THE QUEENSLAND JOURNAL OF
AGRICULTURAL SCIENCE

Vol. 11. - - No. 1.
MARCH, 1954.

INSECTICIDAL CONTROL OF *AGROTIS INFUSA* (Boisd.) AND *LEUCANIA UNIPUNCTA* (Haw.) IN FIELD CROPS.

By A. W. S. MAY, M.Agr.Sc. (Senior Entomologist) and T. PASSLOW, B.Sc.Agr.
(Assistant Entomologist), Science Branch, Division of Plant Industry.

SUMMARY.

Several species of cutworms and armyworms are recorded in Queensland, and some of these periodically infest crops in plague numbers. Such infestations by *Agrotis infusa* **(Boisd.) and** *Leucania unipuncta* **(Haw.) were experienced during the spring of 1952 on the Darling Downs and in neighbouring districts. Field trials were carried out to determine the optimum DDT dosage for the commercial control of both pests, and several insecticides were screened against** *A. infusa*.

One-half pound p,p'–DDT per acre effectively reduced larval populations, and ensured yields as high as those following heavier dosage rates. With a lower rate, it is doubtful if the saving in cost would compensate for control breakdown risks involved.

DDT, dieldrin and aldrin were the most efficacious against *A. infusa*, **with DDT giving most consistent results.**

I. INTRODUCTION.

Several species of cutworms and armyworms attack cultivated plants and pastures in Queensland. The importance of each varies greatly from year to year, prevalence depending to a large extent on locality and seasonal conditions. In some seasons one or more species may occur in plague numbers and severe crop damage follows.

Three cutworms are of major importance. *Euxoa radians* (Gn.) is by far the most prevalent; the density of its spring larval populations is governed by rainfall in the preceding months (Currie 1931). Records of the Department of Agriculture and Stock reveal outbreaks of this pest in all coastal and subcoastal agricultural areas at frequent intervals since the first record in 1907. *Agrotis ypsilon* (Hfn.) is an important pest of vegetables in south-eastern Queensland, and though often found in association with *E. radians* is more tolerant of high soil moisture (Currie 1931).

The third species, *Agrotis infusa* (Boisd.), has been recorded only at infrequent intervals from southern parts of the State. Known as the bogong moth, it is more often recorded as moth plagues in south-eastern Australia (McKeown 1944), and Common (1952) has suggested that larval development occurs in more northerly regions. Larval plagues have been recorded in southern Queensland on several occasions since 1901. During a widespread outbreak in 1931, larval plagues were experienced in August as far west as Cunnamulla, while later in the same year adults swarmed in tomato fields and infested dwellings in the Brisbane district (unpublished Departmental records). The most recent outbreak occurred in July and August of 1952, when larvae damaged a wide range of crops on the Darling Downs (for example, see Fig. 1), and in the south-western agricultural districts.

Fig. 1.
A Poor Stand of Wheat Caused by the Cutworm *Agrotis infusa* (Boisd.).

Other cutworms, including *Agrotis poliotis* (Hmps.), *A. tibiata* Gn., *A. porphyricollis* Gn. and *Mocis frugalis* (F.), damage crops from time to time but these are seldom of economic importance.

The most important armyworm, *Leucania unipuncta* (Haw.), occurs in most coastal and subcoastal districts, where it may damage pastures, sugar-cane and cereal crops. Outbreaks of this pest have been recorded at frequent intervals since 1899 in various parts of the State (unpublished Departmental records). On the Darling Downs and in neighbouring districts minor attacks may be experienced in spring and autumn (Passlow 1952), but when large pest populations are present, chiefly in the spring months, widespread crop damage results. Plagues occurred in these districts in 1931, 1938, 1948 and 1952.

Relatively infrequent plagues of three other species—*Leucania loreyi* (Dup.), *Laphygma exempta* (Wlk.) and *Spodoptera mauritia* (Boisd.)—have occurred in coastal districts (Jarvis 1927; Smith 1933; Weddell 1936). *Leucania diatrecta* Butl. in small numbers is sometimes associated with *L. unipuncta*.

