of leaves, where adequate chemical coverage is not provided by aerial chemical applications (Johnson et al. 1982;

Horowitz et al. 1988, Akey et al. 1992). Aerial applications previously deposited on the upper side of the leaves provide little control unless translaminar chemicals are used (Mathews 1986). The failure to control whiteflies has also been credited to the ability of immature whiteflies to protect themselves with a wax secretion that covers their body and is impermeable to most insecticides (Johnson et al. 1982; Horowitz et al. 1988).

High density whitefly infestations have also been attributed to whitefly polyphagy. Basu (1995) noted that sweetpotato whiteflies have a host range of some 540 plants. In the Imperial Valley and southern San Joaquin Valley of California, 228 different plants were considered hosts of *Bemisia tabaci*. This group of plants included 12 agronomic crops, 45 vegetable crops, 96 ornamental plants, 18 fruit trees, and 57 weed species (Natwick et al. 2000). In the United States, whitefly epidemics have occurred in California, Arizona, and the Rio Grande Valley of Texas, where a wide variety of crops are grown year round (Leigh 1996). Continuous host availability in a mild climate allows whiteflies to achieve and maintain epidemic densities limited only by the carrying capacity of the environment.

Cotton planted in late spring faces already established epidemics developed on other plants (Natwick et al. 2000). Insecticide applications have a limited effect because whiteflies from alternative hosts quickly reinfest sprayed areas in which natural enemies have been removed (Dowell 1990). Integrated pest management (IPM) strategies such as biological control, cultural control, closed seasons (established host free period), trap crops, planting dates, and the destruction of alternate hosts have been developed in order to lessen the effect of whiteflies on cotton (Cock 1986). These strategies ameliorate but do not eliminate the threat from whiteflies. Action thresholds have also been developed to improve timing of pesticide applications needed to suppress pest outbreaks. These thresholds reduce production costs by eliminating unnecessary applications early on in the growing season. They also allow for the conservation of natural enemies as well as decrease the selection pressure for resistance to insecticides (Harris 2001, Naranjo et al. 2002).

Host Plant Resistance

This inability to control whiteflies using chemicals and IPM techniques has increased interest in finding host plant resistance (HPR) to help reduce the threat posed by this insect. Painter defined host plant resistance as: "the relative amount of heritable qualities possessed by the plant which influence the ultimate degree of damage done by the insect. In practical agriculture it represents the ability of a certain variety to produce a larger crop of good quality than do ordinary varieties at the same level of insect population," (Painter 1968).

Painter divided resistance into three categories; antibiosis, non-preference, and tolerance. Antibiosis is the ability of the plant to prevent, injure or destroy insect life. Usually this type of resistance affects insects by decreasing fecundity, decreasing the size of the insect, or by increasing mortality. Non-preference is used to describe plant characteristics that deter certain insects from using a plant for food, oviposition, or shelter. The third type of resistance, tolerance, is described as the ability of the plant to grow and reproduce in spite of insect populations equal in size to those that cause damage in susceptible plants (Painter 1968). Of these three mechanisms of resistance, it has been stated that tolerant cultivars have the greatest potential in which to develop plant resistance to insects. This is because, unlike the antibiosis and non-preference mechanisms of resistance, tolerant plants do not place selection pressure on insects to overcome plant resistances (Smith 1989).

Field research has shown several plant characteristics in cotton such as early maturity, pubescence, leaf shape, plant allelochemicals, and plant pigmentation that effect resistance to different insects (Norris and Kogan 1980). Cotton leaf characteristics such as low trichome density (Chu et al. 2000) and leaf shape (Chu et al. 2003) have provided limited control of whiteflies in certain cotton cultivars. Dowell (1990) stated that HPR is the best long term solution to controlling whiteflies. He argues that HPR is not influenced by control measures used against other pests and that it functions in spite of any pesticide resistances that may be observed in *Bemisia tabaci*. Immunity is not needed in order for HPR to be considered useful (Basu 1995). Whitefly densities that allow producers to reduce chemical applications and conserve natural enemies will represent improvement in this area.

Cotton Converted Race Stocks

Cotton germplasms from many different locations have been archived in the USDA working Cotton Germplasm Collection located in College Station, TX. This collection is part of the National Plant Germplasm System, which serves to collect, maintain, classify, and distribute germplasms that are kept in the collection (Report of

Cooperative Research 1981). One subgroup of the Cotton Germplasm Collection is the Texas Race Collection (*Gossypium hirsutum* Linnaeus). Percival (1987) listed over 2,300 germplasms that are kept in this collection.

Most of the germplasms in this collection have been collected from tropical and semitropical zones and therefore possess short day flowering characteristics. Since most of the cotton planted throughout the world is located in the temperate zones, it is necessary to overcome this short day flowering characteristic in order to utilize the genetic resources of these germplasms in long-day environments (Percival and Kohel 1990). Several of the germplasms in the Texas Race Collection have been converted to day length neutrality using a series of backcrosses between the short-day race stocks and a day neutral donor line; these germplasms have become known as converted race stocks (CRS) (Report of Cooperative Research 1981). In addition to this method, Percival and Kohel provided other techniques to overcome day length sensitivity which included conducting crosses in areas where day length is not a factor, such as tropical environments; and conducting crosses during short day winter months in greenhouses (Percival and Kohel 1990).

Cotton race stocks are expected to have a wide variety of primitive genetic material that can be useful in cotton breeding. Studies have been conducted to determine the amount of variability among cotton race stocks, as well as the variability relative to a standard *G. hirsutum* (McCarty et al. 1996 and Liu et al. 2000). It is widely known that variability exists within individual race stocks, but the extent of this variability has not been reported.

Many of the USDA collection of wild race stocks have been evaluated for reaction to pink boll worm (Wilson et al. 1979) and boll weevil (Bates et al. 1991). Studies conducted by Bates (1991) identified race stock lines TX0277 and TX1180 as exhibiting a decrease in punctured squares caused by boll weevil. Race stocks also are being screened for characteristics such as water use efficiency (Fish and Earl 2003), nematode resistance (Ripple 2002 and Young 2002), and recoverability of the recurrent parent after one backcross to upland cotton (Rosenbaum 2002). However, limited research has been reported relative to the existence of whitefly resistance in these stocks. With the vast genetic resources potentially provided by these race stocks, there is reason to believe that some degree of resistance will be found.

Research Objective

The objective of this research was to screen 116 cotton race stocks (CRS) for host plant resistance to whiteflies, *Bemisia tabaci* (Gennadius), Biotype B, (Homoptera: Aleyodidae). Data from field observations, greenhouse tests, and laboratory excised leaf tests allow the identification of whitefly resistance in these cotton race stocks while comparing them with two known susceptible commercial cultivars, PSC 355 and Delta Pearl. Multiple screening techniques were used to decrease the probability of escapes occurring throughout this project.

CHAPTER II

EXCISED LEAF COHORT TEST

Painter (1968) listed three main categories of resistance that included antibiosis, non-preference, and tolerance. Antibiosis was described as the ability of the plant to prevent, injure, or destroy insect life. Antibiosis can be measured by insect characteristics such as a decrease in fecundity, decrease in size, delay in reproduction, or an increase in insect mortality. Excised leaf tests were used to examine the 116 cotton race stocks for antibiosis.

Harris (1980) described five bioassay methods to evaluate host plant resistance to insects. These methods included field screening, choice, non-choice, cohort, and yield tests. Cohort tests provide a useful screen for antibiosis resistance characteristics among plants. Tests using excised leaves were conducted to study other insect plant relationships such as soybean looper and Mexican bean beetle in soybeans (Lambert and Heatherly 1991, Jenkins et al. 1997). It is not known whether tests such as these have been used previously in cotton or with whiteflies. The use of excised leaves allows large replicated amounts of plant material to be screened quickly for resistance to whiteflies. Resistance indicated with excised leaves will require further investigation in whole plants to ensure agricultural relevance.

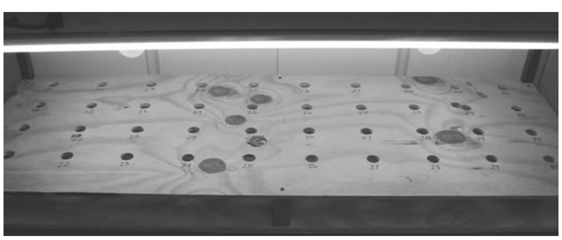
Materials and Methods

Light Rack Design: Light racks consisted of a three-tiered Jewel™ Rack System #53033 retrofitted with Sylvania 40 watt Gro-Lux® fluorescent light bulbs measuring 121.9 cm in length, and 3.8 cm in diameter. Each tier of the light rack was fitted with a plywood bottom and one of two interchangeable plywood surfaces. These surfaces were then placed on wooden blocks to a height of 8 cm. One surface consisted of a flat 1 cm thick piece of plywood for each tier measuring 47.5 cm by 132 cm to fit the size of the light rack. Each of the three pieces was drilled with 30 2.54 cm wide holes in a 4 x 10 block design, giving a total of 120 holes per light rack. This surface was used for the majority of the experiment to support the upright position of the vials. The other surface of the light rack consisted of 1 cm thick plywood cut into twenty-four strips measuring 4 cm by 65 cm. Each strip was drilled with five 2.5 cm holes to match the hole spacing of the other rack. Strips were placed 8 per tier in a 2 x 4 block design so that the hole layout matched the prior surface. Each tier of the light rack contained three plywood braces, one for each end as well as one for the middle, which raised the surface of the strips approximately 6.5 cm off the bottom of the light rack. This surface design allowed the leaves to be inverted for egg deposition at the beginning of each of the experiments (Figure 1).

Clip Cage Design: Clip cages were constructed using metal duckbill hair care clips as a base. The top of each clip was bent to provide a flat surface, while the bottom was bent into two 90˚ angles to accept the clip cage housing. Materials needed to construct the housing included: hot glue, organza, nickel/quarter cardboard coin holders,

Light rack – flat surface

Light rack - infestation surface



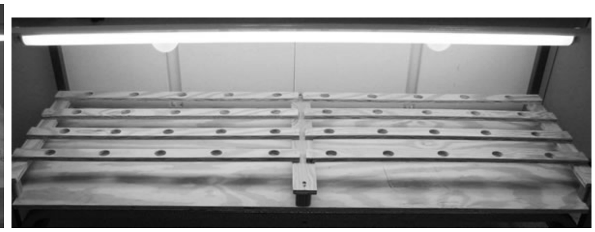


Figure 1. Pictures of light rack design, including both flat and infestation surfaces.

Grafix Duralar acetate alternative film (.005 thickness), and 1.2 cm thick 4 cm wide foam weather stripping. Each side of the two sides of the coin holders was cut into a 4.2 cm diameter circle with the hole of the coin holder acting as the center. A total of three coin holder sides were needed in the construction of each individual clip cage. To construct the lid of the clip cage, one coin holder side was glued to a 4.5 cm square piece of acetate alternative film, which was then attached to the bottom of the upper clamp of the duck bill clip. The bottom of the housing was constructed by forming a 3.5 cm diameter cylinder out of a 1.2 cm x 14 cm strip of acetate alternative film. Two coin holder sides were then glued to the top and bottom of this cylinder, with one of the coin holders topped with organza and the other topped with a piece of weather stripping that was cut to match the shape of the coin holders. This piece was then glued to the bottom of the duck bill clip, organza side down, so to fit against the upper lid of the clip cage (Figure 2).

Cohort Test: 116 CRS and two known susceptible commercial checks, PSC 355 and Delta Pearl, were screened for whitefly resistance using excised leaves. These 116 CRS represent a wide variety of genetic material that has been collected from several countries, but predominantly from Mexico and Guatemala (Table 1). The 116 CRS include all race stock lines that have currently been converted to day length neutrality (McCarty and Jenkins 1993, 2002, 2004). CRS are listed by an eight digit release number. The first two digits indicate year that the day neutral conversion line was released, the following two digits indicate the BC_nF_n generation of the release, and

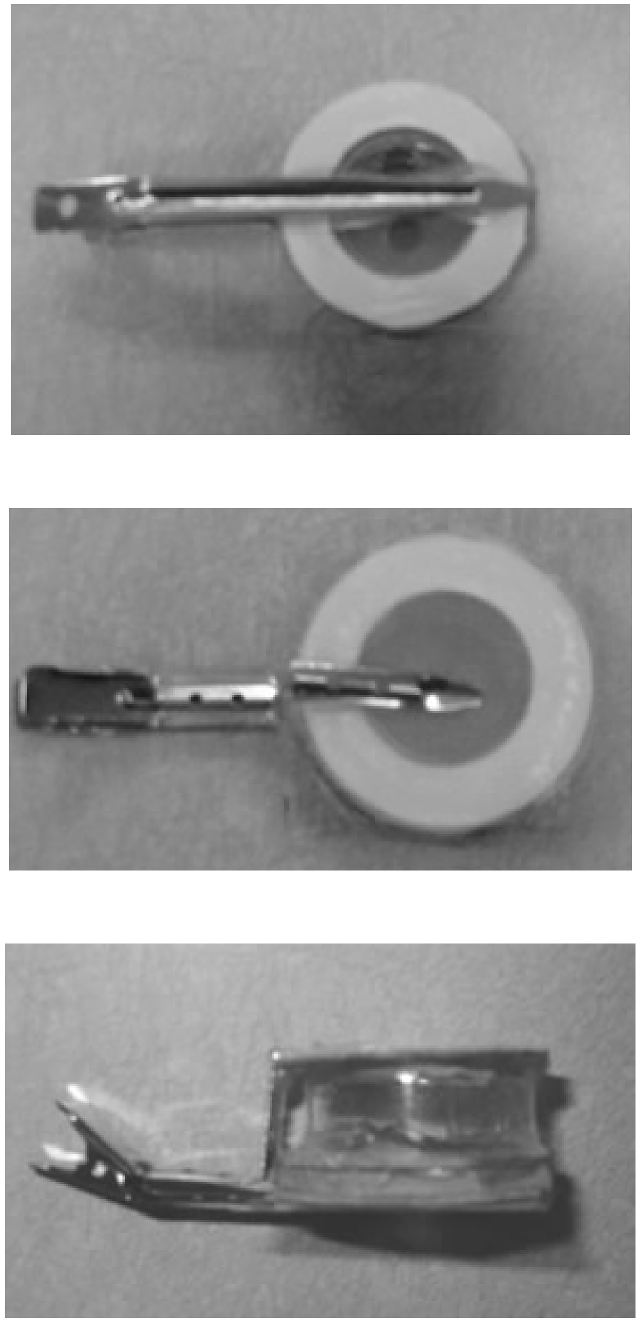


Figure 2. Pictures of clip cage design showing top, bottom and side views.

Table 1. Collection information for 116 converted race stocks. [1,2]

CRS	COUNTRY OF ORIGIN	STATE	SITE	COLLECTOR	YEAR
M-9044-0002	Mexico	Guerrero	Xilitla	Richmond & Manning	1946
M-9044-0007	Mexico	--	--	Richmond & Manning	1946
M-9044-0017	Mexico	Chiapas	--	Richmond & Manning	1946
M-9044-0024	Mexico	Chiapas	--	Richmond & Manning	1946
M-9644-0027	Mexico	Chiapas	Berriozabal	Richmond & Manning	1946
M-9644-0029	Mexico	Chiapas	--	Richmond & Manning	1946
M-9044-0030	Mexico	Chiapas	Acala	Richmond & Manning	1946
M-9044-0031	Mexico	Chiapas	Acala	Richmond & Manning	1946
M-9044-0032	Mexico	Chiapas	--	Richmond & Manning	1946
M-9044-0033	Mexico	Chiapas	Acala	Richmond & Manning	1946
M-9044-0036	Mexico	Chiapas	Acala	Richmond & Manning	1946
M-9044-0040	Mexico	Chiapas	Acala	Richmond & Manning	1946
M-0044-0041	Mexico	Chiapas	--	Richmond & Manning	1946
M-9044-0043	Mexico	Chiapas	Acala	Richmond & Manning	1946
M-9044-0045	Mexico	Chiapas	Acala	Richmond & Manning	1946
M-9044-0048	Mexico	Chiapas	--	Richmond & Manning	1946
M-0044-0050	Mexico	Chiapas	Zapotal	Richmond & Manning	1946
M-8744-0053	Mexico	Chiapas	Comitan de Dominguez	Richmond & Manning	1946
M-8844-0055	Mexico	Chiapas	Comitan de Dominguez	Richmond & Manning	1946
M-9044-0057	Mexico	Chiapas	San Bartalome	Richmond & Manning	1946
M-9044-0060	Mexico	Chiapas	San Bartalome	Richmond & Manning	1946
M-9044-0061	Mexico	Chiapas	San Bartalome	Richmond & Manning	1946
M-9044-0062	Mexico	Chiapas	San Bartalome	Richmond & Manning	1946
M-9044-0063	Mexico	Chiapas	Flores Magon	Richmond & Manning	1946
M-0044-0064	Mexico	Chiapas	Rosario	Richmond & Manning	1946

Table 1. cont.

CRS	COUNTRY OF ORIGIN	STATE	SITE	COLLECTOR	YEAR
M-9044-0067	Mexico	Chiapas	Cardenas	Richmond & Manning	1946
M-9044-0068	Guatemala	Quezaltenango	El Palmar	Richmond & Manning	1946
M-9044-0072	Guatemala	Suchitepequez	San Jose el Idolo	Richmond & Manning	1946
M-9644-0073	Guatemala	--	--	Richmond & Manning	1946
M-9044-0074	Guatemala	--	--	Richmond & Manning	1946
M-8844-0076	Guatemala	--	--	Richmond & Manning	1946
M-9044-0077	Guatemala	--	--	Richmond & Manning	1946
M-8744-0078	Guatemala	--	--	Richmond & Manning	1946
M-0044-0081	Guatemala	--	--	Richmond & Manning	1946
M-9644-0083	Guatemala	Suchitepequez	Mazatenango	Richmond & Manning	1946
M-8744-0087	Guatemala	Suchitepequez	Coronado	Richmond & Manning	1946
M-8744-0088	Guatemala	Suchitepequez	San Jose el Idolo	Richmond & Manning	1946
M-9644-0089	Guatemala	Suchitepequez	San Rafel Panan	Richmond & Manning	1946
M-8744-0091	Guatemala	Suchitepequez	Mazatenango	Richmond & Manning	1946
M-0044-0093	Guatemala	Jutiapa	Santa Catarina Mita	Manning & Ware	1948
M-8844-0096	Guatemala	Jutiapa	Santa Catarina Mita	Manning & Ware	1948
M-8844-0100	Guatemala	Jutiapa	Jutiapa	Manning & Ware	1948
M-9044-0101	Guatemala	Jutiapa	Jutiapa	Manning & Ware	1948
M-8844-0102	Guatemala	Jutiapa	Horcones	Manning & Ware	1948
M-8844-0104	Guatemala	Jutiapa	San Pedro Pinula	Manning & Ware	1948
M-8744-0106	Guatemala	Chiquimula	Chiquimula	Manning & Ware	1948
M-8844-0113	Guatemala	Chiquimula	San Jose Arrada	Manning & Ware	1948
M-9644-0116	Guatemala	Taxixco	Santa Rosa	Manning & Ware	1948
M-9044-0117	Mexico	Oaxaca	Pochutla	Manning & Ware	1948
M-8744-0119	Guatemala	Jutiapa	Valle Nuevo	Manning & Ware	1948

Table 1. cont.

CRS	COUNTRY OF ORIGIN	STATE	SITE	COLLECTOR	YEAR
M-8844-0120	Guatemala	Jutiapa	Horcones	Manning & Ware	1948
M-8844-0121	Guatemala	Jalapa	La Reforma Monjas	Manning & Ware	1948
M-9044-0124	Guatemala	Jutiapa	Valle Nuevo	Manning & Ware	1948
M-9044-0140	Guatemala	Jutiapa	Jutiapa	Manning & Ware	1948
M-0044-0149	Guatemala	Santa Rosa	Orataria	Manning & Ware	1948
M-9044-0150	Guatemala	Jutiapa	Progreso	Manning & Ware	1948
M-9044-0151	Guatemala	Jutiapa	Jutiapa	Manning & Ware	1948
M-9044-0154	Guatemala	Jutiapa	Santa Catarina Mita	Manning & Ware	1948
M-9044-0155	Guatemala	Jalapa	La Libertad Monjas	Manning & Ware	1948
M-9044-0156	Guatemala	Jalapa	San Pedro Penula	Manning & Ware	1948
M-8744-0158	Guatemala	Chiquimula	Chiquimula	Manning & Ware	1948
M-9044-0162	Guatemala	Jutiapa	Jutiapa	Manning & Ware	1948
M-9044-0164	Guatemala	Chiquimula	Chiquimula	Manning & Ware	1948
M-9044-0165	Guatemala	Zacapa	Las Carretas	Manning & Ware	1948
M-8744-0168	Guatemala	Jutiapa	Jacarro Grande	Manning & Ware	1948
M-9044-0170	Guatemala	Chiquimula	Chiquimula	Manning & Ware	1948
M-0044-0171	Mexico	Oaxaca	Ejutla	Manning & Ware	1948
M-0044-0173	Guatemala	Jutiapa	Progreso	Manning & Ware	1948
M-8744-0174	Guatemala	Jutiapa	Progreso	Manning & Ware	1948
M-8744-0175	Guatemala	Jutiapa	Santa Catarina Mita	Manning & Ware	1948
M-0044-0178	Guatemala	Chiquimula	Chiquimula	Manning & Ware	1948
M-9044-0180	Guatemala	Santa Rosa	--	Manning & Ware	1948
M-9044-0182	Mexico	Guerrero	--	Manning & Ware	1948
M-9644-0188	Guatemala	Baja Verapaz	Sanarate	Manning & Ware	1948
M-9644-0195	Guatemala	Jutiapa	San Antonio	Manning & Ware	1948

Table 1. cont.

CRS	COUNTRY OF ORIGIN	STATE	SITE	COLLECTOR	YEAR
M-9044-0197	Guatemala	Jutiapa	Progreso	Manning & Ware	1948
M-9644-0199	Guatemala	Jutiapa	Santa Catarina Mita	Manning & Ware	1948
M-9044-0206	Mexico	Guerrero	Maquina del Rio de Niepa	Manning & Ware	1948
M-0044-0209	Guatemala	Chiquimula	--	Manning & Ware	1948
M-9044-0212	Mexico	Oaxaca	Limon	Manning & Ware	1948
M-9044-0215	Guatemala	Jutiapa	Yupeltepeque	Manning & Ware	1948
M-9644-0216	Guatemala	Jutiapa	Horcones	Manning & Ware	1948
M-0044-0219	Guatemala	Jalapa	Jalapa	Manning & Ware	1948
M-0044-0221	Guatemala	Chiquimula	Tierra Blanca	Manning & Ware	1948
M-9644-0224	Mexico	oaxaca	Tototapan	Manning & Ware	1948
M-9044-0226	Mexico	Guerrero	Maquina del Rio de Niepa	Manning & Ware	1948
M-8744-0228	Guatemala	Jalapa	Chaparron	Manning & Ware	1948
M-9644-0235	El Salvador	--	--	Manning & Ware	1948
M-9044-0237	Guatemala	Jutiapa	Santa Catarina Mita	Manning & Ware	1948
M-9644-0238	Guatemala	Jalapa	San Pedro Pinual	Manning & Ware	1948
M-9044-0239	Guatemala	Chiquimula	Chiquimula	Manning & Ware	1948
M-9644-0240	Guatemala	Chiquimula	Jocotan	Manning & Ware	1948
M-0044-0241	Guatemala	Baja Verapaz	SanArate	Manning & Ware	1948
M-9644-0242	Guatemala	Huehuetenango	San Mateo Ixtaton	Manning & Ware	1948
M-8844-0243	Mexico	Oaxaca	--	Manning & Ware	1948
M-9044-0244	Mexico	Oaxaca	Ixcopa	Manning & Ware	1948
M-9044-0245	Mexico	Guerrero	--	Manning & Ware	1948
M-9044-0247	Guatemala	Jutiapa	Barreal	Manning & Ware	1948
M-9644-0250	Guatemala	Zacapa	--	Manning & Ware	1948
M-8744-0257	Mexico	Oaxaca	Mitla	Manning & Ware	1948

Table 1. cont.

CRS	COUNTRY OF ORIGIN	STATE	SITE	COLLECTOR	YEAR
M-8744-0326	Mexico	Guerrero	Asoyo	Manning & Ware	1948
M-0044-0338	Mexico	Guerrero	Zacualapan	Manning & Ware	1948
M-0044-0347	Mexico	Guerrero	Acapulco de Juarez	Manning & Ware	1948
M-9044-0570	Cambodia via Sudan	--	--	J.B. Hutchinson	1955
M-8744-0612	--	--	--	T.R. Richmond	1946
M-0044-0620	--	--	--	T.R. Richmond	1946
M-9044-0633	Guatemala	Isabal	Motagua River System	Stephens Collection	1947
M-9044-0634	Guatemala	Isabal	Motagua River System	Stephens Collection	1947
M-0044-0636	Guatemala	Isabal	Motagua River System	Stephens Collection	1947
M-9044-0641	Guatemala	--	Pacific Coast & Minterlands	Stephens Collection	1947
M-0044-0725	Belize	belize	Belize City	Stephens Collection	1960
M-0044-0763	Mexico	San Luis Potosi	Tamazunchula	R.L. Cuany	1952
M-0044-0764	Mexico	San Luis Potosi	Axtla	R.L. Cuany	1952
M-0044-0790	Belize	Corozal	Corozal	Stephens Collection	1960
M-9044-1000	Egypt	--	--	Stephens Collection	1971
M-8744-1149	--	--	--	#2029 (increase from TA-18)	1961

[1] Adapted from Percival (1987)

[2] Release designation of CRS; first two digits indicate year that the day neutral conversion line was released, the following two digits indicate the BC_nF_n generation of the release, and the last four digits correspond to the Texas (T-) number of the day length sensitive accession (McCarty and Jenkins 1993).

the last four digits correspond to the Texas (T-) number of the day length sensitive accession (McCarty and Jenkins 1993).

CRS were separated into nine smaller groups (subscreens), each containing between 8 and 12 CRS. These smaller groups of race stocks were screened through time, in a laboratory setting, to compare whitefly resistance among the selected CRS and the two known susceptible commercial checks, PSC 355 and Delta Pearl.

Each group of race stocks was planted in succession, along with the two known susceptible commercial checks, at the Crop Biotechnology Center (CBC) located on the Texas A&M University Campus. Plants were grown in 7.5 L plastic pots filled with Scotts Metro Mix® 200 potting soil. Two pots, each containing two plants, were planted for all race stocks to be screened. This assured the availability of quality leaves later on when the leaves were harvested for the experiments. Pots were watered three times and fertilized once with Scotts Peters Professional® 20-20-20 General Purpose fertilizer every week.

Preliminary studies indicated that insecticide applications with low residual effects could have large consequences on the results of the actual screen. In some preliminary studies, young cotton plants were treated with insecticide and allowed to continue growing. Only leaves that were not present during the application were harvested for the experiment. Initial observations showed adequate whitefly ovipostion. However, subsequent observations initially showed 80% mortality. This preliminary work was terminated before total mortality was observed. To prevent this level of mortality, all plants were grown in a relatively insect free environment free of insecticide applications. In the situation where insecticide treatments were needed for control of pests in the remaining areas of the greenhouse, all race stocks were removed from the greenhouse before the application and were not replaced until 24 h after the application.

For each of the nine subscreens, all cotton race stocks were allowed to grow to approximately the 10^{th} true leaf stage. The top four fully expanded leaves were then collected from two separate plants of each cotton race stock and commercial check. Leaves were harvested from the plant including 5-8 cm of the petiole. The proximal end of petioles were immediately wrapped in cotton batting and the distal end placed in a 10 dram vial with a 25 mm diameter opening and filled with ¼ strength Hoagland's solution (Table 2 and Table 3) (Manfred 2002). Enough batting was supplied for each petiole to provide a tight fit with the vial in order to prevent leaking of the solution. Throughout the experiment, ¼ strength Hoagland's solution was added to the vials as needed to maintain immersion of the distal ends of petioles.

Leaves were inverted and placed in a randomized complete block design using the infestation surface in the light racks. Light racks were kept on a 12:12 h light/dark schedule. Approximately 10-12 adult whiteflies per leaf were taken from a greenhouse colony using an aspirator and placed in a plastic 5 dram vial with a 25 mm diameter opening for establishment of egg cohorts on the cotton race stocks. Whitefly vials were then uncapped and placed upside down on the abaxial side of the inverted excised cotton leaves, and the outer edge of the vial was inscribed on the leaf for future reference. To ensure quality as well as identification of the whitefly colony, voucher specimens, consisting of immature whiteflies, were taken periodically from the colony and placed in

Table 2. Hoagland's nutrient solution (stock solutions). [1]

	Stock Solutions (1 Liter)	grams/liter
1.	Ca (NO_3) 2 · 4 H_2O	236.1
2.	KNO_3	101.1
3.	KH_2PO_4	136.4
4.	$MgSO_4$ · 7 H_2O	246.5
5.	Trace elements (make up to 1 L)	
	a. H_3BO_3	2.8
	b. $MnCl_2$ · 4 H_2O	1.8
	c. $ZnSO_4$ · 7 H_2O	0.2
	d. $CuSO_4$ · 5 H_2O	0.1
	e. $NaMoO_4$	0.025
6.	FeEDTA	
	a. EDTA · 2Na	10.4
	b. $FeSO_4$ · 7 H_2O	7.8
	c. KOH	56.1

[1] Reproduced from Manfred 2002.

