QUEENSLAND

BUREAU OF SUGAR EXPERIMENT STATIONS

DIVISION OF ENTOMOLOGY

BULLETIN No. 4.

On the Value of Poison Bait for Controlling Cane Grubs

BY

EDMUND JARVIS,
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Bureau of Sugar Experiment Stations,
Brisbane, 31st July, 1916.

The Under Secretary, Department of Agriculture and Stock, Brisbane.

SIR,—I have the honour to submit for publication, as Bulletin No. 4 of the Division of Entomology of the Bureau of Sugar Experiment Stations, the following notes on "The Value of Poison Bait for Controlling Cane Grubs," by Mr. Edmund Jarvis, Acting Entomologist at Gordonvale.

I have, &c.,

HARRY T. EASTERBY, General Superintendent.

FOREWORD BY GENERAL SUPERINTENDENT.

The following Bulletin by Mr. E. Jarvis is of such importance that its immediate publication is deemed advisable even though the tests made have been on the laboratory scale and not in the field. The urgency of remedial measures in connection with the most serious pest that sugar-cane is subject to in Queensland is so great that the preparatory methods suggested should be put into operation on a field scale at the time advised—viz., about three weeks after the first general appearance of the beetles. This Bureau will also have tests made on the field. The cheapest method of sowing cow-pea would be by a seed drill such as the "Miss Dixie."

On the Value of Poison Bait for Controlling Cane Grubs.

INTRODUCTORY.

Upon taking up the study of our most serious insect pest of sugar-cane, the so-called Grey-back Beetle (*Lepidiota albohirta*, Water.), special attention was naturally bestowed on the larval stage, which annually occupies a period of about six months.

Control measures applicable to this important phase of its life-cycle were briefly discussed in a previous report (Aust. Sugar Journal, Vol. VII., p. 140), mention being made at the time of a dozen feasible methods of procedure of more or less economic value arranged under the headings—"Remedial," "Preventive," and "Natural Control."

Before starting to fight a pest of this kind, a knowledge of its life-history and economy is, of course, essential.

In the present instance we have much to learn regarding the habits of the grub, but may, I think, assume its subterranean movements to be affected by various tropic influences other than those directly associated with the act of nutrition or with climatic changes.

Probably every grower is familiar with at least two of the principal actions of this pest, viz—(1) that of eating cane roots, and (2) of continually passing quantities of soil through its body. These well-known habits were thought to constitute a fitting basis on which to commence experimentation of a remedial nature, a brief account of which will now be given.

Larvicides.

Research work in this connection was started in February, 1915, when a number of insecticidal solutions were applied to cages containing larvæ of albohirta, with more or less satisfactory results (see Aust. Sugar Journal, Vol. VIII., p. 62). The drawbacks to such a method of control, however, were early realised, and the work abandoned in favour of more hopeful measures.

The question of poisoning the grub by means of arsenicals, &c., applied to the soil appearing worthy of investigation, a series of experiments were undertaken along this line, the knowledge obtained being in some instances of economic value.

EXPLANATION OF PLATE.

Fig. 1.—Eggs of the "Gray-back" Cane Beetle (*Lepidiota albohirta*, Waterh.) a week after deposition (original).

Fig. 2.—Larva of same, third moult, about three-quarters grown (original).

Fig. 3.—Venter of anal segment of larva, showing disposition of setæ or bristles, by means of which grubs of this beetle may be readily distinguished from those of other closely related scarabæidæ (magnified about six times; original).

Fig. 4.—Mandible or jaw of grub (magnified four times; original).

