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WEBWORM AND THE WEATHER

A research programme being carried out by the Entomology Branch aims to give a better understanding of the effects of weather conditions on the seasonal incidence of webworm, and should lead to more effective control of this pest.

By J. A. BUTTON, B.Sc. (Agric.), Entomologist

FOR many years farmers have remarked on the cyclic occurrence of webworm outbreaks in their cereal crops. Webworm, the State's most serious pest of cereals, has frequently assumed a role of major importance for one or two seasons, and then not been troublesome for a number of years.

Research into these variations in population numbers was started recently by the Department of Agriculture, and in this article some of the most interesting aspects of this investigation are discussed.

SEASONAL INCIDENCE

Although there are not enough sampling figures available to show precise population levels in recent seasons the trends have been indicated graphically in Fig. 1.

Fig. 1.—Seasonal trends in the incidence of webworm, 1955 to 1961

Webworm in cereal crops may be controlled by spraying with DDT solutions, as detailed in Bulletin 2555, reprinted from the Journal of Agriculture, July, 1958.
This was constructed on the basis of reports received and field observations made in these seasons.

**Meteorological Records**

A study of weather data from some typical wheatbelt stations indicated, as was expected, that these fluctuations cannot be simply explained on the basis of the season being "wet" or "dry" or whether the opening rains were "early" or "late."

Preliminary laboratory studies and field observations make it clear that the response to environment is a complex one, and that normally the insects' ability to survive at any stage in the life cycle depends largely on the interaction of a number of weather factors.

For instance, the capacity of the pest to survive in the dry conditions normally encountered in the wheatbelt areas in the summer months, seems to be largely determined by the interaction of temperature, humidity levels and exposure time. But having once determined either that a large proportion of individuals survived the particular summer, or that conditions favoured a high survival rate, we still can predict very little until we have information on whether the conditions at mating, egg laying and hatching were also favourable.

Knowledge of when, why and in what numbers the insects die in the field is obviously essential. To obtain it extensive observation in the field, aided by experiments conducted in the laboratory, are in progress.

These are aimed at studying the insect in its own special environment (its microclimate) as well as the general climate of its habitat.

**HIGH SUMMER DEATH RATE**

The webworm is quite well adapted to its rather harsh environment. It has a life cycle which keeps it in phase with the rhythm of the seasons.

Its answer to the challenge of severe temperatures and an absence of suitable food material during the summer is to stop feeding and remain underground in a dormant state. This condition appears to be one which biologists refer to as obligate diapause, and the insect is committed to this period of dormancy notwithstanding the availability of food and moisture.

In the field, of course, food and moisture are not available at this stage and the webworm has evolved this genetic mechanism to protect itself.
Dormant webworm caterpillars in artificial cellophane and plastic cells. In the cell on the left a caterpillar has shed its skin (bottom) and changed into the pupal stage (top).

During this rest period energy losses are extremely low, but under the conditions of a dry atmosphere and high temperature, a gradual loss of moisture from the body of the insect does occur.

Field observations suggest that in normal seasons many individuals finally die through desiccation. However, in exceptional conditions such as in seasons of unusually high temperatures and dryness, the death rate may reach nearly 100 per cent in certain areas.

Laboratory experiments have shown that quite short exposures to high temperatures (+110°F.) in unsaturated atmospheres results in a marked loss of weight and a high mortality level. The critical limits of saturation deficit and length of exposure are still under investigation.

It is evident from this work that the insects will have a greater chance of survival in adverse seasons (such as the summer of 1961-62) in soil where the moisture stress is lowest, and this has been demonstrated to be the case in some areas sampled this season.

Because of the generally low population levels in the last two seasons survival seems to have been mainly confined to isolated areas which in normal seasons support a very high population; an abundance of food, favourable moisture levels and a minimum of cultivation have ensured a high webworm density. With dense stands of long-established barley grass and moist soil, the salt flats which are so widely scattered throughout the wheatbelt meet these requirements very well.

Salt Flats as a Source of Infestation

These areas have been found to normally support extremely high population levels and could generally be considered to be important "spread" centres on any property.

In adverse years (years of very low populations), such as the present season they may assume a very important role as "survival" centres from which the population may build up in surrounding areas when seasonal conditions are again favourable.

The precise importance of these areas has not yet been established, but they may well merit special attention by the farmer.

SURVIVAL OF EGG AND EARLY LARVAL STAGES

Two field experiments on survival of egg and early larval stages are now in progress. These involve seeding various plots with known numbers of eggs so that survival levels may be calculated. Results of this work should be known at the end of this winter.
(i) Starvation:

Since the time of emergence of the moth and subsequent egg laying in April and May does not appear to depend on rain, and since under natural conditions it has been demonstrated that eggs will hatch in about 10 to 14 days after laying (in the absence of free water) many of the eggs laid in early and mid April will, in late seasons, hatch before the opening rains have produced a food supply.

