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GOSSYPIUM THURBERI AS A PINK BOLLWORM (PBW), PECTINOPHORA GOSSYPIELLA (SAUNDERS), REPRODUCTIVE HOST

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Abstract

Eradication of the pink bollworm, *Pectinophora gossypiella* (PBW) (Saunders), from southwestern United States and Northern Mexico cotton, *Gossypium hirsutum* L., growing areas has been a goal of research, action, and regulatory agencies since PBW first occurred in Arizona in 1927. With the availability of newly developed PBW population suppression technology, a USDA-Animal Plant Health Inspection Agency (APHIS) administrated program is being conducted with eradication goals. The occurrence of other cultivated and wild PBW hosts will be factors affecting program success. A wild cotton species, *G. thurberi* Todaro, is found in parts of Arizona and Mexico. We conducted laboratory and field studies to investigate it as a potential PBW reproductive host. In the laboratory, under no-choice conditions, numbers of eggs laid and percent hatched on a commercially grown *G. hirsutum*, Delta and Pine Land (DPL) 5415 cotton cultivar were not significantly different compared with *G. thurberi*. However, more dead early instar PBW larvae were found in *G. thurberi* bolls compared with 'DPL 5415'. PBW larval infestations in the bolls in the field averaged 2.9 larvae per boll compared with no larvae found in *G. thurberi* bolls.

Introduction

'NuCOTN 33B7', a transgenic cotton (Bt), *Gossypium hirsutum* L., with the gene mediating production of the insect toxic protein (Cry1Ac) has been outstanding for pink bollworm (PBW), *Pectinophora gossypiella* (Saunders), control in Arizona since its first commercial use in 1996. Bt cotton, short-season tactics, sex pheromone behavioral control sterile releases and chemical control are some of the technologies of a recently initiated integrated areawide pest management approach to eradicate PBW from West Texas, New Mexico, Arizona, California and Mexico (Anonymous 2001). The National Cotton Council, producers, federal, state, regional, county and local agencies are coordinating their activities to eliminate the PBW. The program is administrated and coordinated by APHIS. Wild cottons and alternate hosts will be a consideration in the eradication attempt. *Gossypium* species are preferred PBW hosts (Noble 1969). However plants in seven families, 24 genera, and 70 species have been identified worldwide as alternate hosts. *Gossypium thurberi* Todaro, a reported PBW host, has been found to occur in eight counties in Arizona, and Sonora and Chihuahua, Mexico. *Gossypium thurberi* is photoperiodic in nature and blooms under short-day conditions. It occurs in the mountains at low to mid elevations in the Arizona Chaparral zone. We conducted studies to compare *G. hirsutum* L., 'Deltapine (DPL) 5415' with *G. thurberi* as PBW hosts.

Methods and Materials

'DPL 5415' and *G. thurberi* cotton seeds were planted on 29 Apr 2002. 'DPL 5415' rows were 40 inches apart and 200 feet long. There were a total of 65 rows. *Gossypium thurberi* seeds were distributed at random within cotton rows. PBW larval host acceptance and development was determined by collecting 30 'DPL 5415' cotton bolls and 30 *G. thurberi* cotton bolls on 21 October 2002. Individual bolls of each cotton were placed, one each in one ounce plastic cups lined with paper toweling. Five, first instar PBW larvae were placed on each cotton boll with camel hair brushes.

Bolls in cups with PBW larvae were held in a constant temperature cabinet at 80° F. On 5 November 2002, bolls were examined for PBW entrance holes and thereafter dissected and examined for PBW larvae. Numbers and developmental instars and numbers of pupae found were recorded. All live larvae found were held in one ounce cups with one inch strips of agar-based artificial PBW diet until they developed to the pupal stage. All pupae were held in three inch diameter by five inch high ice-cream cartons for adult emergence and oviposition. Carton lids had one and a half inch plastic - screen covered holes for ventilation. One-inch squares of paper toweling oviposition substrate were placed over the screened openings and weighed down with three-quarter inch diameter metal washers. Oviposition substrates with eggs were collected every two to three days for a total of five collections. Oviposition substrates with eggs were held at 80° F and total numbers of eggs and numbers of unhatched eggs were

counted after 10 days.

A second experiment was conducted to compare PBW larval acceptance and development on 'DPL 5415' and *G. thurberia* cotton bolls by picking bolls with five inch portions of the stems intact. Fresh-cut stems of the bolls were inserted in water-filled floral tubes to keep bolls from drying out. Five PBW first instar larvae were placed on each boll as discussed. Thereafter procedures were as discussed above except that no oviposition data were obtained because larval survival on *G. thurberi* bolls was so low.

PBW infestation that occurred in the field under choice conditions of 'DPL 5415' vs *G. thurberi* bolls were determined by picking 200 'DPL 5415' bolls and 400 *G. thurberi* bolls on 13 Nov 2002. Twenty-five 'DPL 5415' cotton bolls and 50 *G. thurberi* bolls were placed in each of eight 10 X 18 X 5 inch high rectangular covered plastic container with 1.5 inch screen covered holes in the top and sides for ventilation. Bolls in containers were held in the laboratory for two weeks before dissection and examination for PBW larvae.

