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CONTROL OF SOIL PESTS OF SUGAR BEET WITH A GRANULAR FORMULATION OF BENDIOCARB

K.M.G. Bryan

Fisons Ltd. Agrochemical Division, Chesterford Park Research Station, Saffron Walden, Essex, U.K.

Summary Trials have been carried out in the U.K. and Europe during 1976-79 to test bendiocarb formulated as a 3% granule for the control of soil pests of sugar beet.

In laboratory tests on wireworm (*Agriotes* spp.), bendiocarb gave an average LD_{50} of 0.61 mg a.i. per 14 cm row and LD_{95} of 3.0 mg a.i. per 14 cm row, equivalent to doses of 87 g a.i./ha and 428 g a.i./ha respectively at 50 cm row spacing.

In the field, bendiocarb at rates of 300 and 360 g a.i./ha gave good protection of sugar beet seedlings when applied in the furrow with the seed at the time of drilling.

Pests controlled include wireworm, pigmy beetle (*Atomaria linearis*), spotted snake millipede (*Blaniulus guttulatus*) and symphylids (*Scutigerella* spp.).

Some effect on foliar pests, aphids (*Myzus persicae* and *Aphis fabae*), mangold fly (*Pegomyia betae*) and flea beetle (*Chaetocnema concinna*), has been observed.

No evidence of phytotoxicity has been observed at the recommended rate.

Résumé Les essais ont été effectuées en Grande-Bretagne et en Europe de 1976 à 1979 poor tester le bendiocarbe en formulation granulés à 3 % contre les ravageurs du sol dans la betterave.

Dans les essais de laboratoires contre les taupins (*Agriotes* spp.), le bendiocarb a donné une DL 50 moyenne de 0,61 mg m.a. pour 14 cm lineaires, et une DL 95 de 3,0 mg m.a. pour 14 cm linéaires, ce qui équivaut à des doses de 87 g m.a./ha et 428 g m.a./ha respectivement avec un espacement de 50 cm entre les rangs.

En plein champ, le bendiocarbe à des doses de 300 et 360 g m.a./ha donne une bonne protection des semences de betterave à sucre lorsqu'applique dans le sillon au moment de l'ensemencement.

Les ravageurs contrôlés comprennent les taupins, les atomaires (*Atomaria linearis*), les blaniules mouchetes (*Blaniulus guttulatus*) et les scutigérelles (*Scutigerella* spp.).

Un certain effet est notable sur les ravageurs foliaires, les aphides (*Myzus persicae* et *Aphis fabae*), les pégomyies (*Pegomyia betae*), et les altises de la betterave (*Chaetocnema concinna*).

Aucune évidence de phytotoxicité n'a pu être observé aux doses recommandées.

INTRODUCTION

Bendiocarb (2,2-dimethyl-1,3-benzodioxol-4-yl methyl carbamate) is a broad spectrum carbamate insecticide which acts as a stomach and contact poison against a wide range of insect pests. It is of moderate mammalian toxicity and is not persistent in the environment. It was first introduced in 1972 as an 80% wp formulation for the control of domestic pests (Lemon 1971) and since this time the material has been developed for use in agriculture, particularly for the control of soil pests in sugar beet and maize.

Early work on sugar beet was concerned with testing bendiocarb as a dry powder seed treatment, or incorporated in the pellet, and good results were obtained against pests attacking sugar beet seedlings (Hull 1975 and 1976). However, the low doses applied as seed treatments were not sufficient to control high populations of wireworm, and problems in stability were encountered with certain types of pelleting materials used in some countries. Consequently, a granular formulation was produced in 1975 for testing on sugar beet, maize, potatoes, brassicas and rice.

This paper discusses the results of field trials carried out on sugar beet during 1976-79, primarily with reference to control of wireworms, but also encompassing other pests attacking sugar beet seedlings.

METHODS AND MATERIALS

Bendiocarb 3G is a coated granule formulation on a base of limestone chips. It has been successfully applied with sugar beet seed in the open furrow at drilling through a wide range of commercial machines.

Laboratory tests

In these tests, 10 wheat seeds were sown in pots in 14 cm long rows and weighed amounts of granules were distributed evenly along the furrow before covering the seed. Each pot was then infested with 10 wireworms of mixed instars that had been collected from the field. After 7 days the plants were dug up and counts were made of the numbers of live, moribund and dead wireworms in each pot and of the number of damaged plants.

Field trials

These were conducted in fields where soil pests were known to be present. Bendiocarb 3G was applied in-furrow with the sugar beet seed at the time of drilling through various commercial granule applicators. Plot sizes ranged from 4-6 rows x 10-20 m and plots were replicated four or five times.

Assessments of control of soil pests were generally based on plant establishment and comparisons were made with standard treatments and untreated controls.

