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CONTROL OF BEAN SEED FLY AND ONION FLY

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CONTROL OF BEAN SEED FLY ON RUNNER BEANS AND COURGETTES AND OF BEAN SEED FLY AND ONION FLY ON SALAD ONIONS

SUMMARY

A field experiment on runner beans demonstrated that seed treatments of bromophos or bendiocarb, diazinon or chlorpyrifos soil treatment and chlorfenvinphos granules applied for bean seed fly control could be used safely on the crop. The level of attack by bean seed fly was too low to assess the efficacy of the treatments.

A laboratory study on the phytotoxicity of insecticides applied to courgettes raised in peat blocks indicated fonofos was very safe and chlorfenvinphos was relatively safe. There was a risk of adverse effects on plant growth with chlorpyrifos.

A field experiment on salad onions compared iodofenphos seed treatment with chlorfenvinphos granules and diazinon, chlorpyrifos or chlorfenvinphos drench or soil treatments. All treatments gave significant control of onion fly and bean seed fly and most gave a significant yield increase. No plant phytotoxicity was seen.

INTRODUCTION

Bean seed fly is the common name for several species of flies which are primarily plant scavengers, ie feed on dead plant material. Bean seed flies can under certain conditions attack live plants. The two main species of bean seed flies are Delia platura and Delia florilega and they are significant pests of various horticultural crops including cucurbits, French and runner beans and onions. Although attacks are sporadic they are frequently very serious. Bean seed flies are sometimes present in a pest complex with other Delia spp, particularly Delia radicum (the cabbage root fly) on horticultural brassicas and oil seed rape (and other agricultural brassicas), and Delia antiqua (the onion fly).

Bean seed flies are not a pest each year but where susceptible crops, either drilled or planted, are growing very slowly in cool and wet conditions or are in soil with a high content of unrotted vegetable material they can cause total crop loss. The main periods of risk of attack by bean seed fly are during the late spring or early summer, when soils are cool, and in late summer when new crops are drilled into ground where a lot of unrotted crop debris has been ploughed in.

Onion fly (Delia antiqua) is specific to alliaceous plants such as onions, leeks, shallots and garlic and, unlike bean seed fly which lays its eggs on bare ground, it lays eggs close to a host plant some time after plant emergence. Onion fly is not a problem in all parts of the country but has been confirmed in most areas where susceptible crops are grown and causes serious losses in some seasons.

One of the difficulties with damage by fly larvae, particularly those of the family Anthomyidae, is that correct identification of the species is not usually made by growers and advisers. Treatment techniques will differ somewhat according to what species of fly is involved. The pesticides which are likely to be most effective are common to all the Delia species but the best timing and method of application may vary considerably. Although there are many approved treatments for Delia radicum (cabbage root fly) on most brassica crops there are few approved for control of other Delia spp on any crops. On some crops susceptible to bean seed fly attack there are no approved treatments (eg cucurbits). The work reported deals with three different crops all susceptible to damage by bean seed fly and includes one crop also susceptible to onion fly attack.

Runner beans are particularly susceptible to damage by bean seed fly, damage is usually most severe if May is cool and wet. The standard treatment was a bromophos seed treatment but this insecticide has not been available for several years. Imported seed is sometimes already treated, even though the active ingredient may not be approved in the UK! The active ingredient bendiocarb is available as a seed treatment for other crops in the UK and was included in the experiment. Other materials tested were available for control of other Delia spp on other crops.

In recent years a larger area of cucurbits (ie courgettes, marrows, pumpkins and squashes) have been grown and some serious crop losses due to bean seed fly have occurred. Attacks have been particularly severe on block-raised planted crops. In specific cases crops have been completely killed by field populations of bean seed fly within 7 days of planting out uninfested blocks. There are no approved control measures for bean seed fly control in field grown cucurbits. These types of plant have very soft growth and are very sensitive to some pesticides, and it was considered that crop safety should be the major factor to be investigated initially.