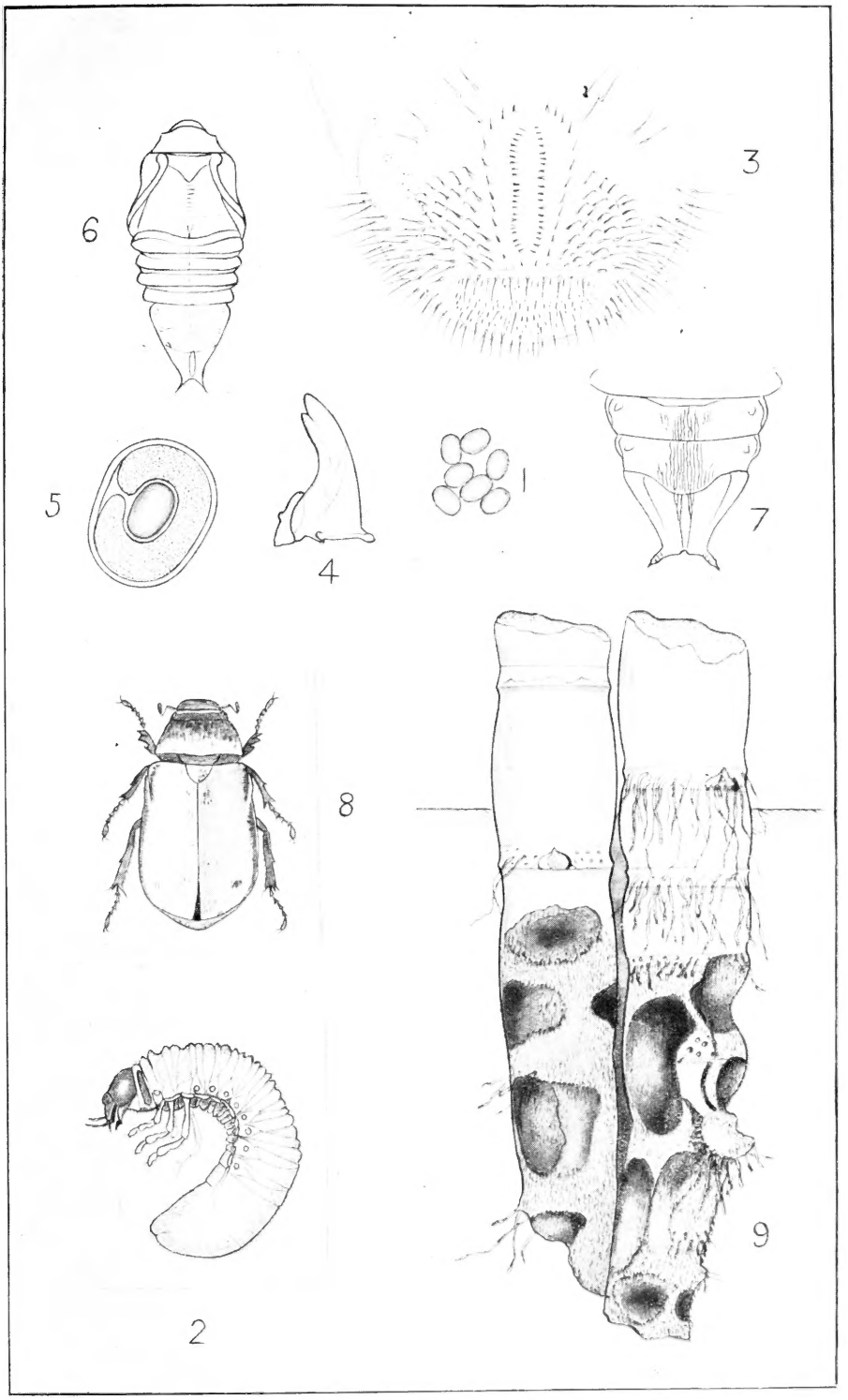
Fig. 5.—Abdominal spiracle and peritreme of grub (magnified seventeen times; original).

Fig. 6.—Pupa of same, dorsal aspect (natural size; original).

Fig. 7.—Abdominal segments of pupa, Nos. 7-8, illustrating the appearance of dorsal striæ and anal horns (twice natural size; original).