In this event a very high mortality is to be expected, since laboratory observations have shown that the young caterpillars will survive for no longer than about a week without food.

Field and laboratory studies indicate that the death rate has been high in larvae which hatched early this season—particularly in those which hatched in the second and third weeks of April. It can therefore be assumed that any crop and pasture damage in the coming season will result from caterpillars emerging in late April or early May.
(ii) Desiccation:
Experience gained with the egg and first stage (instar) larvae suggest that they are likely to be fairly susceptible to drying out in the event of warm weather and inadequate cover.

The question of natural protection from grasses, etc., is to be studied in the field experiments referred to above. These involve the comparison of death rates recorded in plots where the surface vegetation has been disturbed by various treatments such as burning, cultivating, mowing and so on.

This work is to be supplemented by detailed studies of the response of these stages to various controlled levels of moisture stress in the laboratories.

(iii) Flooding:
The effect of sheet flooding for short periods is being examined. Laboratory observations have indicated that normal hatching of eggs was able to take place after as long as 48 hours of total immersion. Longer immersion periods resulted in high mortality levels.

Since the webworm eggs are deposited on the ground and not attached to the plant stalks it is evident that prolonged and heavy opening rains before the main hatching is completed (about the first week in May in many areas), could result in quite high losses, especially in depressions.

The drowning of first instar larvae is also likely to be a factor controlling population levels, but this has not been seen in the field.

Large scale drowning of later instars has been observed in certain situations, but frequently many individuals protect themselves from this hazard in low lying areas by suspending their silken tunnels on old grass stalks two or three inches above the ground.

DISCUSSION
It will be seen from what has been said that weather plays a vital role in determining the abundance of webworm in any season.

It will also be apparent that the population level may be the result of the interaction of a number of factors, each permitting a particular survival rate. These factors may operate on every phase of the existing generation, but their influence on the previous generation in the previous season must also be considered if this abundance is to be adequately accounted for.

A detailed study of the type outlined can provide a great deal of information
about the susceptibility of the webworm at the various stages in its life cycle.

From this knowledge we may eventually be able to more successfully attack the pest at its most vulnerable stage, and to devise more efficient cultural control methods, based on a full understanding of the insect and its weaknesses.

ACKNOWLEDGMENT

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MORE SEED—LESS SUPER FOR SUB. CLOVER ESTABLISHMENT

By J. W. GARTRELL, Research Officer, Plant Research Division

Several thousand acres of virgin land in the 13 to 25 inch rainfall areas will be sown to various strains of subterranean clover this season.

An important problem facing farmers establishing these pastures is what rates of seed and superphosphate to use for high production in the year of establishment, and in later years.

The choice of rates of seed and super is a difficult one, for the farmer must consider the climate and soil type of the area, his financial resources, the phosphate status of the soil, the cost of seed and the likely value of animal production from the pasture.

Despite these complicating factors it is obvious that most farmers should spend more money on seed, even if this means less super in the year of establishment.

It is in the second year that high rates of super give large increases in pasture production.

In the establishment year the main aim is to get enough seed production to give a dense stand in the second season. At today's prices for animal products it rarely pays to produce, in the first year, the dense sward required for high feed production.

Experimental evidence indicates that a seeding rate of 25 lb. per acre can give maximum seed set. Rates down to 10 lb. per acre should produce enough seed for a second year sward of near maximum density. Therefore, farmers should sow at least 10 lb. of seed per acre if a dense productive clover pasture is required in the second year.

Higher rates of super increase seed production less than leaf and stem production. Further, the placement of super, by drilling with the seed, means that it is used much more efficiently in the year of establishment than in later years. It is therefore possible to apply lower rates of super with the seed without markedly reducing the amount of seed set in the first year.

Summing up to this stage it is suggested that—

- A seeding rate of at least ten pounds per acre should be used.
- Low rates of super sown with the seed are sufficient for near-maximum production.

This is well illustrated by the results of a recent experiment in the Moora district, using Dwalganup sub clover on new light land.

The first year pasture production from plots sown with six pounds of seed and 168 lb. of super per acre, was only 10 cwt. per acre. When only 1 cwt. of super was applied with 12 lb. of seed the production was 15 cwt. per acre.

Increasing the seeding rate still further to 24 lb., with 1 cwt. of super, yielded 32 cwt. of pasture per acre.

The price of seed obviously determines the extent to which this principle of more seed and less super can be carried. When sowing the more expensive varieties of sub-clover for general grazing purposes only, lower seeding rates must be used to avoid excessive establishment costs, but a poor stand will result if the seeding rate is too low.

When high seeding rates are used, it may pay to use higher rates of super, but only if the pasture is well grazed.
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