RESULTS

Table 1 shows the percentage mortality of wireworms (i.e. dead and moribund) observed in three trials after 7 days. A good dose response was obtained and the LD_{50}'s and LD_{95}'s were read from log x probability graphs. The mean LD's of 0.61 mg and 3.0 mg a.i./pot are equivalent to doses in the field of 87 g a.i./ha and 428 g a.i./ha respectively at a 50 cm row width.

Laboratory test to demonstrate the toxicity of bendiocarb 3G to wireworms

Table 1

Bendiocarb mg a.i./14 cm row	% mortality corrected using Abbotts Correction Test 1	Test 2	Test 3	
0.3	25.0	14.6	37.5	
0.6	45.8	54.2	25.0	
1.2	79.2	85.4	72.5	
1.8	91.7	89.6	87.5	
Control	4.0	4.0	0	
LD_{50} (mg)	0.56	0.61	0.66	Mean 0.61
LD_{95} (mg)	2.6	1.8	4.6	Mean 3.0

Field trial for the control of wireworms

Following on from the laboratory tests, a replicated field trial was carried out in the U.K. in 1977 on a field with a moderate wireworm infestation (800,000/ha). In this trial bendiocarb 3G was applied at 4, 8, 12 and 16 kg/ha (i.e. 120, 240, 360 and 480 g a.i./ha) compared with the standards carbofuran and chlormephos. Plots of six rows 15 m long were treated at drilling using a Horstine Farmery granule applicator mounted on a Stanhay drill, placing the granules in the furrow with the seed.

Results of this trial are shown in Table 2. On the basis of plant stand counts, bendiocarb at 120 g a.i./ha gave inadequate protection of young plants, but rates of 240 g a.i. and above gave protection equal to that achieved with the standard materials, with no significant differences between the three higher rates. At the highest rate of 480 g a.i./ha the results suggested that there was some delay in emergence, but this was not statistically significant.

Yield data confirmed that rates of 240 g a.i./ha and above were equivalent to the two standard materials.

Table 2

Control of wireworm with bendiocarb 3G - U.K., 1977

Site: Debden, Essex Drilling date: 20.4.77

	g a.i./ha	Plants/10 m of row 16 days after treatment	26	63	Yield t/ha
Bendiocarb	120	30.5	41.3	36.1	36.6
"	240	31.9	48.1	46.7	39.7
"	360	32.2	48.1	49.2	41.6
"	480	28.7	44.3	49.9	40.5
Carbofuran	600	31.7	49.2	50.7	39.7
Chlormephos	360	33.8	50.0	50.8	41.3
Control	-	20.6	19.5	12.0	19.1
Level of significance		***	***	***	***
SE $\pm$		2.44	2.04	2.03	1.38

*** = P 0.001

During 1976-79 bendiocarb 3G has been included in over 100 trials on sugar beet carried out in the U.K. and Europe by Fisons and collaborators. Fifty of these trials were on sites having a moderate or high wireworm population and bendiocarb 3G at rates of 300 and 360 g a.i./ha has been shown to give good protection of sugar beet seedlings equal to that given by the standard materials.

Table 3 shows the results of some Fisons' trials in France and U.K. during 1977-79.

Table 3

Plants established per 10 m row

	g a.i./ha	France 1977	U.K. 1978	U.K. 1978	France 1978	France 1979
Bendiocarb	300	32.1	39.1ab	40.0abc	58.3a	51.4a
Carbofuran	600	-	42.5a	44.4a	65.1a	51.6a
Chlormephos	360	31.6	-	-	65.4a	-
Control	-	26.4	16.3c	33.4d	35.3b	30.1cd
Level of significance		***	***	***	**	***
SE ±		2.74	2.9	1.5	-	2.08

*** = P 0.001

Treatments followed by the same letter are not significantly different from each other at P 0.05.

These results have been confirmed by official trials carried out in France by the Service de la Protection des Vegetaux and the Institute Technique de la Betterave Industrielle; in Italy by the Centro Studi e Ricerche, Eridania ZN and in Holland at the Plantenziektenkundige Dienst, Wageningen and the Sugar Research Institute at Bergen-op-Zoom. Some of these results are shown in Tables 4 and 5.

Table 4

Official Trials - France, 1977 and 1978
L'Institute Technique de la Betterave Industrielle (Anon. 1977 & 1978)

	g a.i./ha	1977 Plants/10 m	1977 Yield t/ha	1978 Plants/10 m	1978 Yield t/ha
Bendiocarb	360	39.5ab	50.1ab	-	-
"	480	-	-	33.4a	51.46ab
Carbofuran	600	36.0ab	52.94ab	26.9a	48.40b
Aldicarb	750	41.0ab	54.82a	26.9a	48.94b
Control	-	20.5b	43.2b	7.9b	-

Treatments followed by the same letter are not significantly different from each other at P 0.005.

