CONTROL OF CLOVER CASE-BEARER MOTH

W. F. LEONARD
Imperial Chemical Industries (N.Z.) Ltd., Wellington

Summary

DDT, diazinon and trichlorphon were applied at 1 lb per acre to a second-year white clover (*Trifolium repens*) crop infested with clover case-bearer (*Coleophora* spp.). From a single early morning application, DDT and diazinon gave a significant increase in seed yield.

INTRODUCTION

THE BIOLOGY of the clover case-bearer was outlined by Dumbleton (1964). He described the flight pattern of the species mainly responsible for white clover seed damage (*Coleophora alcyonipenella*), and commented on ways that management could influence its incidence.

Attempts to control the adult moth have included the use of DDT and toxaphene, but little was known of their effects on clover seed yield. They are, of course, chemicals of relatively long residual life, but the particular difficulties associated with case-bearer control are likely to limit the effects even of these materials. Furthermore, the residual nature of organo-chlorine compounds is itself a problem to New Zealand agriculture and some alternative method of control is needed.

EXPERIMENT

A trial was laid out on November 30, 1964, with the intention of comparing DDT, diazinon and trichlorphon at two times of application. The normal flight pattern of *C. alcyonipenella* in Canterbury consists of two separate peaks, giving rise to two generations of caterpillars which attack white clover seed. These generally occur in November and January so the trial was designed to allow application at each of these flight peaks. The paddock used was one of several being surveyed by R. A. French and timing was based on his results.

Provision was made for application in November, January and November plus January. The dry spring, however, hastened the maturity of white clover seed crops to the extent that the crop was cut and threshed before the January flight occurred.

Treatments employed therefore were DDT emulsion, diazinon and trichlorphon wettable powder applied at 1 lb active ingredient per acre to a second-year white clover seed crop. Applications were made in 22 gal of water per acre with a tractor-mounted boom. Plots measuring 55 yd × 18 yd were laid out in a randomized block design. Treated plots were replicated six times and untreated plots twelve times.

When treated the crop was estimated to be bearing 50% of open flowers with 25% past the flowering stage and 25% of flowers still to open.

Spraying was done between 6 a.m. and 9 a.m. in calm conditions, no bees being observed until after spraying was completed.

RESULTS

Moth Counts

Sampling for moths was carried out by R. A. French, 26 to 30 hours after spraying. Four samples were taken from each plot, each sample being obtained by a "drag" of 20 yd in length. The technique of dragging a net through the crop rather than more-superficial sweeping was found by Mr French to give a more accurate picture of the insect population. The diameter of the net was 12 in. and the number of moths netted prior to treatment (November 25), averaged seven per sample.

The average number of moths per sample after treatment appears in Table 1.

TABLE 1: AVERAGE NUMBER OF MOTHS PER SAMPLE AFTER TREATMENT

Treatment (lb)	*Moths per Sample*
Untreated control	2.0
Trichlorphon 1	1.0
Diazinon 1	0.5
DDT emulsion 1	0.5

Seed Yields

Yields of white clover seed in pounds per acre are set out in Table 2.

TABLE 2: YIELDS OF SEED (LB/ACRE) AFTER TREATMENT

Treatment (lb)	*Machine-dressed Seed*	*Pure Living Seed*
Untreated control	54.3 cB	33.7
Trichlorphon 1	51.7cB	31.7
DDT emulsion 1	68.6 bAB	38.1
Diazinon 1	88.0 aA	51.4

Samples of dressed seed from all plots were examined for insect damage at the Department of Agriculture Seed Testing Station, Palmerston North. The proportion of damaged seed varied between 1.5% and 3.5% with no apparent relationship to treatment.

Bees

No quantitative data were collected on the effects of treatments on bees. Hives were present, however, in an adjoining paddock and the apiarist agreed to observe them fairly closely. He saw nothing unusual in the behaviour of the bees.

In the course of netting the moths the day after treatment, R. A. French noted that bees on the DDT plots appeared unharmed. Few were present on the diazinon and trichlorphon plots although those observed on one trichlorphon plot appeared unharmed.

DISCUSSION

In a low-yielding second-year crop, the yield of white clover seed was significantly increased by a single application of DDT emulsion and of diazinon wettable powder. Harvesting the crop before the second brood of moths emerged no doubt contributed to an increase.

The failure of trichlorphon to reduce moth numbers to the level of DDT and diazinon could be related to the morning — rather than the evening — application. The absence of yield response from trichlorphon could be due partly to the incomplete moth kill initially and partly to this material's short residual life.