In the past, control of cutworms and armyworms was usually undertaken with Paris green or arsenic pentoxide baits and mechanical barriers (Currie 1931; Weddell 1936; Sloan 1937). The labour entailed in mixing and distributing the baits, the erratic availability of materials and the difficulties of obtaining control over large areas have suggested the need for other methods. The introduction of boom spraying and newer insecticides presents an alternative approach to the problem of control in field crops. A provisional recommendation, following reports in overseas literature (e.g., Luginbill 1950), of 1 lb. of *p,p'*—DDT per acre has given staisfactory kills in Queensland. Increasing costs, however, indicated the necessity for dosage level and yield trials, and the 1952 plagues of *A. infusa* and *L. unipuncta* in various crops on the Darling Downs afforded an opportunity for this work. At the same time, several newer insecticides were screened against *A. infusa.*

As the habits and food preferences of the several species of cutworms and armyworms mentioned are somewhat similar, the findings in these trials might reasonably be expected to have general application.

II. AGROTIS INFUSA (BOISD.).

Three DDT dosage level trials, two in lucerne and one in wheat, and two screening trials in lucerne and barley, were carried out against this cutworm.

Materials.

The following insecticides were used:—

Aldrin—An emulsifiable preparation containing 20%, w/v, active ingredient.

BHC—A dispersible powder containing 6·5% gamma isomer.

Chlordane—An emulsifiable preparation containing 80%, w/v, active ingredient.

DDT—an emulsion concentrate containing 25%*p,p'* isomer w/v.

Dieldrin—An emulsifiable preparation containing 16%, w/v, active ingredient.

Parathion (E605)—An emulsifiable preparation containing 25%, w/v, active ingredient.

All insecticides were applied by knapsack at the rate of 100 gallons per acre, but each application rate is expressed as weight of active ingredient per acre.

The various treatments are detailed in the tables of results.

Designs of Trials.

Dosage level trials were set out as 4 x 6 randomized blocks, while screening trials conformed to an 8 x 3 layout. In all trials, a plot size of 1/100th acre was used.

Assessing Results.

Larval Mortality and Survival.—Following spraying, estimates of mortality were usually made by counting the number of dead larvae observed in two or three spaces across each plot, a space being the soil surface between two adjacent crop rows. The period between spraying and the first count was two to three days. A further count was taken in two of the trials two days later to check residual activity of the insecticides.

In one screening trial in barley (Cambooya), efficacies of treatments were determined by the mortalities among 60 live larvae collected at random from each plot two days after treatment. Larval samples supplied with food from the respective plots were held for three days in strong paper bags, when counts of live larvae were made.

In the dosage level trial on lucerne (Glenvale), as well as estimating mortality, a count was made one week after treatment of larvae and pupae surviving in the upper four inches of soil in six foot-square quadrats per plot selected at random.

The data for larval mortality and survival per plot are presented as both the equivalent and transformed means, the latter being calculated by using either the $\sqrt{x+\frac{1}{2}}$ or the $\sqrt{x}$ transformation.

Yields.—Yields were taken in four of the five trials and are expressed in economic units. The lucerne trials were cut with a hand-operated power mower, and the green weights recorded. Following grain ripening, wheat plots were mown, the bulk weighed and then threshed for grain weights in a small stationary threshing machine.

RESULTS.

Level Trials.

Lucerne—Regional Experiment Station, Hermitage.

Considerable foliage damage had already occurred in this seedling crop when treatments were applied on August 12, though no actual thinning of the stand was noticeable. Good growing conditions had prevailed prior to infestation by the cutworms and substantial crown development had taken place. Feeding was concentrated on the leaves and softer stems. It was noticeable that feeding virtually ceased in all treated plots.

Counts of dead larvae were made three days after treatments. For plot yields, the first cut was made on September 23 and 24 shortly before flowering commenced, and the second approximately six weeks later at peak flowering.

The results are given in Table 1.

Table 1.

MORTALITY DATA AND PLOT YIELDS.

(Lucerne—Hermitage.)

Treatment.	Dead Larvae per Plot.		Mean Yield per Plot (tons/acre).		
	Equivalent Mean.	Transformed Mean ($\sqrt{x}$).	First Cutting.	Second Cutting.	First plus Second Cutting.
DDT 1lb./ac.	44·1	6·64	2·05	3·15	5·21
DDT ¾lb./ac.	40·8	6·39	1·98	3·25	5·22
DDT ½lb./ac.	37·1	6·09	2·09	3·14	5·24
No treatment	2·56	*	1·11	3·04	4·15
Differences necessary for significance 5%	..	·77	·24	·31	·38
Differences necessary for significance 1%	..	1·10	·33	·34	·53

* As values for all DDT treatments obviously exceeded that for no-treatment, the latter was omitted from this analysis.