Fig. 8.—Adult female of "Gray-back" Beetle (natural size; original).

Fig. 9.—Cane grub injury to roots and underground portion of stalks of nine-months' old "Goru" (half-natural size; original).



E. Jarvis, Del.

COCKCHAFER BEETLE OF SUGAR CANE (*Lepidiota albohirta*, Water).

(Its metamorphosis, etc., and mode of injury.)

Poisoning the Soil.

Grubs placed in moist earth containing aceto-arsenate of copper in the proportion of 2 oz. to one cubic foot (infected by thoroughly mixing the dry poison with sifted soil) remained normal throughout the course of these experiments, while the same chemical administered at the rate of 8 oz. to a cubic foot was quickly fatal to 100 per cent. London purple (8 oz. to 1 foot) proved effective, but less deadly than the foregoing arsenical. Carbide lime, sulphur, and several other chemicals gave negative results. This mode of application appeared out of the question owing to excessive cost of both labour and materials, so further research was postponed, pending the possible discovery of a more suitable substance possessing manurial properties.

POISON BAIT AS A MEANS OF CONTROL.

The great importance of experimentation in this connection was recognised from the start and kept in view throughout the course of the above-mentioned preliminary research work initiated last year, which, in fact, served as a stepping-stone to more extended investigations.

Our cane grub being voracious in appetite, and what is termed a gross feeder, it seemed highly probable that it would swallow almost any kind of poison providing its odour was not obnoxious and the bait used sufficiently attractive. Later experiments, to be touched on presently, amply demonstrated the correctness of this assumption.

The first step was to discover some vegetable substance that, whilst not quickly decomposing when buried in the soil, would at the same time be palatable throughout a period of three weeks or longer, either in a fresh form or as vegetable humus. In addition to the foregoing qualifications, this desirable substance had, above all, to be cheap, readily obtainable in bulk, and easy to apply.

As a result of numerous experiments it was found that larvæ of our Mealy-back Cane Beetle would eat many kinds of roots, &c., and were apparently very partial to the tubers of both English and sweet potatoes, cucumber skins, and thin slices of cane stalks sectioned transversely.

In May, 1915, whilst watching some ploughing operations on land that had recently been green manured, it suddenly occurred to me that here, perhaps, was the key to the situation—viz., the employment of either Mauritius bean or cow-pea as a bait, which, in addition to the possession, possibly, of all the above-mentioned requirements would act also as a manure, and so help to reduce the expense of application.

Investigations were at once entered upon, and proved conclusively that grubs of our Cane-beetle will readily devour the leaves of both these plants.

Finding cow-pea to be the more attractive, experiments were conducted to determine the rate of decay of foliage of this legume when buried at a depth of about 9 inches, and also with a view to rendering its leaves still more palatable. Before attempting to study the latter point it was necessary to undertake a long series of experiments, that need not be mentioned here, for the purpose of discovering an efficient poison. Results for many months were unsuccessful, owing to the extreme resistance of our cane grub to stomach poisons. Baits treated with arsenical sprays of more than thirty times the strength usually recommended for plant-eating insects failed to produce serious effects, and for a time it seemed likely that this pest might ultimately be found to be altogether proof against the cheaper forms of arsenic administered in this manner. However, towards the end of February last I determined to try the effect of dust sprays, applied, as a supreme test, at full strength.

Now, in a problem of this nature a poison to be suitable needs, in the first place, to be very deadly, and at the same time sparingly soluble, so as to withstand the action of heavy rains which would weaken and soon lessen the efficiency of quickly soluble chemicals. Aceto-arsenate of copper (Paris green) appeared to be more fitted for the purpose than some of the other arsenical compounds, and although previous experiments with it in 1915 had failed, I decided to give it another chance under the most favourable conditions. Results secured last February, 1916, by the first of these tests proved very encouraging.

