THE EFFECTS OF WEEDS ON ARMYWORM IN MAIZE

M.G. HILL and D.J. ALLAN

Entomology Division, DSIR, Private Bag, Auckland

SUMMARY

Plots of maize (*Zea mays*) plants were grown under weedy and weed-free conditions to see if weeds encourage armyworm populations. Peak densities of armyworm were 174 larvae/m² in weedy plots and 18 larvae/m² in weed free plots. Defoliation of maize plants by armyworm larvae was 22.5% in weedy plots and negligible in weed-free plots. Defoliation did not result in a significant yield reduction, although yield in weedy plots was 30% lower than in weed-free plots. Parasitism of armyworm larvae mainly by *Cotesia ruficrus* was greater in weed-free than in weedy plots.

INTRODUCTION

Larvae of the cosmopolitan armyworm *Mythimna separata* are the most damaging pests of mature maize. Damage is caused by defoliation of the leaf laminae, usually after silking, by a single generation of armyworm larvae (Watson and Hill 1985). Anecdotal evidence (Anon. 1971) and our own experience has suggested that outbreaks of armyworm most often occur in weedy crops, the weeds being thought to shelter and hide the young larvae which, when larger, suddenly emerge *en masse* to devastate the crop.

We know of no data verifying this claim, and the only previous attempt to correlate weed cover with armyworm densities on maize in commercial paddocks found no correlation (Hill and Atkins 1983). This study tested the hypothesis that weeds cause a higher incidence of armyworm in maize crops in New Zealand by comparing plots infested by weeds with weed free plots.

METHODS

On 24.11.84 twelve plots, each 4.8 x 5.2 m, were planted with 5 rows of maize (Pioneer hybrid P3709), with gaps of 0.2 m between plants and 0.8 m between rows (equivalent to 62,500 plants/ha). The plots were delimited by 15 cm high sheet iron barriers to reduce the movement of weeds and insects between plots. Four of the plots were chosen at random and given a pre-emergence treatment of herbicide (alachlor and atrazine (Rahman 1980)) while the remaining eight were broadcast with a grass/weed seed mixture (Yates "bush burn").

Beginning on 17.1.85, the maize plants were sampled weekly by removing five randomly chosen plants from each plot. The ground area within each plot was also sampled by taking five 0.2 m² quadrat samples. Armyworm larvae were collected and preserved and a small sample of 215 larvae were reared using a general purpose artificial diet (Singh and Moore 1985). Both samples were examined later to determine rates of parasitism.

On 17.1.85, the vegetation within each quadrat was collected separately as grasses or broadleaf weeds, then oven dried and weighed. The maize plants were also oven dried and weighed. On 20.1.85, four of the weedy plots were selected at random to act as insect-free weedy crop controls, and were watered (using a watering can) with permethrin (Ambush) at an approximate rate of 250 g ai/ha, to kill the armyworm larvae. Sampling of maize plants and ground quadrats was repeated at weekly intervals in the remaining four weedy plots and four weed-free plots for 6 weeks. On the last sampling occasion, the plants were dissected and leaf laminae (the parts usually eaten by armyworm) were dried and weighed to give an estimate of defoliation by armyworm.

Proc. 39th N.Z. Weed and Pest Control Conf.

Thirty five cobs were harvested from each plot on 11.4.85, oven dried and weighed. Weed-free plots were periodically cleared of invading weeds with a hoe and spot applications of glyphosate.

RESULTS

Maize plants in the weedy plots silked on 3.1.85, 9 days before the weed-free plots. Early silking is a well known response to stress (I.R. Brooking pers. comm.). The weedy plots contained considerable amounts of vegetation. The grasses were predominantly yellow bristle grass (*Setaria glauca*) and barnyard grass (*Echinochloa crus-galli*) while the broadleaf weeds were mainly willow weed (*Polygonum persicaria*), redroot (*Amaranthus powellii*) and purple amaranth (*Amaranthus lividus*). Dry weight of plant material from the 17.1.85 sample in the weedy plots was 145 g/m² (S.E. = 12) of grass, 190 g/m² (S.E. = 15) of broadleaf weeds and 344 g/m² (S.E. = 17) of maize. Maize plants in the weedy plots were clearly smaller than those in weed-free plots, where the average dry weight of maize was 603 g/m² (S.E. = 25).

Peak density of armyworm larvae in the weedy plots was 174/m² on 17.1.85, while densities in the weed-free plots peaked at 18/m² at the start of February (Fig. 1). Densities in the weedy plots were substantially higher throughout January, and remained higher than in weed-free plots until the end of February, by which time the crop was senescing. The proportion of total larvae sampled from the maize plants, as opposed to the ground, was much lower in the weedy (18.5%) than in the weed-free (93.4%) plots.

Fig. 1: Densities of armyworm larvae in weedy (open bars) and weed-free (hatched bars) plots, plotted on a log scale, through January and February 1985.

The gregarious braconid *Cotesia ruficrus* was the dominant larval parasite of armyworm (94% of all records). *Rhogas* sp. (Ichneumonidae) and *Euplectrus* sp. (Eulophidae) each contributed 3%. Mean percentage parasitism of armyworm larvae was calculated for weedy and weed-free plots using a logit transformation and back transforming (Table 1). Percentage parasitism of the reared larval sample was substantially higher than for the preserved sample, reflecting the difficulty in detecting small parasite larvae and eggs on dissection. However, both estimates of parasitism show that it was greater in weed-free than in weedy plots (Table 1), although the

TABLE 1: Percentage parasitism ($\pm$ 95% confidence intervals) of armyworm larvae from weedy and weed-free maize plots. n = sample size.