Though no differences were found between the three levels of DDT application, spraying produced more than an 80% increase in yield for the first cutting. This benefit did not continue, as the crop recovered before the second cutting.

Lucerne—Glenvale District.

Though a seedling crop, the lucerne was more advanced than the stand used for the previous trial. When treatments were applied on August 22, considerable leaf and stem damage had been caused by a large population of late instar larvae.

Counts of dead larvae in three inter-row spaces per plot were made three and five days after treatment. Larval survival was estimated one week after treatments were applied. These data are presented in Table 2.

The trial was harvested on November 3 and 4, and the mean weights of green lucerne are also in Table 2.

For larval mortality, all treatments significantly exceeded no treatment. Greater numbers of both larvae and pupae were alive in no-treatment plots than in any of those receiving DDT, but no significant differences were found for this criterion between DDT treatments. Migration of larvae from the surrounding untreated lucerne into the trial area had occurred, and this would account for the apparent survival in treated areas. This movement of larvae would also tend to reduce yield differences due to treatments.

Table 2.

MORTALITY AND YIELD DATA.

(Lucerne—Glenvale.)

Treatment.	Dead Larvae per Plot.				Survival per Plot.		Yield (tons/acre).
	3 days.		5 days.				
	Transformed Mean.*	Equivalent Mean.	Transformed Mean.*	Equivalent Mean.	Transformed Mean.*	Equivalent Mean.	
DDT 1lb./ac.	5·63	31·2	4·87	23·2	2·50	6·25	3·02
DDT $\frac{1}{2}$lb./ac.	5·32	27·8	4·42	19·0	2·72	7·40	3·00
DDT $\frac{1}{4}$lb./ac.	3·74	13·5	3·48	11·6	2·67	7·13	2·78
No treatment	1·53	1·8	1·36	1·3	4·22	17·81	2·88
Differences necessary for significance 5%	1·15	..	·99	..	·94	..	·47
Differences necessary for significance 1%	1·58	..	1·37	..	1·30	..	·65

* The transformed means in columns 2 and 4 were calculated from the $\sqrt{x+\frac{1}{2}}$ transformation, whilst for larval survival (column 6) the $\sqrt{x}$ transformation was used.

Differences in growth rates between treated and untreated plots were noticeable shortly after treatments were applied, but were not maintained. Prolonged wet weather late in the growing period promoted rapid growth, so at harvest significant yield differences were not obtained.

Wheat—Bowenville District.

A large population of late instar larvae was present when treatments were applied on August 14. At this stage, the crop, approximately four inches in height, had been thinned considerably, while further damage was expected in no-treatment plots.

Because of continuous dry, hot weather during the flowering and grain setting period, yields were low at harvest on November 24, while the grain was pinched severely. Only yield data, bulk (grain and straw) and grain weights, were obtained for this trial. Table 3 gives the mean values in each category.

Table 3.

YIELD DATA.

(Wheat—Bowenville.)

Treatment.	Bulk Weight. (lb. per plot).	Grain Weight. (bus./acre).
DDT 1lb./ac.	26·2	11·4
DDT $\frac{3}{4}$lb./ac.	25·5	10·9
DDT $\frac{1}{2}$lb./ac.	26·0	11·6
No treatment	21·6	9·0
Differences necessary for significance 5%	1·9	1·4
Differences necessary for significance 1%	2·6	2·0

Despite the weather conditions, all DDT-treated plots yielded significantly better than no-treatment plots for both bulk and grain weights. No differences were found, however, between the three levels of DDT application.

Screening Trials.

Lucerne—Glenvale District.

Treatments were applied in this trial, adjacent to the DDT level trial on lucerne (Glenvale), on August 23. Counts of dead larvae in three spaces per plot were made two and four days later. The plots were harvested on November 4 and 5.

The data for larval mortality and yields are given in Table 4.

The first three treatments listed in Table 4 were significantly better than the remainder for the first count, although the differences were not so marked two days later. Larval migration was evident from the surrounding unsprayed crop as well as between plots and would account in part for this levelling. DDT was significantly better than dieldrin on the earlier counting only. This finding is in accord with results from trials with these two insecticides against other noctuid larvae (unpublished Departmental records).