In 1977, bendiocarb at 360 g a.i./ha was equal to carbofuran and in 1978, the very high rate of 480 g a.i./ha gave excellent control of a heavy wireworm infestation.

Table 5

Official Trial - Italy, 1977
Centro Studi e Ricerche, Eridania

	g a.i./ha	% emergence 4 weeks	5 weeks
Bendiocarb	360	79.9	79.8
"	480	72.9	73.5
Aldicarb	1000	73.8	72.2
Chlormephos	300	74.2	73.1
Carbofuran	500	75.0	75.7
Control	-	32.7	32.0

Control of pigmy beetle

Results of bendiocarb 3G against pigmy beetle have been obtained from 27 trials throughout Europe. Bendiocarb has performed consistently well against this pest, being equal to the standard materials. Results of root assessments from one trial in U.K. (Fisons) and one in France (Service de la Protection des Vegetaux) are given in Table 6.

Table 6

Control of pigmy beetle with bendiocarb 3G

	g a.i./ha	U.K. - 1978 % damage	France - 1977 Trial 1 % roots attacked	France - 1977 Trial 2 % roots attacked
Bendiocarb	300	18.7a	-	-
"	360	-	16.7a	26
Aldicarb		24.0abc	-	-
Carbofuran		-	9.5b	42
Control		32.7c	90.0c	100
Level of significance		***	***	

***, P 0.001

(Trial 1) Medium attack - Counts of roots with more than two bites.
(Trial 2) Heavy attack - Counts of roots with more than five bites.

Trials followed by the same letter are not significantly different from each other (P 0.05).

The results from U.K. are a percentage damage index based on number of roots x degree of damage and were made when the plants were at the six leaf stage. The counts in France were made at the four leaf stage.

In Table 7, the performance of bendiocarb 3G at 300-360 g a.i./ha has been compared with other standard materials on a basis of percentage increase in plant stand over the untreated control. The mean percentage increase with each material is also shown.

Table 7

Bendiocarb 3G for control of pigmy beetle

Total Trials	Bendiocarb	Aldicarb	Carbofuran	Chlormephos
	Best performance in no. of trials			
12	10	2		
9	5		4	
6	3			3
Mean % increase in plant stand compared with control (100)				
11 trials	292	272		
8 "	160		159	
6 "	156			154

This table demonstrates that for control of pigmy beetle, bendiocarb performed better than aldicarb in the majority of trials and was equal to carbofuran and chlormephos.

Other soil pests

Good control of spotted snake millipede has been shown in France in three trials where they were the only pest present, although in several other cases wireworms were also present and plant stand counts reflected the control of both pests together. However, one result from the Service de la Protection des Vegetaux in France demonstrates the protective effect of bendiocarb against spotted snake millipede (Table 8).

Table 8

Control of spotted snake millipede with bendiocarb 3G
(Service de la Protection des Vegetaux)

	g a.i./ha	% roots with more than 2 bites
Bendiocarb	360	11.5
Carbofuran	600	14.3
Control	-	40.2

Bendiocarb 3G at 300 g a.i. has also given good control of symphylids in four trials in France.

Foliar Pests

Bendiocarb has shown some systemic activity in beet through the roots, but is generally not sufficiently persistent to give good control of most foliar pests. However, control of flea beetle has been assessed in 10 trials in Europe and bendiocarb at higher rates has been found to be equal to the standard materials in France and Italy. Some activity has also been shown against early aphid and mangold fly attack.

Crop Safety

No serious phytotoxic effects have been observed with bendiocarb used at the recommended rate, although some delay in emergence and reduction in vigour has been observed at higher rates under certain conditions. However, there has been no significant reduction in yield.

In one trial, carried out in the U.K. in 1978 bendiocarb was shown to be compatible with the common herbicide spray programmes applied to sugar beet.

CONCLUSION

Extensive trials carried out in Europe over three years have shown that bendiocarb 3G has given good protection of sugar beet seedlings against soil pests when applied at rates of 300 and 360 g a.i./ha (10 kg and 12 kg product/ha). Pests controlled include wireworms, pigmy beetle, millipedes and symphylids.

There is some systemic activity against foliar pests but it is not high enough to be important except possibly in the case of flea beetles.

Bendiocarb has proved safe to the crop at the recommended rates.

