A COST-BENEFIT ANALYSIS OF BIOLOGICAL CONTROL OF ROSE-GRAIN APHID IN NEW ZEALAND

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SUMMARY

The rose-grain aphid (*Metopolophium dirhodum*) is a pest of economic concern to cereal growers in New Zealand. In 1985 the DSIR introduced a parasitoid, *Aphidius rhopalosiphi*, in an effort to control the aphid. It is estimated that the annual benefits to the nation from biocontrol of the aphid range from \$300,000 to \$5 million. The initial DSIR investment of about \$1.3 million in an integrated pest management programme for rose-grain aphid is likely to be repaid in savings to the community within 7 years at most.

INTRODUCTION

The rose-grain aphid (*Metopolophium dirhodum*) (RGA) first appeared in New Zealand in 1982 (Stufkens and Farrell 1984). It attacks cereals and can cause considerable loss of yield in cereal crops. RGA has also been implicated as a vector in the transmission of barley yellow dwarf virus disease (BYDV) (Waterhouse *et al* 1985). Chemical control of the aphid has been necessary in recent years.

The Entomology Division of the DSIR (now DSIR Plant Protection) undertook an integrated pest management study of RGA. Successful chemical control programmes were developed (Stufkens and Farrell 1984, 1985) and biological control was originally seen as an adjunct to these. In 1985 the aphid parasitoid *Aphidius rhopalosiphi*, known to attack RGA populations in England and France, was introduced. The impact of the parasitoid on RGA was rapid as it became established throughout Canterbury, Marlborough and Southland (Farrell and Stufkens 1987) and in the Manawatu (P. McGregor pers. comm.). High levels of parasitism have been recorded. Farrell and Stufkens (in press) found that in winter barley grown at Lincoln in 1988 and 1989 the level of parasitism increased from approximately 40% to 90% between September and November. In spring barley at Lincoln parasitism levels of 100% have been recorded. RGA levels are much lower than previously. Farrell and Stufkens (1988, in press) found that RGA maxima on spring barley had declined between 10- and 20-fold during the period 1984 to 1989. Anecdotal evidence from Canterbury farmers confirmed that aphids are now much less a problem.

Benefits obtained from biological control represent gains to the nation as a whole. It is desirable to identify these benefits in order to facilitate the efficient allocation of resources. The DSIR recently commissioned an economic evaluation of the RGA programme (Grundy 1989). This paper reports the findings of that study. In future it will become increasingly important to perform economic analyses before committing scarce resources to scientific research projects.

METHODS

A cost-benefit analysis of the biological control project was carried out. The cost of the damage caused by RGA to cereal crops was estimated from published research into the yield losses associated with RGA infestation (Stufkens and Farrell 1984, 1985). Based on conservative assumptions regarding levels of yield loss due to the pest and the impact of the parasitoid, the benefits of biocontrol were estimated.

In addition to the cost-benefit analysis an informal telephone survey of ten Canterbury cropping farmers was undertaken to provide some independent corroboration of the DSIR findings and to assess perceptions of RGA as a pest. The

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respondents were chosen from a list of farmers who have had a past contact with the Lincoln University Farm Management Department. They were asked what crops they believed aphids occurred on in greatest numbers, what crops had been sprayed specifically for aphids in recent years and whether a decline in aphid numbers had been noticed.

RESULTS AND DISCUSSION

Under New Zealand conditions direct damage by RGA can cause yield losses of up to 16% in spring barley and 41% in spring oats (Stufkens and Farrell 1984, 1985). The severity of infestation varies from year to year and from one location to another. A range of yield losses was therefore assumed for each of the major cereals grown in New Zealand (Table 1).

TABLE 1: Assumed yield losses due to RGA damage (%).

