Relative susceptibility of *Crotalaria* spp. to attack by *Etiella zinckenella* in Puerto Rico[1]

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ABSTRACT

Four *Crotalaria* species were found attacked by the lima bean pod borer *Etiella zinckenella* (Treit.) in Puerto Rico: *C. pallida, C. anagyroides, C. zanzibarica* and *C. incana*. Non-susceptible species were *C. retusa, C. stipularia* and *C. lanceolata*. Early literature observations on the effect of soil characteristics (pH, soil penetrability, and organic matter) on attack rates of this borer to *C. pallida* could not be confirmed on the basis of field observations. Only plant patch size seemed to be positively correlated with attack rates. Female oviposition patterns are discussed. Oviposition on *C. pallida* field collected pods was restricted to green pods larger than 3.2 cm. No eggs were found on senescent pods.

INTRODUCTION

The lima bean pod borer, *Etiella zinckenella* (Treit.), was reported in Puerto Rico in 1890 (20). Since then, it has been studied by many visiting and resident entomologists. Leonard and Mills (6) first reported this pyralid boring on pods of lima beans, cowpeas, pigeon peas and *Crotalaria* (no species given). Wolcott (17,18) recorded that among all species of *Crotalaria*, only *C. incana* L. was attacked, and *C. retusa* L. appeared immune to this borer. This author also reported that *Crotalaria* plants growing on sandy soils were more susceptible to pod loss by *E. zinckenella* than those growing on clay soils. Further studies by Scott (12) corroborated Wolcott's observations on *C. retusa* resistance and added *C. stipularia* Desv. to the list of resistant species. Since then no other studies have been conducted on the distribution or susceptibility of *Crotalaria* species to this insect pest, even though the number of newly introduced species has steadily increased in Puerto Rico.

The importance of *Crotalaria* species as key alternate hosts of legume pest populations has been established (5). In Australia, outbreaks of *Etiella behrii* and *E. zinckenella* on grain legumes are determined by buildups of *Crotalaria* populations (14). The aim of the present article is to determine the susceptibility of the most common *Crotalaria* species in Puerto Rico; review some early observations about habit-caused plant

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susceptibility; study the oviposition habits of *E. zinckenella* on its preferred host, *Crotalaria pallida*; and suggest the possible advantages of *Crotalaria* population regulation as a management tool.

MATERIALS AND METHODS

Field surveys of *Crotalaria* species were conducted by driving and/or walking in early successional areas from 1980 to 1983. More than 12,000 road miles were covered. Once a *Crotalaria* patch was discovered, plants were checked for the presence of *E. zinckenella*. Species identity was determined by the senior author. Soil samples were taken from all *Crotalaria pallida* (Ait.) sites in 1980 (n=15). Sites were named according to township and road number. Soil characteristics such as relative patch size, soil pH, percentage organic matter, and penetrability (using soil penetrometer) were recorded. Relative patch size was established by ranking sites from 1 to 5, where 5 represented the largest patches. Attack rates were determined by examining pod raceme samples. Sample size varied from patch to patch according to pod availability. In small patches, all available pods were collected, whereas in larger patches 15-20 mature racemes were sampled. Number of pods per raceme and number of infested pods were determined. Each factor was then correlated with *E. zinckenella* pod attack rates. Determination of pod size selection for oviposition was accomplished by collecting and carefully inspecting pods of all sizes for the presence of eggs. Each pod with eggs was measured longitudinally with a Vernier caliper and recorded. The number of eggs per pod was also noted.

RESULTS AND DISCUSSION

Crotalaria species susceptibility to E. zinckenella. Crotalaria species were found growing virtually in all but the drier districts of the southwestern part of the island (table 1). All species were found restricted to recently disturbed sites, roadsides or river banks. Of the nine *Crotalaria* species mentioned by Martorell et al. (9), seven were found in our survey.

