EFFECT OF SELECTED PLANTS ON THE GROWTH AND DEVELOPMENT OF LEAFROLLERS

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SUMMARY

Plant material from six native plants that are recognised as having few lepidopteran insects associated with them, were incorporated into the diet of greenheaded and brownheaded leafrollers (*Planotortrix octo* and *Ctenopseustis obliquana*) to observe the effects on larval survival, pupation, adult emergence, fecundity and egg mortality. Two plants, kohekohe (*Dysoxylum spectabile*) and mangeo (*Litsea calicaris*) significantly inhibited insect growth and development although the two insects species showed different patterns of sensitivity to the plant materials. Leaves of the apple cultivar 'Dougherty', showed chemosterilant activity toward BHLR, dramatically reducing fecundity and egg survival.

Keywords: greenheaded leafroller, brownheaded leafroller, plant material, diet assays, larval growth and development, adult emergence and fecundity.

INTRODUCTION

The investigation of plant defenses against insect pests as a source of new control agents and strategies is of increasing interest with the decline in effectiveness and market acceptability of many synthetic pesticides and the rapid development of molecular technologies to manipulate plant genes. Plants are recognised to possess many natural resistance mechanisms, including phytochemicals, targeted to interfere with insect feeding, growth and development, reproduction and behaviour. Research into the chemistry of these plant resistance mechanisms has the potential to contribute to the development of new, more environmentally acceptable control agents, the identification of genetic material for incorporation into breeding programmes by conventional or molecular methods, or entirely new approaches suggested by a better understanding of the mechanisms by which plants limit predation.

The New Zealand native flora and the endemic leafroller species must have evolved to some ecological equilibrium over the millions of years since New Zealand has been isolated. Thus, factors regulating endemic leafroller predation must be present in New Zealand plants. Dugdale (1975) has recorded that over 60% of New Zealand lepidoptera are host specific indicating that resistance mechanisms are operating against a majority of the insects. The native flora is likely to be a rich source of insect-active chemicals and in earlier searches several compounds which disrupt insect growth and development were isolated (Russell *et al.* 1970; Singh *et al.* 1978).

In order to extend the search for new sources of resistance and to discover new materials affecting the growth and development of pest insects, we have assessed six native plants from a group recognised by Dugdale (1975) to have few lepidoptera associated with them. The powdered plant material was incorporated into the diet of the endemic pests, greenheaded and brownheaded leafrollers (GHLR, *Planotortrix octo* Walk. and BHLR, *Ctenopseustis obliquana* Walk., respectively) and observations made on mortality, pupation, adult emergence and fecundity. We also wished to initiate an examination of reported sources of resistance within exotic and crop plants, particularly in important horticultural species. For this reason, the leaves of 'Dougherty' apple were included in this study as Green (1984) found that larvae of BHLR failed to develop on this host.

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MATERIAL AND METHODS

Foliage and fruit or bark of the plants, listed in Table 1 were collected from various sites and the plant identity authenticated. Snow totara (*Podocarpus nivalis*) was included in the experiment to provide a link with previous work which showed that this leaf powder was toxic to lightbrown apple moth (LBAM, *Epiphyas postvittana*) (Singh *et al.* 1978). 'Dougherty' apple leaves collected from the HortResearch orchard, Havelock North, were included in response to reports that this apple variety has some resistance to BHLR (Green 1984). Lancewood or horoeka (*Pseudopanax crassifolium*) was included as a species whose genera has several monophages associated with it, while mangrove or manawa (*Avicennia resinifera*), kohekohe (*Dysoxylum spectabile*), hinau (*Elaeocarpus dentatus*) and mangeao (*Litsea calicaris*) were selected as having few or no associated monophagous lepidoptera (Dugdale 1975). The fruit of kohekohe and the root bark of mangeao were included in the study as chemical investigations of other species of this genera have shown this plant material to be a rich source of bioactive compounds.

The plant material was air dried, finely milled and incorporated into the standard lepidopteran diet (Singh 1983) at the rate of 20% of the dry components.

Larvae of greenheaded leafroller (*Planotortrix octo* Walk.) and brownheaded leafroller (*Ctenopseustis obliquana* Walk.) were reared individually at 20°C in plastic tubes on the standard diet containing the plant powders. One hundred neonate larvae were used per treatment. GHLR larvae came from the 40th generation of a culture originating from Canterbury and BHLR came from the 37th generation of a culture originating from Auckland. Larval mortalities were recorded during the larval period and pupation was assessed each day after 21 days. The time taken for each surviving larva to reach pupation was recorded. The pupae were removed from the diet to assess adult emergence. To determine any adverse latent effects of the test diets, five pairs of males and females were transferred into perspex tubes lined with wax paper, allowed to mate and their eggs were collected. The eggs were counted to assess fecundity (eggs/pair) and after the eggs had hatched they were counted again to determine the egg fertility (total eggs laid less the infertile eggs), fertile-egg mortality (those eggs which did not hatch but which contained pre-formed larvae) and total egg mortality (total eggs which did not hatch).

