ARGENTINE STEM WEEVIL CONTROL IN MAIZE

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Summary

Seedling maize (*Zea mays*) is highly susceptible to Argentine stem weevil (*Hyperodes bonariensis*) if planted too quickly after cultivation of infested pasture or crop residues (up to 90% of plants attacked at full emergence). Control can be obtained from a cultivation period of at least four weeks prior to planting (less than 10% of plants attacked). Control can also be effected by carbofuran granules applied as a band with the seed at planting or, with systemic sprays such as oxamyl which can be applied up to a week before planting either with or before application of paraquat as a desiccant.

INTRODUCTION

Argentine stem weevil can be a major problem in seedling maize sown after short cultivation periods from pasture (Kain and Barker 1966), or from a ryegrass (*Lolium* spp) winter greenfeed crop, especially 'Grasslands Tama', or from stubble paddocks in which a lot of grass weeds were present. The problem is accentuated by farmers who plant early for agronomic advantages (McCormick 1974; Farrell 1975) or when wet winter and spring weather prevents an early start to cultivation. Maize direct drilled into pastureland can also be severely damaged by Argentine stem weevil. Argentine stem weevil occurs in all maize-growing areas. As other pests such as black beetle (*Heteronychus arator*) and soldierfly (*Inopus rubriceps*) have receded in importance as maize pests in recent years, Argentine stem weevil has ranked second only to greasy cutworm (*Agrotis ypsilon*) as a pest of seedling maize (personal observation).

Kain and Barker (1966) described fully the symptoms of Argentine stem weevil attack in maize including "failure to emerge, wilting, collapse and death of plants at the two- to four-leaf stage, yellow streaking of leaves, stunting, premature tillering, and splitting of the stems". They suggested that the mode of infection was by transference of larvae from decomposing grass tillers into the emerging maize plants. Eggs could successfully hatch on dead and dying pasture plants and the larvae mine other hosts. Adult weevils were not capable of significant damage to maize plants. *Hyperodes humilis* has caused similar damage to sweetcorn plants in southern USA (Harris 1960).

This paper presents information obtained from two sources.

Initial trials

In spring 1975 and 1976 a number of trials were laid down to investigate time of sowing effects on black beetle infestation. These trials which will be discussed fully elsewhere produced information on the field incidence of Argentine stem weevil, and the time interval between cultivation and damage by Argentine stem weevil to seedlings.

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Argentine stem weevil trial

This was laid down in spring 1977 to look specifically at Argentine stem weevil attack and prevention. One of the aims of this trial was to find the period necessary between the removal of grass residues and maize planting to avoid Argentine stem weevil attack in both cultivated and direct drilled situations. The other aim was to evaluate the effectiveness of the standard chemical control (carbofuran granules applied at planting (MacKay and Rowe 1974)) and to compare this with an alternative treatment, that of killing the larvae in grass tillers by spraying with a systemic insecticide before or at ground preparation for maize. The latter method offers advantages over granular applications of insecticide, particularly if it can be applied effectively with the desiccant paraquat during ground preparation. The chemical selected, oxamyl, was the best of a range of insecticides tested against Argentine stem weevil larvae in ryegrass by Welsh *et al* (1974).

METHODS

Initial trials

In 1975 and 1976 maize was planted at 3-5 sowing dates at fortnightly intervals. In 1975 a late and an early maturing variety ('XL45' and 'XL327' respectively) were planted with and without 2.0 kg/ha of fensulfothion applied as granules (surface broadcast in two trials and banded above the seed and lightly soil-incorporated in another). In 1976 only 'XL45' maize was used, with no insecticide, 2.0 kg/ha isazophos banded above the seed, and 4.0 kg/ha isazophos as a split broadcast banded application. During the seedling stage plant counts and insect damage assessment above and below the ground were conducted fortnightly from the date of seedling emergence. The trials were of split or split-split plot design, with subplots of 4.5 x 9.0 m (six row widths) and four replicates.