Further work is obviously needed on the clover case-bearer moth but a significant yield increase from an organophosphate is of real interest. However, in any flowering crop, the effects of chemical treatment on bees must be kept constantly in view.

ACKNOWLEDGMENTS

Thanks are due to the property owner, T. W. Callander, and his manager, L. L. Carpenter. Also to R. A. French, T. J. Smallridge, Biometrics Section, and Seed Testing Station all of the Department of Agriculture.

REFERENCE

Dumbleton, L. J., 1964: *Proc. 17th N.Z. Weed & Pest Control Conf.*: 161–4.

USE OF DISULFOTON ON POTATOES

B. F. A. ROUGH
Henry H. York & Co. (New Zealand) Ltd., Wellington

R. C. CLOSE
Plant Diseases Division, D.S.I.R., Lincoln

Summary

Control of early infestations of potato aphids is of great importance to potato growers. Failure to control this early infestation results in the development of enormous populations of aphids. Extensive trials over the past two seasons have shown that disulfoton 5% granules when incorporated in the soil at planting will systemically control this early infestation and will give protection from aphids for the greater part of the growing season.

The advantage of granules on potatoes is that, apart from the materials cost, there is no application cost (for it is done at planting). The time and expense and numerous problems associated with spray applications are saved. More important, the plants are protected from insect attack from the time of emergence and erratic emergence ceases to be the problem that it is in a spray programme.

Granule applicators are available for attachment to virtually every potato planter. They comprise, essentially, a hopper with a regulated feed into tubing carrying the granules to the planting furrow. This method of applying the disulfoton granules has proved this season to be acceptably accurate, safe and simple.

Several disulfoton-treated crops were taken to yield this year and increases of between 2 and 3 tons per acre were recorded.

INTRODUCTION

FOR THE CONTROL of potato aphids systemic insecticides have attained rather widespread use. Smith *et al.* (1964) and others have shown that systemic insecticides sprayed on the tuber or applied in granular form to the soil can keep plants relatively free from aphids for several months after emergence. Most effective has been the 5% granular form of disulfoton.

Last season it was decided to concentrate mainly on disulfoton spreading trials over soils ranging in mineral and organic content. Also a more direct approach to granule placement by mechanical means called for evaluation of applicators — a measure in practice of their reliability and accuracy was required. Another aim was to take as many trials to yield as possible since with high production cost yield difference is important. Further information was also sought on disulfoton's effect on pests other than aphids.

The associated method, together with results from nine trials carried out in both Islands last season (1964–5), are reported in this paper.

METHOD

Soil Adsorption

Soils with high organic matter content are reported to reduce the availability of disulfoton through particle adsorption. Light or open soils do not unduly hasten the movement of the insecticide through the soil. It was with factors such as these in mind that trials were extended to cover a reasonably wide variation in soils.

Table 1 simply numbers the trials carried out over the past season, names the site, identifies the soil set, and gives Soil Bureau Bulletin references as well as soil group.

Application — Adopting a New Method

On growers' properties in the Rangitikei in the 1963–4 season, disulfoton granules were mixed with compound and pelleted fertilizers and put into open hoppers on the potato planter. The method proved satisfactory for aphid control but persons doing the mixing and tending the planter were constantly exposed to disulfoton.

Fig. 1: Massey-Ferguson two-row automatic potato planter fitted with a Horstine Farmery granule applicator, planting an insecticide trial on the property of T. R. Mundy, Coutts Island, Canterbury. The applicator is in the centre (below the fertilizer bin) and the granules are metered by fluted rollers into the two tubes and down these into the furrow, falling alongside of and around the planted tuber. The fluted rollers within the applicator are turned by a horizontal drive shaft and this is driven by the ground wheel on the right of the planter.

TABLE 1: TRIAL SITES WITH SOIL REFERENCE

Trial No.	*Site*	*Soil Set*	*Reference No.*	*Group*
1	Silverhope, Hunterville	Kiwitea silt loam	76a	Recent soil*
2	Rata, Hunterville	Kiwitea silt loam	76a	Recent soil*
3	Bulls	Karapoti sandy loam	1	Gleyed recent soil*
4	Kairanga, Palmerston North	Kairanga clay loam	2	Yellow-brown loam*
5	Makerua, Shannon	Makerua peaty loam	107	Organic soil*
6	Lincoln College, Canterbury	Paparua sandy loam	96c	Recent soil†
		Whakanui silt loam	18f	Yellow-grey loam†
7	Harewood, Christchurch	Waimakariri fine sandy loam	95	Recent soil†
8	Coutts Island, Kaiapoi	Kaiapoi silt loam	95b	Recent soil†
9	Crop Research Division, Lincoln	Templeton silt loam	96a	Recent soil†

* Refer to *Soil Bureau Bulletin (N.I.) No.5.*
† Refer to *Soil Bureau Bulletin (S.I.) No. 27* (in press).