Table 3. Hoagland's nutrient solution (full strength). [1]

	Stock Solutions	ml
1.	Ca (NO_3) 2 · 4 H_2O	7
2.	KNO_3	5
3.	KH_2PO_4	2
4.	$MgSO_4$ · 7 H_2O	2
5.	Trace elements (make up to 1 L)	1
6.	FeEDTA	1

Add these amounts of stock solution to 1 L H_2O

[1] Reproduced from Manfred 2002 (dilute to ¼ strength).

the Texas A&M University Insect Collection under voucher #643. The adult whiteflies were left to oviposit on the leaves for a period of 24 h. Adults were then removed, leaving an egg cohort population of known age. Leaves were then inverted back to proper orientation and placed in the holes of the flat plywood surfaces which replaced the infestation surface on the light rack. Initial egg counts were made the day of adult removal, as well as two days later, to ensure accuracy of initial cohort size.

In order to contain mobile first instar nymphs, after the second egg count was conducted, clip cages were placed over the infestation arena to confine first instar crawlers. Cages remained on the leaves until 14 days after the initial egg count to allow for hatch and nymph settling. Clip cages were then removed, and the cohort population was marked and examined periodically until adult whitefly emergence ceased.

Measurements of the cohort density, life stage, and condition were taken on a daily basis with the aid of a 12X dissecting microscope until all whiteflies had emerged as adults or were considered dead. The cohort data were compiled and statistically analyzed using a chi-squared test based on the rank sums of the leaf averages to compare leaves of all cotton race stocks to that of the known susceptible commercial checks for both percent whitefly survival (PWS) and whitefly developmental time (WDT). In addition to this, Abbott's formula was used on all nine subscreens to transform the data of both race stocks and commercial checks to allow comparisons to be made across all subscreens (Abbott 1925). This transformation normalizes differences among subscreens caused by factors affecting individual screens such as temperature.

Cohort Retest of Possible Resistant Cotton Race Stocks: All CRS from the original cohort tests that were determined to be more resistant to whiteflies ($P \leq 0.1$) than the commercial checks as indicated by either PWS or WDT were included in a second screen to retest these lines for putative resistance. In addition to the CRS noted, other race stocks that showed better resistant characteristics than PSC 355 were chosen at random and included in this test.

All aspects of this test were conducted in the same manner as the original cohort test, except that only PSC 355 was included in this second screen as a susceptible commercial check. A total of 14 CRS were included in this second screen. In addition to retesting these lines, individual plants that showed resistance in the retest were grown to maturity for seed. In the original cohort tests, adequate greenhouse space was not available to keep all plants until they could be screened and analyzed; thus resistance designation only pertained to the CRS. Race stocks are not genetically uniform and saving individual plants from the retest ensures seed from promising plants would be available for further use.

Results and Discussion

Cohort Test: Target cohort size for all laboratory whitefly screens was between 15 and 25 eggs per leaf. Uniform cohort populations were difficult to achieve, and egg cohort sizes typically ranged from 0 to 50 eggs per leaf. However, few cohort populations reached sizes that approached 120 eggs per leaf. Due to this lack of uniform cohort size, analysis with standard parametric statistical tests was cumbersome, and cohort data were analyzed using a non-parametric ranked chi-squared test.

The ranked chi-squared test compared the leaf average ranks of each CRS individually to the commercial checks for two separate selection criteria, PWS and WDT. In each individual subscreen, the two commercial checks were compared in a ranked chi-squared test to determine which of these checks yielded the best results for each of the two selection criteria. These checks were used in additional ranked chi-squared tests to determine if any CRS were different ($P \leq 0.1$) from the commercial checks for each of the selection criteria. The use of the best commercial check provided the most rigorous means for determining resistant CRS lines. From the nine smaller subscreens, PSC 355 proved to be better than Delta Pearl in all but two of the subscreens for PWS, as well as two of the subscreens for WDT (Table 4). If the CRS are not able to provide levels of resistance that are better than already available commercial cultivars, then these CRS do not provide any substantial advances in whitefly resistance in cotton.

A certain amount of leaf mortality was expected in each of the nine small laboratory subscreens. Typical leaf mortality during each subscreen ranged from a loss of 3-7 leaves per screen. Other leaves were discarded from the experiment due to a lack of whitefly oviposition on the leaf. In the case of missing leaf data, the average of the remaining leaves of that CRS was used. Missing data usually consisted of one leaf per CRS; however, in a very few cases, up to three of the eight total leaf samples per CRS were missing.

Table 4. Identification of commercial check used in each of the smaller screens for determining resistance based on developmental time and percent survival of whitefly.

Screen	Commercial check used for developmental time comparisons	Commercial check used for percent survival comparisons
1 and 2	PSC 355	PSC 355
3	Delta Pearl	PSC 355
4	PSC 355	PSC 355
5	PSC 355	PSC 355
6	PSC 355	PSC 355
7	PSC 355	Delta Pearl
8	Delta Pearl	PSC 355
9	PSC 355	PSC 355
10	PSC 355	Delta Pearl

Leaf averages for the two selection criteria ranged from 0-100 for PWS and 16.5-31 days for WDT across the nine screens. Adult emergence of individual whiteflies was observed from 15 to 39 days post egg deposition. Averages of the individual leaf averages for each race stock were calculated, and the results ranged from 17.6 ± 0.57 to 25.2 ± 3.1 for WDT. These averages for PWS were observed to be from 42.25 ± 38.9 to 93.8 ± 8.4 days. (Figures 3-20).

Ranked chi-squared tests of each of the nine subscreens revealed a total of 6 CRS that were significantly better ($P \leq 0.1$) than the two commercial checks for at least one of the selection criteria for resistance (Table 5). Four of these race stocks were found to be superior to the commercial checks for WDT. These race stocks were M-9644-0188, M-9644-0195, M-0044-0221, and M-9644-0242. Three of these lines, M-9644-0188, M-9644-0195, and M-0044-0221, were located in subscreen #8 while the fourth, M-9644-0242, was located in subscreen #9. These lines provided approximately a 10% increase in developmental time as compared with the commercial checks.
In addition to these four lines, two others, M-9044-0154 and M-9044-0156, were found to be significantly better ($P \leq 0.1$) than the checks for PWS (Table 5). Both of these race stocks were located in subscreen #5. At first, experimental error was considered the possibly caused for this low level of survival. This idea was dismissed when notes that were taken throughout the experiment revealed that a major portion of the immature whiteflies died before hatch or shortly after on both M-9044-0154 and M-9044-0156. This characteristic was present in both of these CRS, but was more pronounced in M-9044-0154.

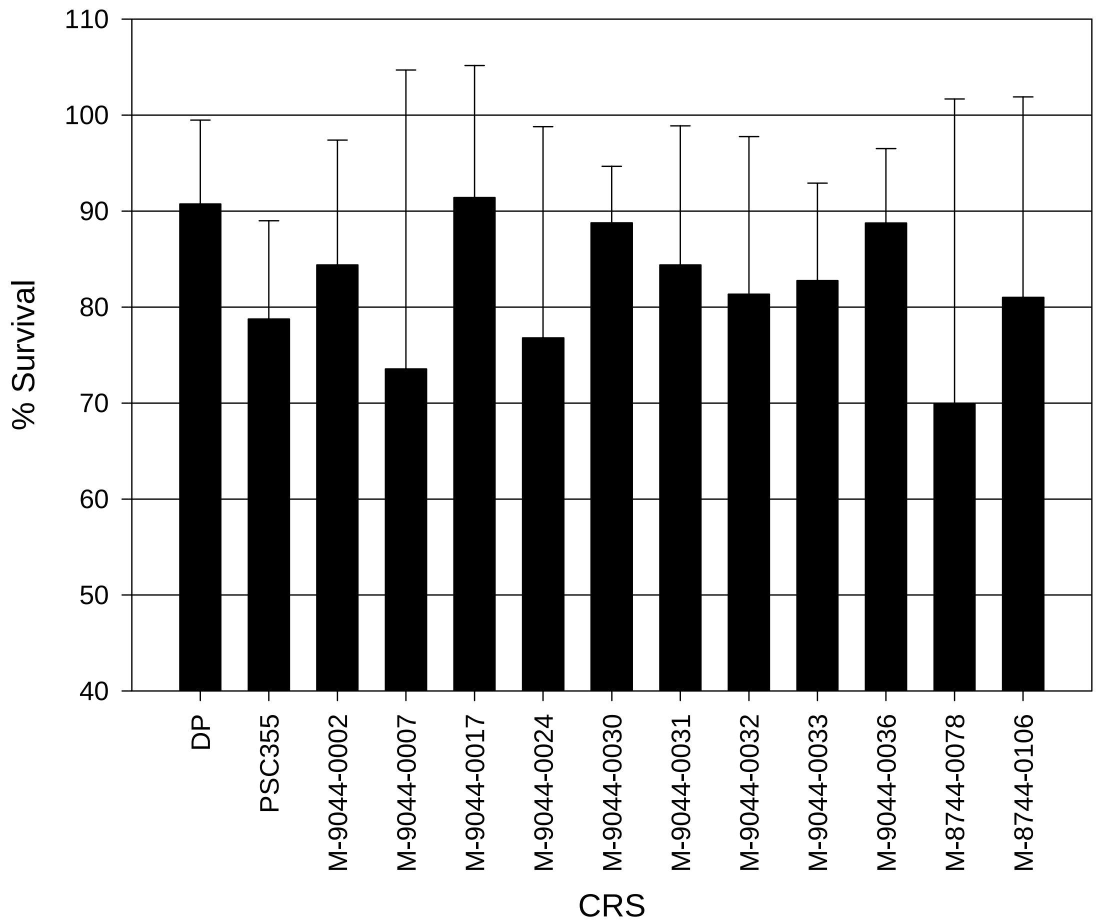


Figure 3. Results of screens #1 and #2 for percent survival of whiteflies on cotton race stock lines.

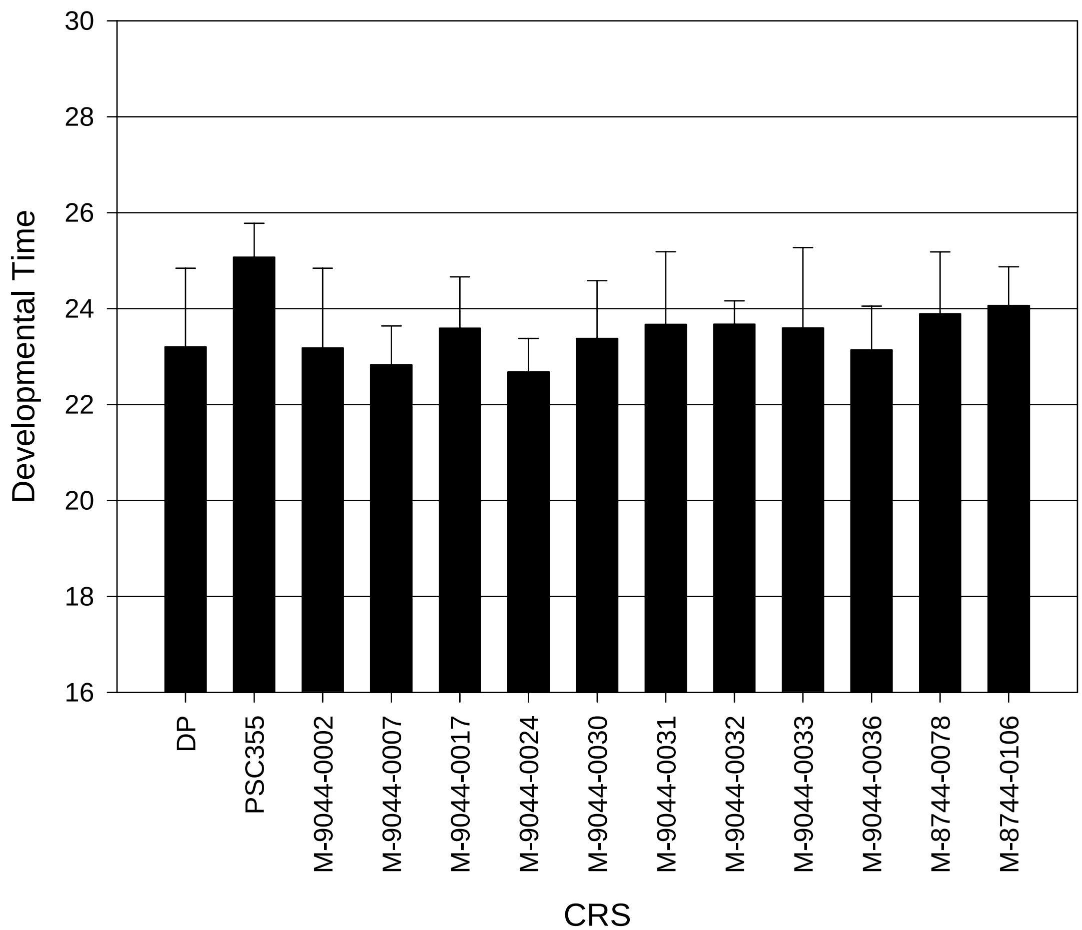


Figure 4. Results of screens #1 and #2 for developmental time of whiteflies on cotton race stock lines.

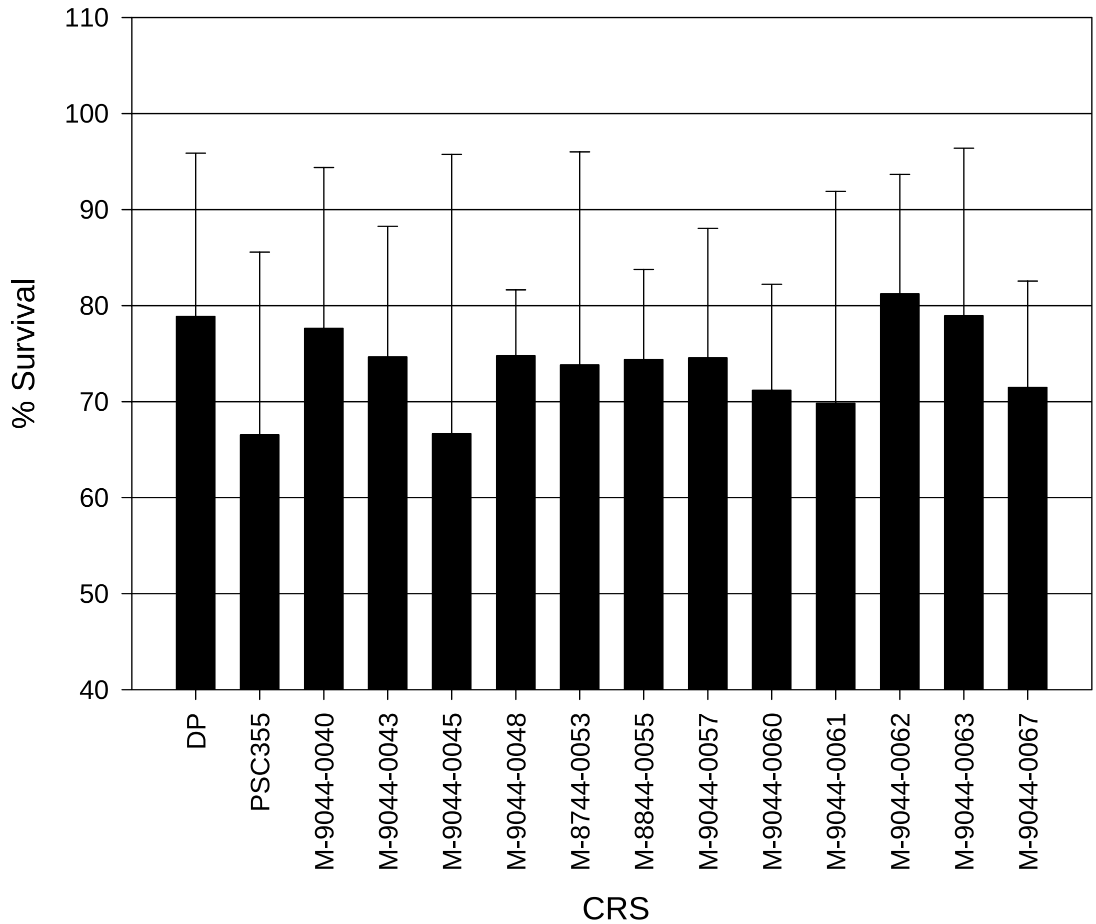


Figure 5. Results of screen #3 for percent survival of whiteflies on cotton race stock lines.

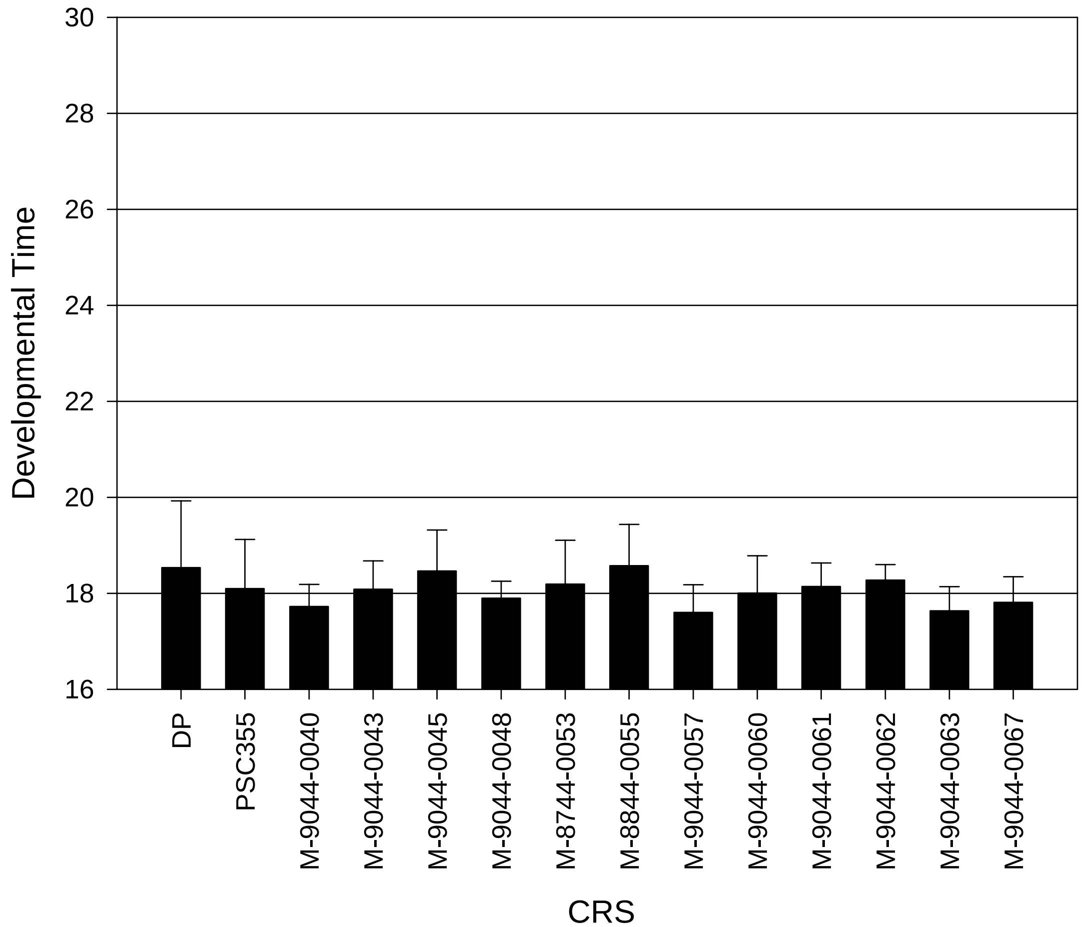


Figure 6. Results of screen #3 for developmental time of whiteflies on cotton race stock lines.

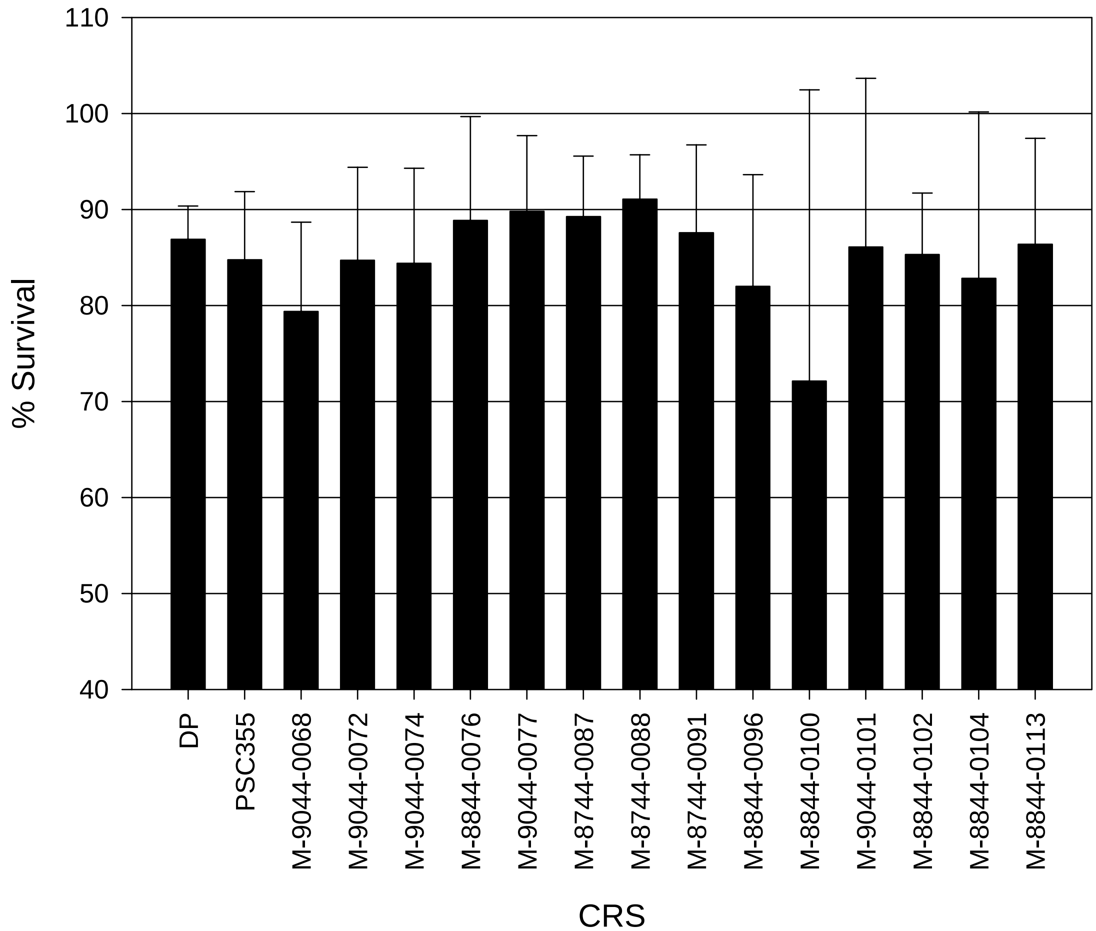


Figure 7. Results of screen #4 for percent survival of whiteflies on cotton race stock lines.

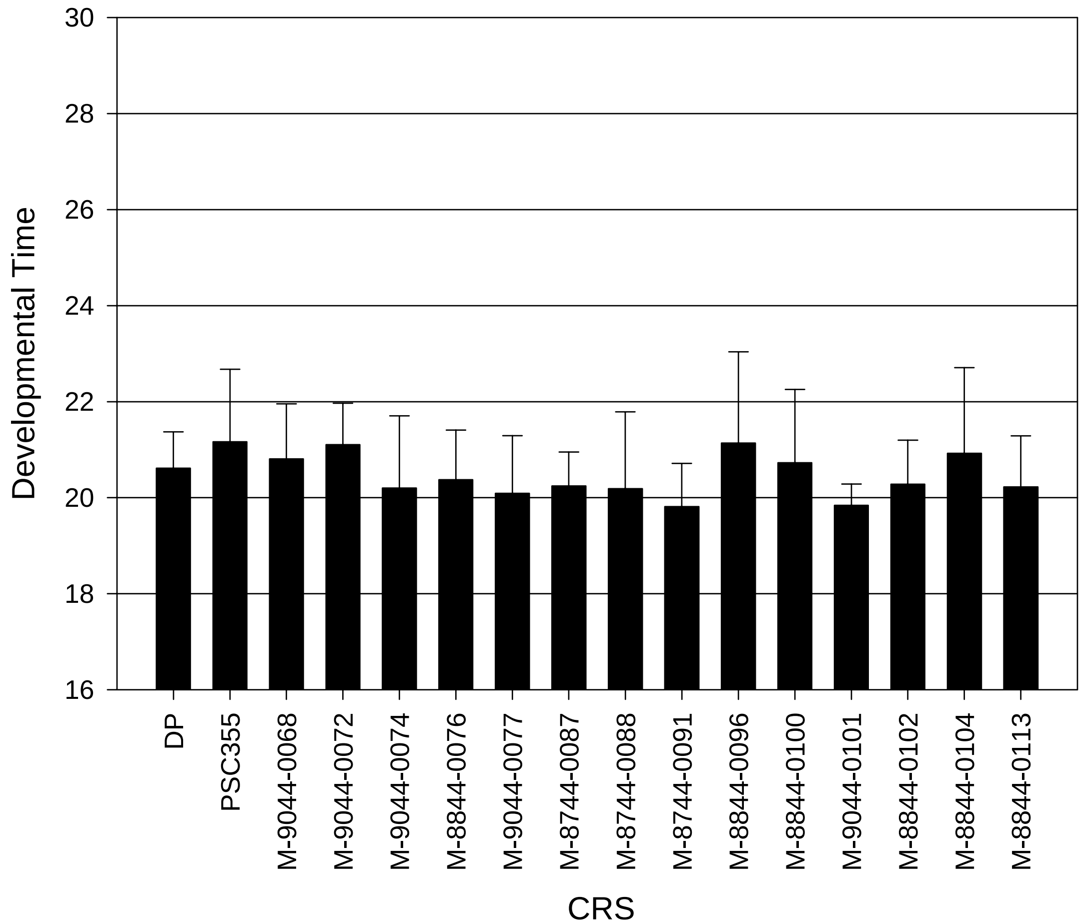


Figure 8. Results of screen #4 for developmental time of whiteflies on cotton race stock lines.

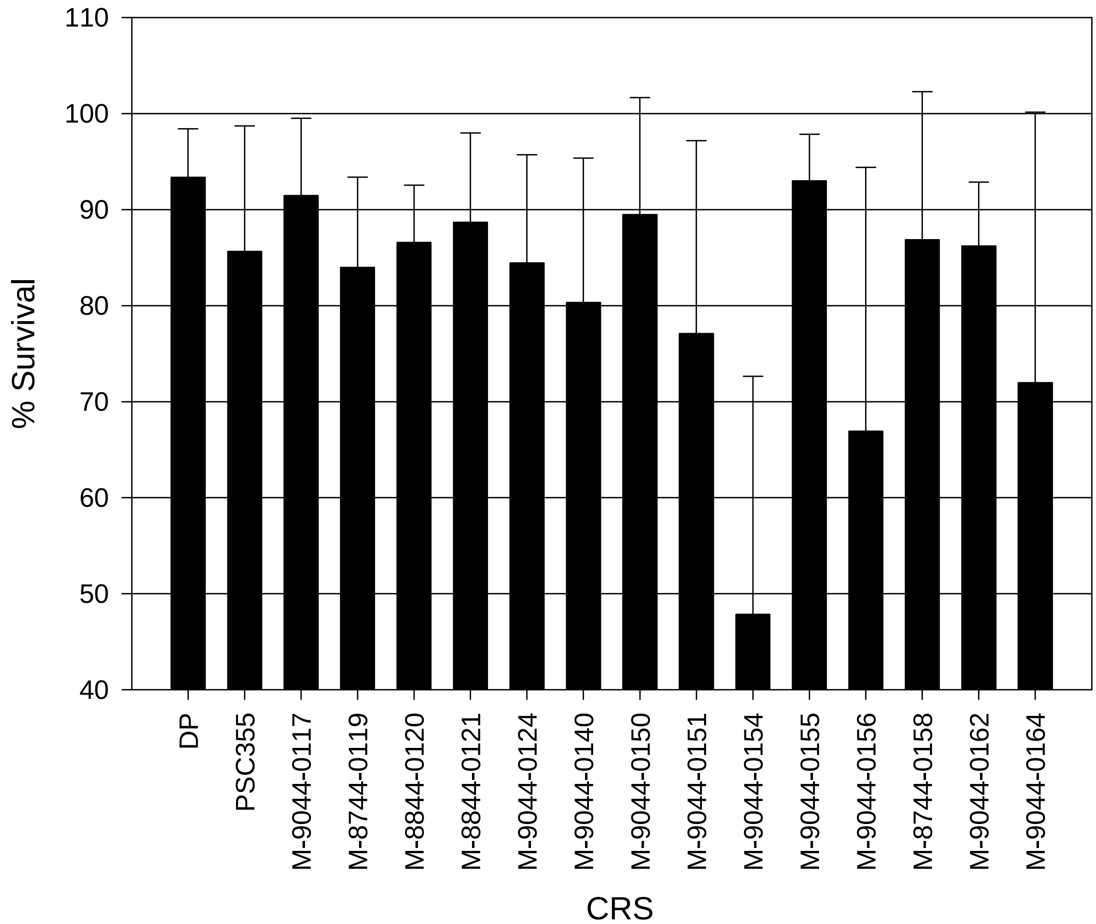


Figure 9. Results of screen #5 for percent survival of whiteflies on cotton race stock lines.