Argentine stem weevil trial

In 1977 a site in 2 year old perennial ryegrass (*Lolium perenne* cv 'Grasslands Ruanui')/white clover (*Trifolium repens*) pasture was selected on Horotiu sandy loam soil near Hamilton. Examination of grass tillers showed the presence of Argentine stem weevil eggs and larvae. There were six treatments (Table 1), each replicated four times in randomised blocks. Individual plots, were 3.0 x 7.0 m, with four rows 75 cm apart. Each row was planted randomly at weekly intervals to give four sowing times within each plot. Seeds were hand planted at 15 cm spacings (equivalent to 87 300/ha).

TABLE 1: Outline of pre-plant treatments used in Argentine stem weevil trial, 1977.

Treatment	Day				
	1	3	5	7	14,21,28
1 C/D		C		C + D	C + D
2 P/C/D	P	C		C + D	C + D
3 P/D			P	D + P	D
4 P+ox/D			P + ox	D + P	D
5 ox/P/D			P	D + P	D
6 P/D+carb			P	D + carb + P	D + carb

C = cultivate (rotary hoe).

D = drill one row per plot at weekly intervals (Day 7 = October 18).

P = paraquat 800 in 300 litres/ha, 700 ml surfactant.

ox = oxamyl 0.5 kg in 300 litres/ha or with paraquat application.

carb = carbofuran 10G 1.7 kg/ha banded over the row after planting.

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Four days before the first planting Treatments 1 and 2 were cultivated with two passes of a rotary hoe to achieve a fine tilth. All unplanted rows in these plots were given a further pass with the hoe immediately before each planting. Treatments 3-6 received an application of paraquat on the first sowing date because the first application gave a poor kill of grasses. Alachlor (3 kg/ha) and atrazine (1.2 kg/ha) were applied to individual rows within all treatments 1 week after planting.

Cool soil temperatures delayed full emergence of seedlings until 3 weeks after the first three sowings. Plant counts were made at full emergence and plants visually rated as healthy (all leaves turgid), partly wilted (at least one turgid leaf) and completely wilted. Up to ten spaces where seedlings had failed to emerge were cored with a 10 cm diameter corer to seed depth and the seeds extracted and examined to determine the reason for emergence failure. In addition, cores were taken over ten plants in each row and the plants examined for Argentine stem weevil boring within the stem and insect damage to the seeds. Argentine stem weevil accounted for nearly all insect damage to plants, with insignificant levels of greasy cutworm and wireworm (*Agrypnus variabilis*). The last sowings of some cultivated plots were damaged by pheasants. Assessments were made on remaining plants in these plots where possible.

TABLE 2: Damage levels by Argentine stem weevil relative to cultivation and fortnightly sowing intervals.

Trial location and previous crops	Weeks cult. before sowing 1	Insecticide treatment	% plants attacked by Argentine stem weevil at emergence			
			sowing 1	sowing 2	sowing 3	mean
1975						
Maungatapere, Northland. 'Tama' ryegrass	0	u	45.6	19.2	7.5	20.3
		f	50.0	32.5	4.2	24.7
Hikurangi, Northland. maize	1-2	u	6.7	0.8	0.8	2.8
		f	2.5	0.8	1.7	1.7
Huntly, Waikato. maize	3	u	7.0	0.0	0.0	2.5
		f	8.0	2.0	0.0	3.6
1976						
Parakai, Auckland. pasture	2	u	16.7	0.0	0.0	5.6
		i	0.8	1.7	0.8	1.1
Kaikohe, Northland. maize*	0	u	13.3	13.3	0.0	8.9
		i	2.5	0.8	0.8	1.4
Mean, untreated			20.6	8.1	1.7	

* grass weeds abundant prior to planting.

u = untreated

f = fensulfothion rates and application method see text.

i = isazophos

RESULTS AND DISCUSSION

Results of the initial trials are shown in Table 2. In the 1975 trials there was no significant difference in maize varietal susceptibility to Argentine stem weevil and the results for the two varieties were combined. Fensulfothion as applied had no effect on Argentine stem weevil attack. In the 1976 trials the results for the two rates of isazophos were not significantly different and were combined. Band applications of this chemical reduced the incidence of Argentine stem weevil, by about 82% overall. Isazophos has also been successfully used against another *Hyperodes* species (Tashiro *et al* 1977).

