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Biological control of Heliothis in sorghum

Preliminary reports of studies by P. J. Michael, Entomologist, Department of Agriculture, Kununurra.

1. EGG PARASITES CAUSE HIGH MORTALITY

Following the discovery of a lepidopterous egg parasite in the Ord Irrigation Area in October, 1972, many attempts have been made to determine its effectiveness.

This proves to be difficult. Eggs which are collected from the field too early, as from sorghum heads before flowering, have not been exposed to parasites as long as they would in the field and may show a low level of parasitism. If the egg collection is made too late, such as from sorghum heads at full anthesis, many eggs may have hatched normally and only parasitised eggs remain.

However, the main practical concern is the total mortality in the egg stage and any other stage. A short study was made to determine the total egg and larval mortality of Heliothis armigera in sorghum heads found in an unsprayed field on the Ord Beef Farm.*

Methods

Several plants were marked on the day when the heads began to emerge. Each day over the study period, 30 heads at the same stage as the marked reference heads were collected. These were then rotated rapidly over fine organdie bags to separate all loose material in the head. The eggs and larvae were then separated and counted.

Eggs less than one day old are white and parasitised eggs are totally pink, grey or black.

Results

Results are presented in the form of a graph. Most of the eggs were laid over three days as the heads were emerging and the total number of eggs laid was just over 500, or nearly 17 per head.

On three occasions, over 250 eggs were parasitised. It can be seen that the total number of eggs parasitised must have been well in excess of 50 per cent of the total laid. Over a five-day period an average of five larvae, or one per cent of the total number of eggs laid, was found.

No fifth or sixth instar larvae were found and rearing at the time showed that a large proportion of the larvae was being parasitised by a species of Microgaster.

Discussion

It is obvious that parasites may give complete mortality of Heliothis armigera in sorghum heads despite the potential for a population of about four million per hectare. One-third of this population could consume all grain in the highest yielding crops in the area if no mortality factors operated in the egg or larval stages.

Most of the mortality in the study was apparently in the egg stage, although some of the small larvae may have been missed or may have died before the counts. Larval mortality is important in reducing numbers before the fifth and sixth instars, which are by far the most damaging.

As a sorghum crop is never uniform in maturity, there would in fact be a more gradual increase in egg numbers than shown by this study. Nevertheless the parasites must be very efficient. Similar mortality studies conducted on the early and late heads will probably indicate the mobility of the parasites.

Apparently sorghum is extremely attractive to the pest as the head emerges. As this stage may be present in a crop for several weeks, egg-laying probably continues at a high level for that time. Moreover, sorghum may be found in all stages at all times in this area because sorghum midge is not present. This ensures a continuous and large supply of eggs, which is ideal for the egg parasite.

The situation in other crops growing here is not known, but, if egg-laying is not continuous, these crops may benefit from sorghum being in close proximity.
2. TRIALS WITH VIRUS SPRAYS

Early in 1973, the Kimberley Research Station imported a commercial preparation of the polyhedrosis virus of the \textit{Heliothis} genus ("Viron H") to assess its effects on \textit{Heliothis} populations in cotton. The virus was seen to be far more effective in a small area of sorghum than in the cotton, so a larger quantity was imported for commercial scale trials on sorghum.

Crops in five different areas were sprayed, located among regularly sprayed cotton crops, where it was assumed that parasitism would be limited and measured effects would be largely due to the virus.

The virus was applied by aircraft at the rate of 150 g in 110 litres of water per hectare. Because of the conditions under which the trials were carried out several factors varied, including rate of virus, volume sprayed, stage of crop and degree of parasitism.

The effects of the virus were seen five days after application. Affected larvae tended to move to the tip of the sorghum head and die. The body contents became pus-like and other insects, including predators and other \textit{Heliothis} larvae were seen to feed on the dead larvae.