Table 4.

Larval Mortality and Plot Yields.

(Lucerne—Glenvale.)

Treatment.	Dead Larvae per Plot.				Yields (tons/acre).
	2 days.		4 days.		
	Transformed Mean.*	Equivalent Mean.	Transformed Mean.*	Equivalent Mean.	
DDT ½lb./ac.	4·94	23·9	3·11	9·17	3·17
Dieldrin ½lb./ac.	3·52	11·9	3·45	11·40	2·81
Aldrin ½lb./ac.	4·34	18·3	2·87	7·74	2·81
Chlordane ½lb./ac.	1·64	2·2	1·72	2·46	2·86
Toxaphene ½lb./ac.	1·68	2·3	1·27	1·11	2·70
BHC ⅕lb./ac.	1·79	2·7	1·56	1·93	2·74
Parathion $\frac{1}{10}$lb./ac.	1·78	2·7	1·68	2·32	2·68
No treatment	1·10	·7	1·29	1·16	2·95
Differences necessary for significance 5%	1·13	..	1·20	..	·54
Differences necessary for significance 1%	1·57	..	1·67	..	·75

* $\sqrt{x+\frac{1}{2}}$

Numbers were not unduly high in this trial, but the differences in larval mortalities between the first three treatments and the others were reflected in crop growth soon after spraying. Good rains and excellent growing conditions during the later stages of crop growth helped to nullify these earlier differences.

Barley—Cambooya District.

When treatments were applied on August 13, the barley was approximately 10 inches high and a large population of late instar larvae was present.

Yield data were not obtained in this trial. The stand had been so depleted by the cutworms before treatments were applied that worthwhile differences between plots either for green weight of crop or grain yield could not be expected.

The data for larval survival per plot are set out in Table 5.

Table 5

MEAN NUMBER OF LARVAE SURVIVING PER PLOT.

(Barley—Cambooya.)

Treatment.	Transformed Mean.*	Equivalent Mean.
DDT $\frac{1}{2}$lb./ac.	1·38	1·90
Dieldrin $\frac{1}{2}$lb./ac.	1·91	3·65
Aldrin $\frac{1}{2}$lb./ac.	2·66	7·08
Chlordane $\frac{1}{2}$lb./ac.	4·62	21·34
Toxaphene $\frac{1}{2}$lb./ac.	5·00	25·00
BHC $\frac{1}{4}$lb./ac.	5·03	24·30
Parathion $\frac{1}{10}$lb./ac.	4·86	23·62
No treatment	5·19	26·94
Differences necessary for significance 5%	·63	..
Differences necessary for significance 1%	·88	..

* $\sqrt{x}$

It was evident when counts were made three days after field sampling that escape losses and attacks of imprisoned larvae on one another had occurred in all samples except those from the first three treatments listed in Table 5. The figures for this small group are a fair indication of efficacies, whereas for the others the values as indicated by the counts are low. Less than half the number of larvae collected from no-treatment plots were present in the containers at the final counting.

DISCUSSION.

Level Trials.

Marked yield differences between treated and untreated plots were obtained following DDT applications during early plant growth, but yield improvements were not so marked when treatments were applied late. This was borne out in the lucerne trials at Hermitage and Glenvale, though other factors also influenced results. The cutworm population was much higher in the Hermitage trial, and commercial spraying of the surrounding areas prevented larvae migrating onto the trial site.

There were no significant differences in either kills or yields following dosages of DDT from ½ lb. to 1 lb. per acre. When ¼ lb. per acre was used quite a satisfactory kill was obtained, but it was lower and slower than those by the higher dosages. Furthermore, there was some evidence that following sub-lethal doses of DDT, larvae are repelled by the insecticide. In most instances an application of ¼ lb. DDT per acre would be followed by further crop damage. On a cost basis, however, it is doubtful if the relatively small saving in material would compensate for the possible breakdown in control which might occur.

Screening Trials.

At the dosage rates used in these trials, DDT, dieldrin and aldrin will control cutworm infestations, but DDT gave most consistent results. Some of the formulations did not wet the plants properly, but deposits on the soil surface generally and at plant bases should have ensured contact with the larvae.