Table 2 reflects the greater Argentine stem weevil attack of maize crops ex 'Tama' ryegrass and pasture and the low incidence of Argentine stem weevil typical of multiple cropped maize, except where grass weeds are abundant prior to planting. A period of 4 weeks fallow was required to reduce Argentine stem weevil attack to safe levels (less than 10% of plants damaged) where there was a high risk of damage in the absence of effective insecticidal control. A similar period of 4-6 weeks was evident in the 1977 trial (Fig. 1). In this trial the use of paraquat before cultivation helped to reduce Argentine stem weevil incidence, although this was only significant ($P < 0.05$) for the second time of sowing. Maize planted between existing rows of the cultivated plots 7 weeks after initial cultivation had no Argentine stem weevil in emerged seedlings.

In the Argentine stem weevil trial the three insecticide treatments greatly reduced both the proportion of seeds that failed to emerge because of weevil (Table 3) and the proportion of emerged plants damaged by weevils (Fig. 1). It was found that coring and examination of stems of individual plants was a more accurate method of assessing Argentine stem

FIG. 1: Damage levels by Argentine stem weevil in relation to pre-plant treatments and weekly sowing intervals.

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weevil infestation than visual assessment by plant appearance. At this stage some 38-50% of actual infestations were not evident from visual appearance of the plant. The oxamyl treatments worked effectively when planting occurred within a week of application. Reduced effectiveness after this period was probably the result of loss of insecticide activity by the short lived chemical, with subsequent hatching of stem weevil eggs.

Unexpectedly in insecticide treated plots the reduction in seedling emergence failures caused by Argentine stem weevil was almost exactly compensated for by an increase in emergence failures because of seedling deformity (Table 3). This meant that there were no significant differences between treatments in total seedlings emerged. The reasons for deformities are not fully understood. Pre-emergence seedling failure because of deformity has not been uncommon in our trial work (unpublished data), and cold temperatures have been claimed to cause similar deformities (Buckle and Grant 1974). Potentiation of herbicide activity by insecticides has been noted (Matsunaka 1968; Chang *et al* 1971) and *vice versa* (Lichtenstein *et al* 1973; Chio and Sanborn 1977). It would appear in this case that the insecticides may have enhanced the herbicide activity against maize seedlings. Although the emergence of seedlings was not increased by insecticides in the trial, protection of emerged plants (Fig. 1) meant that the numbers of healthy plants in sowings 1 and 2 were significantly greater in treatments 4-6 than in the treatments which did not include insecticides (1-3).

TABLE 3: Seedling emergence failure in Argentine stem weevil trial as a percentage of seeds sown.

Treatment	Sowing time			
	1	2	3	4
Failure to emerge because of Argentine stem weevil				
1 C/D	24.5 aA	9.2 a	5.9 a	4.6*a
2 P/C/D	18.8 aA	8.4 a	2.5 ab	0.0 a
3 P/D	17.6 aA	8.1 a	5.0 a	2.2 a
4 P+ox/D	2.9 bB	3.6 a	2.2 aB	1.3 a
5 ox/P/D	1.5 bB	4.9 a	1.2 b	1.0 a
6 P/D+carb	4.0 bB	2.6 a	0.4 b	1.5 a
Failure to emerge because of seedling deformity				
1	4.5 c	6.4 ab	0.5 bB	0.0*b
2	7.0 bc	1.9 b	0.8 bB	1.7 b
3	12.1 abc	3.4 ab	5.1 aA	3.4 ab
4	20.9 a	12.2 ab	6.2 aA	5.6 a
5	14.5 ab	13.8 a	3.3 aAB	4.2 a
6	17.1 ab	11.6 a	4.2 aAB	4.9 a

* one replicate only
statistical analysis on arcsin transformation of data presented.

The method by which Argentine stem weevil larvae prevent the emergence of seedling maize appears to be penetration of the coleoptile and destruction of the growing point prior to emergence. These plants are affected by secondary infections of fungi, saprophytic nematodes and the two species of Diptera larvae (*Hylemya platura*: Anthomyiidae, and a species of Sciariidae). Many of the remaining plants may be infected at, or

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very soon after, emergence as indicated in Fig. 1. Subsequent infections by larvae sometimes resulted in boring within the rolled leaf lamina tissue prior to its unfolding, or within aerial root buds, but did not appear to cause permanent plant injury.