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CONTROL OF CABBAGE ROOT FLY (DELIA BRASSICAE) BY INCORPORATION OF INSECTICIDES IN PEAT BLOCKS

R. Dunne, M. Donovan and J. Coffey

Agricultural Institute, Kinsealy Research Centre, Malahide Road, Dublin 5

Summary Experiments to evaluate the effectiveness of incorporation of insecticides in peat blocks for the control of cabbage root fly (Delia brassicae) in summer cabbage are described. In one experiment made at two sites, I5 mg a.i. of carbofuran, chlorfenvinphos, chlorpyrifos and isofenphos per 4.3 X 4.3 cm block gave control comparable with field spot treatments of carbofuran and chlorfenvinphos, while diazinon gave no control. Carbofuran and chlorpyrifos were severely phytotoxic, chlorfenvinphos slightly so, while isofenphos and diazinon were not. There was evidence that emulsifiable concentrate formulations were less toxic than granules and wettable powders.

In a further experiment which compared rates of I0, I5, 20 and 25 mg a.i. per block of carbofuran, chlorfenvinphos, isofenphos and chlorpyrifos, phytotoxicity increased with increasing chemical concentration, while root damage decreased. Yields from carbofuran and chlorpyrifos treatments also progressively decreased, although all treatments gave excellent control.

The results indicate that increasing the insecticide concentration from I0 to I5 mg a.i. gives a worthwhile reduction in root damage, but levels above I5 mg do not.

It is emphasised that the work was done during an exceptionally wet early summer.

Résumé Expériences faites pour évaluer l'efficacité de l'incorporation d'insecticides dans des mottes de tourbe pour la prévention de la mouche de la racine du choux (Delia brassicae) dans le choux d'été décrit. Lors d'une expérience effectuée en deux endroits, I5 mg de carbofuran, chlorfenvinphos, chlorpyrifos et isofenphos incorporés dans une motte de 4.3 X 4.3 cm ont fourni une prévention comparable aux traitements sur place de carbofuran et chlorfenvinphos tandisque le diazinon n'a apporté aucune prévention. Le carbofuran et le chlorpyrifos sont extrêmement phyto-toxiques, le chlorfenvinphos peu phyto-toxique et l'isofenphos et le diazinon ne le sont pas du tout. It a été observé que les formulations de concentrés émulsifiables étaient moins toxiques que les granulés ou les poudres pouvant être mouillés.

Lors d'une autre expérience dont le but était de comparer les taux de I0, I5, 20 et 25 mg a.i. par motte de carbofuran, chlorfenvinphos, isofenphos et chlorpyrifos, la phyto-toxicité s'est accrue avec l'augmentation de la concentration chimique et les dégats causés aux racines ont diminué. Le rendement de traitements au carbofuran et au chlorpyrifos s'est progressivement diminué mais tous les traitements ont cependant apporté une protection efficace.

Les résultats semblent indiquer que la concentration d'insecticide de I0 à I5 mg a.i. apporte une diminution valable du dégat causé aux racines mais qu'un taux au dessus de I5 mg n'apporte pas cette diminution.

Il est à souligner que les travaux ont été accomplis lors d'un ete particulièrement pluvieux.

INTRODUCTION

The advantages of sowing brassica seed in peat blocks and raising seedlings in a protected environment prior to transplanting in the open, has led to increasing interest in this technique of early season production. A further advantage would arise if satisfactory control of cabbage root fly could be achieved by incorporation of insecticides in peat.

Several authors (Saynor and Davies, I977; Thompson and Percivall, I978) have reported promising cabbage root fly control by incorporation of insecticides in peat blocks while the technique has also been used successfully in the control of carrot fly in celery (Bevan, I966). Incorporation of chemicals in mushroom compost is a well established practice (Wyatt, I975) while the incorporation of fungicides in compost gives good control of root diseases of celery and ornamentals (Saynor and Davies, I977).

Serious difficulties are being experienced by Irish growers in the control of first generation cabbage root fly in early brassicas. These difficulties are probably due in part to lack of precision in placement of insecticide granules and partly to lack of moisture in the top layer of soil in early summer. Transplanting seedlings grown in peat blocks containing an adequate dose of insecticide, would remove the insecticide placement problem.

MATERIALS AND METHODS

Summer cabbage (cv Greyhound) was used in the experiments described.

The insecticides were incorporated in Shamrock Blocking Compost by shaking (granular and w.p. formulations) or sprinkling (e.c.) in 0.5l water over 4 kg compost and hand miximg on a tray prior to shaking with a tumbling action for I min. in a large plastic bag held between two people. Judging by the eveness of phytotoxicity symptoms on seedlings, subsequently, there was no reason to believe that mixing was inadequate. The peat had previously been wetted to blockmaking consistency and left overnight before blocks were made. The blocks, 4.3 X 4.3 cm, were made with a Flier blockmaking machine, the seed being sown simultaneously; then were subsequently maintained in a polythene tunnel at a minimum night temperature of I5°C until hardening off.

Blocks were made and seeds sown from 9 to I3 March, I979; plants were transplanted from 26 April to 3 May and harvested from 5 to I2 July, I979. Transplanting was done by hand to a depth which left approximately 25 mm of soil covering the block. One harvesting only was made as the plants matured evenly.