III. LEUCANIA UNIPUNCTA (HAW.).

Three trials were established against late instar larvae to determine the most effective dosage of *p,p′*–DDT, and the levels tested are given in the tables of results. Method of application and quantity of spray applied per plot were similar to those for the cutworm trials.

Designs of Trials.

The autumn trial (on oats at Wyreema) comprised a 5 x 4 randomized layout with plots in line along the face of a heavy infestation of migrating larvae.

Both spring trials, also on oats, consisted of 4 x 6 randomized blocks. The first, at Wellcamp, was set out in a uniformly infested crop, though in the second, at Biddeston, plots were arranged in line, ahead of migrating larvae.

In all trials, a plot size of 1/100th acre was used.

Assessing Results.

Data were obtained in terms of plant stand counts, laboratory and field estimates of larval kills, and plot yields.

Stand Counts.—In the autumn trial (Wyreema), the number of plants in five-row sections, each 10 feet long, was recorded just prior to and again one week after treatment. All plants visible above ground were counted.

Larval Mortality and Survival.—From 50 to 100 larvae were collected at random from each plot 24 hours after treatment. Samples were held in strong paper bags for several days, when the numbers alive and dead at various intervals after treatment were recorded. All larvae showing movement on each counting day were classed as alive. In the laboratory, the larvae from the autumn trial were fed on insecticide-free plant material, while those from the two spring trials were fed on plants from the respective plots from which the samples were taken.

Field estimates of mortality, similar in method to that employed in the cutworm trials, were made in one spring trial (Wellcamp). The number of dead larvae observed in three spaces across each plot was recorded after treatment.

The data for larval mortality and survival per plot are presented as both the equivalent and the transformed means. When presented as numbers of dead larvae per plot, the latter was calculated using the transformation $\sqrt{x + \frac{1}{2}}$. When expressed as percentage mortality or survival, the inverse sine transformation was used to equalise the variances.

Plot Yields.—The Wyreema trial, conducted during a small outbreak in the autumn, was not harvested. Damage to the untreated experiment plots and the remainder of the commercial crop in the same field (Fig. 2) was so extensive that the field was prepared for replanting soon after mortality data and stand counts were recorded.

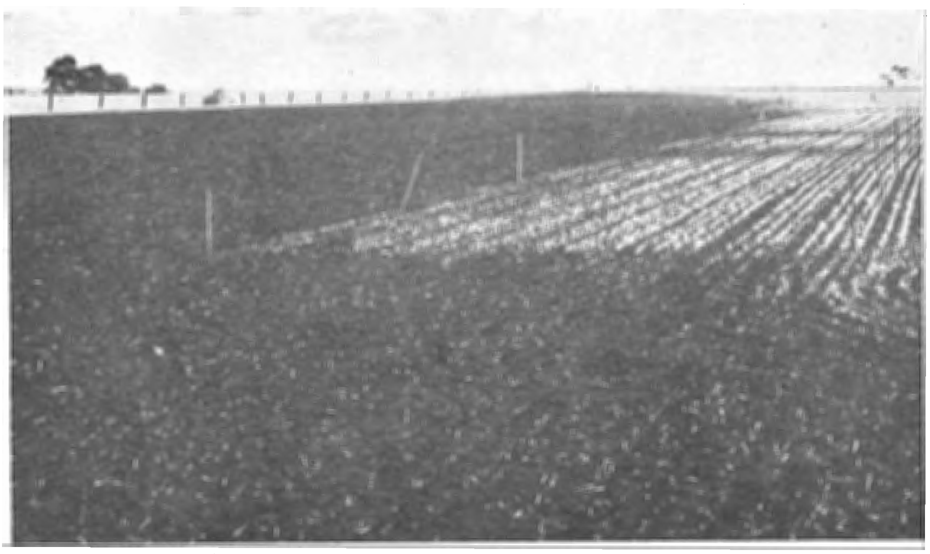

Fig. 2.

The DDT Dosage Level Trial Against *Leucania unipuncta* (Haw.) at Wyreema. Larvae entered the field from the left of the photograph. The denuded bands within the trial are the untreated plots.

At grain maturity, the spring trials were mown. In the Wellcamp trial, both weight of bulk material and grain per plot were recorded, the grain being threshed out in a small stationary threshing machine. For the Biddeston trial, only grain weights were recorded, the bulk material being passed through a field header. This proved unsatisfactory for experimental purposes. Yields are expressed in economic units.