Many plants in the later sowings of these trials were noted to contain Argentine stem weevil eggs. These were usually laid in the leaf sheath, particularly that of the primordial leaf, between the cuticle and mesophyll. Subsequent plant attack did not develop from this source of infection as the newly hatched larvae appeared to be unable to penetrate through the hardening leaf cuticle to gain entry to the stem.

CONCLUSIONS

The results showed that a satisfactory method for control of Argentine stem weevil in maize was to delay planting until turf or infested grassweeds were thoroughly broken down and decomposed. This may take at least 4-5 weeks depending on soil moisture and temperature conditions and the amount of infected grass. Most infestation occurred prior to emergence of seedlings. Many plants failed to emerge if the growing point was severed. Other plants collapsed and died before the four leaf stage, some survived as stunted, multi-tillered and generally non-productive plants, while a proportion made a complete or nearly complete recovery.

It was shown that chemical control was possible where delay of planting or extra cultivation was not feasible. This was achieved by using systemic sprays such as oxamyl to kill Argentine stem weevil larvae in the pasture up to about 1 week prior to cultivation or direct drilling, or by banding granules such as carbofuran above the seed to prevent transference of larvae onto germinating seeds. It seems possible that sprays may be applied with paraquat prior to cultivation or direct drilling. Since most infestation occurred prior to seedling emergence, post-emergence treatments with DDT (Harris 1961) or other chemicals as attempted by some growers in New Zealand are likely to produce smaller responses than pre-plant treatments.

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REFERENCES

- Buckle, J. A. and Grant, P. M., 1974. Effects of soil temperature on plumule growth and seedling emergence of maize (*Zea mays* L.) *Rhod. J. Agric. Res.* 12: 149-161.
- Chang, F. Y., Smith, L. W. and Stephenson, G. R., 1971. Insecticide inhibition of herbicide metabolism in leaf tissues. *J. Agric. Food. Chem.* 19: 1183-1186.
- Chio, H. and Sanborn, J. R., 1977. Atrazine inhibition of carbofuran metabolism in the house cricket. *J. Econ. Ent.* 70: 544-546.
- Farrell, C. A., 1975. Importance of timing in planting maize. *N.Z. Journal of Agriculture* 131(3): 21-23.
- Harris, E. D., 1960. *Hyperodes humilis*, a new pest of sweetcorn in the Everglades and its control. *J. Econ. Ent.* 53: 251-257.
- Harris, E. D., 1961. DDT spray formulations and dosages for control of corn stem weevil, *Hyperodes humilis*, and fall armyworm, *Laphygma frugiperda*, on sweetcorn. *J. Econ. Ent.* 54: 546-549.
- Kain, W. M. and Barker, M. A., 1966. Argentine stem weevil; a pest of maize. *Proc. 19th N.Z. Weed and Pest Control Conf.*: 180-185.

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- Lichtenstein, E. P., Liang, T. T. and Anderegg, B. N., 1973. Synergism of insecticides by herbicides. *Science* 181: 847-849.
- Mackay, A. G. and Rowe, G. R., 1974. Chemical control of Argentine stem weevil in maize. *Proc. 27th N.Z. Weed and Pest Control Conf.*: 191-193.
- McCormick, S. J., 1974. Early sowing of maize: effect on rate of development, growth, yield and optimum plant population. *Proc. Agronomy Society of N.Z.* 4: 90-93.
- Matsunaka, S., 1968. Propanil hydrolysis: inhibition in rice plants by insecticides. *Science* 160: 1360-1361.
- Tashiro, H., Murdoch, C. L., Straub, R. W. and Vittum, P. J., 1977. Evaluation of insecticides on *Hyperodes* sp., a pest of annual bluegrass turf. *J. Econ. Ent.* 70: 729-733.
- Welsh, R. D., Moore, R. W. and Pottinger, R. P., 1974. Chemical control of Argentine stem weevil in ryegrass seed crops. *Proc. 27th N.Z. Weed and Pest Control Conf.*: 187-190.