Assessment of root damage and calculation of the Root Damage Index (RDI) was done by one individual according to the method of Coaker and Wheatley (I97I).

Experimental layout was a randomized block design with four replicates and single line plots of 25 - 30 plants.

RESULTS

Experiment I

In this experiment, chemicals were incorporated at the rate of I5 mg a.i.

Phytotoxicity

Seed germination was not affected by the chemicals. Of the chemicals used, carbofuran and chlorpyrifos were the most phytotoxic, chlorfenvinphos slightly phytotoxic, isofenphos non-toxic, while diazinon slightly stimulated seedling growth.

Carbofuran phytotoxicity caused scorching of cotyledon tips and "cupping" of true leaves, while seedlings had a pale yellow colour. Chlorpyrifos phytotoxicity was reflected in poor growth with the leaves showing an exceptional dark green colour and there was a tendency by plants to produce additional lateral roots on the block surface. Chlorpyrifos, emulsifiable concentrate (e.c.) was much less phytotoxic than the w.p. formulation. Chlorfenvinphos phytotoxicity appeared as slight leaf "cupping" ; the e.c. being less toxic than granular formulation.

Plants treated with carbofuran and chlorpyrifos w.p. were smaller at transplanting and, as they failed to develop a sufficient root system to bind the block adequately, care was needed at transplanting to avoid excessive fragmentation of blocks. This effect would preclude machine planting.

Table I

Comparison of insecticides at I5 mg a.i. per block with field spot treatments

	KINSEALY		MALAHIDE	
	R.D.I.	Yield (kg/plot)	R.D.I.	Yield (kg/plot)
Carbofuran 5% G	6.6	2I.3	20.4	20.0
Chlorfenvinphos I0% G	0.0	23.0	0.4	26.I
Chlorfenvinphos 24% e.c.	2.3	I9.5	I.6	26.I
Isofenphos 7.5% G	3.5	20.8	6.I	22.9
Isofenphos 50% e.c.	2.7	2I.4	I4.9	28.0
Chlorpyrifos 25% w.p.	0.6	22.2	7.4	23.I
Chlorpyrifos 48% e.c.	I.9	22.I	2.3	20.8
Diazinon 40% w.p.	62.9	I7.6	73.3	I8.9
Carbofuran 5% G Spot (i)	I.0	24.I	0.I	23.7
Chlorfenvinphos 24% e.c. drench (ii)	0.0	I9.7	0.0	23.3
CONTROL	62.0	I7.8	75.5	I8.0
S.E. (difference between means)	I.77	I.45	3.26	I.48

(i) = 0.04 g product (20 mg a.i.) /plant (ii) 70 ml/plant of 0.05% a.i. solution

At both sites, all treatments except diazinon incorporated in blocks gave a level of control which compared favourably with the more established field spot treatments. Carbofuran at the Kinsealy site and particularly at the Malahide site, was less effective than the other materials, with the exception of diazinon, but this may have been due partly to the fragmentation of blocks at transplanting and partly to a lower insecticidal persistance.

Seedling phytotoxicity of carbofuran and chlorpyrifos did not have such a serious effect on yield as was expected. The high R.D.I. for isofenphos at Malahide cannot be explained.

Experiment II

In this experiment, chemical formulations were compared at rates of I0, I5, 20 and 25 mg a.i./block.

Phytotoxicity

As in Experiment I, seed germination was not affected by the chemical treatments.

Carbofuran 5% G

Growth was not seriously affected at the I0 mg rate but "cupping" of leaves, together with a pale yellowish-green colour, was evident. The I5 mg and 20 mg rates were moderately phytotoxic and the 25 mg rate very phytotoxic and caused stunting of seedlings in addition to the other effects.

Chlorfenvinphos I0% G

All rates caused slight "cupping" of leaves which increased with increasing dosage and this was accompanied by stunted growth at the 25 mg rate.

Chlorfenvinphos 24% e.c.

Less severe leaf "cupping" than with granules and not accompanied by stunting at the high rate.

Isofenphos 7.5% G and 50% e.c.

No phytotoxicity symptoms at all rates from either formulation.

Chlorpyrifos 25% w.p.

Severe phytotoxicity symptoms which increased in intensity with increased dosage.

All chemicals and rates of application gave excellent control of cabbage root fly, with root damage tending to decrease in severity with increased concentration. The R.D.I. data suggests that it may be worthwhile to increase the rate/block from I0 mg to I5 mg but not higher. (Table 2).

The yield data reflects the degree of root fly control and effect of phytotoxicity from carbofuran and chlorpyrifos treatments.

