THE EFFECT OF AUSTRALIAN SOLDIER FLY ON DIRECT DRILLED FORAGE MAIZE

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Summary

High density maize (*Zea mays*) is used as a forage crop throughout the North Island. Maize is susceptible to Australian soldier fly (*Inopus rubriceps*) larvae and the trials reported in this paper suggest that the direct drilling technique of establishing forage maize can lead to depressed yields. The maize suffered damage at relatively low soldier fly populations. Insecticide did not give increased yields of maize, and only 50-60% control of larvae was achieved at 1-3 kg carbofuran/ha. A 10% increase in maize yield was apparent for each decrease of 100 soldier fly larvae/m².

INTRODUCTION

Greenfeed maize is a useful summer supplementary feed on North Island farms (Cumberland and Hutton 1974; Campbell *et al* 1978). Maize and other cereal crops are susceptible to Australian soldier fly when sown in infested soil (Hewitt 1969). Hutton (1971) considered that soldier fly damage was the main factor limiting maize silage yield on highly productive dairying land.

Direct drilling leaves soldier fly larvae undisturbed, to feed on the seedlings. Considerable reductions in emergence and final yield of ryegrass (*Lolium perenne*) occurs where populations of soldier fly are high (Dixon and Davison 1976). Insecticide has been necessary to protect grass seed sown directly into soldier fly infested pastures (Dixon 1977).

Traditional methods of pasture renovation and maize establishment controlled soldier fly by intensive surface cultivation (Wilcocks and Hewitt 1971; Cumberland *et al* 1973).

The trial work reported in this paper was designed to study the effects of soldier fly on direct drilled maize yields with and without insecticide, and to compare two herbicide treatments and four rates of insecticide on crop establishment and soldier fly control.

METHOD

Trial 1

The trial site was on a Bruntwood-Eureka sandy-clay loam complex near Matangi, Hamilton. The site had previously been used as part of a stocking rate experiment with the result that a range of soldier fly densities had been established (Dixon and Campbell 1978). Six adjacent plots of approximately 0.05 ha had populations between 100/m² and 2000/m², as assessed from 20 soil cores of 7.65 cm diameter per plot on 5 October 1978.

The bulk soil density varied by up to 5% between plots (Judd *et al* 1977). The establishment of maize was probably not influenced by this compaction difference, as Byford (1980) could not show any yield differences between maize grown in cultivated compared with direct-drilled soil. Soil fertility differences were small, as determined from analyses of pH, Ca, K, P and Mg on each plot.

Glyphosate (2.0 kg/ha in 200 litres water/ha) was sprayed on one half of each plot 4 weeks before drilling, and the second half of the split-plot design was sprayed

Cereals and Maize

with paraquat (0.6 kg/ha) and dicamba (0.4 kg/ha) in 200 litres water/ha 2 days before drilling. The pasture was grazed before the latter spraying.

Maize seed (cv "XL 45") was drilled with a triple-disc direct drill at 250 kg/ha on 22 November 1978. Carbofuran (1.1 kg/ha) was sown with 100 kg/ha reverted superphosphate through the drill on one half of the trial, and the remainder was drilled with the fertiliser alone in a split, split-plot design. Each drilling treatment was replicated twice, and each treatment was 2.5 m wide by at least 12.0 m in length.

Plant emergence was determined on 7 December 1978, by seedling counts from 5 x 1 m row lengths in each treatment. Herbage production was assessed by drying and weighing a sub-sample of 50 randomly selected plants from each treatment on 12 February 1979, and converted to kg/ha by reference to the plant density.

Soldier fly densities were assessed before drilling by taking 10, 7.65 cm diameter cores per treatment, and again two months after drilling (2 February 1979) by taking 7, 10.16 cm cores per treatment removed from over maize rows. The larvae were extracted by wet sieving and flotation in a MgSO solution.

Trial 2

The trial site was on a Horotiu sandy loam near Rukuhia. Paraquat (0.6 kg/ha) and dicamba (0.4 kg/ha) were applied to short pasture on 3 December 1979. As rain fell shortly after spraying, the paraquat was reapplied on the following day.

Maize seed (cv "XL 45") was sown with a triple-disc drill at 300 kg/ha on 4 December 1979. The four treatments were 0, 2.0, 3.0 and 4.0 kg/ha carbofuran (10% granule), arranged in a complete randomised block design with four replicates of each treatment. The seed was sown with 100 kg/ha reverted superphosphate in which the insecticide was mixed.

The soldier fly populations were assessed on 30 November 1979, and 13 February 1980, by taking 10, 7.65 cm cores per plot at each date.

