Published January, 1981

Nectariless Cotton: Effect on Growth, Survival, and Fecundity of Lygus Bugs[1]

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ABSTRACT

Experiments were conducted in the laboratory, greenhouse, and field to evaluate the effect of the nectariless character in cotton, *Gossypium hirsutum* L., on growth, survival, oviposition rate, and population increase of lygus bugs, *Lygus hesperus* Knight. Survival of *L. hesperus* nymphs on Stoneville 7A nectariless was 16% lower than on 'Stoneville 7A' during a 7-day growth period. Reduction on other nectariless lines was not as great. Survival of female *L. hesperus*, confined for 14 days on a nectariless cotton, was 6% less and the number of nymphs emerging was 12% less than on the nectaried commercial standard, 'Acala SJ-1.' Growth rates of lygus populations, during two generations in field cages, were reduced 34% by the nectariless character in Acala H4016 nectariless and 40% on Stoneville 7A nectariless when compared to their near-isogenic nectaried commercial standards. Populations of lygus bugs on Deltapine 16 nectariless were not lower, however, than on its nectaried near-isoline. Thus, the response of the insect was affected not only by the nectariless character but also by the genetic backgrounds of the cultivars and lines tested.

Additional index words: Host-plant resistance, *Gossypium hirsutum* L., Antibiosis, *Lygus hesperus* Knight.

CARBOHYDRATES, in the form of sugars, are important in the diet of the lygus bug, *Lygus hesperus* Knight (Hemiptera-Heteroptera: Miridae). Survival of *L. hesperus* nymphs on preflowering alfalfa, *Medicago sativa* L., was increased from less than 10 to 80% when a sugar source was provided (3). Butler (3) found that sucrose, glucose, fructose, and melezitose were all important dietary sugars. In nature, *L. hesperus* can obtain melezitose from honeydew excretions of certain homopterous insects and the other sugars from the nectar of flowering plants such as cotton, *Gossypium hirsutum* L., and alfalfa (3). Behavioral studies of the tarnished plant bug, *L. lineolaris* (Palisot de Beauvois) (5) and *L. hesperus* indicate that these insects commonly feed on nectar secreted from the extrafloral nectaries of cotton (1).

In an effort to develop insect resistant cotton, geneticists have bred cottons that lack extrafloral nectaries (7, 8). Comparative studies demonstrate that many adult insects prefer to feed and lay eggs on cottons that have extrafloral nectaries (2, 4, 6, 9). However, very few studies have been conducted to investigate antibiosis in nectariless cotton. Information on antibiosis is essential to determine the full impact of a plant resistance character on the population dynamics of a target pest and the amount of crop damage done by that pest.

The studies reported in this paper were conducted to evaluate the effect of the nectariless character in cotton on growth, survival, oviposition rate, and population increase of *L. hesperus*. We were also interested in the effect of various cotton genetic backgrounds on the level of insect resistance provided by the nectariless character.

MATERIALS AND METHODS

For greenhouse experiments, cotton plants were grown in a peat moss/soil mixture in 0.946-liter plastic pots. Plants used in experiments had been fruiting for 3 to 5 weeks. All blooms and bolls were systematically clipped from the plants to stimulate continued production of flower buds (squares).

The cotton plants represented five commercial cultivars and their near-isogenic nectariless equivalents. The entries and the experiments in which they were used are listed in Table 1. Acala H4006 and Acala H4016 are derivatives of 'Acala SJ-1.' In some tests, these nectariless cottons were compared to 'Acala SJ-2,' which is closely related to Acala SJ-1.

Nymphal Growth and Survival. Female *L. hesperus* were collected from hay alfalfa and placed on green bean, *Phaseolus vulgaris* L., to obtain eggs from which to rear nymphs. At 3 days posteclosion, the nymphs were individually confined to intact squares in cellulose dialysis tube cages 4.1 cm diameter by 15.2 cm long. The squares were enclosed in the cage approximately 3 days pre-anthesis. Dialysis tubing was used because of its light weight, transparency, and permeability to water vapor. A polyurethane foam disc, 5.2 cm in diameter by 2.5 cm thick, was slit radially for attachment to the stem. The dialysis tube was then slipped over the terminal and onto the foam disc. A single *L. hesperus* nymph was placed in each cage and confined for 7 days, after which it was weighed and its survival recorded. This method is after Tingey et al. (10).