TABLE 1.—*Relative susceptibility of* Crotalaria *species to* E. zinckenella

Species	Relative abundance	Elevation			Susceptibility
		Low	Mid	High	
C. pallida	+ + +	+	+	+	Yes
C. incana	+ +	+	+	+	Yes
C. anagyroides	tr	+	–	–	Yes
C. zanzibarica	+	+	+	–	Yes
C. retusa	+ + +	+	+	+	No
C. stipularia	+	–	+	–	No
C. lanceolata	+ +	–	+	+	No
C. juncea	tr	+	–	–	n/a[1]

[1] Not available because of small sample.

These species were *C. pallida* Ait., *C. retusa* L., *C. incana* L., *C. stipularia* Desv., *C. zanzibarica* Benth., *C. anagyroides* HBK., *C. juncea* L., and an additional, previously unreported species, *C. lanceolata* L.

Of the eight species sampled, four were attacked by *E. zinckenella*: *C. pallida*, *C. incana*, *C. anagyroides* and *C. zanzibarica*. Samples of the four species listed above revealed a 20-40% pod attack, which approximates figures given by Wolcott (16) for *C. incana*. *Crotalaria juncea* status as a host plant remains uncertain because only two pods could be examined. Evident from comparisons with early literature, is the enrichment of *Crotalaria* species on the island. This enrichment has probably enhanced the alternate host spectrum of *E. zinckenella*. For example, Britton and Wilson (1) record only two of the susceptible species (*C. incana* and *C. pallida* = *mucronata* Desv. = *striata* DC). *Crotalaria pallida*, at present the most abundant species, was regarded as rare and local near the town of Bayamón. Also of interest is the lack of mention of *C. pallida* as a host on early reports of *E. zinckenella* by early authors (7,14,2,17). This could reflect not only the recent invasion by this species, but also the speed at which invasion is possible for some of the recently arrived species.

Patch size and soil characteristics and their effect on Crotalaria *susceptibility to* E. zinckenella *attack*
Oviposition patteras on Crotalaria *pods.*

No significant correlations were obtained between the percentage of pods bored and soil penetrability, pH or percentage of organic matter. Wolcott (17) noted that plants growing on sandy soils were apparently more susceptible to attack than those growing on heavy clay soils (table 2). Fifteen *C. pallida* patches were surveyed including sandy, calcareous and clayey soils. Nevertheless, no soil effect was found among the examined variables, thus failing to support Wolcott's conclusions. The only variable measured with high correlations to attack rates was patch size ($r = 0.75$, $p < 0.05$).

Crotalaria pallida pods examined revealed a clear pattern of oviposition preferences related to size and maturity. Eggs were found only on pods larger than 3.2 cm in length (examined pods ranged from 0.5 to 4.5 cm). Of 1717 pods examined, only 109 (6.3%) contained eggs. A sizable proportion of these (20%) had more than one egg, with seven being the maximum number found on one pod. The mean length of a newly oviposited pod was 3.94 ± 0.04 cm (SE). Apparently, *E. zinckenella* females place their eggs on a specific pod size which could signal proper pod quality. In the field, pods smaller than 3.0 cm were prone to premature abscission. The choice of a pod with a lower probability of abortion would be of adaptive value for an internal pod feeder like *E. zinckenella*.

TABLE 2.—*Soil characteristics of* Crotalaria pallida *patches infested by* Etiella zinckenella, *June-July 1980*

Location	Soil penetrability[1]	pH	Organic matter	No pods examined	Bored	Size rank[2]
			%		%	
Arecibo 129	4.00	8.5	2.7	435	52.1	4
Añasco 109	0.62	6.3	0.5	145	52.6	3
Añasco 108	2.25	6.4	1.8	87	12.5	2
Aguada 110	1.25	7.8	5.5	263	49.9	2
Hatillo 2	0.28	8.7	2.1	230	40.4	3
Playa Jobos	0.25	8.2	6.5	143	42.6	5
Isabela	0.26	8.3	7.1	202	33.6	2
Las Marías	3.48	7.2	0.7	52	7.1	1
Las Marías 2	3.00	5.9	2.5	284	18.3	2
Maricao 105	1.27	8.2	2.1	172	23.5	1
Lares 129	3.07	5.4	1.4	127	0.0	1
Mayagüez 106	3.22	7.8	0.6	183	34.2	2
San Sebastian 433	3.24	4.7	2.1	248	92.3	5
Yauco 128	1.58	5.6	1.9	223	18.3	3
Villalba	2.25	8.1	6.0	227	39.2	2