When the spray was applied to coincide with the presence of maximum numbers of larvae about a third of the population was killed within a week. However, many factors confused the issue and the effectiveness of the material is therefore still not accurately known.
As the trials progressed it became evident that parasitism was at a significant level and on several occasions 80 per cent of a collection of larvae were found to be parasitised. It was clear that the combination of virus and parasites greatly reduced large populations, as shown in the graph for Crop 3. Few large larvae (which cause most of the damage) were found.

Crop 3 was probably sprayed near the ideal stage of insect development, which contributed to the favourable result. Crop 2 was apparently sprayed too late and large caterpillars escaped to damage the crop. Results were poor in a crop sprayed early, before most of the eggs hatched.

Crop 5 sustained the most damage despite the application of two sprays of Parathion at the rate of 1.1 kg/ha. In this crop the virus was applied too late and the sprays would have killed most of the parasites.

Crop 4 shows the situation where parasites were abundant and no further control measures were needed. This occurred on the Ord Beef Farm (see previous article).

Little reliance can be placed on figures gained from rearing larvae in the laboratory because virus contamination occurred so that even larvae from unsprayed areas became infected. There is evidence that larvae being reared artificially succumb more readily than those in the field. However, laboratory rearing was valuable in showing the percentage parasitised.

Although the results are preliminary and by no means conclusive, they do indicate that aerial application of Viron H can kill large numbers of *Heliothis* larvae in sorghum. Combined with parasites, it reduced large populations more successfully than two sprays of Parathion and this must be considered a promising approach to biological control. Timing of virus applications is obviously important.

**Acknowledgment**

The virus preparation used in the above trials was supplied by Ord Beef Pty. Ltd.

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**Insecticides for control of *Heliothis* in cotton**

P. J. Michael, Entomologist, Department of Agriculture, Kununurra

Since 1970, *Heliothis armigera* has shown resistance to both DDT and toxaphene, but not to the organophosphates, which include Parathion. DDT, the cheapest and most effective chemical available, gave control of *Heliothis* until the development of resistance in 1970-71.

Trials then showed that a mixture of DDT and toxaphene was more effective than DDT alone. This result from a synergistic effect, in which the combined effect is far greater than could be expected from either on its own. The addition of Parathion gives a further increase in effectiveness.

This combination gave the most economical control of *Heliothis* after DDT alone was abandoned because of the development of resistance, and has been the standard control spray this season.

Local investigations have also shown that spraying with this combination is most effective if timed to coincide with hatching, when it gives good kills of eggs and young caterpillars. Larger caterpillars are harder to kill and also migrate down the cotton bushes, where they tend to be protected from the spray.

Times of spraying are therefore based on close observation of egg-laying and hatching cycles.

The increasing resistance to at least two of the chlorinated hydrocarbon insecticides, exhibited by *Heliothis armigera*, necessitates the continual assessment of chemicals which have a possibility of giving economic control. Standard chemicals as well as some old and new products were tested in one trial during 1973, using a tractor-mounted boom spray.

**Methods**

The crop was grown just as the farmer would grow it and at the same time so that results would be applicable to the farm situation. Spraying was carried out in such a way as to simulate the aircraft applications, which meant using a small volume of liquid which had to be applied at night. Blanket aerial applications were necessary when the ground was boggy during the wet.

Eleven chemicals were applied using rates considered to give good control of *Heliothis*. Three replications were used. During the first month of the trial sprays were applied every three days, while during the second month the interval between sprays was lengthened to seven days and the rates of application of some chemicals were increased.

The crop was sampled almost weekly to determine the degree of insect damage and the numbers of larvae present. A count of the fruit was taken after the first month and yields were determined after the second month by hand-picking and machine harvesting.

**Results**

Of the chemicals being used in the area, the DDT + toxaphene + Parathion combination costing $5 per hectare, Monocrotophos costing $5.20 per hectare and Parathion costing $3.20 gave good control when sprayed at three-day intervals. At this spray frequency three new chemicals, Orthene, Phosvel and Monitor, also gave good control.

During the second month of spraying, the level of control fell in all treatments with the longer intervals between sprays.