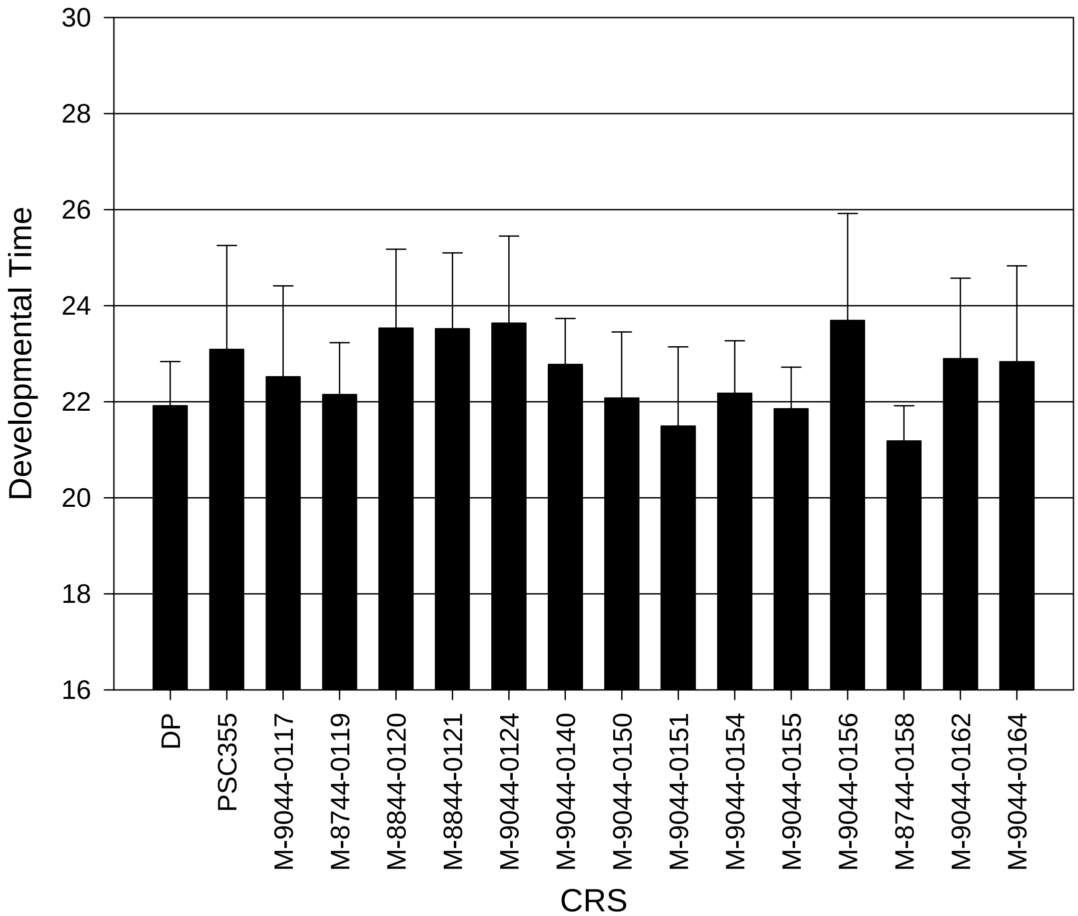


Figure 10. Results of screen #5 for developmental time of whiteflies on cotton race stock lines.

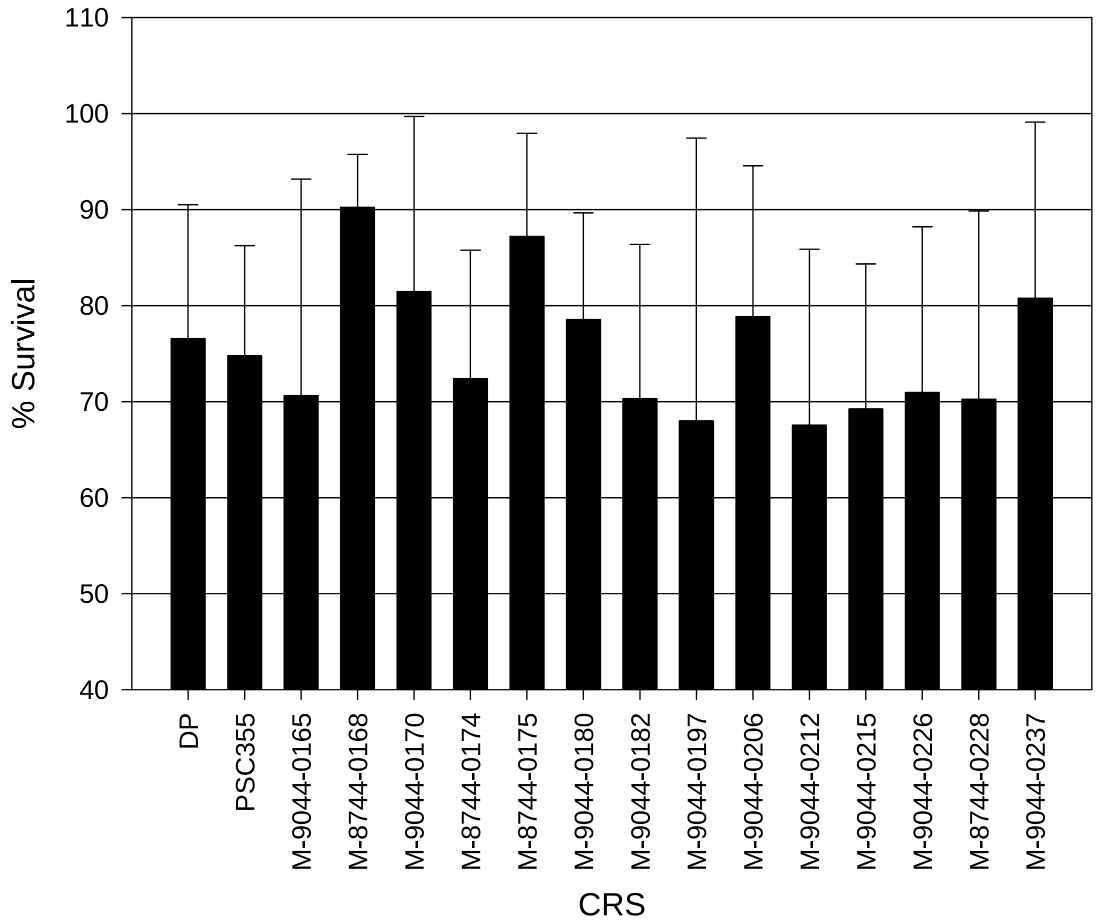


Figure 11. Results of screen #6 for percent survival of whiteflies on cotton race stock lines.

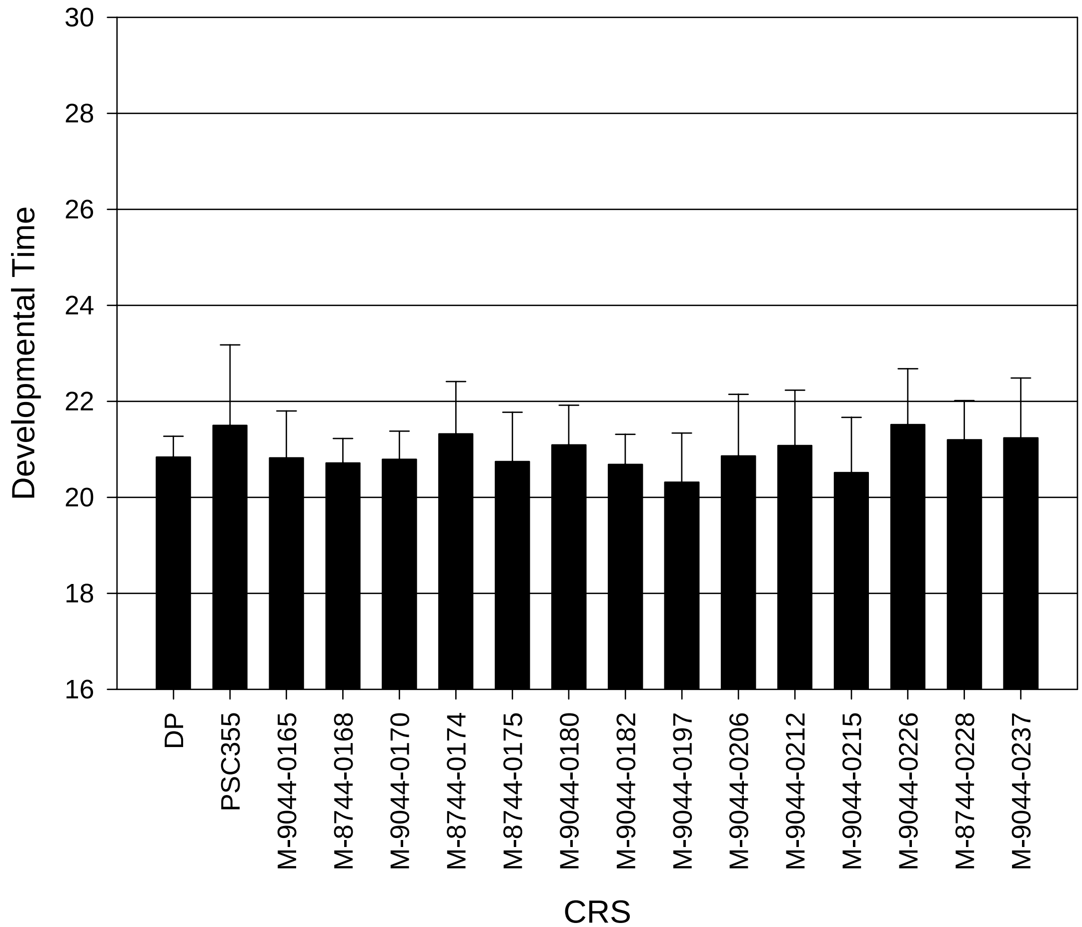


Figure 12. Results of screen #6 for developmental time of whiteflies on cotton race stock lines.

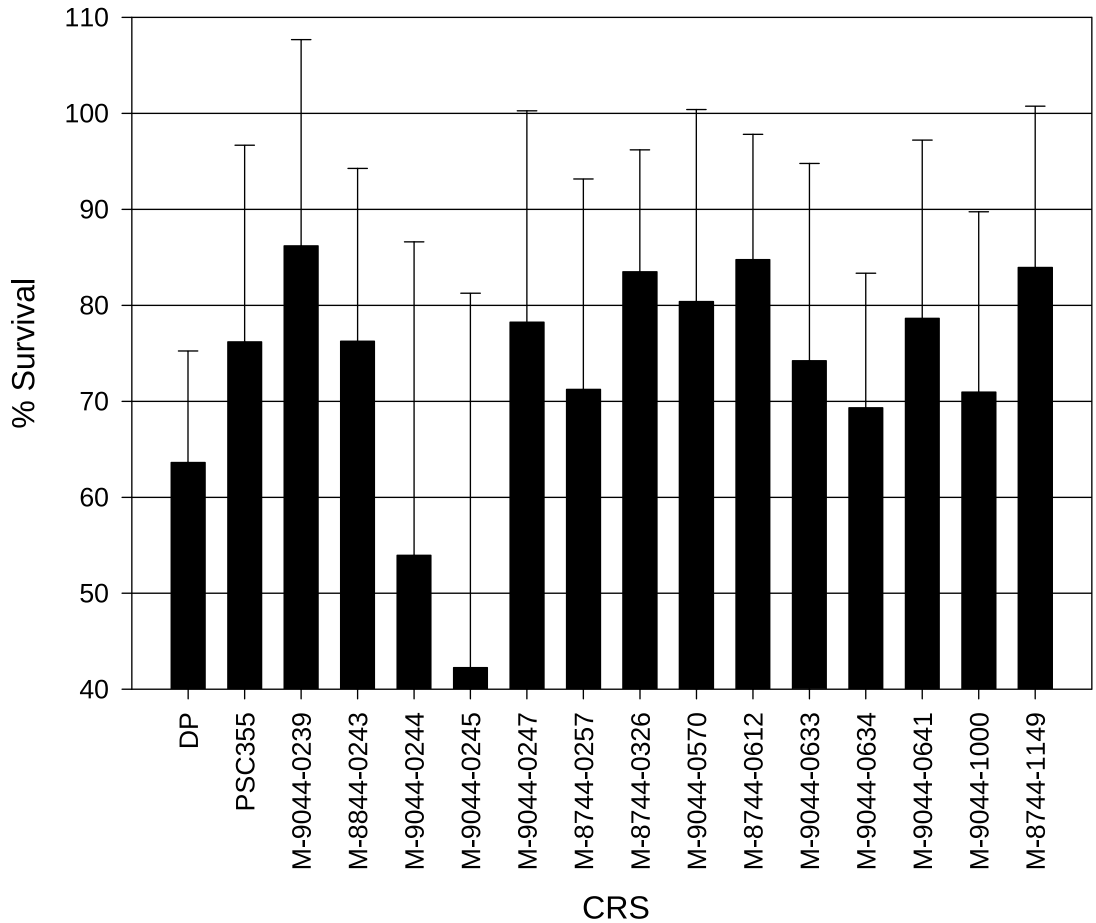


Figure 13. Results of screen #7 for percent survival of whiteflies on cotton race stock lines.

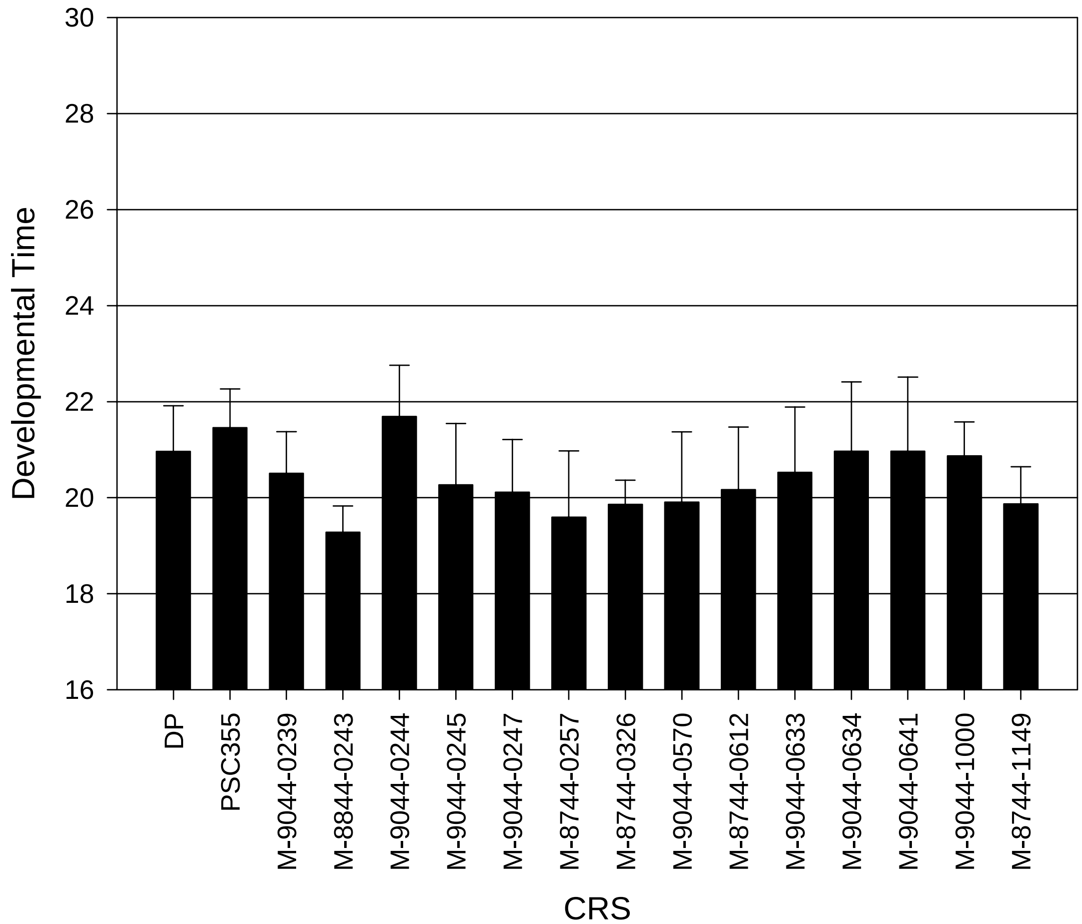


Figure 14. Results of screen #7 for developmental time of whiteflies on cotton race stock lines.

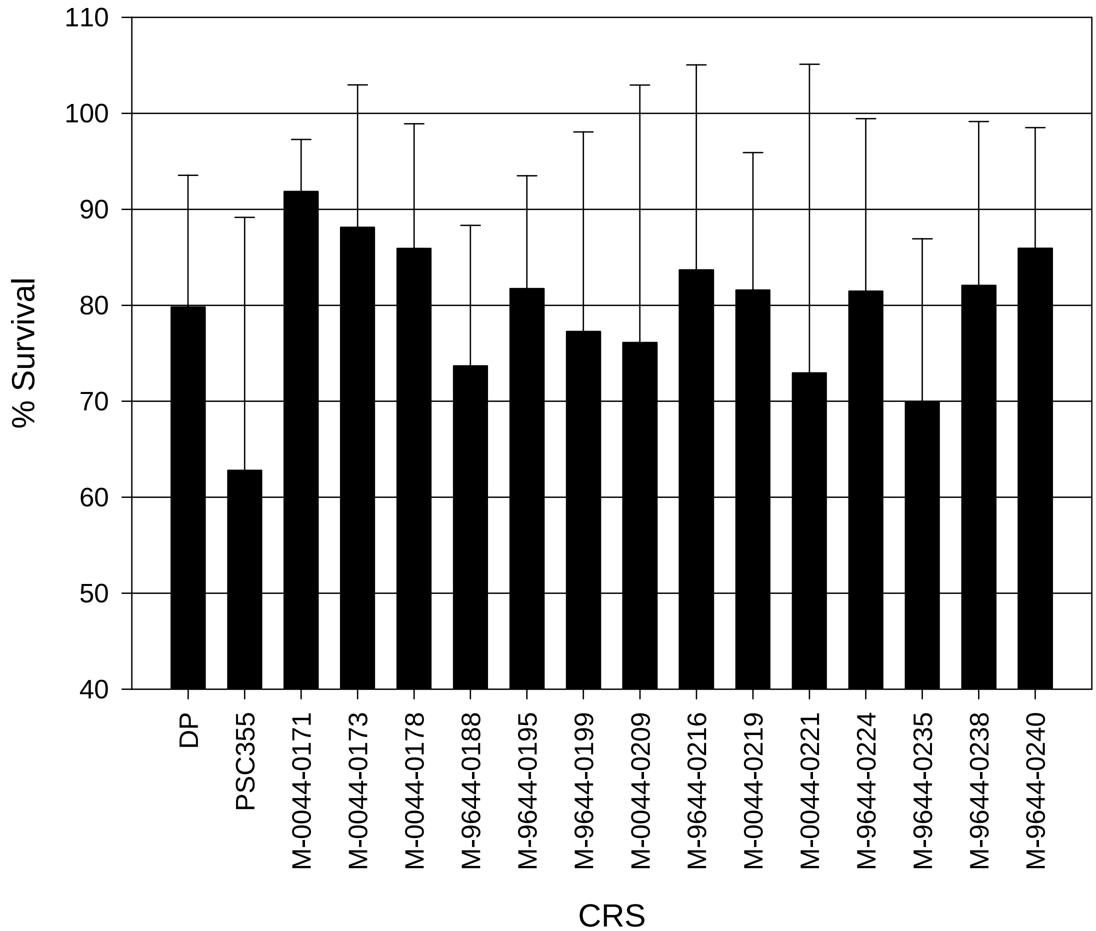


Figure 15. Results of screen #8 for percent survival of whiteflies on cotton race stock lines.

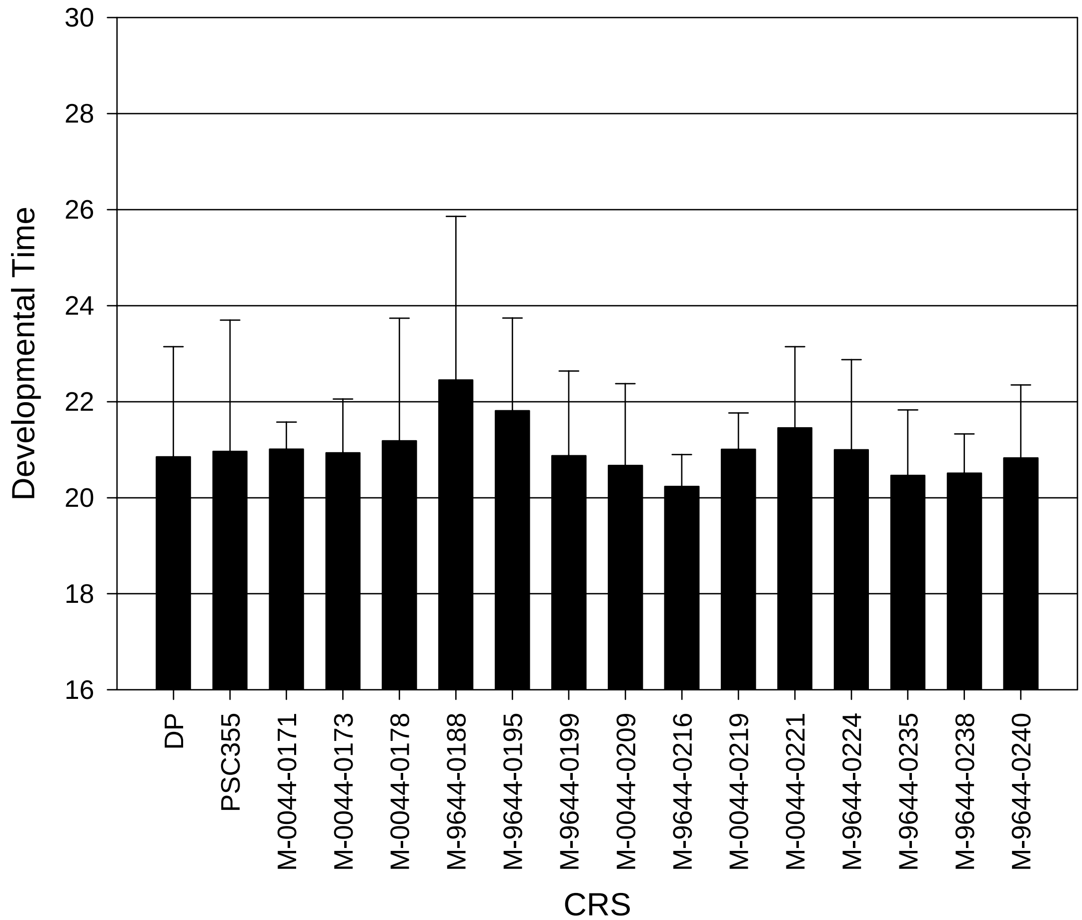


Figure 16. Results of screen #8 for developmental time of whiteflies on cotton race stock lines.

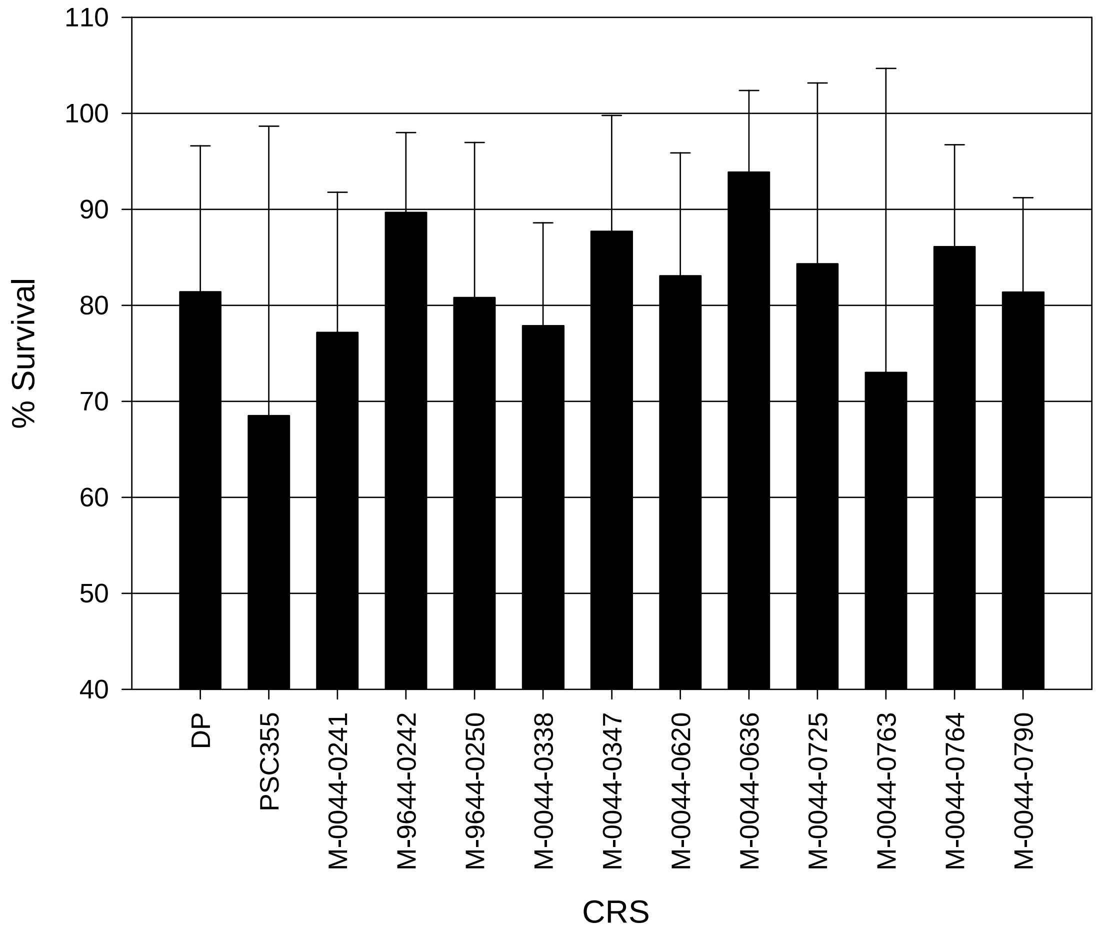


Figure 17. Results of screen #9 for percent survival of whiteflies on cotton race stock lines.