	Weedy Plots			Weed-Free Plots		
	Mean	95% CI	n	Mean	95% CI	n
a) Preserved and dissected:						
Maize plants	63.4	59.6 – 67.1	175	64.1	61.6 – 66.6	265
Ground layer	49.7	48.4 – 51.0	706	73.2	60.6 – 82.9	82
Total	52.6	51.6 – 53.7	881	66.3	64.0 – 68.5	347
b) Reared:						
Total	79.9	75.7 – 82.8	170	91.2	75.2 – 97.2	45

difference is not significant in the reared sample probably because of the small sample size. This difference in parasitism rate was due to a lower percentage parasitism of larvae collected from the ground layer of weedy compared with weed-free plots. Percentage parasitism of larvae collected from maize plants was the same in both types of plots.

The dry weight of leaf laminae taken from the four weedy insecticide-free plots on 20.2.85 was significantly lighter than a similar sample from the four weedy insecticide-treated plots (13.4 g/plant cf. 17.3 g/plant; LSD = 2.8 g/plant). This represents a minimum 22.5% defoliation of the plants in the untreated plots, since some defoliation had occurred in all weedy plots prior to insecticide application. This amount of defoliation did not significantly reduce yield in the untreated weedy plots, although the average yield from all of the weedy plots combined was 30% lower than in the weed-free plots (11.3 t/ha cf. 16.1 t/ha, LSD = 2.3 t/ha at 15% moisture content). This is within the range of 46% $\pm$ 24% S.D. yield reduction of maize given by van Heemst (1985) in a review of the effects of weed competition on crop yield in a range of crops. Defoliation in the weed-free plots was negligible.

DISCUSSION

The results support previous anecdotal suggestions (Anon. 1971) that weeds in maize encourage armyworm infestations but are contrary to observations by Altieri and Whitcomb (1980) of fall armyworm which caused less damage in weedy than in weed-free maize, probably because of increased predation pressure. Our results showing lower levels of armyworm parasitism in weedy plots are also contrary to suggestions that weeds in crops enhance natural enemy effectiveness by increasing habitat diversity. (Altieri and Letourneau 1982; Baliddawa 1985).

It seems likely that the suggested reasons for enhanced natural enemy effectiveness in weedy crops such as the presence of nectar sources, alternate hosts and an increase in generalist predators (Altieri and Letourneau 1982; Baliddawa 1985) are inconsequential in the present case where the pest has associated with it a highly effective natural enemy species which is temporally well synchronised with its host and presumably has a high searching ability. The reason however for lower level of armyworm parasitism in weedy plots in this trial is unknown. The most likely explanation for the higher armyworm populations in the weedy plots is either preferential adult oviposition or enhanced larval survival due to more favourable microhabitat conditions. These alternative hypotheses cannot be tested using the present data.

The results from the weedy plots show that in the presence of a ground sward, most armyworm spend the daytime at ground level, rather than in the maize and probably feed preferentially on grass weeds, moving onto maize as they become larger and exhaust their grass food supply.

The later peak in larval numbers in the weed-free plots could be related to the later flowering of maize plants in these plots. Armyworm defoliation usually occurs after silking and physiologically younger plants may be less palatable (Watson and Hill 1985).

The failure of 22.5% armyworm defoliation to cause a significant yield reduction in the weedy plots supports earlier findings that defoliation levels in excess of 50% are

required to cause a significant yield reduction (Hill and Atkins 1982). However, the severe yield reduction as a result of weed competition emphasises the importance of maintaining weed control in maize. This will simultaneously maximise yield and minimise armyworm incidence.

ACKNOWLEDGEMENTS

Rosemary Gilbert provided technical help, Tony Cooper and Chris Triggs, Applied Maths Division, DSIR provided statistical help and Ian Brooking, PPD, DSIR, provided advice on maize phenology.

REFERENCES

- Altieri, M.A., Letourneau, D.K., 1982. Vegetation management and biological control in agroecosystems. *Crop Prot. 1*: 405-430.
- Altieri, M.A., Whitcomb, W.H., 1980. Weed manipulation for insect pest management in corn. *Environ. Management 4*: 483-489.
- Anonymous, 1971. Guide to maize. *N.Z. Farmer Supplement* 48 pp.
- Baliddawa, C.W., 1985. Plant species diversity and crop pest control; an analytical review. *Insect Sci. Appl. 6*: 479-487.
- Hill, M.G., Atkins, A.W., 1982. Effects of defoliation by cosmopolitan armyworm *Mythimna separata* (Walker) on maize yield. *N.Z. J. Agric. Res. 25*: 251-254.
- Hill, M.G., Atkins, A.W., 1983. Incidence of the armyworm, *Mythimna separata* Walker (Noctuidae: Lepidoptera) and its introduced parasite, *Apanteles ruficrus* Haliday (Braconidae: Hymenoptera) in maize. *N.Z. J. Agric. Res. 26*: 135-138.
- Rahman, A., 1980. Weed control in maize: herbicide techniques. *AgLink FPP404*.
- Singh, P., Moore, R.F. (Eds.), 1985. Handbook of insect rearing. Elsevier.
- van Heemst, H.D.J., 1985. The influence of weed competition on crop yield. *Agric. Systems 18*: 81-93.
- Watson, R., Hill, M.G. 1985. Pests of maize in New Zealand. *N.Z. Agronomy Soc. Special publication 4*: 47-58.