Table 2

Comparison of insecticide formulations at I0, I5, 20 and 25 mg a.i./block

	R.D.I.				YIELD kg/plot			
	I0 mg	I5 mg	20 mg	25 mg	I0 mg	I5 mg	20 mg	25 mg
Carbofuran 5% G	5.0	0.5	0.6	0.8	2I.6	I9.7	I4.0	I2.3
Chlorfenvinphos I0% G	2.9	I.6	0.2	0.5	I6.8	22.7	22.8	24.4
Chlorfenvinphos 24% e.c.	0.8	0.8	0.6	0.4	20.5	I9.9	24.6	23.6
Isofenphos 7.5% G	7.5	3.4	3.6	I.3	I9.I	20.2	22.0	I9.8
Isofenphos 50% e.c.	9.2	2.5	0.2	0.2	20.5	20.2	I8.5	I9.8
Chlorpyrifos 25% w.p.	2.7	3.2	0.9	I.7	20.8	I7.4	I8.4	I2.2
CONTROL	56.4				I7.2			
S.E. (difference between means)	2.98				I.77			

DISCUSSION AND CONCLUSIONS

With the exception of diazinon, which has been shown to be relatively non-persistent (Suett et.al., I978, I979), the insecticides incorporated in peat blocks gave an effective control of cabbage root fly, both from the viewpoint of reduction of root damage and increased yield. The phytotoxicity of carbofuran and chlorpyrifos should preclude their use in favour of chlorfenvinphos, which was not seriously phytotoxic or isofenphos which was non-phytotoxic at all levels used.

It is important to point out that these trials were done in a relatively wet year - evapotranspiration at Kinsealy in May, I979 was 47.9 mm, while the average for May is 76.3 mm, consequently, there was no soil moisture deficit during May. The results may be different under drier conditions as soil moisture availability has a major effect on the performance of insecticides in the control of cabbage root fly. The high soil moisture may also explain why there was little root fly attack on stems above the level of the peat blocks in the soil.

In the practical application of this technique of root fly control, the precision of on-farm incorporation of an insecticide with the potting compost would be of major importance. There is no reason why such plants cannot be machine planted but for safety reasons, personnel handling them should wear rubber gloves. The low rate of a.i. applied, together with the evidence of Saynor and Davies (I977), indicated that residue problems should not arise.

These experiments support the confidence in this technique for cabbage root fly control expressed by Saynor and Davies (I977) and Suett et.al., (I979) they indicate the relative usefulness of certain chemicals, and that with a block size of 4.3 X 4.3 cm and adequate soil moisture, a rate of I5 mg active ingredient per block gives adequate control.

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PROTECTION OF EMERGING SUGAR BEET IN CZECHOSLOVAKIA

V. Rimsa
Beet Research and Breeding Institute, Semcice, Czechoslovakia.

SUMMARY Where sugar beet crops are precision drilled the protection of emerging plants is of major importance. The main pests and diseases affecting seedlings in Czechoslovakia include pigmy mangold beetle, sugar beet flea beetle, mangold fly, black bean aphid and black root. Treatment with a combination of fungicides and insecticides achieves acceptable field emergence and optimum plant stand.

Satisfactory results were obtained with bendiocarb, carbofuran and partly with mercaptodimethur as seed dressings. Good control was also obtained from the combination of the fungicides TMTD and hydroxyisoxazole on a wide spectrum of fungi. The same pesticides can be used for the treatment of pelleted and non-pelleted seed but the doses are different.

The best control of seedling pests was achieved with granular formulations of aldicarb, bendiocarb, carbofuran, oxamyl and thiofanox applied with the seeds in the row.

INTRODUCTION

Effective protection of the emerging crop is very important where sugar beet is sown to a wide spacing. The risk of damage by both pests and diseases has increased as seed rates have decreased. The pests concentrate on the smaller numbers of plants although their population density remains much the same. Pigmy mangold beetle (*Atomaria linearis*) and sugar beet flea beetle (*Chaetocnema concinna*) are serious pests in Czechoslovakia annually. Severe occurrence of mangold fly (*Pegomyia betae*) and bean aphid (*Aphis fabae*) is less frequent. Early attacks of virus diseases cause greatest yield losses and are correlated with the extent of the aphid population. The problems arising from black root *Pleospora bjoerlingii* etc.) are also serious and combined protection with insecticides and fungicides is essential.

Preventive pesticide application remains the basic practice, to ensure high field emergence and optimum plant stand (Rimsa 1978). This protection consists of the use of seed dressings, the application of pesticides in the pelleting material and into the soil as granular formulations. The methods chosen vary from region to region and with different technologies of beet growing. Experience shows that the protection of emerging beet with granular insecticides is the most effective in terms of the spectrum of pests controlled and in persistence of action. However, the use of granular insecticides requires a more complex approach to the organisation of chemical treatment on the farm. Success also depends on the correct prognosis of the occurrence of pests and prompt action for their control.