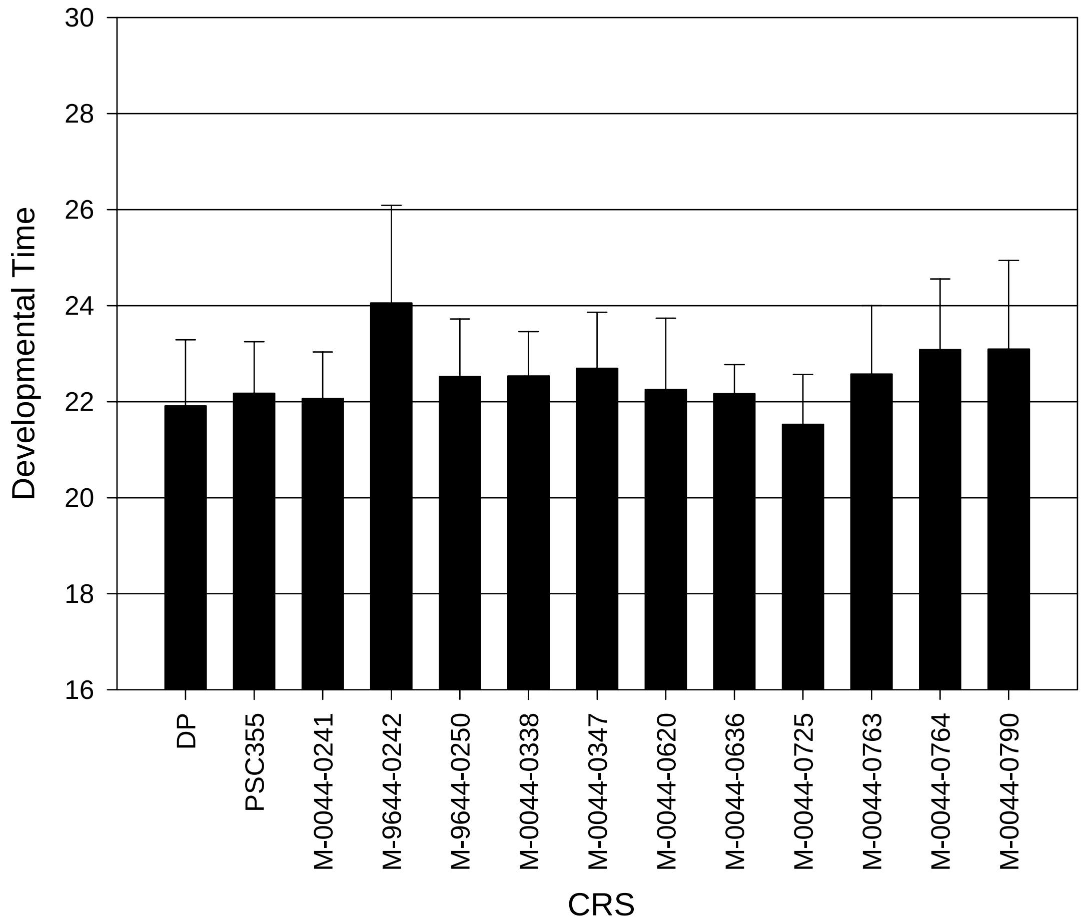


Figure 18. Results of screen #9 for developmental time of whiteflies on cotton race stock lines.

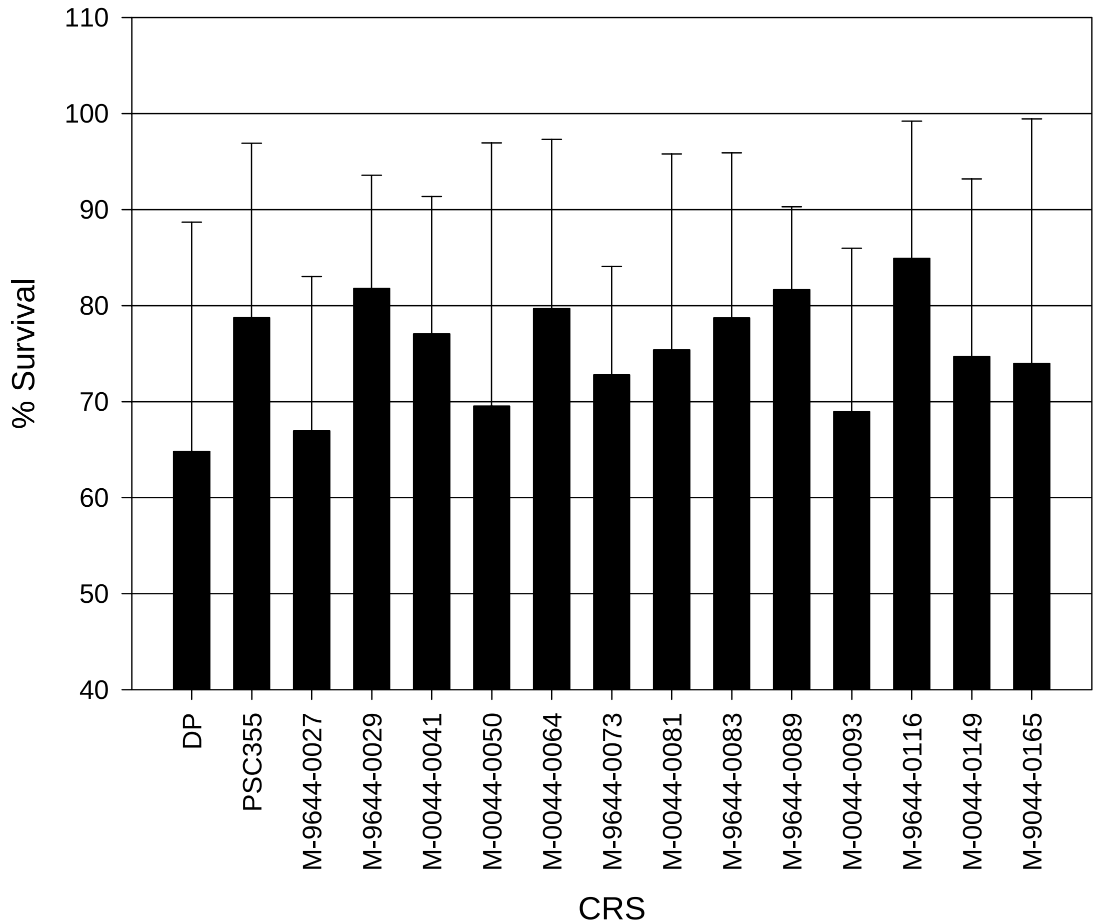


Figure 19. Results of screen #10 for percent survival of whiteflies on cotton race stock lines.

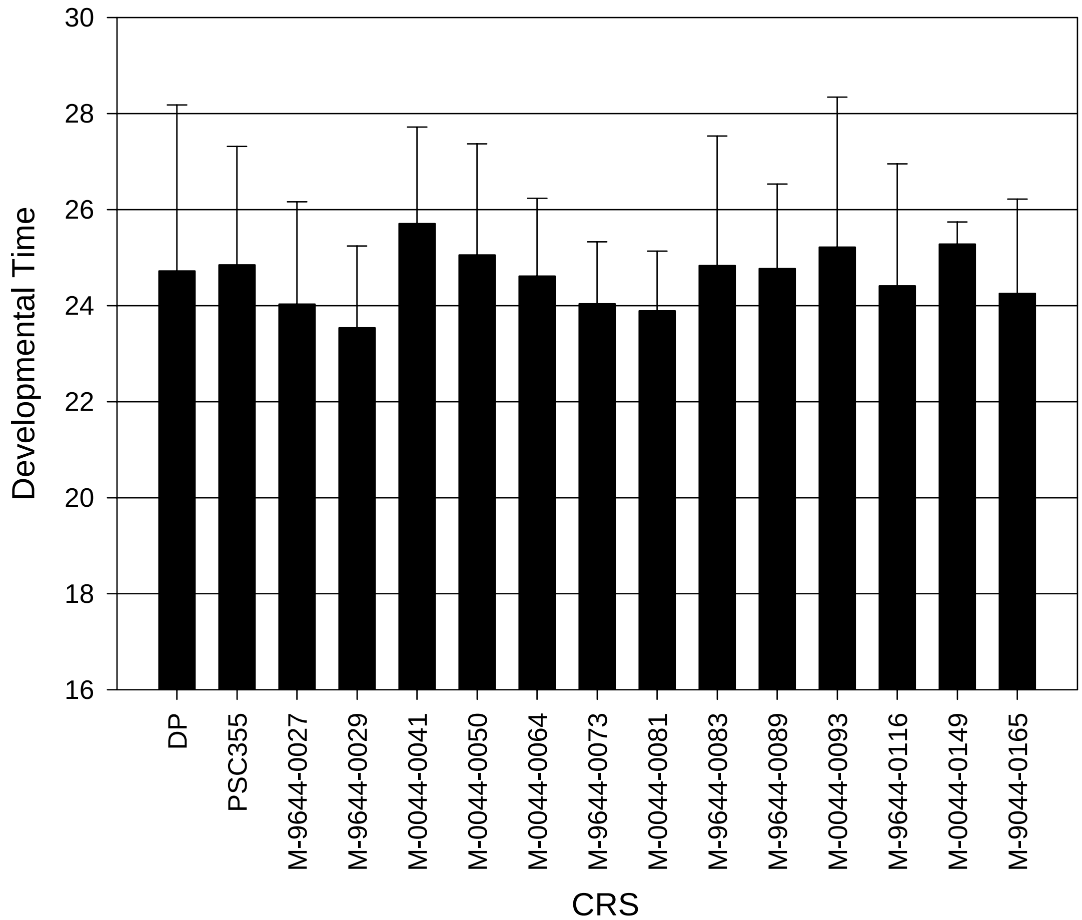


Figure 20. Results of screen #10 for developmental time of whiteflies on cotton race stock lines.

Table 5. Results of chi-squared test comparing cotton race stocks to commercial checks for whitefly developmental time and percent whitefly survival.

Screen	Race Stock	Developmental time χ^2 value	Better/Worst	Percent Survival χ^2 value	Better/Worst
1 and 2	PSC 355/PSC 355				
1 and 2	M-9044-0002	8.47	W **	2.88	W *
1 and 2	M-9044-0007	15.06	W **	0.72	W
1 and 2	M-9044-0017	8.47	W **	6.49	W **
1 and 2	M-9044-0024	15.06	W **	0.37	W
1 and 2	M-9044-0030	10.72	W **	8.47	W **
1 and 2	M-9044-0031	4.25	W **	2.88	W *
1 and 2	M-9044-0032	12.37	W **	1.78	W
1 and 2	M-9044-0033	7.12	W **	1.19	W
1 and 2	M-9044-0036	12.37	W **	8.47	W **
1 and 2	M-8744-0078	7.12	W **	0.01	B
1 and 2	M-8744-0106	7.78	W **	1.78	W
1 and 2	M-9044-0154	15.06	W **	0.13	B
1 and 2	M-9044-0164	9.19	W **	0.24	B
3	Delta Pearl/PSC 355				
3	M-9044-0040	2.88	W *	0.72	W
3	M-9044-0043	0.53	W	0.37	W
3	M-9044-0045	0.06	W	0.53	W
3	M-9044-0048	0.94	W	0.94	W
3	M-8744-0053	0.53	W	1.78	W
3	M-8844-0055	0.01	B	0.72	W
3	M-9044-0057	3.76	W *	0.72	W
3	M-9044-0060	0.94	W	0.01	W
3	M-9044-0061	0.24	W	0.24	W
3	M-9044-0062	0.06	W	2.88	W *
3	M-9044-0063	3.76	W *	2.12	W
3	M-9044-0067	2.12	W	0.37	W

* Significantly different from the commercial checks at a 0.1 level.
** Significantly different from the commercial checks at a 0.05 level.

Table 5. cont.

Screen	Race Stock	Developmental time χ^2 value	Better/Worst	Percent Survival χ^2 value	Better/Worst
4	PSC 355/PSC 355				
4	M-9044-0068	0.06	W	2.12	B
4	M-9044-0072	0.06	B	0.06	B
4	M-9044-0074	2.12	W	0.06	B
4	M-8844-0076	1.47	W	2.12	W
4	M-9044-0077	1.47	W	2.88	W *
4	M-8744-0087	2.12	W	2.12	W
4	M-8744-0088	3.76	W *	2.88	W *
4	M-8744-0091	5.88	W **	0.06	W
4	M-8844-0096	0.00	W	0.24	B
4	M-8844-0100	0.53	W	0.94	B
4	M-9044-0101	2.12	W	2.12	W
4	M-8844-0102	2.88	W *	0.00	W
4	M-8844-0104	0.24	W	0.24	W
4	M-8844-0113	2.88	W *	2.12	W
5	PSC 355/PSC 355				
5	M-9044-0117	0.94	W	2.88	W
5	M-8744-0119	1.47	W	0.06	B
5	M-8844-0120	0.06	B	0.00	W
5	M-8844-0121	0.00	W	0.94	W
5	M-9044-0124	0.53	B	0.24	B
5	M-9044-0140	0.53	W	0.94	B
5	M-9044-0150	1.47	W	1.47	W
5	M-9044-0151	2.12	W	0.24	B
5	M-9044-0154	1.47	W	11.53	B **
5	M-9044-0155	2.88	W *	2.88	W *
5	M-9044-0156	0.06	W	3.76	B *
5	M-8744-0158	3.76	W *	0.53	W
5	M-9044-0162	0.24	W	0.06	W
5	M-9044-0164	0.24	W	1.47	B

* Significantly different from the commercial checks at a 0.1 level.
** Significantly different from the commercial checks at a 0.05 level.

Table 5. cont.

Screen	Race Stock	Developmental time χ^2 value	Better/Worst	Percent Survival χ^2 value	Better/Worst
6	PSC 355/PSC 355				
6	M-9044-0165	0.53	W	0.06	W
6	M-8744-0168	0.94	W	9.94	W **
6	M-9044-0170	0.94	W	1.47	W
6	M-8744-0174	0.06	W	0.06	B
6	M-8744-0175	0.53	W	4.76	W **
6	M-9044-0180	0.06	B	2.12	W
6	M-9044-0182	0.24	W	0.24	B
6	M-9044-0197	8.47	W **	0.24	W
6	M-9044-0206	2.12	W	0.24	W
6	M-9044-0212	0.06	W	1.47	B
6	M-9044-0215	2.88	W *	0.24	B
6	M-9044-0226	0.24	B	0.24	B
6	M-8744-0228	0.24	B	0.24	B
6	M-9044-0237	0.00	W	3.76	W
7	PSC355/Delta Pearl				
7	M-9044-0239	7.12	W **	8.47	W **
7	M-8844-0243	15.06	W **	4.76	W **
7	M-9044-0244	1.47	B	0.24	B
7	M-9044-0245	5.88	W **	0.53	B
7	M-9044-0247	8.47	W **	5.88	W **
7	M-8744-0257	8.47	W **	0.94	W
7	M-8744-0326	13.24	W **	8.47	W **
7	M-9044-0570	8.47	W **	5.88	W **
7	M-8744-0612	7.12	W **	11.53	W **
7	M-9044-0633	5.88	W **	3.76	W *
7	M-9044-0634	2.88	W *	2.12	W
7	M-9044-0641	0.53	W	5.88	W **
7	M-9044-1000	0.94	W	0.94	W
7	M-8744-1149	11.53	W **	9.94	W **

* Significantly different from the commercial checks at a 0.1 level.
** Significantly different from the commercial checks at a 0.05 level.

Table 5. cont.

Screen	Race Stock	Developmental time χ^2 value	Better/Worst	Percent Survival χ^2 value	Better/Worst
8	Delta Pearl/PSC 355				
8	M-0044-0171	2.12	B	7.12	W **
8	M-0044-0173	0.94	B	5.88	W **
8	M-0044-0178	0.24	B	3.76	W *
8	M-9644-0188	3.76	B *	1.47	W
8	M-9644-0195	2.88	B *	2.88	W *
8	M-9644-0199	0.06	B	2.88	W *
8	M-0044-0209	0.00	W	1.47	W
8	M-9644-0216	0.53	B	3.76	W *
8	M-0044-0219	1.47	B	2.88	W *
8	M-0044-0221	2.88	B *	2.12	W
8	M-9644-0224	0.01	W	4.76	W **
8	M-9644-0235	0.06	W	0.53	W
8	M-9644-0238	0.24	B	2.12	W
8	M-9644-0240	0.06	B	5.88	W **
9	PSC 355/PSC 355				
9	M-0044-0241	0.53	W	0.06	W
9	M-9644-0242	4.25	B **	2.49	W
9	M-9644-0250	0.06	B	0.00	W
9	M-0044-0338	0.01	B	0.37	B
9	M-0044-0347	0.24	B	2.12	W
9	M-0044-0620	0.13	W	0.53	W
9	M-0044-0636	1.19	W	5.88	W **
9	M-0044-0725	3.76	W *	1.47	W
9	M-0044-0763	0.01	W	0.01	B
9	M-0044-0764	0.94	B	1.78	W
9	M-0044-0790	0.37	B	0.13	W

* Significantly different from the commercial checks at a 0.1 level.
** Significantly different from the commercial checks at a 0.05 level.

Table 5. cont.

Screen	Race Stock	Developmental time χ^2 value	Better/Worst	Percent Survival χ^2 value	Better/Worst
10	PSC355/Delta Pearl				
10	M-9644-0027	0.53	W	0.24	W
10	M-9644-0029	2.12	W	3.76	W *
10	M-0044-0041	0.94	B	1.78	W
10	M-0044-0050	0.00	W	0.37	W
10	M-0044-0064	0.01	W	2.49	W
10	M-9644-0073	0.72	W	2.12	W
10	M-0044-0081	0.94	W	0.94	W
10	M-9644-0083	0.24	W	3.31	W *
10	M-9644-0089	0.01	W	3.31	W *
10	M-0044-0093	0.06	B	0.00	W
10	M-9644-0116	0.24	W	6.49	W **
10	M-0044-0149	0.01	B	2.49	W
10	M-9044-0165	0.37	W	1.78	W

* Significantly different from the commercial checks at a 0.1 level.
** Significantly different from the commercial checks at a 0.05 level.

Resistance Ranking of Cotton Race Stocks: Data from individual subscreens varied because of variability in room temperatures where the light racks were placed. Additional variability was added due to incandescent lamps that were turned on in the light racks during cold periods. These lamps typically increased the temperature of the light racks, thus accelerating the development of the whiteflies. Average minimum and maximum temperatures were taken daily from the light racks and reported (Table 6).

Due to the variability of the data from subscreen to subscreen, direct comparisons could not be made among separate subscreens. A conversion procedure using Abbott's formula was applied to the data from all subscreens in order to make the PSC 355 check of each of the subscreens approximately equal (Abbott 1925). The PSC 355 checks were adjusted to 100% for survival and to 22 days to adulthood (the approximate average from all screens) for developmental time. Data from each of the subscreens was then adjusted accordingly for all race stocks. PSC 355 was chosen for the conversion due to its superiority in the ranked chi squared test. By converting the data of each subscreen, all 116 CRS could be ranked for each of the resistant selection criteria.

Rankings of the 116 CRS for developmental time revealed 30 race stocks that ranked better than the PSC 355 commercial checks (Figures 21 and 22). All four of the race stocks that were found to be significantly better ($P \leq 0.1$) for WDT, M-9644-0188, M-9644-0195, M-0044-0221, and M-9644-0242, fell into this category and ranked 2nd, 5th, 10th, and 1st respectively. Other lines that ranked high included M-0044-0790 and M-0044-0764; however, enough variability existed within these lines that they did

Table 6. Average and standard deviations of temperature for all laboratory screens.

Screen	Minimum Average (ºF)	Minimum Standard Deviation (ºF)	Maximum Average (ºF)	Maximum Standard Deviation (ºF)
1and 2	71.4	0.9	80.4	1.0
3	74.8	4.0	84.2	1.8
4	72.3	1.0	82.2	1.5
5	72.3	1.4	79.9	1.7
6	71.2	2.9	84.1	1.9
7	74.4	2.4	82.6	2.0
8	72.4	1.0	80.5	1.7
9	72.3	1.9	81.1	1.5
10	71.5	1.1	79.4	1.4
Retest	71.4	1.6	82.6	2.2

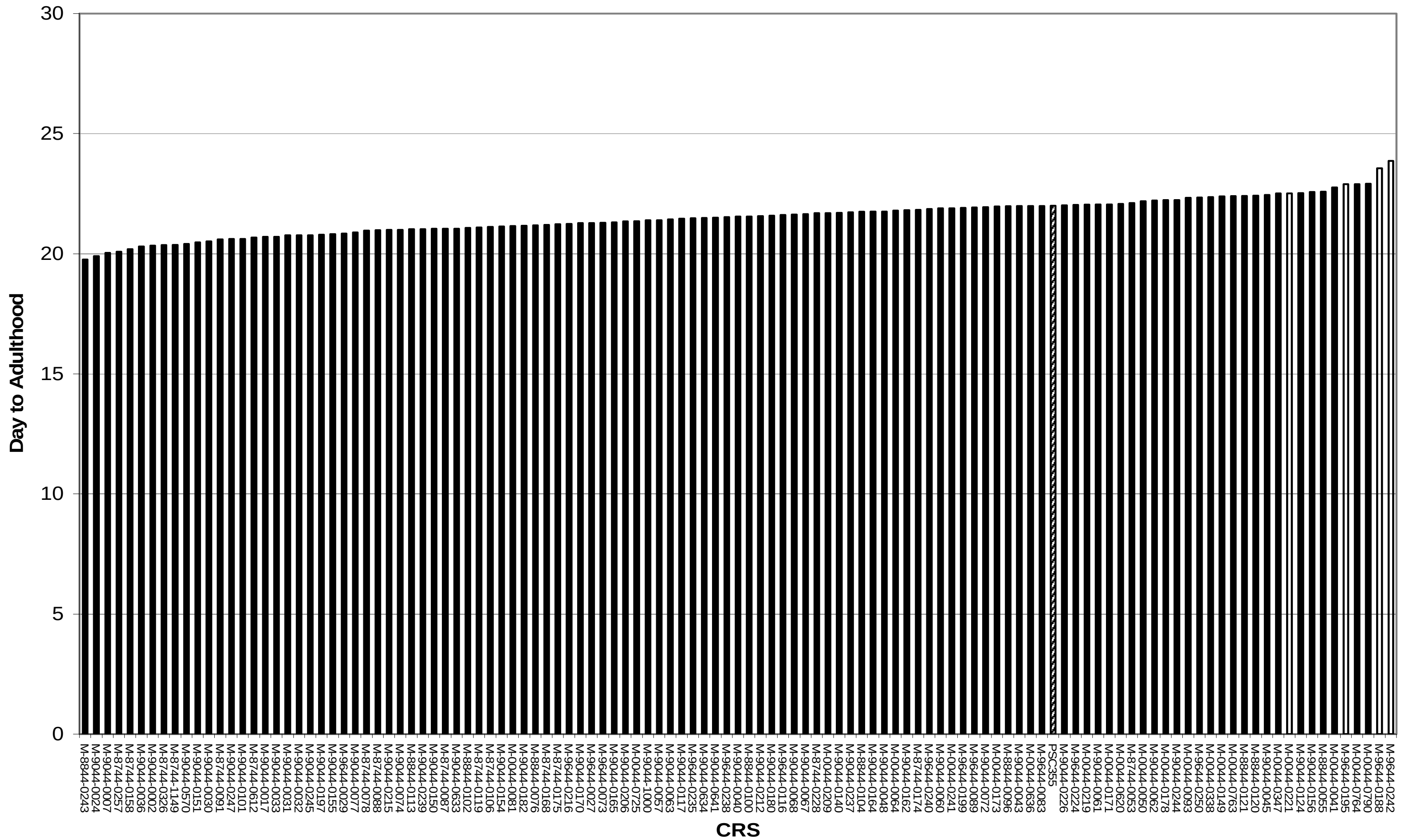


Figure 21. Rankings (trend) of 116 CRS for whitefly developmental time, data transformed with Abbott's formula. PSC 355 is shown with cross-hatched bar and four CRS with longer ($P \leq 0.1$) whitefly developmental times are shown as hollow bars.

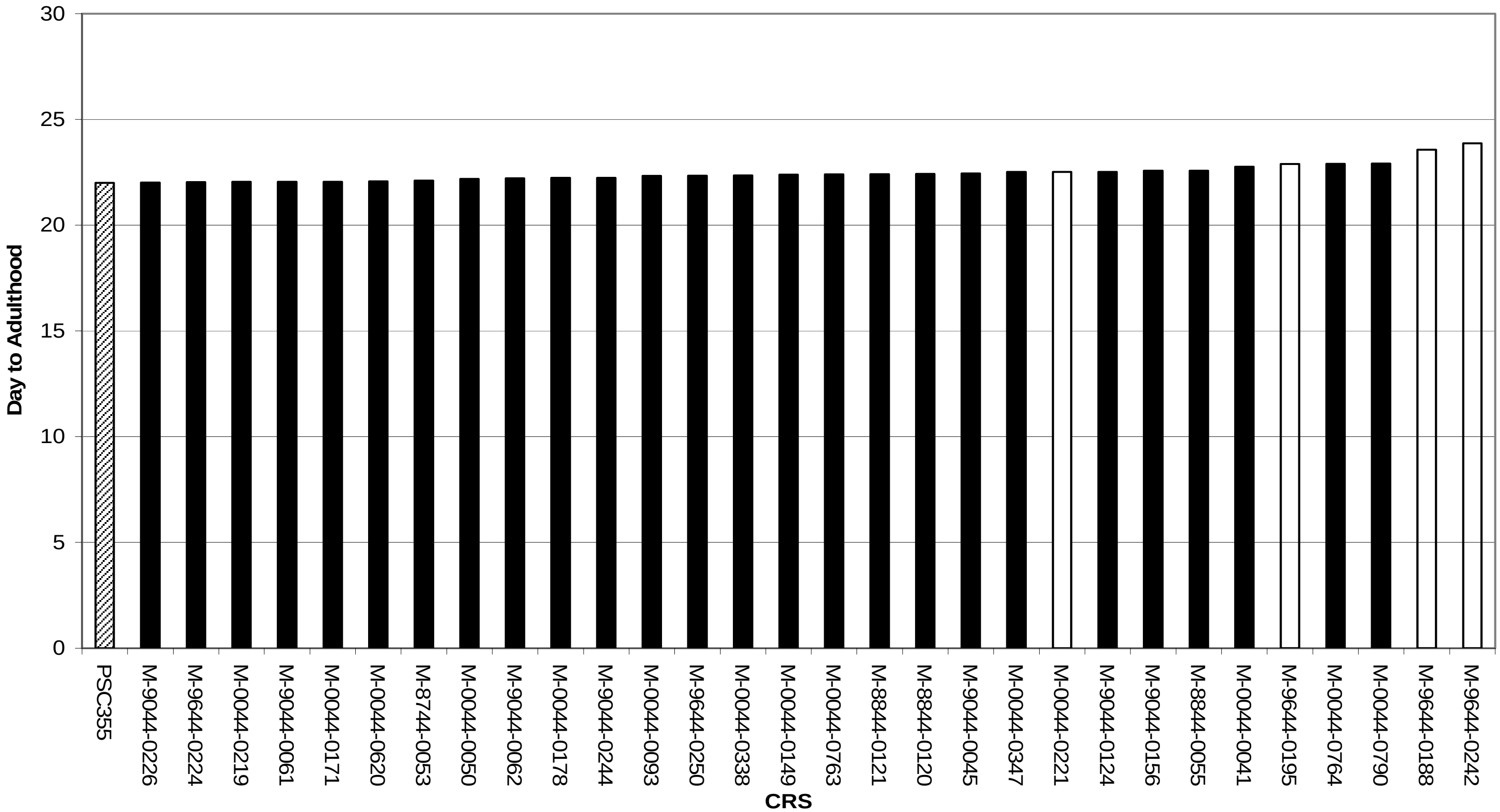


Figure 22. Rankings of 30 CRS for whitefly developmental time equal to or greater in absolute value than PSC 355, data transformed with Abbott's formula (subset of Figure 21). PSC 355 is shown with cross-hatched bar and four CRS with longer ($P \leq 0.1$) whitefly developmental times are shown as hollow bars.