Three dialysis tube cages, each containing a single 3-day-old nymph, were placed on each plant. The 7-day weights of the three bugs/plant were averaged. Eight plants/entry were grown. The weights and survival of the nymphs on each nectariless cotton were compared with weights and survival on its nectaried near-isoline.

Oviposition Preference and Nymphal Emergence. Oviposition pereference and emergence of *L. hesperus* nymphs were

[1] Contribution of the Dep. of Entomology, Univ. of California, Davis, CA 95616, and U.S. Cotton Res. Stn., AR, SEA, USDA, Shafter, CA 93263. Received 12 May 1980.

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[3] Mention of a trademark or proprietary product does not constitute a guarantee or warranty of the product by the USDA and does not imply its approval to the exclusion of other products that may also be suitable.

Table 1. Growth, survival, nymphal emergence, and population development of *L. hesperus* confined to nectaried (Ne) and nectariless (ne) cottons in field and greenhouse tests, Shafter, Calif. 1976 to 1977.

		Greenhouse tests						
		Growth and survival/7 days		Oviposition/24 hrs.	Exposure/14 days			Field cage test
					Female survival after			
Cultivar or line	Phenotype	Nymphal weight	Nymphal survival	Nymphs emerging/plant	7 days	14 days	Nymphs emerging/plant	Bugs/plant†
		mg	%	no.	%		no.	
Acala SJ-1	Ne	–	–	–	43	22	173	38.3
Acala H4006	ne	1.76	79	45.3	31	16	152	28.1
Acala H4016	ne	1.28	71	41.2	–	–	–	25.3†
Acala SJ-2	Ne	1.46	86	31.1	–	–	–	–
Stoneville 7A	Ne	1.87	100	39.0	–	–	–	65.7
Stoneville 7A	ne	2.07	84	30.9	–	–	–	39.6†
Stoneville 213	Ne	1.73	79	23.9	–	–	–	–
Stoneville 731N	ne	1.96	79	40.0	–	–	–	–
Deltapine 16	Ne	–	–	–	–	–	–	33.5
Deltapine 16	ne	–	–	–	–	–	–	42.2
L.S.D. $_{0.10}$		0.49	15	12.1	12	12	38	–†
Ne mean‡		1.69	88	31.3	–	–	–	45.8
ne mean		1.77	78	39.4	–	–	–	33.8
Level of probability		NS	0.05	0.05	–	–	–	0.05

† Original data transformed to log (X + 0.5) for ANOV. Retransformed means reported here. Mean of a nectariless line followed by a dagger (†) is significantly different at the 0.10 level of probability from that of its nectaried near-isoline. The L.S.D. was calculated on transformed data and therefore cannot be reported here with retransformed data. ‡ All nectaried and nectariless genotypes were combined for statistical analysis. The indicated level of probability is based on ANOV.

measured as one parameter, "nymphal emergence." The open ends of cotton organdy sleeve cages 20 cm wide by 24 cm long were fitted with Velcro fasteners[3]. One end was placed over the plant terminal and secured around the main stem with the Velcro fastener. Six female *L. hesperus* were placed in each cage and allowed to feed and oviposit for 24 hours, after which the cage and the females were removed. The egg-infested plants were held in a greenhouse at 27 ± 3 C for 6 days. On the 7th day each plant was shaken over a white surface to remove newly emerged nymphs. This procedure was repeated daily for each plant until no more nymphs were collected—usually about 5 days. The test was replicated eight times. Nymphal emergence was compared between nectariless and nectaried near-isolines.

Greenhouse Adult Longevity and Nymphal Emergence. Acala SJ-1 nectaried and the near-isoline Acala H4006 nectariless were individually enclosed in cotton organdy cages 80 cm tall by 24 cm wide. These cages were fitted on two ends with Velcro fasteners. The bottom end was enclosed around the main stem just above the soil line, whereas the top was sealed above the plant after 15 *L. hesperus* females and five males had been introduced. These adult bugs were of unknown age and had been collected from alfalfa and held on green beans. Bugs were confined to these two cottons for 14 days. After 7 days, survival was recorded and the bugs were moved to a second set of plants and confined for another 7 days, after which survival was again recorded. Bugs were then removed from the plants and nymphal emergence tallied daily for 10 days by shaking newly emerged nymphs from test plants onto a white surface. The test was replicated 10 times.