The product in general use for seed treatment is a mixture of heptachlor and TMTD. This no longer meets the required standards of efficacy or of application and handling characteristics. Alternative pesticides which may be available for protection of emerging sugar beet in Czechoslovakia are being evaluated and this paper reports on work to date.

METHODS

Many pesticides have been tested and bendiocarb, carbofuran and mercaptodimethur have proved to be suitable for seed treatment. TMTD and hydroxyisoxazole have given effective fungicidal activity. Good results were obtained from granular formulations of aldicarb, carbofuran, bendiocarb, oxamyl and thiofanox. These pesticides were tested in both small plot experiments and on a larger scale on many sites during 1977 to 1979. The mixture bendiocarb/TMTD was tested only in 1979. Results are presented as average values for several replications, for several sites and years.

Seeds were treated by the half-damp dressing method to allow the chemicals to stick better to the seeds. Insecticides were applied at a dose of 15 kg/t of seed. Fungicide doses ranged up to a maximum of 10 kg/t. The mixture of heptachlor and thiram was used as the standard.

Pelleted seeds were tested in 1979 at four sites only. The fungicide was introduced in the middle layer of the coat of the pellet and the insecticides in the outer layer. The pelleting material was one which was developed in Czechoslovakia.

Granular insecticides were applied at sowing at 15.0 kg/ha in 1977 and 1978 and at 16.5 kg/ha in 1979.

The effect of the pesticides was evaluated according to the degree of damage and is expressed as an index and as the percentage of damaged plants (see Tables 1-3). The evaluation was carried out at the cotyledon stage and at the two true-leaf stage. Damage by sugar beet flea beetle, pigmy mangold beetle and black root was evaluated every year, damage by mangold fly in 1977 and 1979 (due to irregular occurrence), damage by bean aphid in 1977 and by beet carrion beetle (*Aclypea opaca*) in 1979.

RESULTS

In the seed dressing tests the most effective insecticides were bendiocarb and carbofuran. Mercaptodimethur was less effective. Bendiocarb and carbofuran gave approximately 50% control of pigmy mangold beetle, 75% of flea beetle and 40% of beet carrion beetle. Mercaptodimethur was not effective on flea beetle and its control of other pests was also less (by 10-15%).

The results from fungicides varied from year to year. Doses from 6 kg to 10 kg/t seed were not very different in effect. The activity of TMTD and hydroxyisoxazole, as well as of mancozeb which had been tested earlier, against black root were similar. Owing to the different spectra of pathogenic fungi affected by individual fungicides, reliability against the main causal agents of black root can best be achieved by combining two chemicals. The combination of TMTD and hydroxyisoxazole, together with insecticides, gave better seedling emergence.

Plant damage by black root was closely related to the efficacy of the insecticidal dressings. If the plants were less damaged by pigmy mangold beetle the number of sites for secondary infection was lower and less pathogenic fungi entered the plant. Field emergence fluctuates even in treated sugar beet seed. The level of field emergence, of the action of fungicides on pathogenic fungi, depends also on the contamination of the seeds with fungi and on abiotic factors affecting the development of the microflora. Nevertheless, seed treatment with fungicides increased field emergence by more than 10% on average.

The application of pesticides and/or other chemicals in the pelleting material became important as the area sown with pelleted seeds increased. The efficacy of such treatment on the main harmful agents was similar to that from treatment of non-pelleted seed. Both carbofuran and bendiocarb gave approximately 60% control of mangold fly in the tests with pelleted seed. Fungicides included in the pellets had an increased effect on black root.

Results indicated that the same pesticides can be used to protect emerging beet in both pelleted and non-pelleted seed. However, further experiments with pelleted seed are needed to ascertain the optimum doses, which may differ with differing pelleting technology and with the influence of the pellet coat on the seed.

The treatment of seeds with pesticides has a beneficial influence on germination and field emergence, thus making it possible to achieve higher yields. The protection of emerging beet can also be achieved by the application of granular formulations. This method has also proved effective in achieving satisfactory plant stand. Another important fact is that the gradual release of the active component from granules provides protection, from a single application at sowing, against first generation aphids and mangold fly as well as against seedling pests. This longer persistence makes it possible to omit the first insecticidal spray on young plants when the transmission of viruses occurs. Of the wide range of granular insecticides used on sugar beet in other countries, the best for Czechoslovak conditions were aldicarb, bendiocarb, carbofuran, oxamyl and thiofanox. Aldicarb and carbofuran have already been registered for use and certification and wider use of other products is expected in the near future.

The effect of pesticides on emergence and growth of plants is an important factor underlying their selection. They should not be phytotoxic nor retard growth. The granular formulations of aldicarb, bendiocarb, carbofuran, oxamyl and thiofanox have not damaged young beet plants when applied in the row.

