J. Aquat. Plant Manage. 24: 91-92

Effect of Leaf Hardness on Penetration of Waterhyacinth by *Sameodes albiguttalis*

A. D. WRIGHT AND A. S. BOURNE[2]

INTRODUCTION

Sameodes albiguttalis (Warren) (Lepidoptera: Pyralidae) was released in Australia in 1977-78 as a biological control agent for the aquatic weed waterhyacinth, *Eichhornia crassipes* (Mart.) Solms. The moth is selective in the type of waterhyacinth plant attacked (Harley and Wright 1984) and damage to the weed results from the larvae of *S. albiguttalis* tunnelling into the petioles. Characteristics of waterhyacinth which may vary and influence the distribution and level of attack by *S. albiguttalis* include nutrient status, defensive chemistry and physical attributes of leaves.

In oviposition studies in Argentina, DeLoach and Cordo (1978) found that fewer eggs of *S. albiguttalis* were deposited on undamaged waterhyacinth plants than on those where the leaf surface had been damaged by the weevil *Neochetina eichhorniae* Warner, by snails or by other causes. DeLoach and Cordo (1978) and Center and Durden (1981) described methods of culturing *S. albiguttalis* in which intentionally damaged leaves were provided for moth oviposition. This may have assisted neonates to enter leaf mesophyll rapidly and with minimum effort.

The following study was undertaken to test the hypothesis that epidermal hardness affects entry by neonates of *S. albiguttalis* into undamaged petioles of waterhyacinth.

MATERIALS AND METHODS

Waterhyacinth plants were collected on five occasions from three infestations in suburbs of Brisbane, Queensland. On the first occasion plants came from a site (A) having permanently flowing water; on the second, fourth and fifth from a site (B) with still water; and on the third occasion from a site (C) which has flowing water only after rain. Plants were rinsed, first with tap water and then with deionized water, and placed singly in small plastic buckets containing sufficient deionized water to cover the roots.

Polypropylene tubes (internal diameter 13 mm) were cut to *ca.* 15 mm. One end of each tube was sealed with a cap and the other was held lightly against a petiole using rubber bands. Thin foam-plastic rings sealed the tubes to the petioles. The foam ring also prevented the wall of the tube indenting or othewise damaging or weakening the epidermis of the petiole.

One unfed, neonate *S. albiguttalis* from a laboratory colony was placed inside each tube. Tubes were attached to petioles (one per petiole) at leaf positions one to five (*sensu* Center 1981) on plants. The number of tubes mounted on each occasion depended on the availability of larvae and varied from 16 to 92. An equal number of tubes was used for each leaf position on each occasion except the last when only positions 1 and 2 were used. The five leaf positions of each plant were not always available as it was necessary that petioles be undamaged.

The plants were kept for 18 h in the dark in a cabinet at a constant 23°C. Leaves were then cut from the plants and each petiole was inspected for evidence of entry by the larva. The hardness of each petiole was estimated using the penetrometer described by Wright and Fuller (1984).

Analysis of variance was performed on binary data where 0 = failure and 1 = success of individual larvae (Narula and Levy 1977). The effects of site, occasion and leaf position on successful entry were tested against the occasion by leaf position interaction in the analysis. Data from each leaf position on each occasion formed 22 groups. The effect of hardness on successful entry was tested between and within these groups, after adjustment for occasion and leaf position in the former case.

RESULTS

There were 224 attempts at entry and a further 52 cases in which data were rejected because no larvae were found at the final inspection. Successful entry was defined as at least one entrance hole through the epidermis having been made by the larva. The mean petiole hardness for the 144 successful entries was 132.5 g (SD 19.1). All the successful larvae were alive at the time of final observation.

There were 80 unsuccessful entries having a mean petiole hardness of 162.0 g (SD 39.2). Of these, 55 larvae were dead when observed (mean petiole hardnesses of

[1]Entomologist, Division of Entomology, and Statistician, Division of Mathematics and Statistics, CSIRO Long Pocket Laboratories, PMB No. 3, Indooroopilly, Queensland 4068, Australia.

TABLE 1. ANALYSIS OF VARIANCE (BINARY DATA) OF INSECT PENETRATION OF WATER HYACINTH PLANTS. THE ANALYSIS SEPARATES PETIOLE HARDNESS, COLLECTION TIME (OCCASIONS), COLLECTION SITES AND LEAF POSITION ON THE PLANTS.