Of the standard chemicals, Parathion costing $3.20 per hectare and the DDT + toxaphene + Parathion mixture costing $5 per hectare provided poor control while Monocrotophos costing $5 per hectare gave control of *Heliothis* larvae in sorghum. Combined with parasites, it reduced large populations more successfully than two sprays of Parathion and this must be considered a promising approach to biological control. Timing of virus applications is obviously important.

**Acknowledgment**

The virus preparation used in the above trials was supplied by Ord Beef Pty. Ltd.
Tophos costing $7.45 per hectare gave a moderate degree of control. Monitor gave moderate control while Orthene and Phosvel were somewhat better.

It was obvious halfway through the trial that there would be no differences in yield because of the long period over which blanket aerial sprays were necessary and because of the generally good level of control. There were in fact no differences in the final yields but they were over 3000 kg/ha.

Conclusions
The standard DDT + Toxaphene + Parathion mixture should provide adequate control of Heliothis armigera during 1974 but must be applied frequently. Parathion alone should provide reasonably cheap control but also must be applied frequently.

Three new chemicals look promising, especially Orthene, which provided outstanding control. However, as the cost of Orthene sprays may be about $13 per hectare, lower rates will have to be tested.

Haemoglobin type of ewes not related to clover disease

R. W. Wroth, R. J. Lightfoot, T. Marshall and P. Steele

The article “Clover disease—what we know and what we can do” in this issue1, briefly mentions the possible association between haemoglobin type and susceptibility or resistance to clover disease. This report covers in more detail Western Australian research on this aspect of clover disease.

Sheep can be classified into blood groups by various factors, one of these being haemoglobin type. The technique involves analysing a blood sample by electrophoresis2. The result classifies the animal as being haemoglobin type AA, AB or BB.

South Australian research has suggested that ewes with the haemoglobin type AA are resistant to clover disease, ewes of type BB tend to be the most susceptible and those with type AB intermediate3. It was also suggested from this work that lambs from type BB ewes suffer higher mortality rates, especially in wet and windy conditions4. It was decided to investigate more fully the suggestions arising from the South Australian research.

Ewes from three existing experiments at Badgingarra Research Station (225 km north of Perth), the Bakers Hill C.S.I.R.O. Yalanbee Field Station (74 km east of Perth) and Esperance Downs Research Station (740 km south-east of Perth) were used in this investigation.

The original experiments were designed to test the effect of prolonged grazing of various legume species (mainly subterranean clover cultivars) on ewe fertility. In all experiments there had been a marked fall in fertility of the ewes grazing the highly oestrogenic strains of subterranean clover compared with ewes grazing pastures of low or zero oestrogenicity5, 6, 7.

The haemoglobin type of blood from the ewes grazing the highly oestrogenic pastures was determined, and related to their lambing performance. At their third lambing the fertility of the ewes grazing the potent oestrogenic pastures had declined to about 50 per cent ewes lambing compared with about 85 per cent in the ewes grazing non-oestrogenic pastures.

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* See page 198.
It was expected that ewes most susceptible to clover disease would be the first to show the effects of reduced fertility, and by the third lambing any relationship between susceptibility to clover disease and haemoglobin type would be evident. This was not so, as 38 per cent AA, 47 per cent AB and 40 per cent BB ewes lambed.

The lambing performances of the ewes in each year of the experiments were graphed (Figs. 1, 2 and 3) for each haemoglobin type. This clearly demonstrated that the susceptibility of the ewes to clover disease was not related to these haemoglobin types. The rates of decline in fertility were similar for ewes of each of these haemoglobin types.

The overall lambing performances, pooling data for all years at all locations were: AA 53 per cent (87/163), AB 48 per cent (229/477) and BB 49 per cent (172/348) ewes lambing. There were no significant differences in fertility between the different haemoglobin types in either individual years or overall. All of this information indicates that resistance to clover disease is not associated with haemoglobin type.

Similarly, the overall lamb mortality data fails to show any significant relationship between ewe haemoglobin type and lamb survival.