The data were compared with the normal development of the insects reared on a control diet. The number of days to pupation was analysed using the Student t-test. All other data were analysed with a Chi-square test in a 2 x 2 contingency table.

RESULTS AND DISCUSSION

The effect of incorporating the selected plant material into the larval diets of greenheaded and brownheaded leafrollers is given in Table 1. Of the plant species tested, two, kohekohe and mangeao significantly inhibited larval growth and development of both insects and four others reduced fecundity and egg survival in BHLR. The two insects showed distinct patterns of sensitivity to these plant materials.

GHLR showed high sensitivity to both kohekohe leaves and fruit, with low larval survival and very low adult emergence. The time taken to pupation was dramatically increased and the majority (60%) of pupae were deformed. Insect active limonoids, have been isolated from related plant species (Champagne *et al.* 1992) and preliminary evidence from continuing chemical investigations of the fruit of kohekohe indicates compounds of this class are present in this plant. Isolated compounds will be tested as they become available. Mangeao root bark also affected pupation, adult emergence and fecundity of GHLR whereas the leaf material showed no effect. Antifeedant, aporphine alkaloids have been isolated from the root bark of mangeao (unpublished results) and warrant investigation for wider activity. Mangrove leaves reduced the fecundity (eggs/pair) of GHLR and also had latent effects on the egg fertility and survival.

BHLR showed high sensitivity to mangeao root bark with low larval survival, adult emergence and fecundity. The leaf material did not affect the larvae but fecundity

and egg survival were reduced. BHLR larvae, in contrast to GHLR larvae, were insensitive to kohekohe but fecundity and egg survival were affected. Lancewood and mangrove leaves also affected fecundity and egg survival. Snow totara leaves gave a high egg mortality and slight delay to pupation with BHLR, the only evidence for insect activity in this study. Previous work with snow totara (Singh *et al.* 1978; Singh *et al.* 1982) has shown the leaf powders of this plant are toxic to larvae of LBAM and that norditerpene lactones are the active constituents. This contrast points to the differential sensitivity of the leafroller species to plant constituents and the need for wide and comprehensive surveys to identify sources of resistance to this pest complex.

TABLE 1: The effects of plant material on growth and development and adult emergence and fecundity of greenheaded leafroller (GHLR) and brownheaded leafroller (BHLR).

Plant	Larval mortality (%)	Pupation (%)	Time to pupation (Mean days)	Adult pmerg (%)	Eggs/ pair	Egg fertility (%)	Fert.egg mortality (%)	Total egg mortality (%)
Greenheaded leafroller								
Untreated	0	97	26.2	92	327	64	12	44
Dougherty Apple lvs	0	94	29.6*	82*	327	79	8	27
Kohekohe leaves	66*	27*	44.3*	2*	-	-	-	-
Kohekohe fruit	61*	30*	46.9*	4*	-	-	-	-
Hinau leaves	0	91	30.6*	78*	464	94	5	11
Hinau bark	0	98	28.6*	89	320	75	5	29
Lancewood leaves	0	94	27.4*	90	332	76	14	35
Mangeao leaves	1	94	29.1*	83	383	63	7	41
Mangeao root bark	7*	70*	39.8*	54*	114	46*	35*	70*
Mangrove leaves	1	94	27.9*	93	232	50*	4	52*
Snow Totara leaves	0	94	28.9*	89	371	88	5	17
Brownheaded leafroller								
Untreated	0	87	32.7	79	200	76	9	31
Dougherty Apple lvs	0	88	32.2	79	135	2*	50*	99*
Kohekohe leaves	1	83	34.4*	76	213	71*	10	36*
Kohekohe fruit	1	90	34.4*	84	420	60*	7	45*
Hinau leaves	1	89	34.2*	87	411	82	12	28
Hinau bark	1	92	33.5	85	221	80	20*	36*
Lancewood leaves	1	82	35.3*	80	167	33*	57*	86*
Mageao leaves	1	92	34.5*	82	10	10*	100*	100*
Mangeao root bark	10*	57*	49.1*	42*	-	-	-	-
Mangrove leaves	0	93	32.5	82	111	85	21*	33
Snow Totara leaves	1	85	37.3*	84	453	65*	50*	68*

* Significantly different from control ($P < 0.05$).

We were unable to demonstrate any larval mortality of GHLR and BHLR on the 'Dougherty' apple leaves in contrast to the report of Green (1984) who found 0-14% survival of BHLR larvae to adulthood when fed leaves of the cultivars, 'Dougherty' and 'Granny Smith'. Our results confirm those of Ferguson (1991) who showed good survival of larvae fed on leaf disks of these plants. However, our results do show that 'Dougherty' apple leaves have a chemosterilant effect on BHLR, significantly reducing their fecundity and egg survival. Although the effect may be less dramatic than those of the active metabolites from non-host plants, a chemical definition of a source of resistance within apple and an understanding of its mode and target-range of activities, could be of major practical importance in future plant breeding. This result with 'Dougherty' apple has encouraged us to begin a bioassay-directed isolation of the active principle and to examine, in diet assays, further apple cultivars noted by Ferguson (1991) to cause significant leafroller larval mortality.

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