RESULTS AND DISCUSSION

Trial 1

There were no significant differences between any treatments in maize seedling emergence at 7 December 1978 ($P > 0.10$). Seedling density was approximately 300,000/ha in all plots. There was a significant difference in DM yields on 12 February 1979, as a result of the two herbicides (Table 1). Glyphosate pre-treatment resulted in an average 80% increase in DM yield over paraquat ($P < 0.001$). The herbicides also had a different effect on the soldier fly populations with 75% more larvae occurring in paraquat compared with glyphosate treated plots ($P < 0.001$). This is probably related to the four week fallow after application of glyphosate.

TABLE 1: The effect of herbicide and insecticide on maize yield (11 weeks growth) in kg DM/ha

	Insecticide* (1.1 kg/ha carbofuran)			No insecticide		
	◀200	200-600	▶600	◀200	200-600	▶600
Post-treatment soldier fly density (No./m ²)						
glyphosate (2.0 kg/ha)	6670	4130	NA +	6680	7180	4160
paraquat (0.6 kg/ha)	3870	3820	2030	4900	3910	1340

* insecticide gave 54% control of untreated soldier fly population.

+ no populations greater than 600/m² after glyphosate and insecticide usage.

N.B. Apparent depression of maize yield with insecticide usage is an artifact of higher pre-treatment densities of soldier fly causing damage before mortality.

Cereals and Maize

Paraquat did not control paspalum (*Paspalum dilatatum*) but glyphosate did remove this and other established plants. Paspalum competition with maize may have been a major factor in the low yields of maize in the paraquat treatments.

The interaction between soldier fly density and maize yield was significantly different between glyphosate and paraquat pre-treatments ($P \leq 0.05$) (Fig 1). Maize yield was depressed with increased soldier fly density, in the presence and absence of insecticide ($P \leq 0.001$). A decrease of 100 soldier fly/m² resulted in a 10% increase in maize yield in both glyphosate and paraquat plots.

Fig. 1 Relationship between maize (11 weeks growth) and soldier fly density (insecticide and no insecticide treatments combined).

The use of insecticide resulted in a constant mortality (54%) of soldier fly over the range of soldier fly densities (i.e., mortality was density independent). Insecticide did not significantly increase the yield of maize within this trial (see Table 1). This is probably because the low rate (1.1 kg/ha) gave only moderate control (54%) and the initial soldier fly densities were not high.

Trial 2

Insecticide did not give good control of soldier fly in this trial; the higher rates (3-4 kg carbofuran/ha) gave 44-58% control as assessed on 13 February 1980 (Table 2).

TABLE 2: The effect of different rates of carbofuran on soldier fly larvae in forage maize (Trial 2)

Rate (kg/ha)	Soldier fly No./m ²		% control initial population	% control of untreated
	before drilling	after treatment		
No insecticide	947 (115)	630 (103)	33	0
2.0	641 (182)	400 (158)	38	37*
3.0	649 (192)	263 (68)	59*	58**
4.0	1079 (303)	350 (24)	68*	44**

* $P \leq 0.05$

** $P \leq 0.01$

(Standard errors in brackets)

Cereals and Maize

Carbofuran gave reasonable control of soldier fly when drilled in 15 cm rows with grass seed in several experiments (Dixon 1977) and the lack of adequate control when drilled with high density maize seed in this experiment cannot be readily explained. The herbicide treatment removed the existing pasture satisfactorily, therefore, the larvae did not have alternative host plants on which to feed as was possible in the paraquat treatment in Trial 1.

Economic forage maize production

The minimum maize yields at which returns equalled costs, from crops produced by the methods in trials 1 and 2 are shown in Figure 2.

Fig. 2 Economic thresholds for the production of forage maize on soldier fly infested pasture (Matangi 1978-79): Costs at 1979 values.

The value of green forage is difficult to assess but was taken as equivalent to standing meadow hay (\$1.00 per 20 kg DM bale). The cost of producing the crop by the methods employed in Trials 1 and 2 are presented in Figure 2. Greenfeed maize seed (\$0.32/kg) and contract drilling costs (\$30/ha) were used to determine the basic expenses.

Forage maize cannot be considered as a complete stock diet due to the low mineral content (Cumberland and Hutton 1974), but supplementary feeding costs were not taken into account.

The density of soldier fly at which forage maize production was uneconomic under the conditions of Trial 1, was 450/m², or 600/m² if insecticide was used (Figure 2). The reasons for the low economic returns from forage maize in soldier fly infestations include:

1. the low tolerance of maize to soldier fly feeding;
2. the poor control of soldier fly larvae with insecticide (assuming 50% control at best, with carbofuran);
3. the high cost of herbicide when paspalum must be controlled.

CONCLUSION

Direct drilled, high density forage maize was sensitive to moderately low densities of soldier fly larvae. The crop, therefore, could not be economically produced where infestations typical of many northern North Island pastures were present (i.e.

Cereals and Maize

500-1000/m²). The use of glyphosate to remove paspalum was economical when the yield was high (i.e. in the absence of soldier fly). Insecticide was only justified over a narrow range of soldier fly densities (viz. 400-600/m²).

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