REVIEW OF CONTROL MEASURES FOR THE AUSTRALIAN SOLDIER FLY

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Summary

Control methods against the Australian soldier fly (*Inopus rubriceps*) are reviewed. Recommendation for control by thorough and repeated surface cultivation during the late summer-autumn months, (Hewitt, 1969), is probably one of the soundest measures to date.

INTRODUCTION

LITTLE WORK has been done to evaluate the effectiveness of the control methods which are at the moment being recommended. Where an attempt has been made it has usually been subjective. The object of this paper is to review the various methods which have been advocated for the control of Australian soldier fly (*Inopus rubriceps*) and to examine their theoretical basis.

SOLDIER FLY CONTROL

Hewitt (1964) screened eleven different insecticides but found the larvae difficult to control. It was discovered that the abnormally high rates of organochlorines required to achieve control eventually induce an inferior sward. Hewitt (1964, 1969) concluded that, at rates acceptable to normal field practice, there seemed to be no suitable chemical for pasture use.

Dumbleton (1949) found that a significant reduction in larval population was obtained by combining a cultivation with the use of chemicals. Moller (1965) reported that the broadcast application of insecticide to the soil of sugar cane fields during land cultivation gave good control of young larvae. BHC dust and dieldrin were reported to be equally effective. Moller (1965) emphasized that the insecticide should be applied immediately prior to egg laying and be thoroughly worked into the soil. However, older larvae were reported to be resistant to most insecticides (Moller, 1961, 1964).

Wilson (1969) reported that, in sugar plantations, poor control resulting in ratoon failure had occurred in some fields despite the use of dieldrin or BHC. He also stated that, in laboratory bioassays against the larvae, using nine different insecticides, each one mixed with the soil at a concentration of 8 ppm, "Dursban" proved several times more toxic than any other chemical. Attempted control of the emerging adults by misting either DDT at 2 lb/ac or dimethoate at 1 lb/ac was reported ineffective (Wilson, 1969).

Dumbleton (1949), Saunders (1963) and Hewitt (1964, 1969) all have emphasized that under pasture conditions the use of chemicals is prohibited by the cost involved.

Hewitt (1969) and Southon (1970a) have carried out work which suggests that parathion, if applied with maize at sowing, reduces early

plant mortality and stunting due to soldier fly attack. Southon (1970a) suggested that the parathion acted more as a repellent than a poison.

Mungomery (1932) was the first to suggest cultivation as a control measure in the sugar cane fields of Queensland. Bell (1934) recommended ploughing, when the insect was in the prepupal and pupal stages, and the maintenance of a dry surface mulch after the adults had emerged. By this means, the pupae were buried to prevent emergence and the surface maintained as dry as possible to expose any eggs to desiccation. As Dumbleton (1949) pointed out, in the sugar cane areas the maximum rainfall is in summer, with a relatively dry winter. This would tend to increase the effectiveness of the method. However, it was probably not realized that the larval period usually lasted considerably longer than twelve months (Wilson, 1969). Thus larvae would have been buried with the pupae and so continued the life-cycle.

Dumbleton (1949) reported a reduction in larval population following a cultivation which consisted of initially ploughing out an oat crop at the beginning of August, then rolling, double discing and harrowing during the following three months.

Moller (1965) emphasized the importance of a fallow period with frequent surface cultivations to discourage egg laying and desiccate any eggs that were laid. He warned against ploughing out and replanting as this allowed the life-cycle to proceed unchecked.

Campbell (1968) questioned the value of the fallow period. He reported an experiment in which larvae were kept without food at a range of temperatures. Desiccation was prevented. The results were as follows:

Temperature

Comments

40° C	All larvae died within 24 hrs
30° C	LT ₅₀ = 22 days, LT ₉₅ = 43 days, LT ₁₀₀ = 49 days
20° C	LT ₅₀ = 68 days, LT ₉₅ = 140 days, LT ₁₀₀ = 183 days
10° C	LT ₅₀ = 186 days, LT ₉₅ = 406 days, LT ₁₀₀ = 497 days
5° C	LT ₅₀ = 119 days, LT ₉₅ = 357 days, LT ₁₀₀ = 469 days
(No. of larvae kept at each temperature = 100)	

Also Wilson (1970) has reported that soldier fly larval populations were not much reduced by bare fallowing from mid-December till March in the Bundaberg district of Queensland.

In the light of the above, ploughing out of infested pastures under New Zealand conditions is not to be recommended. Not only are the larvae buried with a plentiful food supply, but in addition the temperature at which they would be buried could allow them to survive for months without food. Kain, *et al.* (1971) have shown that a larval population was unaffected after an infested pasture was ploughed and fallowed for two months during the late winter-early spring period.