These data show that neither ewe fertility nor lamb mortality among ewes affected with clover disease is related to haemoglobin type under West Australian conditions.

References

1 Marshall, T. (1973), J. Agric West. Aust. (Series 4) 14:
Bruising losses in northern cattle

Estimates of economic loss to producers through bruising and mortality of slaughter cattle are high—$1 million for Queensland and $17 million for Australia, according to a recent Department of National Development report. Available evidence indicates that the problem is especially serious in the Kimberley region, followed by the Northern Territory and Queensland. Cattle types, transport distances and handling are seen as major causes.

Bruising and mortality losses occur at many stages of the often long journey from paddock to freezer or export pack but can be separated under the following general headings—

• deaths on road or rail (non-arrivals)
• dead on arrival (downers on arrival)
• dead in yards (downers)
• whole carcases condemned for bruising
• quarters condemned for bruising
• carcases or quarters downgraded because of bruising
• bruised trim in killing floor and boning room
• downgrading of high-value cuts because of trimming to remove bruises
• general loss in condition and physical appearance.
• down time on the killing chain when stopped for badly bruised carcases.

Recognition of the seriousness of the problem has prompted several organisations to investigate bruising. One investigation was conducted by CSIRO Meat Extension Officer Mr. D. Roberts at five northern export meatworks in 1972. The investigation included a study of statistics kept by individual meatworks, and a detailed examination of condemnations and trimming associated with bruising at various works.

Handling and transport losses

Of 131,199 cattle delivered to the five works in 1972, 1,798 (1.4 per cent.) were delivered dead, or died, usually of wounds, in the meatworks yards. (No figures were obtained for non-arrivals, but these have been estimated elsewhere as about 0.1 per cent. of cattle consigned, giving an estimate of 130 head for the five works for the year.) Most of these deaths can be readily attributed to injury received during mustering, loading, transporting and unloading operations, but they are only the most obvious results of unsatisfactory handling and facilities.

Condemnations

Of the 129,401 cattle slaughtered at the works, 2,478 were so badly damaged that whole bodies, sides or quarters were condemned. The actual condemnation rate varies around about 2 per cent. and, for part of the investigations, 49 per cent. of 509 condemnations were judged as caused by bruising. Taking the typical northern carcass weight as about 210 kg (460 lb), bruising can thus be calculated as causing the condemnation of about 255,000 kg (560,000 lb) of carcass for the five works for the year.

Indications of the level of bruising are given by figures in the table for station cattle delivered to the Broome meatworks in 1972.

| Estimated total meat losses to producers supplying the five meatworks. |
|--------------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Non-arrivals       | 130 x 210 kg x 68% = 18 564 |
| Downers            | 1 798 x 210 kg x 68% = 256 754 |
| Condemnations      | 255 000 kg x 68% = 173 400 |
| Dressing floor trim| 126 923 x 7.4 = 939 230 |
|                    | 1 387 948 |

* 210 kg is used here as the typical northern carcass weight and 68% is used as the average dressing out percentage.

Bruise trimming

As part of the investigation, a day was spent at the scales of one meatworks to identify bodies with "acceptable bruise trimming" which could then be used for boning room yield tests. Of 234 bodies, or parts of bodies, passing inspection on that day only 22 (9.4%) showed acceptable bruising or less—i.e., required such little trimming that they could still be graded as a second quality body. Of the 212 mutilated carcases, trimming was often so severe that only a butt could be salvaged.

A quality control programme for one of the meatworks indicated an average of 7.4 kg of meat was trimmed from 8,839 carcases to remove bruises. The figure is thought to be conservative but if accepted as average for the 126,923 carcases passed as fit for human consumption it appears that about a million kilograms of meat were lost to producers through bruising.

Boning room losses

Not all bruises are discovered on the dressing floor and additional deep-seated bruising has to be trimmed from individual cuts during boning operations. Besides increasing the total amount of meat lost, trimming to remove these bruises often disfigured the cut carcass so much that it was no longer suitable for top quality export and had to be repacked as lower grade manufacturing meat.

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