Crop	High	Medium	Low
Wheat	10	5	0
Barley	15	7.5	1
Oats	30	10	5

The likely range of cereal production (in tonnes) was determined based on historical production data published by the Department of Statistics. The crop prices used in the study were the medium term average projections intended for planning purposes published by the Ministry of Agriculture and Fisheries (MAFCorp 1989), rather than actual prices applying in any one year. The cost of each of the assumed levels of yield loss could therefore be calculated. At 1987 production levels the value of "high" RGA damage nationally would be about \$20 million (1988 dollars). Even at the lowest historical levels of production the "low" yield losses would be valued at around \$1 million. However, much of the data on both RGA and the parasitoid has been gathered in the Canterbury region so it may be inappropriate to extend results beyond this area. Nevertheless, even the "low" damage levels would cause yield losses valued at over \$0.5 million if only production from the Canterbury area was considered.

Further losses from RGA can stem from its role as a vector of BYDV (Waterhouse *et al* 1985; Stufkens and Farrell 1986). BYDV can cause crop losses of between 20% and 30% but it occurs in very localised areas and at irregular intervals. Stufkens and Farrell (1986) estimated the rate of infection of BYDV in the mid-Canterbury area was about 1% or less in 1985 — a year in which BYDV infection was apparently high. The annual cost of RGA induced BYDV is therefore unlikely to exceed \$1 million in any year (the approximate value of 1% of the national barley crop).

Effective control of RGA is possible using chemicals (Stufkens and Farrell 1984, 1985). The telephone survey of 10 Canterbury grain growers found that current practice for most farmers seems to be not to spray crops for aphids unless a significant build-up is detected. The farmers surveyed had all sprayed for aphids at least once in the past 5 years but only three had sprayed within the past 2 years. No estimate of actual expenditure on chemical control of RGA was possible. However, the hypothetical cost of treating the total area sown in cereals in New Zealand was estimated to be between \$3.6 million and \$5 million which gives an upper limit to chemical costs.

The cost of the entire research programme into RGA control was estimated by the DSIR as being \$1.32 million (in 1988 dollars). The biocontrol component of the research programme cost was \$264,000 but has to be seen in the context of the wider project.

The greatest benefits to farmers of the RGA research have stemmed from the introduction of the parasitoid. Table 2 shows the expected value of increased crop yields due to biocontrol of RGA for a range of aphid infestation levels assuming 10%, 50% and 90% reductions in aphid damage. If a "low" level of infestation and a 50% reduction in damage are assumed, the expected annual benefit to the Canterbury region alone is \$300,000. Assuming a 10% discount rate to reflect a positive time preference

TABLE 2: Estimated benefits of biological control (\$'000).

Damage Level	10%		% Control Achieved		90%	
	NZ	Canty	NZ	Canty	NZ	Canty
High	1850	1020	9240	5090	16630	9165
Medium	860	480	4310	2420	7760	4350
Low	130	65	660	330	1180	590

for benefits (that is, benefits are preferred now rather than later) the DSIR outlay of \$1.32 million would be recovered in just under 7 years. The costs of "medium" or "high" yield losses, and consequently the benefits of RGA control, are much greater — possibly as high as \$20 million. However, it would not be appropriate to attribute this level of benefit to biocontrol since, as noted earlier, chemical sprays could effectively control RGA for about \$3.6 to \$5 million nationally. The economic benefit of biocontrol under these circumstances is thus the reduction in chemical control costs — at most \$3.6 to \$5 million. At this level of benefit, the DSIR programme would already have recovered its costs in savings to the community. The actual benefits of biocontrol are likely to be between \$300,000 and \$5 million but it is quite possible that the benefits of biocontrol already exceed the cost of the research programme.

Some additional benefits, not so easily quantified, are also obtained from biocontrol. The parasitoid has also been found to attack the cereal aphid (*Rhopalosiphum padi*) and some other aphids. A reduction in pesticide use due to biological control of RGA represents an environmental benefit as well as a cost saving. There were also benefits to science from the experience gained in the project, irrespective of its outcome.

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