RESULTS.

Autumn Trial.

Oats—Wyreema District.

Large numbers of armyworms were migrating into the newly germinated crop when treatments were applied on May 1. The stand counts and percentage larval mortality for treatments are given in Table 6.

Table 6.

PLANT STAND COUNTS AND LARVAL MORTALITY.

(Oats—Wyreema.)

Treatment.	Plant Stand Count.			Larval Mortality (percentage).	
	Pre-treatment.	Post-treatment.			
	Mean.	Mean.	Adjusted Mean.*	Transformed Mean.	Equivalent Mean.
DDT 1lb./ac.	82·0	103·6	104·2	77·4	95·3
DDT ¾lb./ac.	85·2	99·4	98·6	69·9	88·2
DDT ½lb./ac.	73·0	92·9	97·6	63·5	80·1
DDT ¼lb./ac.	84·8	96·1	95·5	59·1	73·6
No treatment†	92·0	66·8	62·9	38·0	37·9
Differences necessary for significance 5%	16·5	..	10·1	10·1	..
Differences necessary for significance 1%	23·1	..	14·2	14·2	..

* The post-treatment mean has been adjusted following examination of the error regression of post-treatment on pre-treatment counts.

† Data for no-treatment plots, which were obviously inferior (see also Fig. 2), were not included in the analysis.

All DDT treatments effectively prevented further damage. The recorded mortality in no-treatment plots was due to larval immigration after treatments were applied.

Spring Trials.

Oats—Wellcamp District.

Armyworms were distributed throughout this crop when treatments were applied on September 3. At this time, plants were 12 inches high and had tillered considerably following earlier grazing. Extensive flag injury was apparent.

Counts of dead larvae were made one day after treatments, while percentage larval survival among collected samples was estimated five and seven days after sampling. The trial was harvested on November 21, when bulk and grain weights were recorded.

The data are set out in Table 7.

Table 7.

LARVAL MORTALITY AND YIELD DATA.

(Oats—Wellcamp.)

Treatment.	Larval Mortality (number).		Larval Survival (percentage).				Yield.	
			5 days.		7 days.		Bulk Weight (lb./plot).	Grain Weight (lb./plot).
	Trans-formed Mean.	Equiva-lent Mean.	Trans-formed Mean.	Equiva-lent Mean.	Trans-formed Mean.	Equiva-lent Mean.		
DDT 1lb./ac. ..	7·97	63·0	21·1	13·1	7·8	1·8	37·8	30·8
DDT ½lb./ac. ..	6·10	36·7	31·8	27·8	19·1	10·7	32·8	27·6
DDT ¼lb./ac. ..	6·16	37·4	46·0	51·7	36·2	34·9	36·1	30·3
No treatment ..	1·45	1·6	83·4	98·2	74·4	92·8	30·9	24·0
Differences necessary for significance 5%	·80	..	5·2	..	7·7	..	4·7	2·7
Differences necessary for significance 1%	1·10	..	7·2	..	10·6	..	6·5	3·7

The highest dosage rate was superior to the others and destroyed a high percentage of larvae soon after spraying. Indifferent results were obtained with the two lower dosage rates within 24 hours of application, but the efficacies of these treatments increased considerably in the later count for larval survival. The gross plant cover prevented effective spray penetration and it could be expected that at the lower dosage rates a longer period would elapse before larvae contacted a lethal dose of insecticide.

Prior to head emergence, differences in crop growth were obvious between treatments. Unusually high rainfall during the grain setting period promoted growth and reduced plot differences. Despite this, worthwhile yield increases due to spraying were obtained in weight of grain.

Oats—Biddeston District.

Treatments were applied on September 10, when the oats was approximately 18 inches high. At this time, late instar larvae were entering the crop from an adjacent field of barley.

Larval survival was determined one and four days after treatments were applied.

Harvesting was carried out on November 19, and relevant data are presented in Table 8.

No significant difference was found between values for the higher levels of DDT four days after spraying, but both gave significantly better results than the lower rate of application.

Table 8.

LARVAL SURVIVAL AND YIELD DATA.

(Oats—Biddeston.)