Campbell (1968) reported that larvae not protected from desiccation usually died within a day or two. A preliminary experiment has been carried out by the writer to investigate the effect of low soil moisture levels on larval mortality. A summary of the results is given in Table 1.

Medium sized larvae were used. There was no mortality in controls (no. of larvae = 60) set up under moist conditions during the course of the experiment. Temperatures during the experiment were maximum, 26.4 ± 1.0° C, and minimum, 13.3 ± 1.7° C.

It is intended to investigate the influence of soil pF values on larval mortality. However, the above does indicate the deleterious effect on larvae of low moisture levels.

TABLE 1: EFFECT OF SOIL MOISTURE ON LARVAL MORTALITY
(Soil: Hamilton clay loam)

Water Content (%)	Larval Mortality (%)	Time (days)
10	13	7
	45	13
	73	21
	95	29
	100	35
5	6	7
	98	13
	100	21
0	48	7
	100	13

(No. of larvae at each moisture level = 60)

Irwin-Smith (1921) reported that a long drought proved unfavourable to pupal development. Campbell and Koehler (1971) reported that all eggs subjected to ambient humidity shrivelled and died.

Hewitt's (1969) recommendation for control, when going from grass to grass, of thorough surface working the damaged sward during the late summer and autumn months is probably one of the soundest control measures to date. By thorough and repeated surface cultivation (the top 4 in.) during the months of March and April, larvae, pupae and eggs are all subject to desiccation and possibly (with respect to the first two stages) bird predation. The use of a herbicide(s) prior to surface cultivation should assist in the drying out of the top 3 to 4 in. of soil. One farmer has reported getting good results by coarse harrowing then heaping the dried, ripped up sods into a line and burning them.

When going from infested pasture into a crop, the same principle of desiccation for reducing the larval population applies as when going from grass to grass. Hewitt (1969) has suggested, when going out of an infested pasture into a crop, fallowing the land for at least three months before sowing and working the surface thoroughly before ploughing. It seems likely that it is the surface cultivation which is much more important than the fallow.

However, certain crops, namely, brassicas, have been recommended specifically for soldier fly control. It was thought that the growing of these crops had a reducing effect on the soldier fly larval numbers. Lowe *et al.* (1971) have isolated two compounds from choumoellier roots, phenethyl-isothiocyanate and phenylisothiocyanate. These substances, at very high levels, have been shown to be toxic to soldier fly larvae but the long-term effects of lower levels of the isothiocyanates were not investigated.

Southon (1970b) reported that a farmer near Te Puke deeply ploughed a badly infested soldier fly paddock in spring, and surface worked the soil before sowing soft turnips, without disturbing the buried turf. The crop was severely damaged by soldier fly. Nine months later the buried turf was still full of active larvae of all visible sizes. Southon (1970b) has recorded soldier fly larvae clinging to the roots of choumoellier plants dug up in the field. Thus it has not been clearly demonstrated that the insecticidal content of the brassica roots is effective in reducing soldier fly larval numbers under field conditions.

Muggeridge (1944) reported that, in the Opotiki district, attacks on maize were usually serious in the first year planting out of old pasture but were much reduced in the second year. There is no information available to explain why the larval population was much reduced in the second maize crop. Repeated cultivation of the land might have been a factor. Hewitt (1969), in agreeing with Muggeridge, emphasized that following crops were generally free of infestation, provided there had been no carry-over of larvae through poor grass growth control.

Allo quoted by Thorpe (1970) has advocated heavy winter stocking for soldier fly control. During the winter period a portion of the farm is thoroughly tramped and then oversown. Hewitt (1969) and Southon (1970b) reported that the above procedure increased grass growth the following season. However, Southon (1970b) commented that the effect lasted only two seasons by which time the oversown pasture had completely deteriorated. Bearing in mind the toughness of the larval cuticle, it appears highly unlikely that any larvae (except the very youngest) would be killed by tramping. Also it is debatable whether the soil could be compacted enough by the above method to make it uninhabitable for the larvae. Southon (1970b) has reported large numbers of grubs to be still present in an area after recent heavy overwinter stocking.

Hewitt (1964) reported a marked pasture response to the basal dressing of superphosphate and potash when put on a soldier fly infested area.

It is doubtful whether either of the above processes reduces the soldier fly larval numbers at all. However, they could provide more food for the grazing animal and the soldier fly, for a limited time.

CONCLUSIONS

At the moment chemical control appears to be too expensive for use under pasture conditions. Even where the cost of chemicals can be justified—e.g., in the sugar cane fields of Queensland—they must be mixed thoroughly with the soil to be effective and appear to control only the very young larvae.

The surface cultivation method proposed by Hewitt (1969) appears to offer the most satisfactory form of control at present. It seems doubtful whether any other form of control that does not entail some surface cultivation is as effective in reducing soldier fly numbers.

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