Source	df	SSQ	F/EMA
Group hardness (unadjusted)	1	11.6107	45.14***
Group hardness (adjusted for occasions)	1	.0703	<1
Occasions (unadjusted)	4	19.3265	18.79***
Sites	2	16.9094	32.87***
Within site	2	2.4171	4.70*
Collections	4	7.7487	7.53**
Sites	2	7.4219	14.43***
Within sites	2	.3268	<1
Leaf position (unadjusted)	4	1.3474	1.31
Leaf position	4	1.3855	1.39
Error (a)	12	3.0867	.2572
Hardness within groups	1	.7471	5.68*
Error (b)	202	26.5594	.1315
Estimates of Regression Coefficients			
Hardness between groups		b (SE) =	−.0022 (.0018)
Hardness within groups			−.0030 (.0013)

these was 170.3 g (SD 42.6)). Of the 25 failures still alive at observation (mean petiole hardness 142.1 g (SD 20.3)), 10 were working on their first hole into the petioles (hardness = 153.1 g (SD 20.8)) when observed. It appeared that when petiole hardness exceeded *ca.* 170 g, larvae had little chance of entering the leaf.

The analysis (Table 1) showed a strong negative correlation ($p < .001$) between successful entry and mean hardness of the groups of occasion by leaf position data. But the effect was completely confounded with the differences between the five occasions when waterhyacinth was collected, so over all the occasions it was not possible to tell if the results observed were due to hardness or some other factor associated with the collection time or locality.

However the analysis showed the same negative correlation ($p < .05$) between hardness and entry within the groups so that hardness was a significant factor in successful entry of larvae of *S. albiguttalis* into waterhyacinth.

After adjusting for hardness, there were still significant differences in successful entry between the three different sites sampled ($p < .001$), but hardness removed differences between the three collections at Long Pocket. There were no detectable differences in the success of entry between leaf positions.

In Australia severe damage by larvae of *S. albiguttalis* has been restricted to vigorously growing plants with bulbous petioles, although luxuriant growths of tall plants with slender petioles have also been attacked (Wright 1982). Center and Durden (1981) found that *S. albiguttalis* established readily where plants appeared healthy and were growing vigorously, whereas on less thrifty plants, the moth either failed to establish or moved to other plants. They speculated that infestation was influenced more by age of plant tissue than petiole form, as proposed by DeLoach and Cordo (1978). Our results show that petiole hardness influences entry by larvae of *S. albiguttalis*, although hardness may itself be a reflection of the physiological age of a leaf. However significant differences in successful entry into plants from different sites indicated that entry is also influenced by other characteristics of the plant. These may include cuticle thickness or content of phenolics in epidermal cells.

The possibility of altering epidermal hardness by application of plant growth regulators to favour attack by *S. albiguttalis* is being investigated.

ACKNOWLEDGMENTS

We thank Mr. S. C. Fuller for excellent technical assistance.

LITERATURE CITED

Center, T. D. 1981. Biological control and its effect on production and survival of waterhyacinth leaves. Proceedings of the 5th International Symposium on Biological Control of Weeds, Brisbane, Australia 1980, pp. 393-410.

Center, T. D., W. C. Durden 1981. Release and establishment of *Sameodes albiguttalis* for the biological control of waterhyacinth. Environ. Entomol. 10:75-80.

DeLoach, C. J. and H. A. Cordo 1978. Life history and ecology of the moth *Sameodes albiguttalis*, a candidate for biological control of waterhyacinth. Environ. Entomol. 7:309-321.

Harley, K. L. S., and A. D. Wright 1984. Implementing a program for biological control of water hyacinth. Proceedings of the International Conference on Water Hyacinth, Hyderabad, India, Feb. 7-11, 1983. United Nations Environment Program, Nairobi, pp. 58-69.

Narula, S. C. and R. J. Levy 1977. A Monte Carlo comparison of several methods for analyzing small sample binomial data in a disproportionate two-factor experiment without replication. J. Stat. Comput. Simul. 5:239-244.

Wright, A. D. 1982. Progress towards biological control of water hyacinth in Australia. *In:* Report of the Regional Workshop on Biological Control of Water Hyacinth, India, May 1982. Commonwealth Science Council, London, CSC(82)RT-27:31-33.

Wright, A. D. and S. C. Fuller. 1984. A simple penetrometer for laboratory and field use. Aust. Entomol. Mag. 11:13-15.