Cow-pea foliage was sprayed on the upper surface with mill molasses (1 pint to 3 pints water), and then dusted with the arsenical by sifting it through coarse linen. The experiment comprised eleven cages, each containing 20 cubic inches of fresh soil and a grub, nine supplied with a poisoned leaf and the remaining two being controls with unsprayed leaves, the foliage in each case being buried about 2 inches deep. An examination made twenty-four hours later showed 70 per cent. of dead larvæ in various stages of decomposition, which had between them consumed less than three-quarters of a square inch of the poisoned leafage. Subsequent examinations up to 10th February gave a mortality of 90 per cent. in sixteen days. This important experiment was at once repeated on 24th February, with seventeen treated and four control cages containing first and second stage grubs confined with poisoned cow-pea leaves, cut up in various forms as recorded by the following table:—

Table I.

EXPERIMENT STARTED 24TH FEBRUARY, 1916.

Effect on cane grubs of aceto-arsenate of copper sifted through linen on to cowpea leaves sprayed with mill molasses (1 pint molasses—2 pints water).

Seventeen cages, each containing a grub of Lepidiota albohirta and a poisoned leaf buried in 20 cubic inches of moist soil.

Date of Examinations		3 grubs (II. stage) and half-leaf in each cage.			3 grubs (II. stage) and 6 pieces leaf ½ inch sq.			6 grubs (I. stage) with half-leaf in each cage.						5 grubs (II. stage) with a leaf in each cage cut into strips.					*Controls.* 4 grubs (I. and II. stages) in cages with untreated leaves.			
		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.	18.	19.	20.	21.
February	25	Dead	Sick	Dying	Dead	Dead	Dead	Normal	Dead	Normal	Normal	Dead	Normal	Dead	Dead	Dead	Dead	Normal	Normal	Normal	Normal	Normal
February	26	..	Dead	Dead	..	..	..	Dead	..	Dead	..	..	..	..	..	..	..	..	do.	do.	do.	do.
February	28	..	..	..	..	..	..	..	..	..	..	..	Dead						do.	do.	do.	do.
February	29	⅛ sq. inch eaten.	½ sq. inch bitten.	⅛ sq. inch eaten.	Edge of leaf nibbled.	1/16 sq. inch eaten.	⅛ sq. inch eaten.	Leaf nibbled.	⅛ sq. inch eaten.	Leaf nibbled.		1/16 sq. inch eaten.	⅛ sq. inch eaten.	Leaf nibbled.	Leaf nibbled.	Leaf nibbled.	¼ sq. inch eaten.		do.	do.	do.	do.
March	2																		do.	do.	do.	do.
March	4																		do.	do.	do.	do.
March	6	..	..	..	..	..	..	..	..	..	Dead	..	..	..	..	..	..	..	do.	do.	do.	do.
March	10	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	..	Dead	do.	do.	do.	do.

Summarising results shown by the foregoing figures, it was found that ten out of seventeen grubs placed with poisoned leaves were dead and partially discoloured a day after treatment, and by the end of fifteen days 100 per cent. had perished, controls remaining perfectly normal.

The above result was, of course, highly satisfactory as far as it went, but it was necessary to determine how long these leaves would continue palatable and the insecticide effective when subjected to damp conditions underground. Foliage that had been poisoned for this purpose and then buried 6 inches deep between rows of cane was accordingly dug up after the lapse of a fortnight, and discovered to be more or less rotten, the leaves having quite lost their rigidity. Fungi were present, but the soil in contact with the surface of the leaves was not matted with mycelium to a serious extent, as frequently happens with other vegetable baits of a more or less starchy nature.

On the 8th of March fragments of these decaying leaves were placed in six cages with second stage grubs of *Lepidiota albohirta* (table omitted here for sake of brevity), and when examined fourteen days later all were dead. Thus it was proved that cow-pea foliage poisoned with copper arsenate will remain palatable and deadly in the ground for at least twenty-seven days.