Arising from this experience, it seemed desirable last season (1964–5) to have a granule applicator attached to the planter; one with a tight fitting lid to seal in the disulfoton. Just as essential in such an appliance was even distribution of granules at the required rate throughout the whole duration of treatment.

The Horstine Farmery "microband" machine was recommended based on tests carried out and reported by N.I.A.E., U.K.

The unit consists of a tapered hopper holding 30 lb of 5% disulfoton granules. The feed mechanism consists of interchangeable fluted rollers situated in a casting at the base of the hopper. Each roller is held by a grub-screw on to a long steel driving shaft driven by a V-belt from a ground wheel carried out to the side of the planter. A range of interchangeable pulley wheels is provided to vary the roller shaft speed; in addition, fluted rollers of different width provide a large range of feed rates. Clear plastic tubing carries the granules to the ground.

Use was made of the Horstine Farmery applicator in all but Trials 2 and 9. Apparently the machine can be adapted to fit on virtually every potato planter available, but it is designed to attach directly to the Massey-Ferguson two-row automatic planter and, for this reason, growers with Massey-Ferguson planters were sought for trials.

Row spacing adopted by growers varied between 30 in. and 34 in. in Trials 1, 3, 4 and 5. To apply the equivalent of 1.5 lb (all rates given in a.i. per acre) of disulfoton to each row at this spacing, use was made of one ¾ in. fluted roller, one ⅜ in. fluted roller, and a ⅜ in. spacer in the middle, while to apply 1 lb disulfoton only one ¾ in. fluted roller alone was used. The 7 in. pulley was used next to the land wheel and the 3¼ in. pulley on the driving shaft for both the 1.5 and the 1 lb rates. The granules were placed in the bottom of the planting furrow along with the tuber of the seed potato. In Trial 2, disulfoton was mixed with pelleted fertilizer and the combination banded into the soil on either side of the seed.

Another granule applicator made use of by three growers for disulfoton application last season was the Griffith's applicator, and this, again, can be adapted to fit any make of planter. The machine is clamped or bolted to the planter, and is necessarily sturdy in construction with few moving parts. Like the Horstine Farmery machine, it has a tapered hopper attached to a feed unit, but instead of several fluted rollers there is one and it is rubber covered. When the roller is rotated by a ground wheel drive, the disulfoton granules are carried under two feed control slides and fall in two even flows through 1 in. diameter clear plastic tubes into the delivery chute down which the seed falls to the furrow. Both the Griffith's and the Horstine Farmery applicators have undergone trials conducted recently by the Farm Machinery Department of Massey University of Manawatu. Results have yet to be published.

Trial Layout

As the distribution of aphids over a potato field is always fairly even (except for edges) complex randomization was not considered necessary so a simple non-replicated block trial layout was adopted for Trials 1 to 8. Plots ranged in size from 0.5 to 2 acres. Row number varied according to length, and row spacing varied from 30 in. to 40 in. depending on the grower. Trials 2, 3 and 4 compared both a 1.5 and 1 lb rate with "no treatment", while Trials 1, 5, 6, 7 and 8 were all comparisons between 1.5 lb on its own and "no treatment". Being a soil treatment, there was little likelihood of one