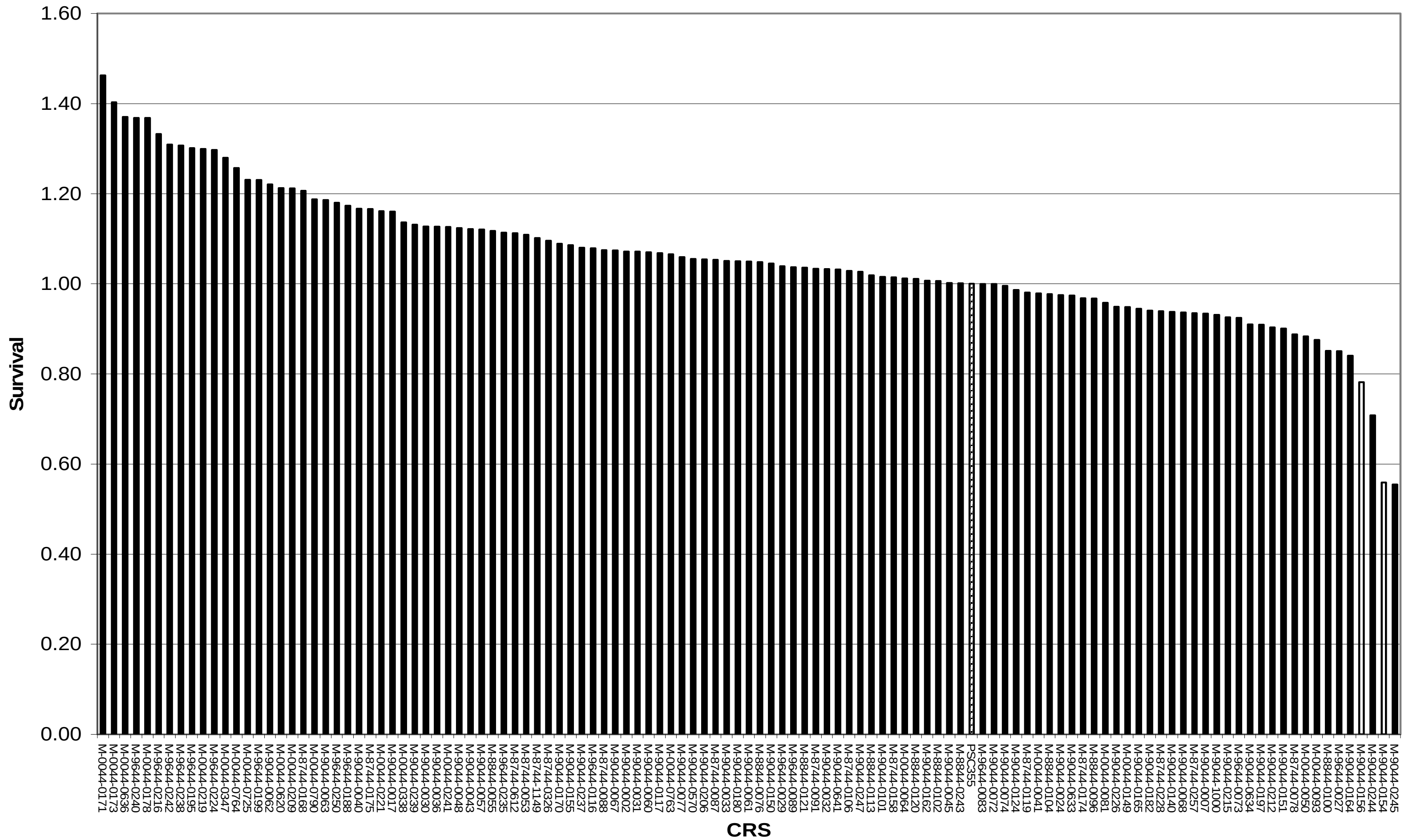


Figure 23. Rankings (trend) of 116 CRS for percent whitefly survival, data transformed with Abbott's formula. PSC 355 is shown with cross-hatched bar and two CRS with lower ($P \leq 0.1$) percent whitefly survival are shown as hollow bars.

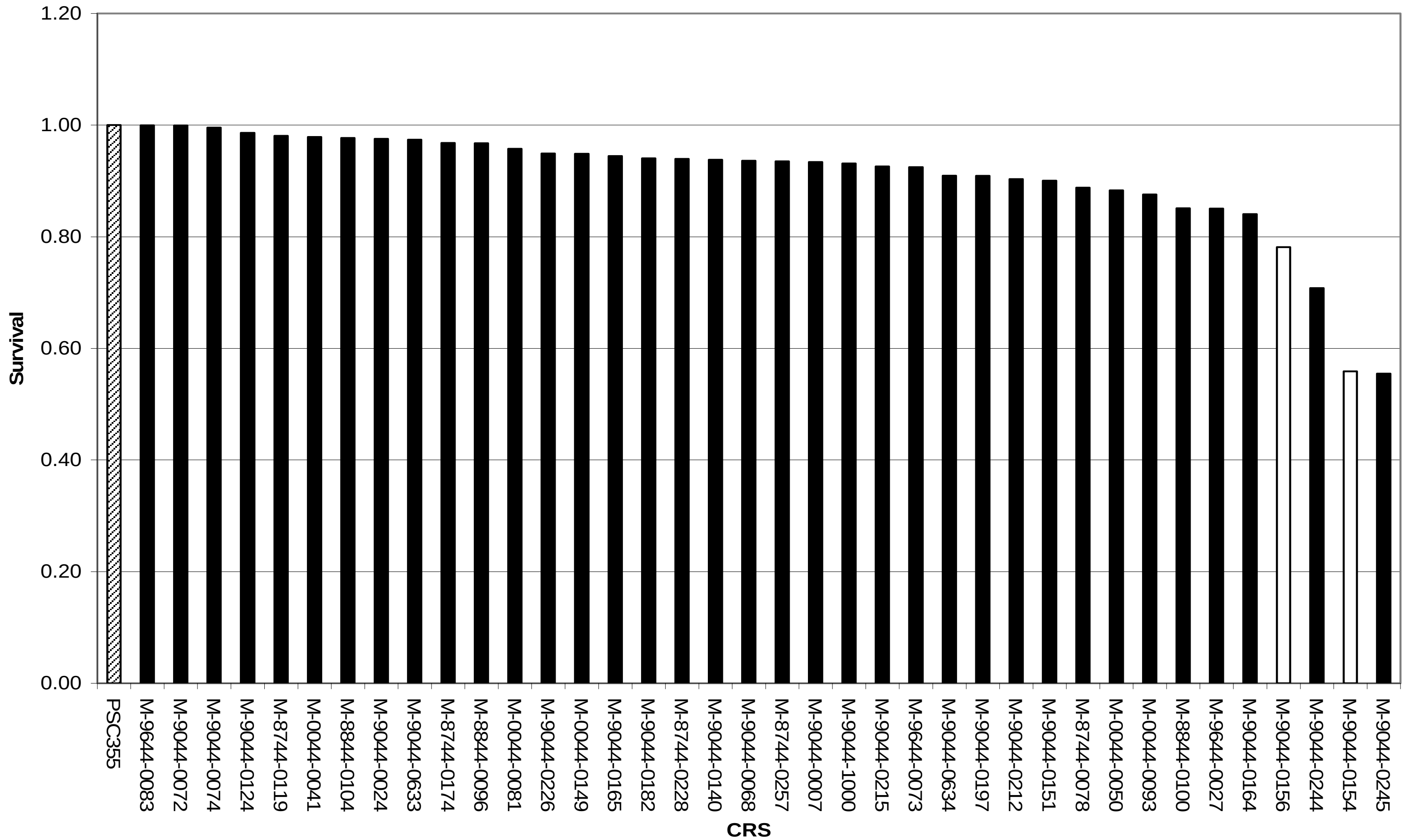


Figure 24. Rankings of 38 CRS for percent whitefly survival equal to or lower in absolute value than PSC 355, data transformed with Abbott's formula (subset of Figure 23). PSC 355 is shown with cross-hatched bar and two CRS with lower ($P \leq 0.1$) percent whitefly survival are shown as hollow bars.

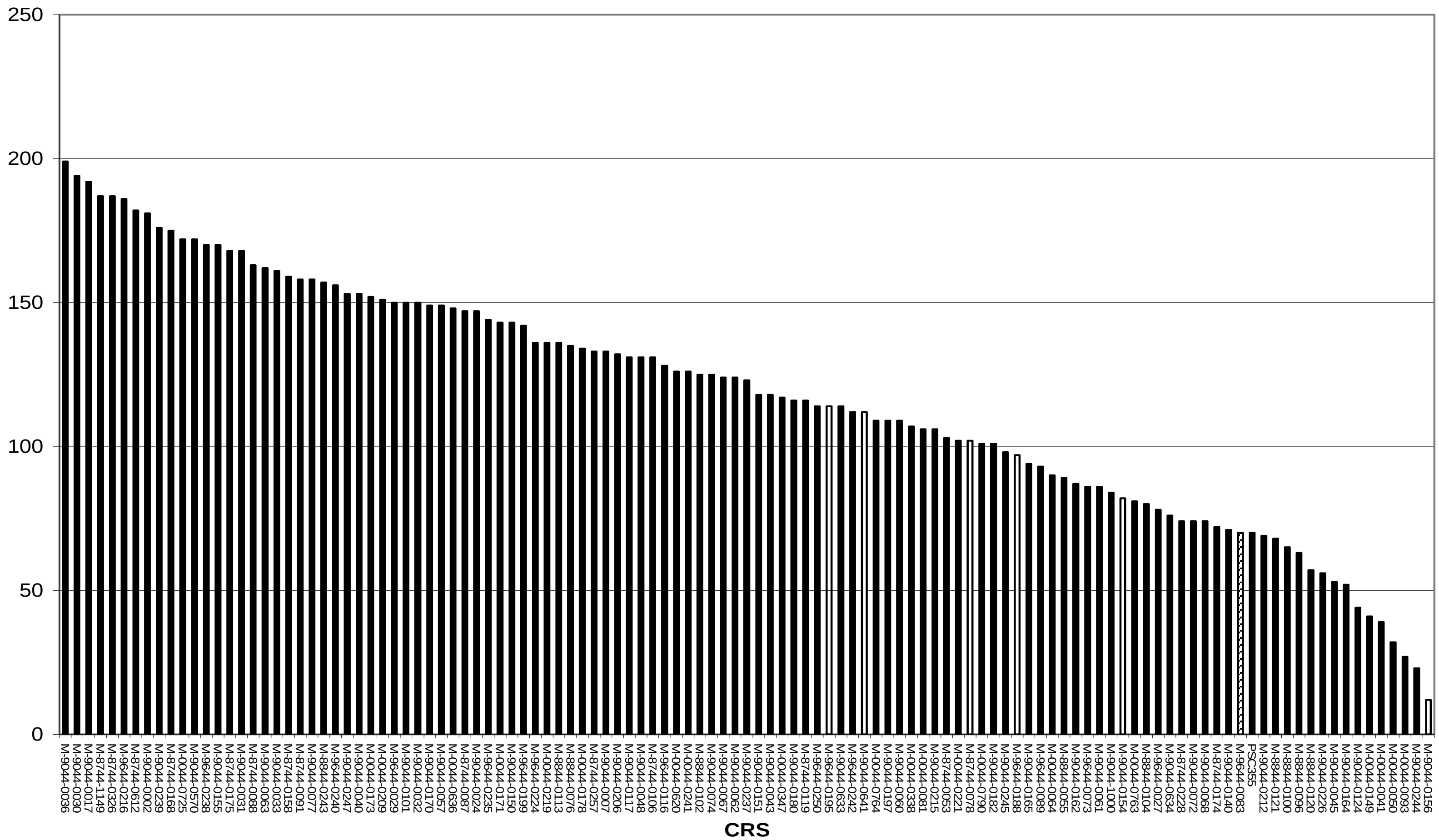


Figure 25. Rankings (trend) of 116 CRS for whitefly resistance based on combined effect of whitefly developmental time and percent whitefly survival, data transformed with Abbott's formula. PSC 355 is shown with cross-hatched bar and six CRS with either lower ($P \leq 0.1$) percent whitefly survival or longer ($P \leq 0.1$) whitefly developmental time are shown as hollow bars.

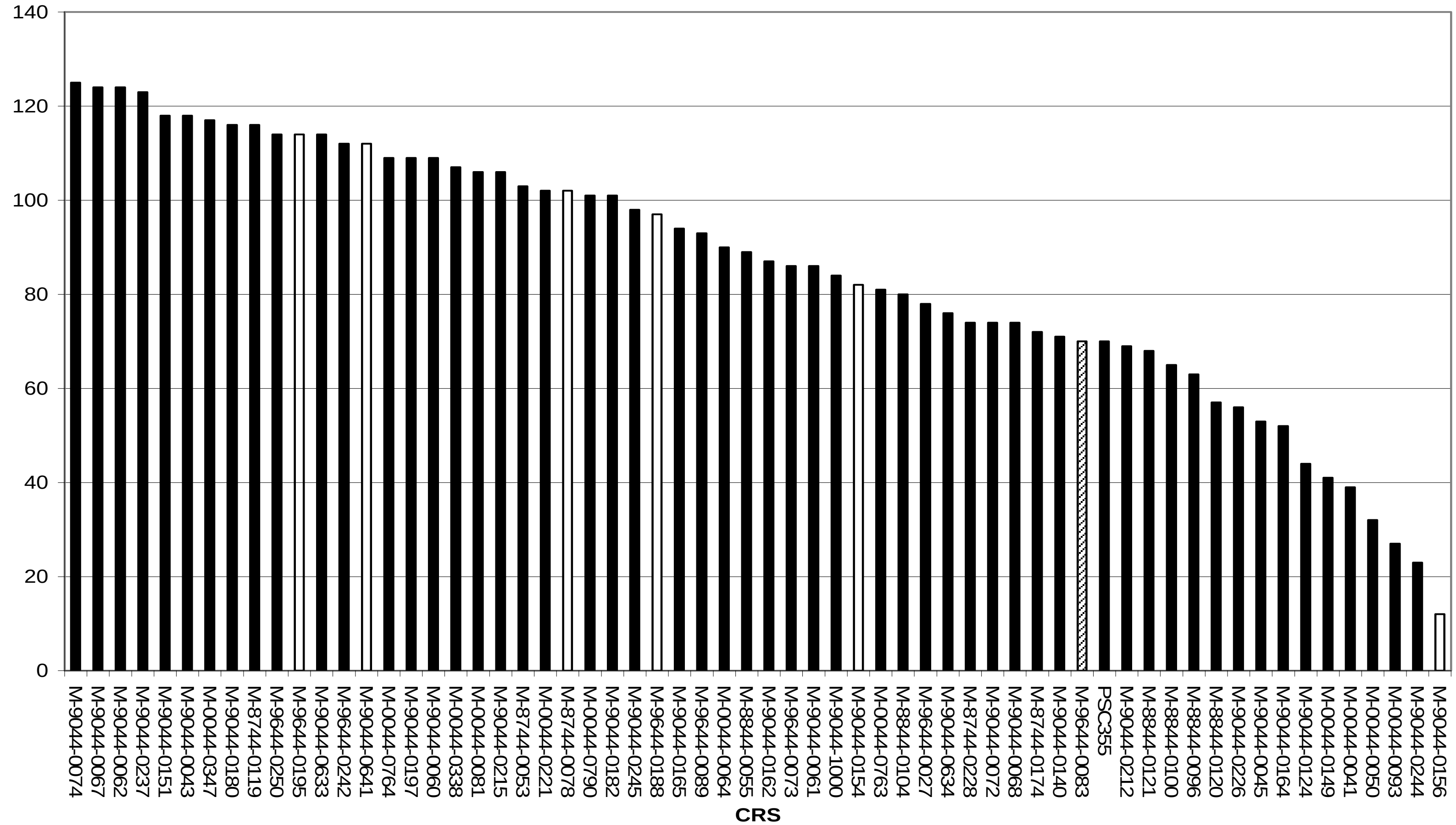


Figure 26. Subset of Figure 25 showing rankings of the best 61 CRS for whitefly resistance based on combined effect of whitefly developmental time and percent whitefly survival, data transformed with Abbott's formula. PSC 355 is shown with cross-hatched bar and six CRS with either lower ($P \leq 0.1$) percent whitefly survival or longer ($P \leq 0.1$) whitefly developmental time are shown as hollow bars.

not show to be significantly different ($P \leq 0.1$) from the checks in the previous chi-squared test.

A total of 38 race stocks ranked better than the PSC 355 commercial check for the PWS selection criteria (Figures 23 and 24). Two race stocks, M-9044-0154 and M-9044-0156, which showed to be significantly better ($P \leq 0.1$) for PWS in the previous chi-squared test, ranked 2nd and 4th respectively. Much like the ranking for WDT, several CRS lines did rank high for PWS, but variability among these lines kept them from being significantly better. Two of these lines, M-9044-0245 and M-9044-0244, exhibited very good averages for percent survival, but these low averages of whitefly survival in M-9044-0245 were skewed by several leaves with low cohort sizes, and M-9044-0244 had only four of the eight leaves suitable for analysis. While M-9044-0244 may contain resistance, some skepticism is warranted until further testing can be conducted.

A third ranking was conducted in which the rankings for both categories, i.e., PWS and WDT, were totaled for each of the CRS and then ranked again for resistance based on this combined total. This ranking determined if any of the CRS, while not being significantly different for either of the two selection criteria, might in fact contain a combined effect of the two criteria that was better than the PSC 355 combined effect. This ranking yielded only 16 CRS that were better than PSC 355 for whitefly resistance (Figures 25 and 26). M-9044-0156 ranked best and was the only CRS of the significantly better CRS from the subscreen chi-squared tests that fell into this category. M-9044-0156 ranked 4th for percent survival and 8th in developmental time. Other significantly better CRS as defined by the subscreens fell between the 52nd and 27th rank in this combined ranking. This separation in rankings indicates that these two characteristics for resistance are probably inherited independent of each other. Another interesting observation from the combined data is that PSC 355 ranked relatively high. This indicates that during development of this commercial line, some amount of whitefly resistance was incorporated.

Cohort Retest of Possible Resistant Cotton Race Stocks: Subsequent screening of promising resistant lines revealed two additional lines, M-0044-0171 and M-9644-0188, that were significantly better ($P \leq 0.1$) than the commercial check for PWS (Table 7 and Figure 27). Of the two CRS that were significantly better in the previous subscreens, only M-9044-0156 continued to show increased levels of whitefly mortality. The other of these lines, M-9044-0154, did not show the same characteristics as observed in the subscreen, and in fact showed levels of whitefly survival that equaled that of the commercial check PSC 355. These results are not meant to show that resistance does not exist in this line, but only to suggest that even further screening is needed. Perhaps variable results were due to variability within this race stock line.

For the other resistant selection criterion, WDT, no CRS was significantly better ($P \leq 0.1$) than the PSC 355 check in the retest screen. Several CRS that were determined to be significantly better ($P \leq 0.1$) in the previous subscreens, however, were numerically better than PSC 355 in this retest screen. These CRS lines included M-9644-0188 and M-9644-0195 (Table 7 and Figure 28). The CRS M-9044-0156 also showed levels of

Table 7. Results of chi-squared test for retest screen, comparing cotton race stocks to commercial checks for whitefly developmental time and percent whitefly survival.

Screen	Race Stock	Developmental time chi*2 value	Better/Worst	Percent Survival χ^2 value	Better/Worst
Retest	M-9044-0068	0.00	W	0.37	
Retest	M-8844-0104	0.94	W	3.31	W *
Retest	M-9044-0154	1.78	W	0.94	W
Retest	M-9044-0156	0.94	B	2.88	B *
Retest	M-0044-0171	0.24	W	3.76	B *
Retest	M-9644-0188	0.01	B	6.49	B **
Retest	M-9644-0195	0.94	B	0.53	W
Retest	M-9044-0212	1.47	B	0.01	B
Retest	M-9044-0215	0.01	W	1.47	B
Retest	M-0044-0221	0.53	W	0.01	B
Retest	M-9644-0224	4.76	W **	1.19	W
Retest	M-9644-0242	2.12	W	2.12	W
Retest	M-9044-0244	0.37	W	1.78	B
Retest	M-9044-0634	0.94	W	0.13	W

* Significantly different from the commercial checks at a 0.1 level.
** Significantly different from the commercial checks at a 0.05 level.

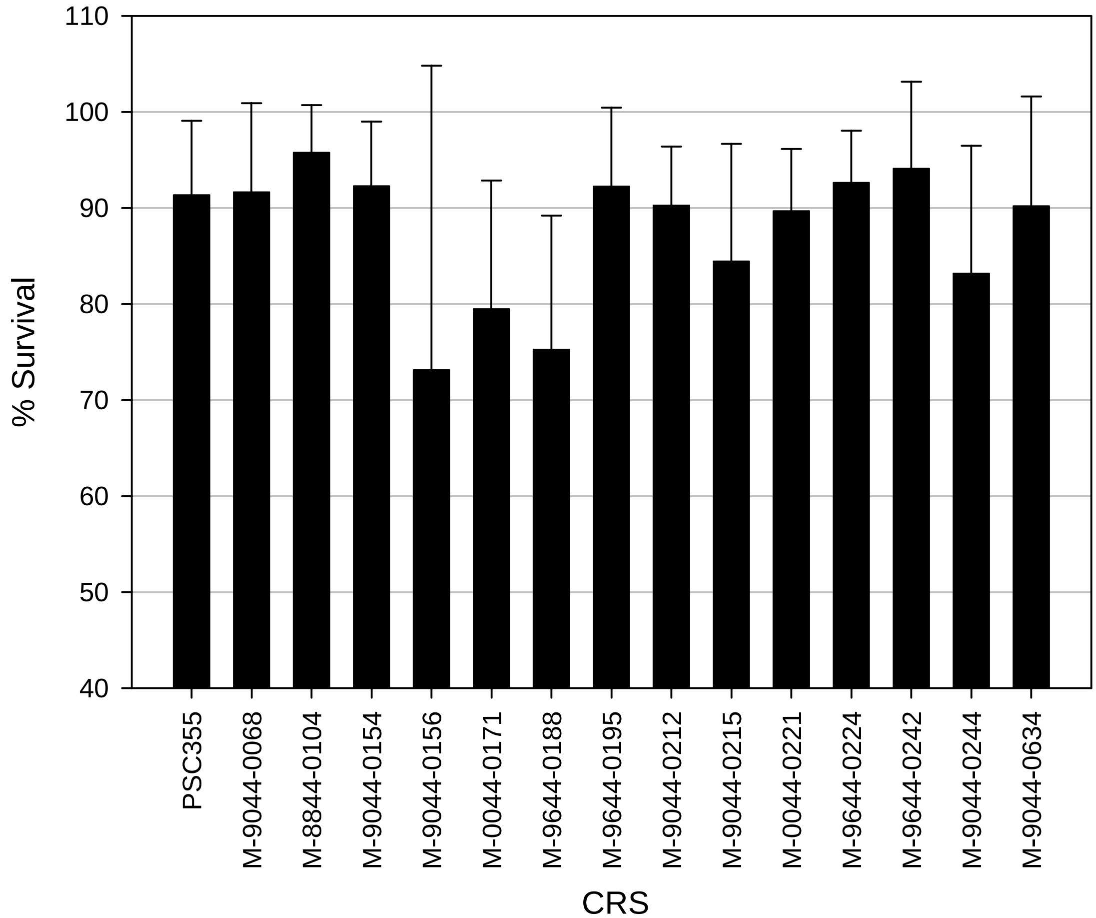


Figure 27. Results of retest screen for percent survival of whiteflies on cotton race stock lines.

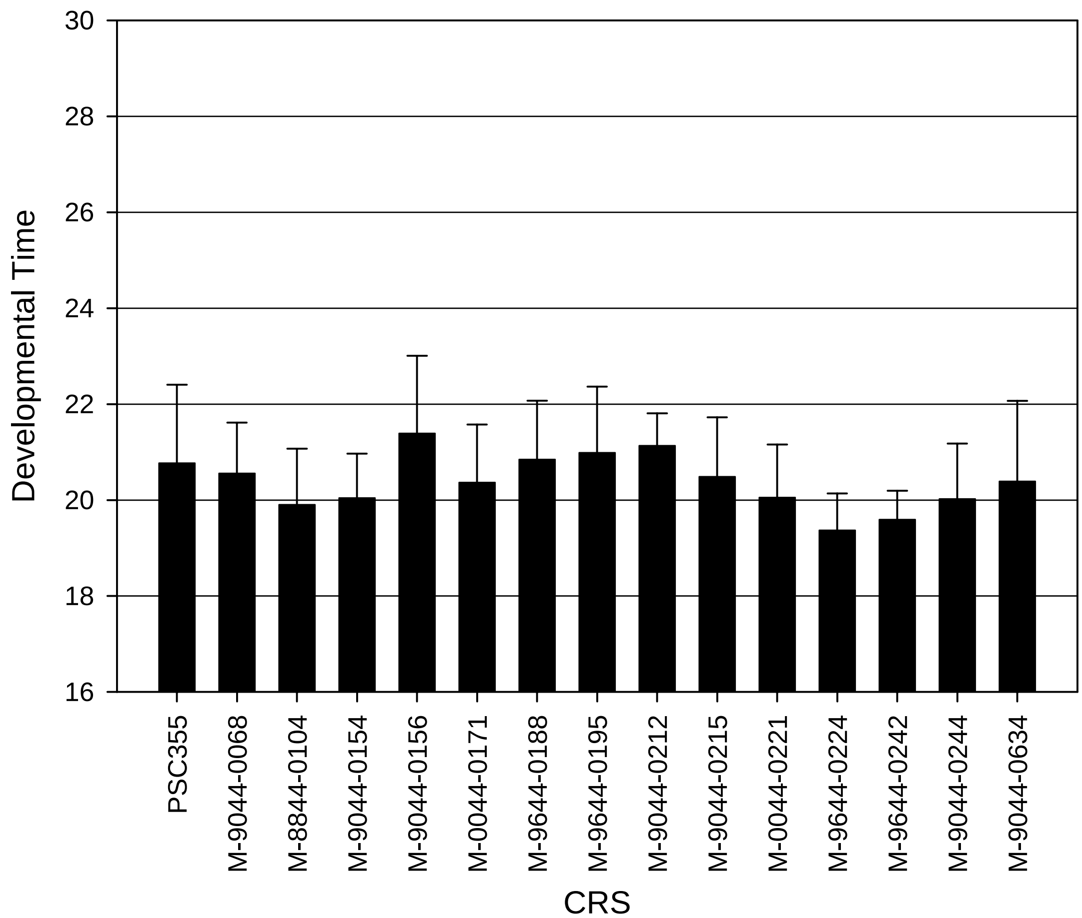


Figure 28. Results of retest screen for developmental time of whiteflies on cotton race stock lines.

increased time of whitefly development, yet was not determined to be significantly better ($P \leq 0.1$) than PSC 355 in this retest screening.

The retest screening not only allowed the rescreening of promising resistant lines, but provided the opportunity to isolate individual plants that showed resistant characteristics as well. The results of the retest screen, along with the initial screening, have allowed the identification of two individual CRS lines that contain potential resistance for both of the selection criteria. In at least one of the two screenings, M-9644-0188 was significantly better than commercial checks for each of these selection criteria. M-9044-0156 was significantly better for PWS in the original screening and had a high average that exceeded that of the commercial check for WDT in the retest screening. M-9044-0156 and M-9644-0188 show good characteristics for more than one type of resistance and should be a priority of any additional work. These CRS could serve as parental material to improve whitefly resistance in cotton.

CHAPTER III

GREENHOUSE EXPERIMENT

Painter (1968) listed three main categories of resistance that included antibiosis, non-preference, and tolerance. Non-preference was described as characteristics of a plant that prevent certain insects from using that plant for food, oviposition, or shelter. A choice test was used to identify resistant characteristics within the 116 CRS following bioassay methods outlined by Harris (1980).

Choice tests were conducted in a greenhouse environment in which 10,000 whiteflies were released on a total of 380 cotton plants, which were periodically examined with replacement until the known susceptibles showed damage, at which time leaf samples were taken and the experiment terminated. This greenhouse method provided a certainty that plants would be infested with whiteflies. Except for slight movements during molting, immature whiteflies do not move after settling of the first instar crawlers (Byrne 2003). This lack of movement allowed the evaluation of all race stocks for ovipositional preference based on the number of immature whiteflies located on leaf samples taken from the greenhouse.

Materials and Methods

Choice Test: A choice test to compare 116 CRS was set up in a greenhouse environment to determine possible host plant resistance to silverleaf whiteflies. All CRS included in the prior laboratory experiments were included in this test (Table 1). Due to space limitations in the greenhouse, each of the 116 cotton race stocks was replicated only 3 times. To determine a base line of resistance, two separate commercial checks, PSC 355 and Delta Pearl, incorporated into this test at a rate of 16 pots each. A total of 380 pots were placed in the greenhouse in a completely randomized design. Available pot placement in the greenhouse was as follows:

> Three rows of 18 pots (54 total pots) were placed in the back of the greenhouse located near the cooling wall. A single row of pots was also placed on each side wall. These rows were comprised of 26 and 25 pots respectively. Two large benches made up the middle of the greenhouse, and pots were placed 5 rows across on each bench. Due to existing equipment in the greenhouse, 5 of these rows were of 33 pots in length, and 5 were 22 pots in length (Figure 29).

All pots were filled with Metro Mix® 200 potting soil and were watered just prior to planting. All 116 cotton race stocks and commercial checks were planted at a rate of two seeds per pot to ensure a proper stand. Initially, plants were watered 3 times per week on a schedule of Monday, Wednesday, and Friday. During the later summer months it was determined that this watering schedule was insufficient, and watering was conducted every other day from that point on. Fertilization of all plants was conducted as needed, and was accomplished using a fertilization plan that included applications of Scotts Peters Professional® 20-20-20 General Purpose fertilizer at a rate of .21 tablespoon per liter. Fertilization was accomplished using a hose line fertilizer injection system, which allowed fertilizer to be applied during the normal watering schedule.