The question of application was the next step, and I concluded that the simplest way, requiring least handling, would be to sow the peas in a single line about 1 foot from the stools on each side of a row of cane, and when the resultant plants were a few inches high, dust and plough them under in such manner as to bury the poisoned leaves against the main roots of the cane, where grubs when moving about in the soil would be most likely to meet with them. The adoption of this method, however, would necessarily entail an appreciable loss of material, it being impossible to treat the foliage without at the same time dusting the surface of the ground to some extent. For several reasons it seemed wisest to adopt the above-mentioned simple method of application, and at the same time reduce expenditure to a minimum by diluting the chemical.

In the following table it will be seen that Paris green mixed with three times its weight of stale flour proved fatal to about 58 per cent. of cane grubs in one week, 75 per cent. in fifteen days, and 100 per cent. after the lapse of twenty-five days.

Table II.

EXPERIMENT STARTED 22ND MARCH, 1916.

Effect on cane grubs of Paris green and flour (1 part P.G.—3 parts by weight flour) dusted on damp cowpea leaves.

Date of Examinations.	Twelve cages, each containing a cane grub and poisoned leaf in 20 cubic inches soil.												*Controls.* Four cages containing grubs and untreated leaves.			
	Arsenical sifted through wire gauze (fine mesh).						Arsenical sifted through butter cloth.									
	III. stage grubs.			II. stage grubs.			III. stage grubs.			II. stage grubs.			II. stage grubs.		III. stage grubs.	
	22.	23.	24.	25.	26.	27.	28.	29.	30.	31.	32.	33.	34.	35.	36.	37.
March 23	Normal	Sick	Sick ..	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal	Normal
March 24	..	..	Dead	..	..	..	..	Dead	..	..	..	..	do.	do.	do.	do.
March 25	Normal	..	..	..	..	..	..	..	Dead	..	..	..	do.	do.	do.	do.
March 27	Normal	..	..	..	..	..	..	..	..	Dead	..	..	do.	do.	do.	do.
March 28	Sick	..	..	..	..	..	..	..	..	..	..	..	do.	do.	do.	do.
March 29	..	..	..	..	..	..	..	..	..	..	Dead	..	do.	do.	do.	do.
March 30	..	..	..	..	..	..	..	..	..	..	..	..	do.	do.	do.	do.
April 1	..	..	..	..	..	..	..	..	..	..	..	..	do.	do.	do.	do.
April 3	..	..	..	..	..	..	..	..	..	..	..	..	do.	do.	do.	do.
April 5	..	..	..	..	..	Dead	..	..	..	..	..	Dead	do.	do.	do.	do.
April 8	..	Dead	..	..	..	..	..	..	..	..	..	..	do.	do.	do.	do.
April 11	..	..	..	..	..	..	..	..	..	..	..	..	do.	do.	do.	do.
April 12	Dead	..	..	..	..	..	..	..	..	..	..	..	do.	do.	do.	do.

The experiment shown in Table II. was repeated on 12th April with sixteen grubs, but using leaves that had been similarly treated on 22nd March and left for three weeks lying in damp soil. The result was a mortality of 45 per cent. in twenty-one days, demonstrating that leaves dusted with copper arsenate and flour (1-3 formula) retain a marked degree of effectiveness after remaining in the ground for about five weeks.

WHITE ARSENIC BAIT.

Having secured such good results with arsenate of copper, I decided to experiment with arsenious acid, commonly known as white arsenic, which, although more soluble in water than Paris green, is much cheaper, and has the additional advantage of being very conspicuous in the field.