Treatment.	Larval Survival (percentage).				Yield (bus./acre).
	1 day.		4 days.		
	Transformed Mean.	Equivalent Mean.	Transformed Mean.	Equivalent Mean.	
DDT 1lb./ac.	40·8	42·6	21·9	13·9	37·0
DDT ½lb./ac.	46·7	52·9	27·0	20·6	37·6
DDT ¼lb./ac.	54·8	66·7	39·0	39·6	30·7
No treatment	85·2	99·3	77·7	95·5	32·2
Differences necessary for significance 5%	8·8	..	7·8	..	11·8
Differences necessary for significance 1%	12·2	..	10·8	..	16·5

Differences between larval survival for treatments at four days are not reflected in the yield data. The method of grain recovery (see pp. 10-11) and excessive rain during grain setting probably reduced differences that were apparent between treatments at head emergence.

DISCUSSION.

Though larval feeding was prevented almost entirely by spraying, high mortality was obtained only with the higher dosages of DDT. Kills were slow when DDT was used at ½ lb. per acre, but four days after application these were comparatively satisfactory.

Despite a slower killing rate and differences in larval mortality, significant differences in yields between dosage were not obtained. This suggests that all rates of DDT application were effective in reducing the activities of pest populations to below the level at which economic crop damage occurs. When ¼ lb. DDT per acre was used a proportion of final instar larvae was not prevented from pupating normally.

IV. GENERAL COMMENTS AND RECOMMENDATIONS.

General field observations also indicate that the extent and rapidity of damage by cutworms and armyworms depend to some extent on the age of the crop attacked. This was particularly evident with infestations of *A. infusa* in lucerne prior to crown development, as the plants were destroyed, necessitating replanting. More advanced crops though defoliated by these pests usually recovered sufficiently to give worthwhile yields at the second cutting. Similarly in cereals, depletion of stands occurred only when crops were infested in the seedling stage. Damage by cutworms and armyworms after the development of the main root system and subsequent tillering was usually confined to defoliation. Armyworms, however, sometimes caused serious reduction in yields when late instar larvae chewed through the stems just below the heads. This occurred after the plants had been defoliated, or the leaves were drying out with plant maturity.

Based primarily on the data from these trials, the use of DDT, preferably in emulsion form, applied at the rate of one-half pound of active ingredient per acre, was recommended for the controls of cutworms (May 1953) and armyworms (Passlow 1952) in field crops. The importance of spraying at the first signs of damage was stressed.

Results from the wider commercial use of these recommendations during 1952 and 1953 amply confirmed the findings presented in this paper.

V. ACKNOWLEDGMENTS.

All statistical analyses were carried out by Mr. P. B. McGovern (Biometrician, Division of Plant Industry). Facilities for conducting these trials were provided by several farmers and Hermitage Regional Experiment Station, where threshing machinery was also made available. The Officer-in-Charge, Gatton Irrigation Research Station, collaborated by providing machinery for harvesting plots.

All this assistance is gratefully acknowledged.

REFERENCES.

COMMON, I. F. B. 1952. Migration and gregarious aestivation in the bogong moth, *Agrotis infusa.* Nature 170: 981-2.

CURRIE, G. A. 1930-31. The brown cutworm (*Euxoa radians* Guen.). Qd Agric. J. 34: 10-16, 138-63, 383-9, 488-95; 35: 18-33. Reprinted as Qd Dep. Agric. Stock Div. Ent. Plant Path. Bull. 7, 1931.

JARVIS, E. 1927. Notes on insects damaging sugar cane in Queensland. Qd Bur. Sug. Exp. Sta. Bull. 3.

LUGINBILL, P. 1950. Habits and control of the fall armyworm. Fmrs Bull. 1990 U.S. Dep. Agric.

MCKEOWN, K. C. 1944. Australian Insects. An Introductory Handbook. 2nd ed. (Royal Zoological Society of New South Wales: Sydney).

MAY, A. W. S. 1953. Cutworm control in field crops. Qd Agric. J. 77: 219-21.

PASSLOW, T. 1952. Armyworm control in cereal crops. Qd Agric. J. 75: 242-4.

SLOAN, W. J. S. 1937. Seedling pests of cotton and their control. Qd Agric. J. 47: 358-41.

SMITH, J. H. 1933. Caterpillar plagues in grasslands and cultivation paddocks. Qd Agric. J. 39: 155-60.

WEDDELL, J. A. 1936. A recent army worm outbreak. Qd Agric. J. 45: 449-60.

(Received for Publication, Jan. 11, 1954.)