Salad and bulb onions are attacked by bean seed fly during and shortly after germination. Damage is most common on late summer drilled crops which follow other horticultural crops where large amounts of crop waste are ploughed in after harvest. Onion fly attacks onion seedlings causing death of young seedlings, often in short lengths of row. Damage on more mature crops also occurs in some areas and crops attacked cannot be marketed. Bromophos applied as a seed treatment was the standard control method but it has not been available in recent seasons. Approval for the use of iodofenphos as a seed coating has since been obtained (Polycote Pedigree) and diazinon (as Basudin WP) has an approval for onion fly control (on salad onions only) when applied as a pre-drilling treatment. Chlorpyrifos is approved on onions for control of cutworms and is active against other anthomyid fly larvae (eg cabbage root fly) and therefore can be expected to give good control of both onion fly and bean seed fly. Chlorfenvinphos, although not approved on onions, is one of the most active insecticides used against cabbage root fly and has an approval on radish. Radish is a much shorter term crop than any of the onion crops and it was therefore considered that residue problems on onions would be unlikely to be a limiting factor in obtaining approval if the treatment proved effective.

PART I - CHEMICAL CONTROL OF BEAN SEED FLY ON RUNNER BEANS

Materials and Methods

Site: Stoulton, Worcestershire

Crops: Variety - Enorma

Seed was not treated with any pesticide before treatments were applied.

Drilled individually by hand in early May - approximately 10 cm apart.

In order to encourage bean seed flies to lay eggs a small amount of chopped bean seeds were placed beneath each seed.

Layout: The experiment was conducted in 2 single rows of beans, rows were 2 metres apart, each plot was drilled with 20 seeds. Each treatment was replicated three times and replicates were arranged as randomised blocks.

Treatments:

1. Untreated.

2. Bromophos - 'Bromotex T' seed treatment applied as a slurry at 4 g product per kilogramme of seed.

3. Bendiocarb - 'Agrichem Hi-flier' seed treatment applied as a liquid at 4 ml product per kilogramme of seed.

4. Diazinon - 2.5 kg Basudin 40 WP applied in 350 l/ha of water pre-drilling and cultivated into the top 8 cm of soil.

5. Chlorfenvinphos - 4.5 kg of Birlane Granules per hectare, broadcast and rotovated in to the top 10 cm of soil pre-drilling.

6. Chlorpyrifos - 2.0 l of Dursban 4 applied in 1,000 litres of water per hectare pre-drilling and cultivated in to the top 8 cm of soil.

Assessments:

1. An emergence count was made 18 days after sowing.

2. Half of the plants from each plot were dug up after 22 days to check on plant damage - plant damage was recorded as 'snake-head' (a symptom of bean seed fly attack) and as a direct mining in the seed.

3. 30 seeds from each seed treatment were checked in the laboratory using portable germination boxes for germination and for lateral root growth 5 and 10 days after the start of the observation.

4. From emergence visual checks were made for any symptoms which could have been due to phytotoxicity caused by the treatments applied.

It had been planned to record the yields from each plot but due to heavy and uneven growth of perennial weeds and poor growing conditions further assessments in the experiment could not be done.

Results: Table 1 shows the results of the emergence count and the plant and seed damage recorded.

Table 2 gives the results of the germination observations done in the laboratory.

TABLE 1 - Number of plants emerged in each treatment and the number damaged

Treatment		No.Plants Emerged (max 10)	No.Un-affected plants	No.with snake head	No.of seeds mined
1.	Untreated	7.33	6.33	1.00	2.33
2.	Bromophos	8.66	8.00	0.66	1.00
3.	Bendiocarb	7.66	7.33	0.33	2.00
4.	Diazinon	8.33	8.00	0.33	2.66
5.	Chlorfenvinphos	8.33	7.66	0.66	1.66
6.	Chlorpyrifos	8.66	8.33	0.33	1.66

TABLE 2 - Germination Counts on Treated and Untreated Seed

		No.days to emergence of radicle	Number of lateral roots per plant		No. plants with plumules after 10 days
			5 days	10 days	
1.	Untreated	5	2.2	5.0	11
2.	Bromophos	5	5.6	10.0	20
3.	Bendiocarb	5	2.0	5.0	17

At no time from emergence of the beans until the experiment was terminated was any sign of phytotoxicity seen on any plants in the experiment.