In the first experiment, started 25th February with six infected and two control cages, the arsenical was applied in undiluted form as a dust spray, with most encouraging results. It was sifted through butter cloth on to cow-pea leaves moistened with mill molasses solution (1-3 formula), and 2 square inches of the poisoned leafage placed in each treated cage enclosing a second stage grub of albohirta in 20 cubic inches of soil. A mortality of 100 per cent. was obtained in ten days, the amount of poisoned leafage eaten collectively by the six dead grubs being about 1 square inch. Controls remained perfectly normal throughout. This experiment was repeated on 14th March with foliage that had been poisoned on 25th February and buried for eighteen days between rows of sugar-cane. These leaves when dug up were in a semi-rotten state, and more or less interlaced by slender cane roots, that appeared to be deriving nourishment from them. Portions of this decaying vegetation were then placed with cane grubs in five cages of soil, and by the end of fourteen days had caused a mortality of 100 per cent., proving that this arsenical retains its efficiency underground for at least a month.

WHITE ARSENIC *versus* PARIS GREEN.

Desiring to ascertain the effect of diluted white arsenic, an experiment was started on 24th March identical in construction with that given in Table II., the only difference being the employment of this arsenical in the place of Paris green.

Detailed results need not be tabled here, it being sufficient to state that after a lapse of three weeks the death rate did not exceed 33·30 per cent.

Compared with copper arsenate, the effect obtained may be summarised thus:—

Paris Green (1-3 formula)—
In one week killed 58 per cent. of grubs.
In two weeks killed 75 per cent. of grubs.
In three weeks killed 91·60 per cent. of grubs.

White Arsenic (1-3 formula)—
In one week killed 16 per cent. of grubs.
In two weeks killed 25 per cent. of grubs.
In three weeks killed 33·30 per cent. of grubs.

In spite of this failure in diluted form the claims of arsenious acid as a suitable insecticide for fighting the cane-grub deserve recognition, owing to its being fully six times as cheap as Paris green; for we have already seen that both these arsenicals when undiluted occasion about the same percentage of mortality.

The quicker action of Paris green may prove to be an unimportant factor in the present instance, since grubs affected by either poison probably cease feeding, and provided that all ultimately perish it matters little whether some die sooner than others.

Owing to the greater solubility of arsenious acid and its burning action on foliage, it is seldom recommended as an orchard spray unless in combination with lime or various chemicals; but, again, such drawbacks do not necessarily apply to its application underground in a dry form, although possibly during wet weather foliage dusted in this way may rot more quickly than would be the case were it treated with copper arsenate. If deemed advisable the soluble arsenates in commercial white arsenic could be easily rendered insoluble.

There is no necessity, however, to discuss the subject more fully just now, but I may mention than in addition to its trifling cost this well-known arsenical is considered to be less poisonous to man than Paris green, and, as a rule, is freer from adulteration with foreign substances.

MODE OF PREPARING AND ADMINISTERING THE BAIT.

The most favourable time to start the preparatory work of drilling in cow-peas for bait would be about three weeks after the first general appearance of Gray-back Beetles, as we should then disturb the soil shortly after oviposition and probably break up many egg chambers. In the event of an occurrence of protracted dry weather it might be found advisable to sow a little sooner in order to take advantage of moisture still remaining from the heavy rain that usually ushers in the first emergence of these beetles.

Having got the peas to germinate and come up, their after growth, if retarded, would not matter much, our object being to obtain stocky plants, bearing, say, a dozen leaves, and together making a compact line of foliage about 6 inches high by 8 inches broad. Should the rows exceed these dimensions, a month after sowing they could be dusted and ploughed under in the manner already described on page 7, but if dry weather should happen to keep the plants stunted it would be better to allow six weeks from date of sowing to elapse before treatment, as cane grubs would by that time have moulted to the second stage, in which they manifest a greater liking for vegetable food and acquire increased powers of locomotion.

To ensure complete burial in the most favourable position, it might be found necessary to plough a trench close alongside the stools, sow the peas in the bottom, and later on, after dusting the plants, turn a furrow on top of them, the weight of which would tend to press the poisoned leaves downward to the requisite depth.