Greenhouse Cooling Wall

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
	55			81	114	147	180	213	246	268	290	312	334			356	
	56			82	115	148	181	214	247	269	291	313	335			357	
	57			83	116	149	182	215	248	270	292	314	336			358	
	58			84	117	150	183	216	249	271	293	315	337			359	
	59			85	118	151	184	217	250	272	294	316	338			360	
	60			86	119	152	185	218	251	273	295	317	339			361	
	61			87	120	153	186	219	252	274	296	318	340			362	
	62			88	121	154	187	220	253	275	297	319	341			363	
	63			89	122	155	188	221	254	276	298	320	342			364	
	64			90	123	156	189	222	255	277	299	321	343			365	
	65			91	124	157	190	223	256	278	300	322	344			366	
	66			92	125	158	191	224	257	279	301	323	345			367	
	67			93	126	159	192	225	258	280	302	324	346			368	
	68			94	127	160	193	226	259	281	303	325	347			369	
	69			95	128	161	194	227	260	282	304	326	348			370	
	70			96	129	162	195	228	261	283	305	327	349			371	
	71			97	130	163	196	229	262	284	306	328	350			372	
	72			98	131	164	197	230	263	285	307	329	351			373	
	73			99	132	165	198	231	264	286	308	330	352			374	
	74			100	133	166	199	232	265	287	309	331	353			375	
	75			101	134	167	200	233	266	288	310	332	354			376	
	76			102	135	168	201	234	267	289	311	333	355			377	
	77			103	136	169	202	235								378	
	78			104	137	170	203	236								379	
	79			105	138	171	204	237								380	
	80			106	139	172	205	238									
				107	140	173	206	239									
				108	141	174	207	240									
				109	142	175	208	241									
				110	143	176	209	242									
				111	144	177	210	243									
				112	145	178	211	244									
				113	146	179	212	245									

Figure 29. Map of available pot placement in whitefly greenhouse.

Once a proper stand was ensured, pots were thinned to one plant per pot, and plants were allowed to grow to approximately the 4th true leaf stage. At this time all plants were rated for health, actual growth stage, and any prior insect infestations. Other arthropod infestations that could be observed in this initial rating included isolated infestations of thrips, aphids, spider mites, and several worm species. None of these insect infestations ever reached levels that would jeopardize the experiment. Once plants became large enough, bamboo stakes were used throughout the greenhouse to support all plants.

Whitefly infestation of the greenhouse occurred once the fourth true leaf stage was observed over most of the plants in the greenhouse. Initially, 4,000 whiteflies were released as evenly as possible throughout the entire greenhouse. On the following day another 4,000 whiteflies were released in the same manner, and then 2,000 the day after that, giving a total of 10,000 whiteflies. This entire whitefly infestation averaged approximately 26 adult whiteflies per plant. Whiteflies originated from caged colonies kept in the greenhouse and used for the excised leaf tests. Voucher specimens for this experiment were taken from this colony and placed in the Texas A&M University Insect Collection under voucher #643.

The experiment was to be terminated when the commercial checks scattered throughout the greenhouse began to show high levels of whitefly damage. At that time all cotton race stocks and commercial checks were rated for plant growth stage, plant health, and whitefly damage. Following termination of the experiment, plants were also inspected, and leaf samples were taken from the top leaves of the plants. These leaves were taken back to the lab, and counts from 2 previously determined sites on each leaf were made with the aid of a 12x dissecting microscope to determine the number of whitefly eggs and immatures. These two counts were added together to give a total whitefly count for each leaf. Each count was made on a 1.5 cm diameter circle of leaf located near the area of leaf vein convergence. These egg and immature whitefly counts were compared between race stocks in order to determine if any non-preference resistant characteristics exist among these 116 cotton race stocks.

Temperature Zones: Shortly after whitefly infestation of the greenhouse, it was observed that whiteflies seem to congregate in certain areas of the greenhouse and not in others. The cause of this behavior was determined to be inadequate cooling of the greenhouse, which caused a steep temperature gradient from the front of the greenhouse to the back. Areas near the cooling pads were unable to sustain whitefly populations, while some areas of the greenhouse seemed to draw whiteflies from other locations due to an increase in temperature. This problem of temperature gradience was only intensified during the hot summer months.

Due to this event, twenty one indoor/outdoor thermometers were placed evenly throughout the entire greenhouse to identify temperature zones, as well as to determine the extent of the temperature gradient. Minimum and maximum daily temperatures were observed and recorded for a period of three weeks. From this data the greenhouse was divided into individual temperature zones. Each temperature zone was analyzed separately in order to prevent excessive escapes caused by decreased temperatures along the front of the greenhouse.

Results and Discussion

Temperature Zones: Temperature gradients throughout the greenhouse were discovered and were determined to be problematic. However, the extent of this problem was not as great as anticipated upon its discovery. Using the daily maximum temperature from the thermometers spread throughout the greenhouse, a map was produced to identify these zones of temperature differences (Figure 30). A total of four temperature zones were identified and their temperature ranges were as follows: Zone A: 90 - 110˚F, Zone B: 110 - 115˚F, Zone C: 115 - 120˚F, Zone D: 120 - 125˚F.

Originally a steep incline was expected in the immature whitefly counts as we moved from zones of lower temperature to zones of higher temperatures. This incline was very prominent in zones A and B as the temperature increased; however, zones C and D did not show the same characteristics. A map detailing the egg and immature whitefly counts from leaf samples was created (Figure 31) and compared to the temperature zone map. Observations of these two maps yielded no patterns that showed an increase in whitefly counts as the temperature increased. In zones C and D, certain peaks of whitefly densities were observed; however, these peaks could not be explained by temperature increases. No explanation could be given for these peaks that would suggest causes other than individual plants within the experiment that were extremely susceptible to whitefly oviposition, and thus caused surrounding plants to exhibit high whitefly immature counts as well. Due to this observation, zones C and D were considered equal and analyzed together. The majority of the greenhouse screen was located in zones C and D, which contained a total of 310 plants. Whitefly presence in

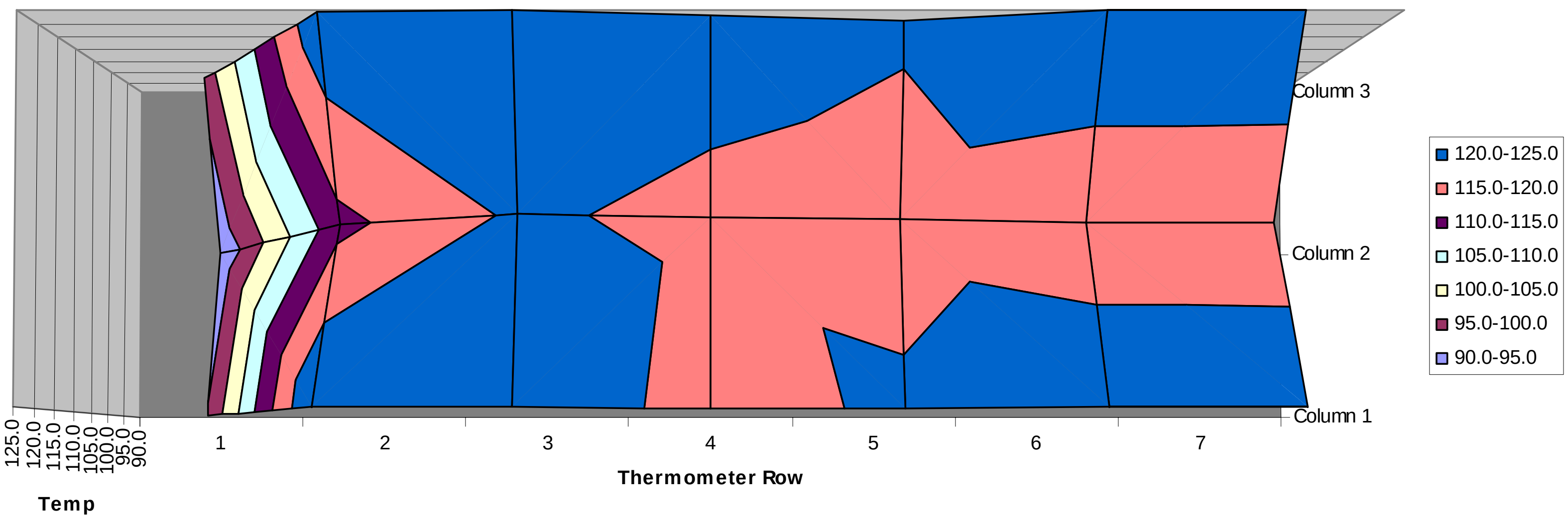


Figure 30. 3-D map of individual temperature zones spread throughout whitefly greenhouse.

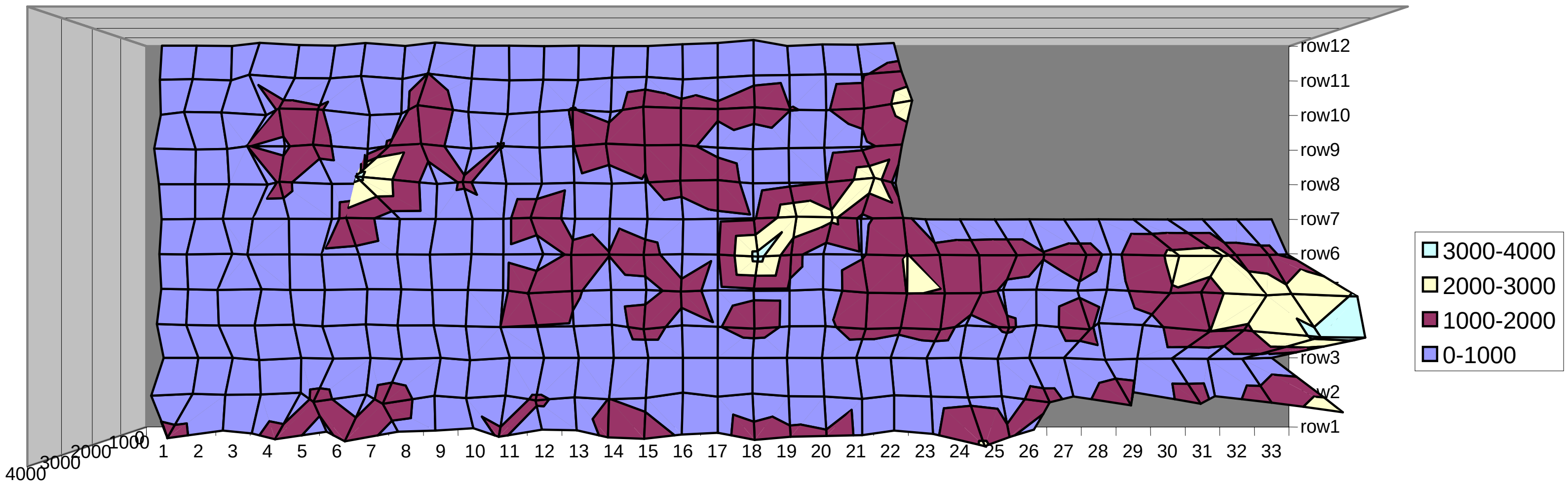


Figure 31. 3-D map of egg and immature whitefly counts in greenhouse zones B, C, and D.

both zones A and B were low enough that no reasonable assumptions could be made towards resistance, and therefore zones A and B were not considered during the analysis of this experiment.

With zones C and D exhibiting temperatures ranging from 115-125˚F, the only concern is that these levels could be outside the whiteflies' limit of survivable temperatures. However, the increased temperatures of the greenhouse provided an environment that maximized the reproductive capabilities of the whitefly population. Whitefly immature counts ranging from 68 to 2,800 on commercial checks throughout the greenhouse indicate that whiteflies can, in fact, survive in this environment, and that elevated whitefly infestations were achieved for this experiment.

Choice Test: With zones A and B being discarded from the experiment, certain race stocks were left without their second and third replicates. Because of this, it was decided that analysis should be done on individual plants within the greenhouse instead of on each separate cotton race stock line. The amount of variability known to exist within individual cotton race stock lines was also considered when making this decision. With replication only ranging from 1 to 3, it was felt that average immature whitefly counts could mask resistant characteristics within cotton race stock lines that might only be observed in a small portion of the total race stock line.

Ideally, resistant race stock lines would be classified as those lines that showed whitefly counts that were lower than 2 standard deviations from the average whitefly count of the best commercial check. For this experiment, this criterion would eliminate all cotton race stocks from the possibility of containing resistant characteristics.

Therefore, all race stocks distanced one standard deviation from the average whitefly count of the best commercial check were considered as having possible resistance to whitefly oviposition. Analysis in this manner does, however, create a larger chance of escapes throughout the experiment.

Delta Pearl was shown to have the lowest average whitefly count of the two commercial checks in the experiment. For the leaf samples, Delta Pearl exhibited an average of 504.5 ± 351 eggs/immature whiteflies; whereas PSC 355 had an average of 1181.5 ± 464.5 eggs/immature whiteflies. Therefore, leaf counts from the Delta Pearl commercial check set the cutoff point for possible resistance at 153 eggs/immature whiteflies. Only 21 out of the 310 possible plants in the experiment fell into this possible resistant category (Figure 32). Leaf samples for this category yielded counts that ranged from 21 to 153 eggs/immature whiteflies. All other plants contained counts which ranged from 156 eggs/immature whiteflies all the way to 3,356 eggs/immature whiteflies (Table 8).

The possible resistant classification of this greenhouse experiment contained two cotton race stocks, M-9044-0156 and M-9644-0188, which were considered significantly different from commercial checks in the previous laboratory experiments. Both of these race stocks exhibited egg/immature whitefly counts that were on the extreme low end of the spectrum, and neither exceeded a count of 50. This indicates that these two lines not only contain antibiosis resistant characteristics to whiteflies, but may possibly contain non-preference resistant characteristics as well. These race stocks that contain two different mechanisms of resistance could be very important in the development of

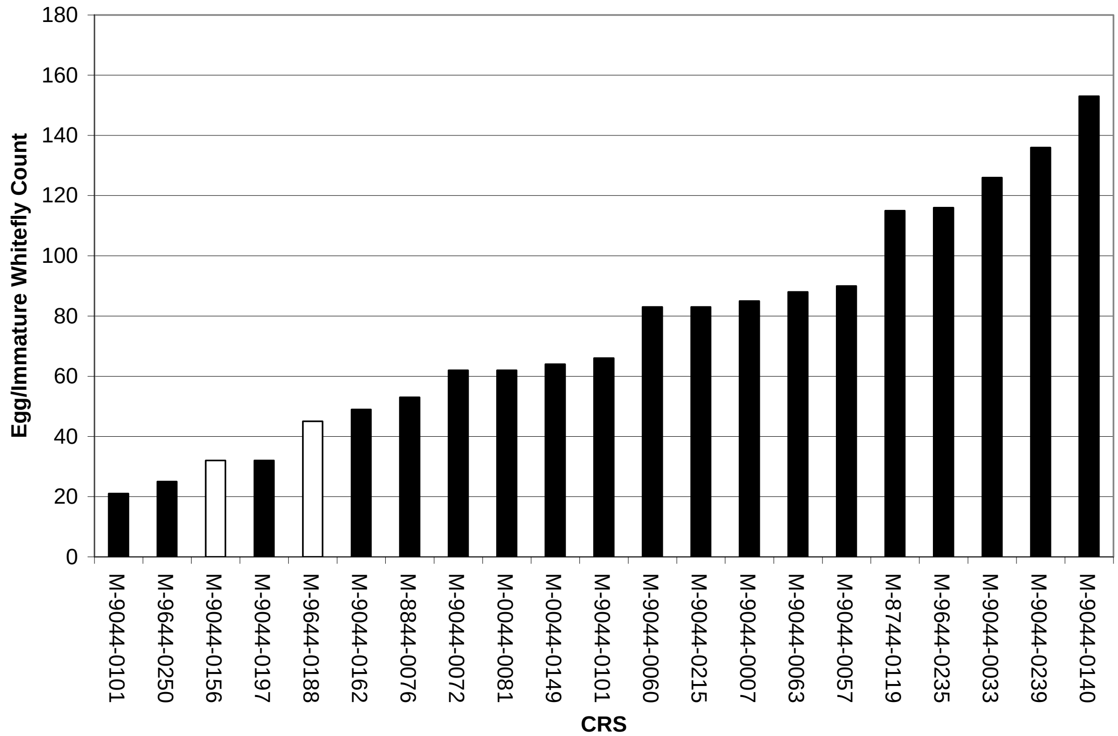


Figure 32. 21 possible resistance race stock lines based on greenhouse whitefly test.

Table 8. Leaf sample whitefly counts from greenhouse experiment.

Plant Position in Greenhouse	TEMP ZONE	CRS	Rep	Total Eggs	Total Nymphs	TOTAL Egg + Nymph
96	C	M-9044-0101	1	21	0	21
367	D	M-9644-0250	3	24	1	25
369	D	M-9044-0156	2	32	0	32
215	C	M-9044-0197	3	32	0	32
363	D	M-9644-0188	3	45	0	45
358	C	M-9044-0162	1	49	0	49
370	D	M-8844-0076	1	52	1	53
374	D	M-9044-0072	2	62	0	62
344	D	M-0044-0081	3	61	1	62
315	C	M-0044-0149	1	64	0	64
365	D	M-9044-0101	3	66	0	66
368	D	Delta Pearl	3	66	2	68
357	C	Delta Pearl	6	71	4	75
336	C	M-9044-0060	1	82	1	83
366	D	M-9044-0215	2	82	1	83
85	D	M-9044-0007	1	77	8	85
318	D	M-9044-0063	2	88	0	88
361	D	M-9044-0057	1	90	0	90
291	C	M-8744-0119	1	113	2	115
312	C	M-9644-0235	2	95	21	116
346	D	M-9044-0033	2	119	7	126
269	C	M-9044-0239	1	122	14	136
360	D	M-9044-0140	3	152	1	153
334	C	M-8844-0055	1	156	0	156
224	D	Delta Pearl	8	165	0	165
345	D	M-8744-0053	2	169	2	171
379	D	M-9044-0212	3	170	2	172
64	D	M-9644-0027	1	177	0	177
270	C	M-9644-0250	1	132	50	182
98	C	M-8744-0174	2	178	5	183
349	D	M-8844-0102	3	171	17	188
376	D	M-0044-0050	1	181	12	193
375	D	M-9644-0083	1	228	0	228
307	C	M-9644-0089	2	208	26	234
132	C	M-9644-0188	2	240	0	240
371	D	M-9044-0155	3	236	5	241
335	C	M-9044-0165	2	244	1	245
82	C	M-8744-0106	1	223	23	246
296	D	M-9044-0040	1	249	0	249
322	D	M-9044-0247	1	247	4	251

Table 8. cont.

Plant Position in Greenhouse	TEMP ZONE	CRS	Rep	Total Eggs	Total Nymphs	TOTAL Egg + Nymph
186	D	Delta Pearl	5	255	4	259
131	C	M-8744-0088	2	197	64	261
292	C	M-8744-0106	2	263	1	264
341	D	M-0044-0178	3	241	24	265
255	D	M-9044-0182	3	265	0	265
276	D	M-8744-0106	3	271	2	273
228	C	M-9644-0240	2	276	1	277
273	C	Delta Pearl	14	269	18	287
260	C	M-9044-0077	2	278	13	291
183	C	M-9044-0007	3	299	0	299
251	C	M-9044-0072	3	274	26	300
343	D	M-0044-0093	3	334	1	335
128	C	M-0044-0763	3	312	25	337
87	D	M-0044-0764	1	337	0	337
84	D	M-9044-0170	3	337	5	342
378	D	M-0044-0338	2	342	0	342
80	D	M-9044-0226	1	343	3	346
319	D	M-9044-0212	1	336	13	349
187	D	M-9644-0240	3	346	3	349
279	D	M-8744-0088	3	351	1	352
299	D	M-9044-0641	1	353	1	354
66	D	M-0044-0636	2	359	3	362
83	C	M-9044-0048	1	305	61	366
199	C	M-0044-0041	3	368	0	368
222	D	M-9044-0060	2	368	1	369
278	D	M-0044-0081	1	361	8	369
339	D	M-9044-0062	1	375	2	377
377	D	M-8844-0102	2	327	51	378
118	D	M-0044-0041	1	339	44	383
153	D	M-0044-0725	1	345	38	383
362	D	M-9044-0215	1	363	24	387
372	D	M-8744-0168	3	390	0	390
232	C	M-9044-0154	3	360	32	392
359	D	M-9644-0073	1	403	0	403
254	D	M-9044-1000	3	401	6	407
338	D	M-8744-0053	3	408	1	409
281	D	M-9044-0072	1	401	9	410
274	C	M-0044-0241	3	419	0	419
67	D	M-8744-1149	2	412	7	419

Table 8. cont.

Plant Position in Greenhouse	TEMP ZONE	CRS	Rep	Total Eggs	Total Nymphs	TOTAL Egg + Nymph
160	C	M-8744-0087	2	324	97	421
102	C	M-9044-0182	2	411	19	430
364	D	M-9044-0164	3	434	0	434
76	D	M-9044-0247	2	385	50	435
347	D	M-9644-0240	1	436	0	436
63	D	M-9044-0036	1	379	58	437
181	C	M-9044-0074	2	418	19	437
151	C	M-9644-0224	3	397	43	440
253	C	M-9644-0195	2	277	168	445
57	C	M-9644-0188	1	443	19	462
285	C	M-0044-0338	1	469	0	469
350	D	Delta Pearl	10	435	38	473
248	C	M-0044-0636	3	447	32	479
91	D	M-9044-0239	3	425	61	486
114	C	M-0044-0219	2	486	2	488
207	C	Delta Pearl	9	475	19	494
81	C	M-8744-0175	2	511	0	511
205	C	M-9044-0002	2	515	0	515
308	C	M-0044-0050	3	507	10	517
89	D	M-9044-0237	1	488	34	522
148	C	M-0044-0620	2	519	7	526
175	D	M-0044-0763	2	531	2	533
172	D	M-0044-0338	3	516	19	535
314	C	PSC 355	3	549	0	549
170	D	M-8744-0088	1	550	0	550
99	D	M-9044-0045	3	524	29	553
155	D	PSC 355	1	557	1	558
348	D	M-8744-1149	1	555	16	571
111	D	PSC 355	6	468	111	579
105	D	M-9044-0247	3	453	132	585
62	D	M-8744-0175	1	560	28	588
60	D	M-9044-0117	3	530	63	593
162	C	M-9044-0031	3	508	87	595
193	C	Delta Pearl	11	594	2	596
100	D	M-8844-0120	1	570	30	600
107	D	M-9644-0116	3	476	130	606
309	C	M-0044-0064	1	601	7	608
154	D	Delta Pearl	16	611	6	617
289	C	M-8744-0091	1	494	123	617

Table 8. cont.

Plant Position in Greenhouse	TEMP ZONE	CRS	Rep	Total Eggs	Total Nymphs	TOTAL Egg + Nymph
103	D	M-8744-0174	3	622	0	622
306	C	M-9044-0077	3	453	171	624
313	C	M-9044-1000	2	625	0	625
133	C	M-8744-0158	2	562	68	630
135	C	M-8744-0257	3	634	0	634
245	C	M-9044-0007	2	587	48	635
97	C	M-8844-0113	1	495	143	638
301	D	M-9044-0036	3	642	0	642
129	C	M-8844-0100	1	630	12	642
220	C	M-9044-0077	1	643	1	644
321	D	M-9044-0633	2	646	0	646
258	C	Delta Pearl	13	647	0	647
184	C	PSC 355	16	653	0	653
150	C	M-9644-0216	3	619	34	653
149	C	M-9044-0140	1	492	162	654
189	D	PSC 355	5	546	115	661
194	C	M-0044-0347	1	649	19	668
325	D	M-0044-0209	1	669	0	669
204	C	M-9044-0030	2	670	0	670
323	D	M-0044-0764	2	646	24	670
340	D	PSC 355	14	687	1	688
217	C	M-9644-0195	1	696	0	696
185	C	M-9044-0634	2	645	51	696
188	D	M-0044-0347	2	699	2	701
256	D	M-8844-0076	2	630	73	703
182	C	M-9044-0068	1	697	8	705
223	D	M-9044-0156	3	684	23	707
196	C	M-0044-0173	2	667	41	708
71	C	Delta Pearl	2	565	145	710
250	C	M-8844-0104	3	613	102	715
190	D	M-0044-0636	1	701	21	722
93	D	M-9044-0197	2	709	21	730
249	C	M-8744-0091	3	476	257	733
120	D	M-9044-0206	3	684	50	734
240	C	M-8744-0091	2	739	0	739
373	D	M-9044-1000	1	745	0	745
286	C	M-0044-0347	3	751	1	752
104	D	M-9644-0250	2	754	0	754
351	D	M-9644-0242	2	716	54	770

Table 8. cont.

Plant Position in Greenhouse	TEMP ZONE	CRS	Rep	Total Eggs	Total Nymphs	TOTAL Egg + Nymph
310	C	M-0044-0041	2	630	145	775
262	C	M-8744-0168	1	626	154	780
266	C	M-9044-0154	1	780	1	781
280	D	M-9044-0180	1	583	205	788
58	D	M-9044-0033	1	762	28	790
95	C	PSC 355	10	536	257	793
259	C	M-9044-0151	3	791	10	801
166	C	M-9044-0017	2	810	2	812
219	C	M-8744-0119	2	814	0	814
121	D	M-8844-0121	2	525	292	817
165	C	M-9644-0029	2	807	22	829
77	D	M-9044-0245	2	822	10	832
352	D	Delta Pearl	15	636	198	834
152	D	M-0044-0221	1	785	53	838
198	C	M-0044-0050	2	793	48	841
197	C	M-0044-0221	2	766	83	849
90	D	M-8744-0228	2	533	318	851
206	C	M-9644-0027	2	819	34	853
156	D	M-0044-0173	1	863	0	863
221	D	M-9044-0124	1	870	0	870
218	C	M-9044-0043	1	882	0	882
159	D	M-9644-0199	2	874	8	882
233	C	M-9644-0238	2	888	0	888
263	C	M-9044-0057	3	792	102	894
337	D	M-9044-0024	3	899	1	900
353	C	M-0044-0149	2	707	199	906
70	C	M-9044-0244	2	694	217	911
354	C	M-9044-0045	2	680	240	920
294	C	M-9044-0162	2	917	3	920
229	C	M-9644-0216	1	880	44	924
282	C	M-9044-0032	3	920	16	936
163	C	M-9044-0067	3	931	16	947
158	D	M-9644-0089	1	921	29	950
101	C	M-8744-0078	2	970	0	970
331	C	M-9044-0164	2	972	0	972
75	D	M-0044-0171	1	807	169	976
302	D	M-9644-0089	3	972	5	977
380	D	M-8844-0055	2	876	125	1001
216	C	M-8844-0120	2	981	20	1001

Table 8. cont.

Plant Position in Greenhouse	TEMP ZONE	CRS	Rep	Total Eggs	Total Nymphs	TOTAL Egg + Nymph
287	C	M-0044-0790	2	1002	0	1002
157	D	PSC 355	8	949	55	1004
293	C	M-8844-0096	2	1008	0	1008
330	C	M-9044-0170	2	1008	1	1009
94	C	M-8744-0326	1	1007	2	1009
342	D	M-9644-0199	1	1004	9	1013
226	C	M-8744-0168	2	1014	3	1017
300	D	M-8844-0104	1	964	66	1030
324	D	M-9044-0197	1	1040	0	1040
126	D	M-9044-0002	3	1010	36	1046
74	C	M-9044-0165	1	766	306	1072
238	C	M-0044-0081	2	940	136	1076
317	D	M-0044-0064	2	1091	0	1091
122	D	M-9044-0057	2	1094	0	1094
137	D	M-9644-0199	3	1094	5	1099
125	D	M-9044-0165	3	1066	42	1108
92	D	M-8744-0119	3	1135	5	1140
192	D	M-9644-0235	3	1141	0	1141
297	D	M-9044-0031	1	1146	2	1148
171	D	M-8744-0087	3	1092	56	1148
116	C	M-9644-0238	3	1151	3	1154
277	D	M-0044-0093	2	1155	0	1155
65	D	M-8744-0158	3	1159	0	1159
328	D	M-9044-0062	2	1167	0	1167
73	C	M-9044-0237	2	1088	82	1170
304	D	M-9044-0633	3	1074	110	1184
79	D	M-8744-0087	1	1182	5	1187
272	C	M-0044-0209	3	912	308	1220
316	D	M-9044-0156	1	1223	1	1224
68	D	PSC 355	9	1188	38	1226
332	C	M-9044-0067	2	985	259	1244
225	C	M-9044-0170	1	1244	0	1244
305	C	M-9044-0068	2	1262	0	1262
168	C	PSC 355	12	1083	180	1263
56	C	M-8844-0121	3	1038	267	1305
231	C	PSC 355	2	1187	129	1316
244	C	Delta Pearl	4	1232	102	1334
86	D	M-9044-0002	1	1343	2	1345
355	D	M-0044-0219	1	1300	52	1352

Table 8. cont.