TABLE 2: CONTROLLING APHIDS ON POTATOES BY APPLYING DISULFOTON 5% GRANULES IN THE FURROW WHEN PLANTING THE 1964–5 CROP

Trial No.	*Location*	*Potato Variety*	*Treatment*	*Rate (lb)*	*Aphid Counts at These Periods after Planting (days)*			
					37	*51*	*64*	*79*
1	Silverhope, Hunterville	Ilam Hardy	Untreated	0	66*	484	3326	0
			Disulfoton	2	3	0	24	0
					42	*54*	*68*	
2	Rata, Hunterville	Katahdin	Untreated	0	502	2294	5	
			Disulfoton	1	11	24	0	
			Disulfoton	1.5	8	0	1	
					31	*53*	*65*	*79*
3	Bulls	Katahdin	Untreated	0	48	1701	1344	1
			Disulfoton	1	0	9	11	0
			Disulfoton	1.5	0	6	2	0
					36	*64*	*76*	
4	Kairanga, Palmerston North	Ilam Hardy	Untreated	0	67	1927	0	
			Disulfoton	1	7	13	0	
			Disulfoton	1.5	0	10	0	
					35	*54*	*66*	
5	Makerua, Shannon	Ilam Hardy	Untreated	0	171	389	1	
			Disulfoton	1.5	12	16	0	
					34	*48*		
6	Lincoln College	Ilam Hardy	Untreated	0	795	30		
			Disulfoton	1.4	9	3		
					31	*46*	*55*	
7	Harewood, Christchurch	Ilam Hardy	Untreated	0	615	940	6	
			Disulfoton	1.45	2	11	1	
					28	*43*	*52*	
8	Coutts Island, Kaiapoi	Katahdin	Untreated	0	289	203	56	
			Disulfoton	1.45	9	10	0	

* Number of wingless aphids per 100-leaf sample.

treatment affecting another so buffer rows were dispensed with and treatments were blocked together. There was shelter adjacent to trial areas in some cases but arrangement of layout prevented this having a bearing on aphid population in the "no treatment" blocks. Where plots had to run down edges of fields, disulfoton treatments occupied the edges as against "no treatment". All varieties of potatoes were considered susceptible to leaf roll virus, so little consideration was given to choice of varieties in the North Island apart from ensuring they were "Mother Seed", Group No. 1, 2 or 3. As a result, Ilam Hardy appears as the variety in six out of the nine trials. The choice was that of the grower.

Aphid Counts

Aphid counting for control results commenced as close as was practicable to 90% emergence and continued at approximately fortnightly intervals until predators had accounted for all or almost all the apterae in the no treatment blocks. Control results given in Table 2 are based on the number of aphids counted from a top, a middle, and a bottom leaf taken in order from 100 plants selected at random from each block treatment. The alate forms are not listed.

Yield

Yield data are given for Trials 1, 3 and 5. No assessment was attempted with the other trials. Calculations in Trials 1 and 3 were based on total yields and in Trial 5 table potatoes were collected from 20 ft lengths of row, 6 samples being taken at random in each treatment. Tubers were weighed and yield assessed.

Other Pests

Only one treatment was made, and that in Trial 3 at Bulls, to determine whether disulfoton has any effect on pests other than aphids. One thousand tubers were closely examined in both treatment and control.

RESULTS

The various soil types seemed to have little significant effect on the availability of disulfoton to the plant. Where the soil was decidedly peaty as in Trial 5, the control achieved, even in the period of highest infestation, was more than 95%.

The Horstine Farmery "microband" granular insecticide applicator was found to be capable of applying disulfoton at an even rate and correct rate throughout the whole duration of treatment. There was a variation in Trial 1 when one of the spacers kept moving away from the fluted roller and caused an excessive delivery from that particular spout, resulting in 2 lb a.i. of granules being applied per acre instead of 1.5 lb. An improved method of holding these spacers in the required position would be advantageous, especially where the ground surface is uneven as it is so often in the Rangitikei. In the present model the spacers are held by a grub-screw. In Trial 4 (Kairanga clay loam), where the soil had previously been worked up for planting but was damp from passing showers, the skid and torque were excessive; by adding weight to the trailing arm which carries the wheel, the fault was corrected. No other difficulties were experienced in the field when setting or using the machine and there appeared to be no undue risk of the operator being contaminated by the material when filling the hopper or applying it, although the recommended precautions of wearing rubber gloves and face shield should be taken.

TABLE 3: TRIAL AT CROP RESEARCH DIVISION, LINCOLN, CANTERBURY, FOR APHID CONTROL IN POTATOES

Using different insecticides either as a spray on the tubers or as granules in the furrow

Trial No. 9	*Variety*	*Treatment*	*Rate (lb)*	*Aphid Counts at These Periods after Planting* 38 days *Rep. 1*	38 days *Rep. 2*	47 days *Rep. 1*	47 days *Rep. 2*
(A)	Ilam Hardy	Untreated	0	989*	530	32	11
		Menazon Spray†	2.25	81	25	6	8
		Menazon	1.50	40	48	1	1
		Phorate	1.64	33	94	9	3
		Disulfoton	1.35	5	12	0	0
(B)	Ilam Hardy	Untreated	0	352		15	
		Disulfoton	1.42	9		0	
(C)	Rua	Untreated	0	77		12	
		Disulfoton	1.42	6		0	

* Number of wingless aphids per 100-leaf sample.
† Applied as a spray to tubers in the furrow.