In addition to the foregoing advantage, this method of burying the bait would ensure the destruction of numerous eggs, and, moreover, provide ideal conditions for the germination and after development of the cow-peas, which, if sown near the surface, would be more likely to suffer from dry spells that sometimes occur about the beginning of the year.

The dry method of administering insecticides is not only cheaper but far more convenient than spraying with liquids in the ordinary way. Various mechanical contrivances and powder bellows have been specially designed for this class of work, but in the present instance the usual pole and bag method would, I think, meet requirements. With this simple appliance, consisting of a wooden bar about 4 feet long with a cloth bag fixed at each end to contain the insecticide, a man could treat from 3 to 4 acres a day, doing two rows of peas at a time by merely walking between them and slightly jarring or shaking the stick so as to cause a fine cloud of dust to settle down on the plants. Such application should be made either at night, late in the evening, or in the early morning when there is little or no wind and the leaves are wet with dew. By observing certain rules the work is performed without risk to the operator, and danger is well-nigh impossible, as the powder is shaken a few inches only above the ground and over a very limited area.

COST PER ACRE.

Seeing that our cane grub is far harder to kill than any species of leaf-eating caterpillar, dusting operations, although limited to a narrow band of verdure, would need to be done thoroughly.

The comparative cost of material per acre for both arsenicals works out approximately as follows:—

Copper arsenate (undiluted), 8 lb. at 1s. 6d.=12s. per acre.
Copper arsenate and waste flour (1-3 formula), 2 lb. at 1s. 6d.=3s. per acre.
Arsenious acid (undiluted), 10 lb. at 3d.=2s. 6d. per acre.

To this must be added the value of the cow-pea seeds, which at the present market rate of about 18s. a bushel would be something like 10s. per acre; these, however, could no doubt be grown by the farmer for much less than it would cost to purchase them. Presuming that a man could dust 4 acres a day, the outlay for such labour would amount to about 2s. 6d. per acre; but this item, including expenses entailed by sowing the peas and covering in the poisoned plants, would, I presume, be counterbalanced by advantages derived from the breaking up of egg-chambers, destruction of weeds, improvement of both land and cane by extra culture, and lastly by the nitrogen added to the soil by the peas.

It is unnecessary at present to give more than a rough estimate of the total cost per acre for labour and material, which apparently would not exceed 12s. 6d. for the white arsenic treatment, and probably less than 10s. if the cane farmer were to grow his own cow-peas.

CONCLUSIONS.

It must be borne in mind that results now recorded relate exclusively to cage experiments, and have yet to be confirmed in the field. Apart from such considerations, however, the present Bulletin, which announces a cheap, simple, and presumably effective means of combating the grub stage of our most serious cane insect, cannot fail to be of interest to all concerned in the sugar industry.

At the risk of being thought too optimistic, I do not hesitate to say that future field investigations in this connection are not likely to reveal the presence of any vital obstacle to final success.

The chief points requiring settlement by such field work will relate primarily to the question of rainfall, and its effect on the solubility and efficiency of both forms of arsenical; and to various operations of a mechanical nature which will enable us to determine the simplest and most economical method of dusting and burying the poisoned cow-peas.

It need scarcely be stated that the plan of procedure outlined in this Bulletin relates solely to treatment of the late crop, which at Gordonvale is planted from August to October, and is the one principally attacked.

It is my intention to combat the larva as far as possible during its second stage, at a time when young plant and ratoon cane would not be high enough to interfere with the field work connected with this control method.

With reference to the behaviour of the grub under natural conditions, it is well known that although leading a subterranean life it constantly changes its position, becoming especially active during wet weather; hence we may reasonably assume that while travelling among the main roots, feeding, and ingesting soil, it can hardly fail to encounter the bait before able to work appreciable damage.

Rich volcanic soils of a deep and friable nature afford ideal conditions for the development of cane grubs, and it is worth noting that this class of land—seen at Greenhills, Meringa, and other districts—is precisely the one most likely to benefit from the application of poison bait, owing to the fact that grubs are able to move about in it with facility.