Plant Position in Greenhouse	TEMP ZONE	CRS	Rep	Total Eggs	Total Nymphs	TOTAL Egg + Nymph
195	C	M-9644-0073	2	1215	139	1354
327	D	M-9044-0124	2	1361	0	1361
295	D	M-9044-0155	2	1372	0	1372
123	D	M-9044-0061	1	890	486	1376
69	C	M-9044-0155	1	797	579	1376
311	C	M-9644-0083	2	1352	40	1392
130	C	M-9044-0063	1	1397	2	1399
164	C	M-9644-0027	3	1418	0	1418
59	D	M-8744-0326	3	1421	0	1421
239	C	M-9044-0151	2	1416	15	1431
106	D	M-0044-0178	1	1319	113	1432
138	D	M-8844-0113	2	1205	243	1448
112	D	PSC 355	13	1312	139	1451
329	D	M-9044-0024	2	1434	36	1470
235	C	M-9644-0235	1	1280	193	1473
134	C	M-8744-0612	2	1471	5	1476
72	C	M-0044-0149	3	1472	11	1483
243	C	M-9044-0061	3	1490	1	1491
227	C	PSC 355	7	1253	248	1501
167	C	M-9644-0029	1	1500	7	1507
117	C	M-0044-0790	3	1080	431	1511
298	D	M-9044-0060	3	1522	4	1526
161	C	M-9044-0074	1	1513	14	1527
326	D	M-9044-0226	2	1423	130	1553
267	C	M-9644-0242	1	1535	19	1554
252	C	M-9044-0151	1	1180	394	1574
169	C	M-9044-0162	3	1407	168	1575
110	D	M-0044-0241	1	1474	114	1588
209	C	M-9044-0063	3	1517	78	1595
88	D	M-0044-0790	1	1255	355	1610
173	C	M-9644-0242	3	1485	135	1620
303	D	M-9044-0150	3	1634	3	1637
61	D	M-9044-0101	2	1267	385	1652
283	C	M-0044-0725	2	1654	10	1664
236	C	M-9644-0083	3	1589	98	1687
127	C	M-8744-1149	3	1716	1	1717
140	D	M-9044-0164	1	1722	0	1722
257	D	M-9044-0045	1	1716	7	1723
237	C	M-9044-0633	1	1734	0	1734

Table 8. cont.

Plant Position in Greenhouse	TEMP ZONE	CRS	Rep	Total Eggs	Total Nymphs	TOTAL Egg + Nymph
200	C	M-9044-0570	1	1777	0	1777
320	D	M-8744-0078	1	1789	0	1789
108	D	M-0044-0221	3	1819	1	1820
177	D	M-9044-0244	3	1463	366	1829
284	C	M-9644-0116	2	1837	0	1837
119	D	M-9044-0634	1	1656	200	1856
203	C	M-9044-0641	3	1729	153	1882
208	C	M-8744-0326	2	1878	27	1905
136	D	M-9044-0140	2	1843	138	1981
202	C	M-9044-0180	3	1995	1	1996
201	C	M-8744-0158	1	2000	3	2003
176	D	M-9044-0117	1	1388	616	2004
191	D	M-0044-0219	3	1812	205	2017
234	C	M-9644-0216	2	1919	110	2029
139	D	M-9044-0043	2	2062	0	2062
78	D	M-9044-0237	3	1876	273	2149
211	C	M-9044-0067	1	2199	2	2201
265	C	M-9044-0212	2	2235	2	2237
143	D	M-9044-0061	2	2068	204	2272
141	D	M-9044-0124	3	1926	384	2310
241	C	M-9044-0074	3	2197	127	2324
124	D	M-9044-0030	1	2390	0	2390
145	D	M-0044-0620	1	2266	220	2486
242	C	M-9044-0043	3	2488	23	2511
333	C	M-9644-0116	1	2540	13	2553
113	D	M-9644-0224	1	2088	559	2647
144	D	M-9644-0029	3	2409	241	2650
288	C	PSC 355	4	2389	289	2678
142	D	M-9044-0068	3	2485	223	2708
210	C	M-8744-0053	1	2389	324	2713
264	C	PSC 355	15	2788	14	2802
212	C	M-9044-0206	1	2474	636	3110
275	D	M-9644-0238	1	2685	528	3213
178	D	M-9044-0154	2	2242	977	3219
230	C	M-8844-0055	3	1993	1317	3310
179	D	M-9044-0048	2	2658	698	3356

whitefly resistant cotton varieties. Therefore, it is very important that further analysis be done on these two lines to determine if non-preference characteristics do exist, or whether these plants were simply escapes.

Another interesting observation of the greenhouse experiment data was that the Delta Pearl commercial checks seemed to outperform PSC 355 with regards to whitefly oviposition. This is contrary to the previous laboratory experiments which indicated that PSC 355 was the more whitefly resistant of the two commercial checks. These data suggest that while PSC 355 has better antibiosis resistant characteristics, Delta Pearl contains better non-preference resistant characteristics that deter whitefly oviposition. While it cannot be determined which characteristics would lead to a more whitefly resistant plant, a combination of the two characteristics would be ideal for a resistance to whiteflies.

CHAPTER IV

FIELD EXPERIMENT

Painter (1968) listed three main categories of resistance: antibiosis, non-preference, and tolerance. Non-preference was described as characteristics of a plant that prevent certain insects from using that plant for food, oviposition, or shelter. Of the five bioassay methods described by Harris (1980), field screenings were chosen for use in this experiment to determine if non-preference resistant characteristics existed within 116 separate cotton race stocks.

Field screening reflects an agricultural environment by allowing resistant candidates and known susceptible cultivars to be evaluated in a natural agricultural setting. Field screening also provides an opportunity to observe and make selections for insect resistance among large amounts of plant material (Harris 1980). While field screenings provide many benefits in these aspects, they also are susceptible to environmental factors that do not affect other bioassay techniques and depend upon natural densities of insects for infestation. Bioassay techniques such as this are needed to validate findings from other experiments and to determine how putative resistances will perform in a natural agricultural setting.

Materials and Methods

College Station Field Evaluations: Field evaluations were conducted on 104 of the 116 CRS (Table 1) included in the laboratory experiments noted above. The 12 CRS not included in the field evaluation were M-9644-0027, M-9644-0029, M-0044-0041, M-

0044-0050, M-0044-0064, M-9644-0073, M-0044-0081, M-9644-0083, M-9644-0089, M-0044-0093, M-9644-0116, and M-0044-0149. Field evaluations were conducted on an existing seed increase plot located at the Texas A&M Research Farm near College Station, TX.

The observation plots included both a dryland and irrigated planting of unreplicated 2-row plots, 12 m x 100 cm. Commercial checks were not available in this block; however, PSC 355 and Delta Pearl were present in adjacent fields approximately 100 m from the CRS observation. Observations were made on these commercial cultivars to obtain a base line of possible resistance to compare with all race stocks in the seed increase plot.

Multiple ratings were taken within rows of each race stock by selecting four plants within the row at distances approximately 2, 5, 8, and 11 m from the first plant. Ratings were conducted for four consecutive weeks and were taken at these locations for the following: aphids on terminal leaves, aphids on the uppermost fully expanded leaf of the plant, whitefly adults on the uppermost fully expanded leaf of the plant, whitefly pupae on the lower 1/3 of the plant, and whitefly pupae on the upper 1/3 of the plant. All ratings were conducted on single leaves selected at random from these areas. During the four consecutive weeks, individual ratings were taken in approximately the same area. However, the same leaves were not used from week to week.

Ratings for all criteria were carried out on a 1-5 numerical scale as follows:

<u>Terminal aphids</u>
(**1** = 0-10, **2** = 11-20, **3** = 21-30, **4** = 31-40, and **5** = 41+)

<u>Aphids on first fully expanded leaf</u>
(**1** = 0-15, **2** = 16-35, **3** = 36-55, **4** = 56-90, and **5** = 91+)

Whitefly adults on first fully expanded leaf
(**1** = 0-5, **2** = 6-10, **3** = 11-15, **4** = 16-20, and **5** = 21+)

Whitefly pupae on lower 1/3 of the plant
(**1** = 0-25, **2** = 26-75, **3** = 76-125, **4** = 126-175, and **5** = 176+)

Whitefly pupae on upper 1/3 of the plant
(**1** = 0-25, **2** = 26-75, **3** = 76-125, **4** = 126-175, and **5** = 176+)

Weslaco Field Evaluations: All 116 cotton race stocks (Table 1) were planted at the Texas A&M Research and Extension Center at Weslaco, Texas, and evaluated for infestation of whiteflies and aphids, with whiteflies being of major concern. Plots were single rows, 10 m x 97 cm, arranged in blocks of 24 rows; 18 cotton race stocks along with PSC 355 and Delta Pearl spaced out every sixth and seventh row respectively. The entire field was surrounded by border rows planted to PSC 355, and a 2.7 m alley between blocks, which was planted with Primor cantaloupe seed (*Cucumis melo* Linnaeus).

The cantaloupe-filled alleys served to quickly attract and develop colonies of whiteflies in the field during the early stages of development of the cotton race stocks. In addition to the cantaloupe planted in the alleys, application of a ¼ strength pyrethroid insecticide was applied during early season to kill beneficial insects and flare populations of both whiteflies and aphids. During the later stages of development, the cantaloupe-filled alleys were plowed down to destroy the cantaloupe plants and force the whiteflies onto the cotton race stocks.

Field observations were to be conducted once the whitefly populations reached levels that were capable of causing noticeable damage in the commercial check. At this time both cotton race stocks and commercial checks were to be rated on a 1-5 scale, in the same manner as the College Station field observations. The rating guide was as follows:

Terminal aphids
(**1** = 0-10, **2** = 11-20, **3** = 21-30, **4** = 31-40, and **5** = 41+)

Aphids on first fully expanded leaf
(**1** = 0-15, **2** = 16-35, **3** = 36-55, **4** = 56-90, and **5** = 91+)

Whitefly adults on first fully expanded leaf
(**1** = 0-5, **2** = 6-10, **3** = 11-15, **4** = 16-20, and **5** = 21+)

Whitefly pupae on lower 1/3 of the plant
(**1** = 0-25, **2** = 26-75, **3** = 76-125, **4** = 126-175, and **5** = 176+)

Whitefly pupae on upper 1/3 of the plant
(**1** = 0-25, **2** = 26-75, **3** = 76-125, **4** = 126-175, and **5** = 176+)

In addition to these ratings, observations also were to be made for insect damage that was seen throughout the plot. Data for all cotton race stocks were to be compared to the commercial checks to identify race stocks that showed both non-preference as well as tolerance characteristics superior to that of the commercial checks.

Results and Discussion

College Station Field Observations: During initial field observations, data were recorded only for aphid and adult whitefly populations on the first fully expanded leaves. Ratings for both commercial checks, PSC 355 and Delta Pearl, were conducted within single rows of an adjoining research plot. During subsequent ratings, data were recorded for all five criteria, and observations of the commercial checks were increased to include four replications. Throughout the weekly ratings, whitefly populations consisted mostly of bandedwinged whitefly, *Trialeurodes abutilonea* (Haldeman), with few observations of sweetpotato whitefly, *Bemisia tabaci* (Gennadius). Aphid populations throughout the field consisted of cotton aphid, *Aphis gossypii* Glover.

Problems arose with certain aspects of this plan as the experiment progressed. Ratings were taken in both dryland and irrigated fields in order to determine if drought stress could affect resistant characteristics in CRS. Enough rain was received throughout the experiment so that irrigation was not required. Therefore, instead of testing how stress affects resistant characteristics, the test was reduced to simply screening for resistance with supplementary replications.

In addition, uniform insect populations never reached adequate levels to allow discrimination among these CRS. The lack of insects was attributed to two separate factors. First, cotton insect populations as a whole were low for the area in this particular year. Secondly, numerous broad-spectrum insecticide applications were made to this plot by the Texas Boll Weevil Eradication Program that were beyond our control. Insecticide was also applied by the cotton breeder to ensure that smaller populations of worm pests did not destroy plants that were needed for seed stocks.

College Station field observations were terminated after the fourth week due to a lack of insect populations. It was determined that it was too late in the growing season for any insect populations to be able to increase to high enough levels to be useful for this experiment. Because of insufficient insect pressure, field observation data were not analyzed for this experiment. However, the data have been provided as an appendix (Appendix A).

Weslaco Field Observations: Several CRS were replanted due to stand failure, probably due to variation in seed quality across the CRS. Another problem that existed in the experiment included excessive weed populations during early stages of cotton development. However, weeds were pulled by hand and removed from the field when cotton plants reached approximately the 8^{th} true leaf stage.

Throughout this experiment both whitefly population levels and whitefly damage were monitored in order to determine the proper time to rate all race stocks for whitefly resistance. Sufficient field populations were never reached during this experiment due to decreased levels of insect pressure for the region as a whole during this particular summer. Even after cantaloupe plants were destroyed, few whiteflies were observed in the field. Thus, no resistance data were collected.

CHAPTER V

CONCLUSION

This research was designed to identify both antibiosis and non-preference resistant characteristics in 116 CRS. While greenhouse and field studies did not yield the quality of data desired, laboratory screens were able to identified seven different lines that contained antibiotic resistant characteristics. Two of these lines have become of increased importance due to their ability to out compete commercial checks for both of the resistant selection criteria used in this study, namely, whitefly survival and developmental time. One of these two CRS, M-9644-0188, was found to be significantly better that the commercial checks for both of the selection criteria. The other of these CRS, M-9044-0156, was found to be significantly better than PSC 355 for whitefly survival, but was not significantly better for developmental time. However, averages obtained during screenings as well as rankings of all race stocks suggest that this line does contain the ability to delay whitefly development.

Future work in this area should include further investigation of the seven race stocks that were found to be significantly better than the commercial checks for either or both of the selection criteria, whitefly developmental time and percent whitefly survival. One item that still needs to be studied is to determine the exact mechanisms of resistance that are acting in each of these lines. Once this is resolved, heritability studies must be done to find out if these characteristics can be transferred into other lines through breeding. Tests must also be conducted to clarify whether these resistant characteristics are linked to any traits that would convey plant characteristics of low agronomic value. Testing is currently underway to determine the amount of variability that exists within six of the seven lines identified above.

The screening method used throughout the laboratory experiments has proven to be very beneficial. Field studies can be very unpredictable, as has been shown in the field observations that were conducted for this research. Insect populations are not always sufficient and environmental factors are not always cooperative for scientific studies. This laboratory screening method has served its purpose during this research and the technique can be modified slightly to accommodate many different sucking pests. At the present time protocols are being tested to continue this line of research for both aphids as well as thrips.

During the current research presented here, 116 CRS were screened. There are currently 2,300 available cotton race stocks in the Texas Race Collection subgroup of the Cotton Germplasm Collection (Percival 1987). It is believed that these race stocks contain a wide array of genetic traits that could allow for advances to be made in host plant resistance. Most of these lines contain a day length sensitive flowering characteristic, which limits their value to breeders in the United States. The advantage of screening these cotton race stocks with methods such as the laboratory protocol used here is that the flowering characteristic of the plant is no longer applicable. Since only the leaves of the plant are used, it is not necessary to convert all lines before they are screened. Conversion could be delayed until resistance is found within these lines that would justify their inclusion in the conversion process. Therefore, by using this method of screening as a means for determining resistant candidates among the 2,300 available race stock lines, it is possible to save both time and money that would be spent on the conversion of unpromising cotton race stock lines.

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APPENDICES

Appendix A. College Station irrigated field observations.

Week#1	**Rating #1**		**Rating #2**		**Rating #3**		**Rating #4**	
CRS	AL	WA	AL	WA	AL	WA	AL	WA
M-9044-0002	3	1	2	1	5	1	4	1
M-9044-0007	1	1	1	3	1	1	1	1
M-9044-0017	2	3	3	1	1	3	1	1
M-9044-0024	1	1	1	1	2	1	1	1
M-9044-0030	2	1	1	1	1	1	1	2
M-9044-0031	2	1	2	1	1	1	1	1
M-9044-0032	1	1	1	1	1	1	1	1
M-9044-0033	1	2	2	1	1	1	1	2
M-9044-0036	1	1	2	1	1	3	1	4
M-9044-0040	5	1	3	1	2	1	2	1
M-9044-0043	1	1	1	1	1	1	2	1
M-9044-0045	1	1	1	1	5	1	2	1
M-9044-0048	5	1	1	1	1	1	1	2
M-8744-0053	3	1	1	1	1	1	1	1
M-8844-0055	1	1	1	1	1	1	1	2
M-9044-0057	1	1	1	1	1	1	1	1
M-9044-0060	1	1	1	1	1	1	1	1
M-9044-0061	2	2	1	1	1	1	1	2
M-9044-0062	2	5	1	1	1	3	1	1
M-9044-0063	1	2	2	1	1	1	1	1
M-9044-0067	4	2	1	4	2	1	3	1
M-9044-0068	1	1	1	1	1	1	1	1
M-9044-0072	2	1	3	1	1	2	1	1
M-9044-0074	2	1	2	1	1	1	3	1
M-8844-0076	1	1	3	1	1	2	1	1
M-9044-0077	1	1	1	2	1	1	1	2

AL- leaf aphids WA- whitefly adults

Appendix A. College Station irrigated field observations.

Week#1	**Rating #1**		**Rating #2**		**Rating #3**		**Rating #4**	
CRS	AL	WA	AL	WA	AL	WA	AL	WA
M-8744-0078	1	5	1	1	1	1	1	1
M-8744-0087	2	1	1	1	1	1	5	2
M-8744-0088	1	2	2	1	2	1	1	1
M-8744-0091	1	1	2	1	3	1	1	1
M-8844-0096	1	1	2	3	1	3	1	2
M-8844-0100	1	1	1	1	4	1	2	1
M-9044-0101	5	1	5	1	1	1	1	1
M-8844-0102	2	1	2	1	1	1	4	1
M-8844-0104	1	1	1	1	1	1	1	2
M-8744-0106	5	1	1	1	1	4	3	1
M-8844-0113	3	1	1	3	2	1	1	1
M-9044-0117	1	1	1	1	2	1	1	1
M-8744-0119	1	2	1	3	3	2	2	1
M-8844-0120	4	2	1	1	1	1	2	1
M-8844-0121	1	1	1	1	2	1	1	1
M-9044-0124	1	2	1	2	1	2	1	4
M-9044-0140	2	1	1	1	2	1	1	1
M-9044-0150	3	2	2	2	1	3	1	1
M-9044-0151	4	1	1	1	1	1	1	1
M-9044-0154	2	1	1	2	2	1	2	1
M-9044-0155	1	1	2	1	2	1	1	1
M-9044-0156	1	5	1	1	1	1	1	2
M-8744-0158	1	1	2	1	2	2	1	1
M-9044-0162	1	1	1	1	1	1	1	2
M-9044-0164	3	1	1	1	1	1	1	1
M-9044-0165	1	1	1	1	1	1	1	1
M-8744-0168	1	1	2	1	1	1	1	1

AL- leaf aphids WA- whitefly adults

Appendix A. College Station irrigated field observations.

Week#1	**Rating #1**		**Rating #2**		**Rating #3**		**Rating #4**	
CRS	AL	WA	AL	WA	AL	WA	AL	WA
M-9044-0170	1	1	1	1	1	1	3	2
M-8744-0174	1	1	1	1	1	4	2	2
M-8744-0175	3	1	2	4	1	1	4	1
M-9044-0180	2	2	2	1	1	1	2	3
M-9044-0182	5	1	1	1	1	1	5	1
M-9044-0197	1	3	1	1	1	1	1	2
M-9044-0206	1	2	1	2	1	1	1	5
M-9044-0212	3	1	1	1	1	1	1	1
M-9044-0215	2	1	1	1	1	1	2	1
M-9044-0226	1	2	4	2	1	1	1	2
M-8744-0228	1	2	2	1	2	1	1	1
M-9044-0237	1	1	1	1	1	1	1	1
M-9044-0239	2	1	1	1	1	2	1	1
M-8844-0243	1	1	1	2	1	2	1	1
M-9044-0244	1	2	1	5	1	2	1	1
M-9044-0245	4	1	1	1	1	1	4	1
M-9044-0247	1	1	2	1	2	1	1	2
M-8744-0257	1	1	1	1	1	2	1	1
M-8744-0326	1	1	4	1	1	1	1	1
M-9044-0570	1	1	1	2	1	1	2	1
M-8744-0612	1	1	2	1	1	1	1	1
M-9044-0633	1	1	2	1	1	1	2	1
M-9044-0634	2	2	1	1	1	2	1	3
M-9044-0641	1	1	1	1	1	3	1	2
M-9044-1000	1	1	3	1	1	1	2	2
M-8744-1149	1	1	1	1	1	1	1	1

AL- leaf aphids WA- whitefly adults

Appendix A. College Station irrigated field observations.

Week#1	**Rating #1**		**Rating #2**		**Rating #3**		**Rating #4**	
CRS	AL	WA	AL	WA	AL	WA	AL	WA
M-0044-0171	1	1	2	1	1	1	2	2
M-0044-0173	1	1	1	1	1	3	1	1
M-0044-0178	2	2	3	2	1	1	1	2
M-9644-0188	2	1	2	1	5	1	1	1
M-9644-0195	1	1	1	1	1	1	1	1
M-9644-0199	1	1	1	2	2	1	1	1
M-0044-0209	2	1	1	2	1	1	1	1
M-9644-0216	1	1	1	1	1	1	2	1
M-0044-0219	1	2	1	1	2	1	1	1
M-0044-0221	3	1	1	1	1	1	1	1
M-9644-0224	1	1	2	1	1	1	1	1
M-9644-0235	2	5	2	2	1	4	2	1
M-9644-0238	2	3	1	1	1	1	2	1
M-9644-0240	1	4	1	1	1	1	1	1
M-0044-0241	1	2	1	1	1	1	2	2
M-9644-0242	1	1	2	1	1	1	2	1
M-9644-0250	1	2	1	3	1	1	1	1
M-0044-0338	1	1	1	1	1	1	3	1
M-0044-0347	1	1	1	2	1	1	1	2
M-0044-0620	1	2	1	1	1	1	1	1
M-0044-0636	4	1	1	3	1	3	2	1
M-0044-0725	2	1	1	2	1	1	1	1
M-0044-0763	1	1	1	1	2	1	1	1
M-0044-0764	3	1	1	1	1	1	2	1
M-0044-0790	1	1	1	1	1	1	4	1
PSC 355	1	1	1	1	1	1	1	1
Delta Pearl	1	1	1	1	1	1	1	1

AL- leaf aphids WA- whitefly adults

Appendix A. College Station irrigated field observations.

Week #2	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-9044-0002	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0007	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
M-9044-0017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0024	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0030	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0031	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0032	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
M-9044-0033	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0036	1	1	2	1	1	1	1	5	1	1	1	1	5	1	1	1	1	5	1	1
M-9044-0040	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1
M-9044-0043	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1
M-9044-0045	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1
M-9044-0048	1	1	2	1	1	5	5	1	1	1	1	3	1	1	1	1	1	1	1	1
M-8744-0053	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0055	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0057	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0060	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0061	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0062	1	2	1	1	1	1	1	5	2	1	1	1	4	2	1	1	2	4	1	1
M-9044-0063	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1
M-9044-0067	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	5	1	1
M-9044-0068	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0072	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0074	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0076	1	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0077	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix A. College Station irrigated field observations.

Week #2	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-8744-0078	1	2	3	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1
M-8744-0087	2	1	3	1	1	1	1	1	1	1	1	1	1	1	1	2	5	1	1	1
M-8744-0088	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0091	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0096	1	1	1	1	1	1	2	5	1	1	1	1	5	1	1	1	1	1	1	1
M-8844-0104	1	2	1	1	1	1	1	1	1	1	1	2	3	1	1	1	1	1	1	1
M-8744-0106	1	4	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	1	1	1
M-8844-0113	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0117	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0119	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0120	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0121	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0124	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	2	1	1	1
M-9044-0140	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0150	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1
M-9044-0151	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0154	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0155	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0156	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	3	1	1
M-8744-0158	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1
M-9044-0162	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0164	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0165	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0168	1	2	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
M-9044-0170	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0174	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix A. College Station irrigated field observations.

Week #2	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-8744-0175	1	1	2	1	1	1	2	1	1	1	1	2	5	1	1	1	1	1	1	2
M-9044-0180	1	3	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
M-9044-0182	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1
M-9044-0197	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0206	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0212	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1
M-9044-0215	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	2	1	1	1
M-9044-0226	1	1	2	1	1	1	2	1	1	1	1	1	1	1	1	1	2	1	1	1
M-8744-0228	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	2	1	1
M-9044-0237	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1
M-9044-0239	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0243	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	3	1	1
M-9044-0244	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0245	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0247	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0257	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0326	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1
M-9044-0570	1	1	5	1	1	1	2	1	1	1	1	1	1	1	1	1	4	1	2	1
M-8744-0612	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1
M-9044-0633	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0634	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	3	2	1	1
M-9044-0641	1	2	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-1000	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1
M-8744-1149	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0171	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	5	1	1
M-0044-0173	1	1	5	1	1	1	1	1	1	1	1	3	1	1	1	1	2	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix A. College Station irrigated field observations.

Week #2	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-0044-0178	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0188	1	2	1	1	1	1	1	2	1	1	1	5	1	2	1	1	1	5	1	1
M-9644-0195	1	1	3	1	1	2	1	1	1	1	1	1	2	1	1	1	1	1	1	1
M-9644-0199	1	2	5	2	1	1	1	4	1	1	1	3	1	1	1	1	1	1	1	1
M-0044-0209	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0216	1	1	5	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0219	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0221	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0224	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0235	1	3	4	5	1	1	2	1	1	1	1	1	1	1	1	1	2	2	2	2
M-9644-0238	1	2	2	2	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0240	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0241	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	2	1	2	1
M-9644-0242	3	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0250	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0338	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0347	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0620	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0636	1	1	1	1	2	1	1	3	1	1	1	1	1	1	2	1	1	1	2	1
M-0044-0725	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1	1	1	1
M-0044-0763	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1
M-0044-0764	2	1	1	1	1	1	2	1	1	1	1	2	2	1	1	1	1	5	1	1
M-0044-0790	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1
PSC 355	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix A. College Station irrigated field observations.

Week #3	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-9044-0002	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
M-9044-0007	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1
M-9044-0017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0024	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
M-9044-0030	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1
M-9044-0031	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0032	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
M-9044-0033	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0036	1	1	1	1	1	1	2	2	5	1	1	1	2	1	1	1	1	1	2	1
M-9044-0040	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	3	4	1
M-9044-0043	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0045	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0048	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0053	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1
M-8844-0055	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1
M-9044-0057	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0060	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0061	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1
M-9044-0062	1	1	1	1	2	1	1	1	5	1	1	1	1	1	1	1	1	3	1	1
M-9044-0063	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0067	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0068	1	1	1	1	1	2	2	1	1	1	1	2	1	2	1	1	1	1	1	1
M-9044-0072	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0074	1	1	5	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0076	3	3	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1
M-9044-0077	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix A. College Station irrigated field observations.

Week #3	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-8744-0078	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	5	4	1
M-8744-0087	1	1	1	1	1	1	1	1	1	1	1	2	1	2	1	1	1	5	1	2
M-8744-0088	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0091	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
M-8844-0096	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	2	1
M-8844-0100	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0101	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0102	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1
M-8844-0104	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	1	1
M-8744-0106	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0113	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0117	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1
M-8744-0119	1	1	1	1	1	1	1	3	2	1	1	1	1	1	1	1	1	1	1	1
M-8844-0120	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0121	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0124	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	2
M-9044-0140	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0150	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1
M-9044-0151	1	1	1	1	1	1	2	1	1	1	2	2	1	1	1	1	1	1	1	1
M-9044-0154	1	1	1	2	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0155	1	1	2	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0156	1	1	1	1	1	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1
M-8744-0158	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0162	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0164	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0165	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0168	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix A. College Station irrigated field observations.

Week #3	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-9044-0170	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1	1
M-8744-0174	1	1	5	1	3	1	1	1	2	1	1	1	2	2	2	1	1	1	1	1
M-8744-0175	1	1	1	1	1	1	1	1	2	2	1	1	5	2	1	1	1	2	1	1
M-9044-0180	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1
M-9044-0182	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	2	1
M-9044-0197	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	2
M-9044-0206	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0212	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	1	1	1	1	1
M-9044-0215	1	3	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	1	2	1
M-9044-0226	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1
M-8744-0228	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0237	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0239	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0243	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0244	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0245	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1
M-9044-0247	1	1	2	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1
M-8744-0257	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	4	1	1	1
M-8744-0326	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0570	1	3	1	3	1	1	1	2	1	1	1	1	1	1	1	1	1	5	1	1
M-8744-0612	1	1	1	1	1	1	2	2	2	2	1	1	1	1	1	1	1	1	1	1
M-9044-0633	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1
M-9044-0634	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	2	1
M-9044-0641	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
M-9044-1000	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1
M-8744-1149	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix A. College Station irrigated field observations.

Week #3	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-0044-0178	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1
M-9644-0188	1	1	1	2	1	1	2	1	1	1	1	1	1	1	1	1	1	5	1	1
M-9644-0195	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0199	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0209	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0216	1	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1
M-0044-0219	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0221	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0224	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0235	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	5	1	1
M-9644-0238	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
M-9644-0240	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0241	1	1	4	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0242	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0250	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1
M-0044-0338	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0347	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	2	1	1
M-0044-0620	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0636	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0725	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0763	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0764	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1
M-0044-0790	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	4	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix A. College Station irrigated field observations.