[1] Average of five measurements with penetrometer, scale 0-4, where 4 is the hardest soil.

[2] Patches were ranked from smallest (1) to largest (5).

No eggs were found on mature (brown) pods. Singh and Dhooria (10) found that pods which were too hard to be entered successfully resulted in heavy mortality among newly hatched larvae. Mature *C. pallida* pods are appreciably harder and tougher than green pods, perhaps causing similar mortality. More laboratory tests of this mortality factor are still needed to ascertain its importance. If such an effect is demonstrated, a window of pod vulnerability to *E. zinckenella* could be proposed, dictated at one end by pod abortion and at the other by pod hardness. Such a fixed vulnerability window could pose a formidable obstacle to searching females, especially when pods are scarce, such as during dry seasons in Puerto Rico.

On different *Crotalaria* species, eggs were found in different places. In the glabrous podded species *C. pallida*, *C. anagyroides* and *C. zanzibarica* the eggs were normally laid under flower sepals; in the pubescent *C. incana*, the eggs were mostly found on pod hairs. This confirms for *Crotalaria* species what Hattori and Sato (3) demonstrated on laboratory trials on soybeans: that hairs or their lack trigger females to choose different sites for oviposition.

CONCLUSIONS

The importance of alternate host plants in the survival of herbivore pest populations and their parasitoids has been well established (11). In some systems, alternate hosts reduce the risks inherent to food supply unpredicitability. Should a primary food supply become limiting, an alternate source would provide food and shelter (17). The result is a more stable herbivore population, stabilized by each addition of a host plant species (4). In the seasonal tropics, as well as in temperate zones, a succession of host plants with overlapping phenologies helps pests obtain refuge at any given time of their growing season, enhancing their survival (9). Some authors have suggested the elimination of alternate hosts as a pest management tool (5,6,8,13). The same approach is applicable to *E. zinckenella* populations. In the Philippines, feral *Cajanus cajan* L. is responsible for *Etiella zinckenella* outbreaks on nearby soybean plantations (8). In Australia, *Crotalaria* spp. act similarly as alternate species (14). In Puerto Rico, the presence of *Tephrosia* sp. close to pigeon peas significantly increased pod infestation (2). It seems clear that as local populations and diversity of *Crotalaria* species increase with the increase of deforested areas, wastelands and road sides, *Etiella zinckenella* populations will enjoy similar population increases on the Island. However, much information is needed before suggesting elimination of feral *Crotalaria* populations near legume fields. Their impact in the maintenance of the borer's natural enemies should be weighed against their negative influence.

RESUMEN

Susceptibilidad de *Crotalaria* spp. a *Etiella zinckenella* en Puerto Rico

Un reconocimiento de especies de *Crotalaria* determinó la susceptibilidad de cuatro especies al ataque del barrenador *Etiella zinckenella* (Treit.): *C. pallida, C. anagyroides, C. zanzibarica* y *C. incana*. No se hallaron atacadas las especies *C. retusa, C. stipularia* o *C. lanceolata*. No se logró corroborar algunas observaciones informadas en la bibliografía sobre el efecto de los suelos sobre la intensidad del ataque del barrenador a *C. pallida*. Solo la densidad de plantas resultó positivamente correlacionada con la severidad del ataque. Se observó que la postura de huevos está restringida a vainas verdes de *Crotalaria pallida* de más de 3.2 cm. No se hallaron huevos en vainas senescentes.

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