TABLE 4: YIELD DIFFERENCES BETWEEN DISULFOTON TREATED AND UNTREATED POTATO CROPS HARVESTED AUTUMN, 1965

Trial No.	*Site*	*Variety*	*Rate (lb)*	*Yield Increase of Table Potatoes* (tons)*	*Percentage Increase*
1	Silverhope, Hunterville	Ilam Hardy	2	1.3	13
2	Bulls	Katahdin	1.5	2.7	27
		Katahdin	1	2.4	24
5	Makerua, Shannon	Ilam Hardy	1.5	2.5	17.4

* The quantity of seed potatoes harvested did not alter with the treatment. All plots gave between 2.5 and 3.0 tons per acre.

As during the 1963–4 season, persistence of disulfoton has lasted throughout the period of aphid infestation, extending this season (1964–5) in the South Island to between 50 and 60 days from planting and in the North Island to between 70 and 80 days. In almost all instances the control achieved in mineral soils in the North Island, even in the period of highest infestation, was more than 99%. This applies to both the 1 lb and 1.5 lb treatments. In the South Island where only one treatment applied (1.5 lb approx.), the average of all disulfoton counts gives a 97% control.

Table 3 shows disulfoton in Section A of Trial 9 in comparison with three other materials. There are two sets of counts, one at 38 days after treatment when aphids were most prevalent and one at 47 days when predators had roughly decimated the population. Assessing the percentage control in Rep. 1 and Rep. 2 at 38 days, the following is the average:

Menazon spray	93.5% control
Menazon granules	93.5% control
Phorate granules	89.5% control
Disulfoton granules	98.5% control

Taking an average percentage again at 47 days, the following is the result:

Menazon spray	54 % control
Menazon granules	94 % control
Phorate granules	72.5% control
Disulfoton granules	100 % control

The predominant aphid in the North Island potato fields is *Aulacorthum solani*. Others in relatively small numbers are *Macrosiphum euphorbiae, Rhopalosiphum padi, Myzus persicae, Brachycaudus helichrysi* and *Lipaphis erisimi.*

Referring to Table 4, the average increase in yield over the treatments (3 on mineral soils and one on organic) came to 2.2 tons per acre or 20%, and, if the first treatment was deleted because the complete area was flattened with late blight of potato early in the growing season — (New Year's day), this figure becomes 2.8 tons per acre, or 22.8%.

TABLE 5: PERCENTAGE OF POTATO TUBERS DAMAGED BY VARIOUS PESTS AT BULLS

1,000 tubers inspected at harvest in each treatment

Pest	*Treatment*		
	Untreated	*Disulfoton 5% Granules (lb)* 1	1.5
Wireworm	0.1	0.1	2.7
Slugs and slaters	0.9	0.3	1.3
Potato tuber moth	0.9*	0.2*	0

* No damage from potato tuber moth larvae below the soil surface.

Table 5 shows the percentage of tubers damaged by various pests in one trial. It would appear from these counts that disulfoton offers little in the way of control of these pests apart perhaps from potato tuber moth (*Gnorimoschema operculella*). Infestation decreased as the disulfoton concentration increased with potato tuber moth but so slight and superficial was the infestation it would be presumptuous to claim any measure of control.

CONCLUSION

Disulfoton has performed well this season, giving 99% control of apterous aphids on various mineral soils and 95% on an organic soil in the North Island, and 97% on various mineral soils in the South Island. The difference between aphid counts on the 1 lb and

1.5 lb treatments was not significant. Of three other similar systemic treatments, only one, menazon, gave effective control throughout the limited period of aphid infestation in the South Island while in comparison disulfoton gave complete control. Where yields were taken, very useful increases averaging between 2 and 3 tons were gained by using disulfoton. Other soil pests were not controlled and tuber moth results were inconclusive. The applicator proved an acceptably accurate, safe and simple method of applying disulfoton 5% granules.

ACKNOWLEDGEMENTS

The patient co-operation of the following potato growers who have assisted in this work is gratefully appreciated: J. and N. H. Bartlett, E. Craft, L. J. Franks, G. B. Haywood, T. R. Mundy, F. and P. T. Sinclair, W. T. Williamson. The writers are also indebted to the Engineering Departments of Massey University of Manawatu and Lincoln College; H. S. Gibbs, Soil Bureau; and A. K. Booth, Department of Agriculture, Wanganui, for their helpful advice and assistance.

REFERENCE

Smith, H. C.; Close, R. C.; Rough, B. F. A., 1964: *Proc. 17th N.Z. Weed & Pest Control Conf.*, 168–74.