No-Choice Field Cage Test. Individual cotton plants grown in the field were covered with large organdy cages and sealed at the top and bottom with Velcro fasteners. These cages were supported by an overhead wire. To prevent the entrance of predators and mites, we wrapped the plant mainstem with a cotton pad and covered this pad with a layer of cotton organdy. Then the Velcro-lined cage opening was sealed around the plant and clipped on both sides of the mainstem wrap with plastic clothespins. Plots were single rows 6 m long replicated four times in randomized blocks. Three plants were caged in each plot. Each cage was thoroughly saturated from within with tetraethyl pyrophosphate[3] (200 g AI per 379 liters of water) to remove predators, parasites and mites. Cages were left sealed for 3 days then again thoroughly saturated from within with tetraethyl pyrophosphate. Cages were again sealed for 4 days after which five female and two male *L. hesperus* were introduced into each cage. These field-cage populations were allowed to increase for 29 days (approximately two generations), then immobilized by placing the cut plant with cage intact into a drum containing chloroform vapor. The bugs were then shaken from the cage and plant, counted, and recorded.

RESULTS AND DISCUSSION

Nymphal Growth and Survival. Mean weights of lygus bug nymphs fed for 7 days on squares were not significantly different for any of the nectaried-nectariless pairs (Table 1). On the other hand, nymphal survival was significantly lower on the nectariless near-isolines than on their nectaried counterparts, except in the case of 'Stoneville 213' vs. 'Stoneville 731N' (Table 1). We believe that survival is a better measure of nectariless resistance than nymphal weight because it affects population size.

Adult Oviposition Preference and Nymphal Emergence. When adults of *L. hesperus* were exposed to the test cottons for 24 hours, significantly greater numbers of nymphs emerged on the nectariless Acala H4006 (but not on Acala H4016) than on 'Acala SJ-2' and on Stoneville 731N than on Stoneville 213. Nymphal emergence on Stoneville 7A nectariless and nectaried did not differ significantly (Table 1). In retrospect, we suggest that more than a 24-hour exposure period is required for the nectariless character to affect oviposition. The variation in numbers of emerging nymphs between lines may reflect resistance characters other than nectariless in the individual backgrounds.

Greenhouse Adult Longevity and Nymphal Emergence. Seven-day survival of *L. hesperus* adult females was reduced significantly on the nectariless Acala H4006 compared to the nectaried Acala SJ-1 (Table 1). Survival

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at 14 days was not significantly different. Our results agree with those obtained by Schuster et al. (9) for *L. lineolaris*. The total number of nymphs produced on the nectariless cotton was slightly but not significantly lower than on its nectaried counterpart.

No-Choice Field Cage Test. Numbers of lygus bugs/plant in field cages were lower on some nectariless lines than on their nectaried near-isolines (Table 1). Reduction in lygus population growth was greatest on the nectariless Stoneville 7A (40% less than on its commercial nectaried near-isoline). The differences for the Acala near-isolines was similar (30%). The difference was not significant, however, between 'Deltapine 16' and Deltapine 16 nectariless.

Plants in this test were flowering and producing floral nectar secretions as a sugar source in both the nectariless and nectaried lines. However, under field conditions floral nectar is available only on blooming plants for a short time during the day when blooms are open. Hence, we would expect the mortality rate of lygus bugs to be considerably higher on preblooming nectariless cotton than this test indicates.

Conclusions. Our studies show that the nectariless character, in some genetic backgrounds, increased mortality of *L. hesperus* adults and nymphs when no other nectar source was available for 7 or more days. This result indicates that nectariless plants possess antibiosis, that is, they are nutritionally inferior because they lack the sugars provided in extrafloral nectary secretions. The ultimate result of reduced survival of *L. hesperus* nymphs and adult females on nectariless cotton will be the suppression of the population growth rate of the insect.

Nectariless thus appears to be an excellent resistance character to incorporate into cotton cultivars to reduce damage from *L. hesperus*. Our data show, however, that the genetic background of the cotton line in which the nectariless character resides can affect the relative resistance provided by this character. In fact, some of these cottons may have mechanisms of resistance other than that provided by the nectariless character. For example, nymphal survival and emergence were significantly lower on Stoneville 213 than on Stoneville 7A. Also, field-cage populations of lygus bugs were lower on Deltapine 16 than on Stoneville 7A. Thus, it appears that some cultivars will be superior to others as recipients of the nectariless character.

ACKNOWLEDGMENT

The research reported was supported in part by a grant from the Rockefeller Foundation through a project entitled "Development of insect resistance in cotton to minimize use of insecticides for control of the bollworm, *Heliothis zea* Boddie, and the tobacco budworm, *H. virescens* Fabricius."

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