These compounds were all effective against the main pests of emerging beet. Control of flea beetle ranged from 40% to 70% and of pigmy mangold beetle from 30% to 60%. About 50% control of beet carrion beetle was achieved. These figures can be taken as averages at the two true leaf stage of the beet. Their effect on aphids and mangold fly depended on the interval between application and insect attack. In a favourable year an effect on aphids was recorded 12 weeks after application. If pests attacked shortly after insecticides were applied the effect was greater. The better results of granular insecticides on pigmy mangold beetle gave better control of black root.

The application of granular insecticides will require improved labour organisation and involve higher costs. However it can be assumed that granules will be preferred as their application offers a better and more reliable control, particularly of those pests which are difficult to control.

The results of the pesticide tests on the main pests and diseases of emerging beet are shown in the Tables 1-3.

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Table 1

The effectiveness of seed dressings on sugar beet seedling pests and diseases, 1977-1979

Treatment	Pesticide dose kg/t of seed	Sugar beet flea beetle		Pigmy mangold beetle		Beet carrion beetle		Black root	
		D.I.	P.D.	D.I.	P.D.	D.I.	P.D.	D.I.	P.D.
Bendiocarb + hydroxyisoxazole + TMTD	14 + 5 + 5	0.23	23.7	0.21	55.2	0.45	60.8	0.74	87.0
Bendiocarb/TMTD	15	0.60	61.8	0.20	52.6	-	-	0.76	89.4
Carbofuran + hydroxyisoxazole +TMTD	15 + 5 + 5	0.32	32.9	0.24	63.1	0.45	60.8	0.68	80.0
Mercaptodimethur + hydroxyisoxazole + TMTD	15 + 5 + 5	1.02	105.1	0.26	68.4	0.63	85.1	0.96	112.9
Heptachlor/TMTD	12	0.95	97.9	0.29	76.3	0.66	89.1	0.98	115.2
Control, untreated	-	0.97	100.0	0.38	100.0	0.74	100.0	0.85	100.0

D.I. = Damage index
P.D. = % plants damaged relative to control (100%)

Table 2

The effectiveness of pesticides incorporated in the seed pellet, 1979

Treatment	Pesticide dose kg/t of seed	Sugar beet flea beetle		Pigmy mangold beetle		Beet carrion beetle		Mangold fly		Blackroot	
		D.I.	P.D.	D.I.	P.D.	D.I.	P.D.	D.I.	P.D.	D.I.	P.D.
Bendiocarb + hydroxyisoxazole + TMTD	15 + 6 + 6	0.32	49.2	0.17	56.6	0.26	72.2	0.19	35.1	0.27	58.6
Bendiocarb/TMTD	15	0.44	67.6	0.09	30.0	0.17	47.2	0.23	42.5	0.27	58.6
Carbofuran 3F + hydroxyisoxazole +TMTD	37.5 + 6 + 6	0.22	33.8	0.13	43.3	0.10	27.7	0.23	42.5	0.36	78.2
Heptachlor/TMTD	12	0.65	100.0	0.28	93.3	0.30	83.3	0.47	87.0	0.47	102.1
Pellet without pesticide	0	0.65	100.0	0.30	100.0	0.36	100.0	0.54	100.0	0.46	100.0

D.I. = damage index
P.D. = % Plants damaged relative to control (100%)

Table 3

The effectiveness of granular insecticides applied at sowing, 1977-1979

Treatment	Sugar beet flea beetle		Pigmy mangold beetle		Beet carrion beetle		Mangold fly		Bean aphid		Blackroot	
	D.I.	P.D.	D.I.	P.D.	D.I.	P.D.	D.I.	P.D.	D.I.	P.D.	D.I.	P.D.
Aldicarb 10G	0.40	49.3	0.23	43.3	0.42	73.6	0.32	69.5	0.09	2.0	0.58	76.3
Bendiocarb 5 G	0.30	37.0	0.26	49.0	0.32	56.1	0.31	67.3	-	-	0.62	81.6
Carbofuran 10 G	0.28	34.5	0.23	43.3	0.36	63.1	0.23	50.0	0.28	63.6	0.50	65.8
Oxamyl 10 G	0.48	59.2	0.37	69.8	0.41	71.9	0.03	6.5	-	-	0.58	76.3
Thiofanox 10 G	0.33	40.7	0.31	58.4	0.40	70.1	0.30	65.2	0.30	68.1	0.54	71.0
Untreated	0.81	100.0	0.53	100.0	0.57	100.0	0.46	100.0	0.44	100.0	0.76	100.0

D.I. = Damage Index
P.D. = % plants damaged relative to control (100%)

Application rate 15 kg/ha in 1977 and 1978, 16.5 kg/ha in 1979.