Data were statistically compared using Student "t" tests for paired comparisons where appropriate. Percentages were transformed to arcsine before analyses. Significant differences were recognized at $P \leq 0.05$.

Results

In the laboratory, more PBW entrance and exit holes, total larvae and live but not dead larvae were found in 'DPL 5415' bolls compared with *G. thurberi* bolls (Table 1, Experiments 1 and 2). The difference in numbers of dead first instar larvae was not significantly different (Table 2). More larvae developed to the fourth-instar in 'DPL 5415' bolls compared with *G. thurberi* bolls (Table 2, Experiment 1). The results indicate higher larval mortality and possibly lower developmental rates in *G. thurberi* bolls. Average numbers of PBW eggs per oviposition cage and percentages of hatched eggs were not significantly different for PBW female moths from larvae developed in 'DPL 5415' compared with *G. thurberi* cotton bolls (Table 3).

Field-collected 'DPL 5415' bolls (Experiment 3, data not tabulated), had an average of 2.9 ± 0.6 PBW larvae per 25 bolls (200 bolls total). No PBW larvae were found in *G. thurberi* bolls (400 bolls total).

Discussion

Gossypium thurberi can serve as a PBW reproductive host, but was not found readily infested in the field in our studies. These results agree with an earlier report that no PBW larvae occurred in more than 13,000 *G. thurberi* bolls picked from about 100 *G. thurberi* plants growing in the Santa Rita Mountains, AZ at an elevation of about 3850 ft. (Fye 1968). However in the laboratory under no-choice conditions, the numbers of eggs laid by PBW female moths in *G. thurberi* bolls was not significantly different compared to 'DPL 5415' bolls. Larval development to the last instar and pupation were reduced in *G. thurberi* bolls compared with 'DPL 5415' bolls. The reason was not determined but results are preliminary and further research should be conducted to verify the findings and determine the mechanism preventing PBW larval development in *G. thurberi* bolls. The limited acreages of wild cotton in Arizona which are located at remote sites and high elevations in concert with the low PBW reproductive potentials shown in our test suggest that its utilization as a host for PBW may be minimal. Additionally *G. thurberi* plants are photoperiodic and do not produce bolls until late August and thereafter with declining temperatures, day lengths, and the initiation of PBW diapause in overwintering larvae.

References

Anonymous. 2001. Pink Bollworm Eradication. A window of opportunity. National Cotton Council of America Memphis, TN. 6p.

Fye, R. E. 1968. The thurberia weevil in Arizona. J. Econ Entomol. 61: 1264-1268.

Noble, L. W. 1969. Fifty years of research on pink bollworm in the United States. U.S. Department of Agriculture, Agriculture Research Service, Agriculture Handbook 357.

Tables

Table 1. Mean number of pink bollworm larval entrance and exit holes and larvae per *Gossypium hirsutum* and *G. thurberi* cotton boll.

Gossypium species	Holes/boll		Larvae/boll		
	entrance	exit	live	dead	total
Bolls in one ounce plastic cup, Experiment 1					
thurberi	2.67 b	0.00 b	0.33 b	0.27 a	0.60 b
hirsutum	3.83 a	1.80 a	2.83 a	1.00 a	3.83 a
t, df = 58	3.03	10.19	10.76	0.12	9.22
P	≤ 0.05	> 0.05	≤ 0.05	> 0.05	≤ 0.05
Bolls on cotton stems and in floriculture tubes, Experiment 2					
thurberi	2.10 b	0.00 a	0.05 b	0.10 a	0.15 b
hirsutum	3.55 a	0.00 a	1.15 a	0.20 a	1.35 a
t, df = 58					
P	≤ 0.05	> 0.05	≤ 0.05	> 0.05	≤ 0.05

Means not followed by the same letter are significantly different, "t" test

Table 2. Mean numbers of pink bollworm larvae and dead larval instars per boll in *Gossypium hirsutum* and *G. thurberi* bolls.

Gossypium	PBW larval instar								
	1		2		3		4[a]		No.
Species	L	D	L	D	L	D	L	D	Pupae
Bolls in one ounce plastic cup, Experiment 1									
thurberi	3	8	1	0	4	0	8	0	1
hirsutum	0	8	0	0	1	0	36	0	48
Bolls on cotton stems in floricultural tubes, Experiment 2									
thurberi	0	2	0	0	1	0	0	0	0
hirsutum	1	3	0	0	15	0	7	0	0

[a] Fourth-instar larvae recovered in dissected bolls were reared on artificial diet to pupation and pupae held to adult emergence for confinement in mating-oviposition cages. L= Living, D = Dead.

Table 3. Mean number of pink bollworm eggs per cage and percentage egg hatch on *Gossypium hirsutum and G. thurberi* bolls.

Gossypium species	PBW eggs/cage	% Hatch
thurberi	77.4 a	90.2 a
hirsutum	103.0 a	95.1 a
t, df = 8	0.73	0.82
P	0.49	0.43

Means in a column not followed by the same letter are significantly different, "t" test, $P \leq 0.05$.