Field experiments cannot be expected to yield percentages of mortality as high as those shown on the accompanying tables, for the simple reason that grubs confined in small cages of soil must perforce soon discover the bait, whereas, under natural conditions, owing to the very erratic movements of the pest and the presence of other vegetable food, a larva might on occasion feed for days close to poisoned leafage without perceiving it, or even miss it altogether. Unquestionably, this would seldom happen if the treated leaves were artificially rendered enticing enough to induce grubs located within a radius of from 4 to 6 inches to move towards them.

It is proposed to investigate this question next season by studying the underground tropic reactions of the larva, or, in other words, the reflex acts or combination of such, induced mainly by the moisture, temperature, and physical character of soils, and which are probably influenced in some degree by other comparatively obscure forces of a chemotropic or olfactory nature. It will be of interest to mention in this connection an important cage experiment conducted in May (1916) to discover whether grubs would eat this bait if it were closely surrounded by cane roots.

Larger cages holding 60 cubic inches of soil were used, and the bait (about 2 square inches of leafage) placed just below a mass of living roots, arranged so that the caged grub would encounter its natural food first, and be obliged to pass among it to reach the poisoned leaf. Twenty cages were treated in this way, ten with copper arsenate bait and the remainder with arsenious acid, each enclosing a large third stage larva of our Gray-back Beetle.

Results revealed by subsequent examinations proved eminently satisfactory in the case of the former arsenical, which in forty-eight hours had occasioned a mortality of no less than 60 per cent., followed by 90 per cent. in three days, and 100 per cent. in a week. The ten cages containing white arsenic bait yielded 60 per cent. of dead grubs after twenty days.

The season is now too far advanced for further investigations relative to the larval stage of cane-beetles, but this last experiment, and indeed the results of previous research work as a whole, illustrate the very deadly nature of arsenate of copper in undiluted form, and incline me to think that it may ultimately prove to be the best insecticide for our purpose.

In the event of field experimentation next season being successful, we may consider one phase of the cane grub problem as practically solved; but, unfortunately, in the present instance are dealing with an indigenous insect that breeds in untold numbers over a vast portion of Northern Queensland, and must remember that whatever form of control may be adopted in the future, whether preventive or remedial, we cannot eradicate this pest, but only hope, at the best, to effectually combat its ravages on limited areas devoted to the cultivation of sugar-cane.

NOTE BY GENERAL SUPERINTENDENT.

In reply to question as to the possibility of the grubs attacking the cow-pea roots and perhaps destroying the plant before it could be dusted and ploughed under, Mr. Jarvis has supplied the following notes:—

"I think that although individual cow-pea plants might suffer from grub attack, such damage would not be sufficient to seriously interfere with the experiment.

"The question, of course, is one that can only be absolutely settled by field tests, but my view, as stated above, is based on the following conclusions:—

(1) The eggs would have been laid before the planting of the peas, and seeing that the beetles, as a rule, oviposit either close to the stool or directly under it, the chances are that the resultant grubs whilst very small would not travel that far, but feed on the fibrous cane roots close at hand.

(2) Drawing the trench for planting of peas would, as I have intimated in m.s., probably destroy most of the egg chambers formed by beetles at a distance of from 6 to 12 inches from the stool, and so minimise chances of attack from grubs located in that situation.

(3) By sowing the peas in the bottom of a deep trench as suggested in m.s. they (the plants) would be obliged to root in a lower strata of soil than that in which eggs are generally deposited, and being at a lower level would not only be isolated, as it were, from direct attack, but situated partly on subsoil of too firm a nature to admit of easy access from first and second stage grubs; moreover, grubs, as a rule, prefer to travel in loose soil, which they are continually ingesting for the sake of extracting the organic matter."

By Authority: Anthony James Cumming, Government Printer, Brisbane.