Week #3	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
PSC 355 (101)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (131)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PSC 355 (213)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (254)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PSC 355 (351)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (334)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PSC 355 (429)	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (406)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs
(#)- replication location in adjoining field

Appendix A. College Station irrigated field observations.

Week #4	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-9044-0002	1	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	2	3
M-9044-0007	1	1	1	1	1	1	1	5	1	2	1	1	1	1	2	1	1	1	5	1
M-9044-0017	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	2	1	1	1
M-9044-0024	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0030	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	1
M-9044-0031	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
M-9044-0032	1	1	5	1	1	1	1	1	1	1	1	1	5	1	1	1	1	3	1	3
M-9044-0033	1	1	1	1	1	1	1	1	1	2	1	1	1	1	2	1	1	1	2	1
M-9044-0036	1	1	5	2	1	1	1	3	5	2	1	1	1	4	1	1	1	1	2	1
M-9044-0040	1	1	1	5	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1
M-9044-0043	1	2	1	4	1	1	1	1	1	1	1	1	5	4	1	1	1	1	1	1
M-9044-0045	1	1	3	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	2	1
M-9044-0048	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1
M-8744-0053	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0055	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1
M-9044-0057	1	1	1	2	1	1	1	1	2	2	1	1	1	1	1	1	1	1	2	1
M-9044-0060	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1
M-9044-0061	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
M-9044-0062	1	1	2	2	1	1	1	3	3	1	1	1	3	1	1	1	1	1	2	1
M-9044-0063	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1
M-9044-0067	1	1	5	1	2	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1
M-9044-0068	1	1	1	1	2	1	1	1	1	1	1	1	1	2	1	1	1	1	1	5
M-9044-0072	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0074	1	1	5	1	1	1	2	1	1	1	1	1	1	1	1	1	1	2	1	1
M-8844-0076	1	1	4	1	1	1	1	1	4	1	1	1	1	1	2	1	1	1	1	2
M-9044-0077	1	1	1	1	1	1	1	1	2	1	1	1	1	1	2	1	1	1	4	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix A. College Station irrigated field observations.

Week #4	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-8744-0078	1	1	1	2	1	1	1	1	2	2	1	1	1	1	1	1	1	3	1	3
M-8744-0087	1	1	2	1	2	1	1	2	1	2	1	1	1	2	2	1	1	5	1	2
M-8744-0088	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1
M-8744-0091	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1	3
M-8844-0096	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	2	1
M-8844-0100	1	2	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	5	1	1
M-9044-0101	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0102	1	1	1	1	2	1	1	1	1	1	1	1	1	2	1	1	1	1	1	2
M-8844-0104	1	1	1	1	1	1	1	1	2	2	1	1	1	2	1	1	1	1	1	1
M-8744-0106	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0113	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1
M-9044-0117	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1
M-8744-0119	1	1	3	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1
M-8844-0120	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
M-8844-0121	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0124	1	1	1	1	1	1	1	1	1	1	1	1	1	3	2	1	1	1	1	1
M-9044-0140	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0150	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0151	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1
M-9044-0154	1	1	5	2	1	1	1	3	1	1	1	1	4	2	1	1	1	3	1	3
M-9044-0155	1	1	1	1	1	1	4	2	1	2	1	1	1	1	1	1	1	1	1	1
M-9044-0156	1	1	1	2	1	1	1	2	2	1	1	1	1	1	1	1	1	1	2	2
M-8744-0158	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1
M-9044-0162	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0164	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	5	1	1
M-9044-0165	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0168	1	1	1	3	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix A. College Station irrigated field observations.

Week #4	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-9044-0170	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1
M-8744-0174	1	1	1	2	1	1	1	1	1	1	1	1	5	2	1	1	1	1	1	1
M-8744-0175	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	2	2
M-9044-0180	1	1	1	1	1	1	1	2	2	1	1	1	1	1	3	1	1	1	1	2
M-9044-0182	1	1	1	1	1	1	1	5	2	2	1	1	1	1	1	1	1	1	1	1
M-9044-0197	1	1	1	1	2	1	1	1	1	1	1	1	1	1	3	1	1	5	1	2
M-9044-0206	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0212	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0215	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
M-9044-0226	1	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1
M-8744-0228	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0237	1	2	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	4	1
M-9044-0239	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	2
M-8844-0243	1	3	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0244	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0245	1	1	1	1	1	1	1	5	1	1	1	2	1	1	1	1	1	1	1	1
M-9044-0247	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0257	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0326	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0570	1	1	1	2	1	1	1	1	1	2	1	1	2	1	1	1	1	1	1	3
M-8744-0612	1	1	1	2	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1
M-9044-0633	1	1	1	1	1	1	1	2	1	2	1	1	1	1	1	1	1	1	1	1
M-9044-0634	1	1	4	1	2	1	1	5	1	1	1	2	3	2	1	1	1	5	2	1
M-9044-0641	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	4	1	1
M-9044-1000	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	4	2	1
M-8744-1149	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix A. College Station irrigated field observations.

Week #4	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-0044-0171	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	3	1
M-0044-0173	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1
M-0044-0178	1	1	1	1	1	1	1	2	1	1	1	1	1	3	1	1	1	5	1	3
M-9644-0188	1	1	1	2	1	1	2	1	1	1	1	1	1	4	1	1	1	5	1	3
M-9644-0195	1	1	1	2	1	1	1	1	2	1	1	1	1	2	1	1	1	2	1	1
M-9644-0199	1	1	1	1	1	1	1	3	1	1	1	1	5	3	5	1	1	1	1	2
M-0044-0209	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0216	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0219	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
M-0044-0221	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0224	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0235	1	1	3	1	2	1	1	1	3	1	1	1	1	2	1	1	1	3	4	3
M-9644-0238	1	1	1	1	1	1	1	1	2	1	1	1	1	5	1	1	1	1	2	3
M-9644-0240	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1
M-0044-0241	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	2
M-9644-0242	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1
M-9644-0250	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
M-0044-0338	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0347	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0620	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
M-0044-0636	1	1	1	2	2	1	1	1	1	1	1	1	2	1	1	1	1	2	1	1
M-0044-0725	1	1	1	2	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1	1
M-0044-0763	1	1	1	1	1	1	1	1	1	1	1	3	1	2	1	1	1	1	1	1
M-0044-0764	1	1	4	1	2	1	1	1	1	1	1	1	3	2	1	1	1	1	1	1
M-0044-0790	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	5	2	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix A. College Station irrigated field observations.

Week #4	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
PSC 355 (101)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (131)	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PSC 355 (213)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (254)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PSC 355 (351)	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (334)	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1
PSC 355 (429)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (406)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs
(#)- replication location in adjoining field

Appendix B. College Station dry land field observations.

Week#1	**Rating #1**		**Rating #2**		**Rating #3**		**Rating #4**	
CRS	AL	WA	AL	WA	AL	WA	AL	WA
M-9044-0002	2	1	1	1	1	1	2	1
M-9044-0007	1	3	2	2	1	1	1	1
M-9044-0017	1	1	1	1	1	2	1	3
M-9044-0024	1	1	1	1	1	2	1	1
M-9044-0030	1	1	1	1	2	2	1	1
M-9044-0031	2	1	1	1	2	2	1	2
M-9044-0032	3	1	1	1	1	1	1	1
M-9044-0033	1	1	1	1	1	1	1	1
M-9044-0036	1	1	1	2	1	1	1	1
M-9044-0040	2	3	2	1	1	1	1	1
M-9044-0043	2	1	1	1	3	1	1	1
M-9044-0045	1	2	1	1	2	1	1	2
M-9044-0048	2	1	1	1	1	1	1	1
M-8744-0053	1	1	1	1	1	1	1	1
M-8844-0055	1	2	1	2	1	1	5	2
M-9044-0057	1	1	1	1	1	1	1	1
M-9044-0060	1	1	1	1	1	1	1	1
M-9044-0061	2	2	1	1	1	1	1	1
M-9044-0062	1	3	2	1	1	1	2	1
M-9044-0063	4	3	2	1	1	1	1	2
M-9044-0067	1	2	1	1	1	1	1	3
M-9044-0068	1	1	2	2	1	3	1	1
M-9044-0072	1	1	1	1	2	2	4	1
M-9044-0074	2	1	1	2	3	3	1	2
M-8844-0076	1	3	1	1	1	1	2	1
M-9044-0077	1	3	1	1	1	1	1	1

AL- leaf aphids WA- whitefly adults

Appendix B. College Station dry land field observations.

Week#1	**Rating #1**		**Rating #2**		**Rating #3**		**Rating #4**	
CRS	AL	WA	AL	WA	AL	WA	AL	WA
M-8744-0078	1	2	2	2	1	1	1	1
M-8744-0087	1	1	1	1	1	1	1	1
M-8744-0088	2	1	1	1	1	1	1	2
M-8744-0091	2	1	1	1	2	1	1	1
M-8844-0096	1	1	1	3	1	1	1	2
M-8844-0100	1	2	1	1	1	2	1	1
M-9044-0101	1	1	2	2	1	1	1	2
M-8844-0102	1	1	1	1	1	1	1	1
M-8844-0104	1	2	1	3	1	3	1	1
M-8744-0106	1	2	4	4	2	1	1	2
M-8844-0113	1	1	1	1	2	1	3	1
M-9044-0117	2	2	1	2	1	3	4	3
M-8744-0119	1	2	1	1	2	1	1	2
M-8844-0120	1	2	2	3	3	1	1	2
M-8844-0121	1	1	1	1	1	2	1	3
M-9044-0124	1	2	1	4	1	4	1	1
M-9044-0140	1	1	2	2	1	1	1	2
M-9044-0150	1	3	1	5	1	3	1	3
M-9044-0151	1	3	1	4	1	5	1	4
M-9044-0154	1	1	1	1	1	1	2	1
M-9044-0155	1	2	3	1	3	1	2	1
M-9044-0156	2	1	1	1	1	1	1	1
M-8744-0158	1	1	1	3	1	1	2	3
M-9044-0162	1	1	1	1	1	1	1	1
M-9044-0164	1	2	1	1	1	1	1	1
M-9044-0165	1	1	1	1	1	1	1	1

AL- leaf aphids WA- whitefly adults

Appendix B. College Station dry land field observations.

Week#1	**Rating #1**		**Rating #2**		**Rating #3**		**Rating #4**	
CRS	AL	WA	AL	WA	AL	WA	AL	WA
M-8744-0168	1	2	2	1	1	1	1	1
M-8744-0174	1	2	1	1	2	1	1	1
M-8744-0175	2	1	1	1	1	3	1	3
M-9044-0180	1	1	1	1	1	3	1	1
M-9044-0182	1	2	2	2	1	1	2	2
M-9044-0197	2	3	1	2	1	2	2	1
M-9044-0206	1	1	1	1	1	1	1	1
M-9044-0212	2	1	1	1	1	1	1	2
M-9044-0215	1	3	1	3	1	1	1	3
M-9044-0226	2	2	1	3	1	4	1	2
M-8744-0228	3	1	1	1	1	1	1	1
M-9044-0237	1	2	1	1	1	1	1	1
M-9044-0239	1	1	1	1	1	1	1	2
M-8844-0243	1	1	1	1	1	1	1	1
M-9044-0244	1	1	1	1	1	1	1	1
M-9044-0245	1	1	1	1	1	1	1	2
M-9044-0247	1	1	1	1	1	1	1	1
M-8744-0257	1	2	1	2	1	1	1	1
M-8744-0326	1	3	1	2	1	2	2	2
M-9044-0570	1	2	1	1	2	1	2	1
M-8744-0612	1	1	1	1	2	1	1	1
M-9044-0633	1	1	1	1	1	1	1	1
M-9044-0634	1	2	1	1	1	1	1	1
M-9044-0641	1	1	1	1	1	1	1	1
M-9044-1000	1	1	1	1	1	1	1	1

AL- leaf aphids WA- whitefly adults

Appendix B. College Station dry land field observations.

Week#1	**Rating #1**		**Rating #2**		**Rating #3**		**Rating #4**	
CRS	AL	WA	AL	WA	AL	WA	AL	WA
M-8744-1149	1	1	1	1	1	1	1	1
M-0044-0173	2	3	1	2	1	3	3	3
M-0044-0178	1	1	3	1	1	1	1	1
M-9644-0188	1	2	2	1	2	2	3	1
M-9644-0195	1	1	1	1	1	2	1	1
M-9644-0199	1	1	1	1	1	1	1	1
M-0044-0209	1	1	1	1	1	1	1	1
M-9644-0216	1	1	1	1	1	1	1	1
M-0044-0219	2	1	1	1	1	1	1	1
M-0044-0221	1	1	2	2	1	1	1	1
M-9644-0224	1	4	1	2	1	2	1	4
M-9644-0235	3	1	1	1	2	1	1	1
M-9644-0238	2	2	2	1	1	1	1	1
M-9644-0240	1	2	1	1	1	1	1	2
M-0044-0241	1	1	1	1	1	1	2	1
M-9644-0242	1	1	1	1	1	1	1	1
M-9644-0250	1	1	1	1	1	1	1	1
M-0044-0338	1	1	1	1	2	1	1	1
M-0044-0347	1	1	1	1	3	1	1	1
M-0044-0620	3	3	1	1	1	3	2	3
M-0044-0636	1	1	2	1	1	1	1	1
M-0044-0725	1	1	1	1	1	1	1	1
M-0044-0763	1	1	2	1	2	1	1	1
M-0044-0764	1	1	1	1	1	1	2	1
M-0044-0790	1	1	1	1	1	1	1	1
PSC 355	1	1	1	1	1	1	1	1
Delta Pearl	1	1	1	1	1	1	1	1

AL- leaf aphids WA- whitefly adults

Appendix B. College Station dry land field observations.

Week #2	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-9044-0002	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0007	1	1	5	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1
M-9044-0017	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1
M-9044-0024	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0030	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1
M-9044-0031	1	1	5	1	1	1	1	1	1	1	2	2	1	1	1	2	1	1	1	1
M-9044-0032	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0033	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0036	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0040	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0043	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	2	1	1
M-9044-0045	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0048	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0053	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0055	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1
M-9044-0057	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1
M-9044-0060	1	1	5	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0061	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1	1	1	2	1	1
M-9044-0062	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0063	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0067	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0068	1	1	5	1	1	1	1	5	1	1	1	1	1	1	1	1	1	2	2	2
M-9044-0072	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0074	1	1	1	1	1	1	2	1	1	1	3	2	1	1	1	1	1	1	1	1
M-8844-0076	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1
M-9044-0077	1	2	2	2	1	1	1	5	2	1	1	1	1	1	1	1	1	1	2	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix B. College Station dry land field observations.

Week #2	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-8744-0078	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0087	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0088	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0091	1	1	1	1	1	1	1	1	1	1	2	4	1	1	1	1	1	1	1	1
M-8844-0096	1	1	2	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0100	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0101	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0102	1	1	1	1	1	1	1	2	1	1	1	2	1	2	1	1	1	1	1	1
M-8844-0104	1	1	5	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0106	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1
M-8844-0113	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0117	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0119	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0120	1	1	1	1	2	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1
M-8844-0121	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	3	1	1
M-9044-0124	1	1	3	1	1	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1
M-9044-0140	1	1	5	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0150	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1
M-9044-0151	1	1	2	1	1	1	2	5	2	1	1	1	1	1	1	1	1	1	2	1
M-9044-0154	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0155	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0156	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0158	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0162	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0164	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0165	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix B. College Station dry land field observations.

Week #2	Rating #1					Rating # 2					Rating # 3					Rating # 4				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-8744-0168	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
M-9044-0170	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0174	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1
M-8744-0175	1	1	1	1	1	1	1	4	2	1	1	1	1	1	1	1	1	5	1	1
M-9044-0180	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1
M-9044-0182	1	2	3	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0197	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0206	1	2	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0212	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0215	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1
M-9044-0226	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1
M-8744-0228	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1
M-9044-0237	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0239	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0243	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0244	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0245	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0247	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0257	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1
M-8744-0326	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0570	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1
M-8744-0612	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0633	1	1	1	1	1	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1
M-9044-0634	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0641	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
M-9044-1000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix B. College Station dry land field observations.

Week #2	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-8744-1149	1	1	4	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0171	1	1	1	1	2	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0173	1	1	1	1	2	1	1	5	1	1	1	1	1	2	2	3	5	1	1	1
M-0044-0178	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0188	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0195	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0199	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1
M-0044-0209	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0216	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0219	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0221	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0224	1	1	1	1	1	1	1	4	1	1	1	1	5	1	1	1	1	2	2	1
M-9644-0235	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	2	1	1
M-9644-0238	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	2
M-9644-0240	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0241	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0242	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0250	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0338	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0347	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1
M-0044-0620	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0636	1	1	1	1	1	2	2	1	1	1	1	2	1	1	1	1	1	1	1	1
M-0044-0725	1	1	1	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1
M-0044-0763	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0764	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0790	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix B. College Station dry land field observations.

Week #2	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
PSC 355	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix B. College Station dry land field observations.

Week #3	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-9044-0002	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0007	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0024	1	1	5	1	2	1	2	1	1	1	1	1	5	4	1	1	1	1	1	1
M-9044-0030	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1
M-9044-0031	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	5	1
M-9044-0032	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0033	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0036	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0040	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0043	1	1	1	1	1	1	1	1	1	1	1	5	1	1	1	1	1	4	1	1
M-9044-0045	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0048	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	2	1	1
M-8744-0053	1	1	1	1	1	1	3	1	2	1	1	1	1	1	1	1	1	1	1	1
M-8844-0055	1	1	5	4	1	1	1	2	1	1	1	1	1	1	1	2	3	2	3	1
M-9044-0057	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	2	1
M-9044-0060	1	1	4	2	1	1	1	3	1	1	1	1	1	1	1	1	1	2	1	1
M-9044-0061	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1	1	1	5	1	2
M-9044-0062	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0063	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0067	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0068	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0072	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0074	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1	1
M-8844-0076	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1
M-9044-0077	1	5	5	5	2	1	1	4	4	1	1	1	1	1	1	1	1	1	2	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix B. College Station dry land field observations.

Week #3	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-8744-0078	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0087	1	1	1	1	1	1	1	1	1	1	1	3	2	1	1	1	1	5	2	1
M-8744-0088	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	2	1
M-8744-0091	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	2	1
M-8844-0096	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0100	1	1	1	1	1	1	1	1	1	1	1	1	5	1	1	1	1	1	1	1
M-9044-0101	1	1	1	1	1	1	1	1	1	1	1	1	4	3	1	1	2	1	1	1
M-8844-0102	1	1	1	1	1	1	1	5	1	1	1	1	3	1	1	1	1	1	1	1
M-8844-0104	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1
M-8744-0106	1	1	5	1	1	1	2	5	5	1	1	1	1	1	1	1	1	1	1	1
M-8844-0113	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0117	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0119	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0120	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	2	1	1
M-8844-0121	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1
M-9044-0124	1	1	5	1	1	1	1	5	3	1	1	1	1	1	1	1	1	5	1	1
M-9044-0140	2	2	4	1	1	1	1	5	1	1	1	1	1	1	1	1	3	3	1	1
M-9044-0150	1	4	1	1	2	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1
M-9044-0151	1	1	4	1	1	1	1	4	3	1	1	2	1	1	1	1	1	1	1	1
M-9044-0154	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0155	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0156	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	2	1
M-8744-0158	1	1	3	2	1	1	1	1	1	1	1	1	5	2	1	1	1	5	1	1
M-9044-0162	1	1	1	1	1	1	1	1	1	1	2	3	1	1	1	1	1	1	1	1
M-9044-0164	1	1	1	1	1	1	3	4	1	1	1	1	2	1	1	1	2	1	1	1
M-9044-0165	1	2	1	1	1	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix B. College Station dry land field observations.

Week #3	Rating #1					Rating # 2					Rating # 3					Rating # 4				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-8744-0168	1	1	2	1	1	1	1	1	1	1	1	1	1	2	1	1	1	5	1	1
M-8744-0174	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	5	1	1
M-8744-0175	1	1	1	1	1	2	1	3	1	1	1	1	4	1	1	1	3	1	1	1
M-9044-0180	1	1	1	1	1	1	1	1	1	2	1	1	3	1	1	1	1	1	1	1
M-9044-0182	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1
M-9044-0197	1	1	5	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0206	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0212	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0215	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0226	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0228	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0237	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	2	1	1
M-9044-0239	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0243	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0244	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0245	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0247	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0257	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1
M-8744-0326	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0570	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0612	1	1	1	2	2	1	1	1	2	1	1	1	1	1	1	2	1	1	1	1
M-9044-0633	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1
M-9044-0634	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2
M-9044-0641	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1
M-9044-1000	1	1	1	1	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-1149	1	1	1	1	1	1	1	2	1	1	1	2	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix B. College Station dry land field observations.

Week #3	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-0044-0171	1	1	1	1	1	1	1	5	1	1	1	2	2	1	1	1	1	1	1	1
M-0044-0173	1	1	1	1	1	1	1	1	4	1	1	1	5	1	2	1	1	1	1	2
M-0044-0178	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0188	1	1	1	1	1	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1
M-9644-0195	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0199	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0209	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1
M-9644-0216	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	5	1	1
M-0044-0219	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0221	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	4	1	2	1
M-9644-0224	1	1	1	1	1	1	1	5	5	1	1	1	4	2	1	1	1	3	3	1
M-9644-0235	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1
M-9644-0238	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1
M-9644-0240	1	1	1	2	1	1	1	3	2	2	1	1	1	1	1	1	1	1	1	1
M-0044-0241	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0242	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
M-9644-0250	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0338	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1	1
M-0044-0347	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0620	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0636	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0725	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0763	1	1	1	1	1	1	1	3	2	1	1	1	1	1	1	1	1	1	1	1
M-0044-0764	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0790	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix B. College Station dry land field observations.

Week #3	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
PSC 355 (101)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (131)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PSC 355 (213)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (254)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PSC 355 (351)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (334)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PSC 355 (429)	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (406)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs
(#)- replication location in adjoining field

Appendix B. College Station dry land field observations.

Week #4	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-9044-0002	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1
M-9044-0007	1	1	5	1	2	1	1	2	1	1	1	1	2	1	1	1	1	1	1	1
M-9044-0017	1	1	1	2	1	1	1	1	2	1	1	1	4	1	1	1	1	1	1	1
M-9044-0024	1	1	4	2	1	1	1	3	1	1	1	1	3	5	2	1	1	1	1	1
M-9044-0030	1	1	3	2	1	1	1	1	1	1	1	1	1	1	2	1	1	4	2	1
M-9044-0031	1	1	2	5	1	1	1	1	1	1	1	1	3	1	1	1	1	3	1	1
M-9044-0032	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
M-9044-0033	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	2	1
M-9044-0036	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0040	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	1	1	1
M-9044-0043	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	4	1
M-9044-0045	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0048	1	1	1	1	1	1	1	4	1	1	1	1	2	1	1	1	1	1	3	1
M-8744-0053	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	2	1	1	1
M-8844-0055	1	1	1	5	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1
M-9044-0057	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
M-9044-0060	1	1	3	1	1	1	1	3	1	1	1	1	1	1	1	1	1	5	1	1
M-9044-0061	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	1	1
M-9044-0062	1	1	1	3	1	1	1	1	1	1	1	1	1	2	1	1	1	2	2	1
M-9044-0063	1	1	4	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	2	2
M-9044-0067	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	2	1
M-9044-0068	1	1	1	3	1	1	1	1	5	1	1	1	1	1	1	1	1	1	2	1
M-9044-0072	1	1	1	2	1	1	1	1	2	1	1	1	2	1	1	1	1	1	1	1
M-9044-0074	1	1	1	2	1	1	1	1	3	1	1	1	1	1	1	1	1	5	1	1
M-8844-0076	1	1	5	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0077	1	1	4	5	1	1	1	2	5	1	1	1	1	1	1	1	1	1	2	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix B. College Station dry land field observations.

Week #4	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-8744-0078	1	1	1	1	1	1	1	1	3	2	1	1	2	1	1	1	1	1	1	
M-8744-0087	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	4	2	1
M-8744-0088	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0091	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0096	1	1	1	4	1	1	1	1	5	1	1	1	2	1	1	1	1	3	1	1
M-8844-0100	1	1	1	1	1	1	1	1	2	1	1	1	1	2	1	1	1	1	1	1
M-9044-0101	1	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	1	1
M-8844-0102	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
M-8844-0104	1	1	2	2	1	1	1	5	1	1	1	1	2	1	1	1	1	4	1	1
M-8744-0106	1	1	4	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0113	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1
M-9044-0117	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1	1	1	2	1	1
M-8744-0119	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8844-0120	1	1	4	1	2	1	1	1	1	2	1	1	1	1	1	1	1	1	2	1
M-8844-0121	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0124	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	2	2
M-9044-0140	1	1	1	1	1	1	2	1	1	1	1	3	3	2	1	1	1	5	1	2
M-9044-0150	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1
M-9044-0151	1	1	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	5	3
M-9044-0154	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1	1	1	2	1	1
M-9044-0155	1	1	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0156	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
M-8744-0158	1	1	1	1	1	1	1	2	3	1	1	1	4	2	1	1	1	1	2	1
M-9044-0162	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0164	1	1	1	1	1	1	1	3	1	1	1	1	2	2	1	1	1	1	1	1
M-9044-0165	1	1	3	1	1	1	1	1	1	1	1	1	4	1	1	1	1	4	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix B. College Station dry land field observations.

Week #4	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-8744-0168	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	3	1
M-8744-0174	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	1	3	1	1
M-8744-0175	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1
M-9044-0180	1	1	1	1	1	1	1	4	1	2	1	1	1	1	1	1	1	4	1	1
M-9044-0182	1	3	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
M-9044-0197	1	1	3	3	1	1	1	5	1	1	1	1	1	1	1	1	1	3	1	1
M-9044-0206	1	1	1	1	1	1	1	1	2	1	1	1	3	1	1	1	1	1	1	1
M-9044-0212	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	4	2	1
M-9044-0215	1	1	1	2	1	1	1	1	1	1	1	1	3	1	1	1	2	1	1	1
M-9044-0226	1	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0228	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-0237	1	1	2	1	1	1	1	2	1	1	1	1	1	1	2	1	1	1	1	3
M-9044-0239	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
M-8844-0243	1	1	3	1	1	1	1	1	2	1	1	1	1	2	1	1	1	1	1	1
M-9044-0244	1	1	2	1	1	1	1	1	1	1	1	1	2	1	1	1	1	3	1	1
M-9044-0245	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1
M-9044-0247	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-0257	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
M-8744-0326	1	1	1	1	1	1	1	1	1	4	1	1	1	3	1	1	1	1	1	1
M-9044-0570	1	1	1	1	1	1	1	3	1	1	1	1	4	1	1	1	1	5	1	1
M-8744-0612	1	1	1	1	1	1	1	3	2	2	1	1	1	1	1	1	1	1	1	1
M-9044-0633	1	1	1	1	1	1	2	1	2	1	1	1	1	1	1	1	1	1	1	1
M-9044-0634	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2
M-9044-0641	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9044-1000	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-8744-1149	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix B. College Station dry land field observations.

Week #4	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
M-0044-0171	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	2	1
M-0044-0173	1	1	1	1	2	1	1	1	3	2	1	1	1	3	1	1	1	1	1	2
M-0044-0178	1	1	3	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0188	1	1	2	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1
M-9644-0195	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	4	1	1
M-9644-0199	1	1	1	1	1	1	1	4	3	1	1	1	1	1	1	1	1	1	1	1
M-0044-0209	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1
M-9644-0216	1	1	1	1	1	1	2	1	1	1	1	1	2	1	1	1	1	1	1	1
M-0044-0219	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
M-0044-0221	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	1	2	1	2	1
M-9644-0224	1	1	1	2	1	1	1	1	5	1	1	1	1	1	1	1	1	1	1	2
M-9644-0235	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1
M-9644-0238	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	3	1
M-9644-0240	1	1	1	3	1	1	1	4	3	2	1	1	1	1	1	1	1	4	1	1
M-0044-0241	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0242	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-9644-0250	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0338	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1
M-0044-0347	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0620	1	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1
M-0044-0636	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0725	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	3	1	1
M-0044-0763	1	1	1	1	1	1	1	2	2	1	1	1	1	1	1	1	1	1	1	1
M-0044-0764	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
M-0044-0790	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs

Appendix B. College Station dry land field observations.

Week #4	**Rating #1**					**Rating # 2**					**Rating # 3**					**Rating # 4**				
CRS	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN	AT	AL	WA	TWN	BFN
PSC 355 (101)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (131)	1	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PSC 355 (213)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (254)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
PSC 355 (351)	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (334)	1	1	1	1	1	1	1	1	2	1	1	1	1	1	1	1	1	1	1	1
PSC 355 (429)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Delta Pearl (406)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

AT- terminal aphids AL- leaf aphids WA- whitefly adults TWN- top of plant whitefly nymphs
BFN- bottom of plant whitefly nymphs
(#)- replication location in adjoining field

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