Discussion

The level of bean seed fly attack in the field was very low with 75% emergence in untreated plots. Not all of the non-emergence could be attributed to bean seed fly as fungal pathogens also reduce emergence of runner beans. Differences between treatments were slight but no conclusions can be drawn from this with the low level of attack.

The germination tests showed that the seed treatments did not cause phytotoxicity. With bromophos root growth was much more rapid than with bendiocarb or the untreated seed. The reason for this is not clear because the Hi-flier and Bromotex T seed treatments both contain the same fungicide thiram. It is possible that thiram had a beneficial effect but this may have been cancelled out by a slight phytotoxic effect with bendiocarb but not with bromophos.

Conclusion

None of the treatments adversely affected seed germination nor caused any plant damage. Pest attack was too low to draw conclusions on treatment effectiveness.

PART II - PHYTOTOXICITY OF INSECTICIDES USED FOR THE CONTROL OF BEAN SEED FLY ON COURGETTES RAISED IN PEAT BLOCKS

Object

To screen insecticides for their suitability for bean seed fly control on courgettes raised in peat blocks. Peat blocks are the normal method of plant raising for courgettes.

Materials and Methods

The experiment was carried out in a glasshouse at the ADAS Evesham Laboratory. Five different insecticides were used with each insecticide being applied at four rates. Eighteen blocks of compressed peat, each measuring 4.3 cm^3, were used for each rate of each treatment. Two litres uncompressed compost was needed for each rate of each treatment.

500 ml of water plus the appropriate chemical for each treatment were each added to 2 litres of compost and thoroughly mixed. The blocks were made using a hand operated block-making machine.

All treatments used are approved for use on brassicas. It was decided to use the recommended rate for brassicas as a standard (N). The 4 rates used were 1/2 x N, 1 x N, 2 x N, 4 x N.

Treatments

1. Birlane Granules' 10% chlorfenvinphos (incorporation).

(Recommended dose 10 mg chlorfenvinphos per block for brassicas)

Target doses:-

1/2 N	5 mg chlorfenvinphos per block.
1 N	10 mg chlorfenvinphos per block.
2 N	20 mg chlorfenvinphos per block.
4 N	40 mg chlorfenvinphos per block.

There is considerable variation in the number of blocks it is possible to get per litre of compost. The compost used gave 10 blocks/litre after incorporation instead of the 7.8 expected. Actual rates of incorporation was therefore 22% less than planned.

Dose 1/2 x N Birlane = 3.9 mg chlorfenvinphos/block

1 x N Birlane = 7.8 mg chlorfenvinphos/block

2 x N Birlane = 15.6 mg chlorfenvinphos/block

4 x N Birlane = 31.2 mg chlorfenvinphos/block

2. Cudgel, 43.3% Fonofos (incorporation)

(Recommended dose 100 ml in 40 l water/m^3 compost)

Dose 1/2 x N = 0.022 mg fonofos/block

1 x N = 0.043 mg fonofos/block

2 x N = 0.087 mg fonofos/block

4 x N = 0.173 mg fonofos/block

3. Dursban 4, 48% chlorpyrifos (Drench Treatment)

(Recommended dose 25 ml in 5 l water/5000 blocks)

Dose 1/2 x N Dursban 4 = 0.12 mg chlorpyrifos/100 ml/block

1 x N Dursban 4 = 0.24 mg chlorpyrifos/100 ml/block

2 x N Dursban 4 = 0.48 mg chlorpyrifos/100 ml/block

4 x N Dursban 4 = 0.96 mg chlorpyrifos/100 ml/block

4. Dursban Granules 5G, 10% chlorpyrifos (incorporated)

Recommended rate 10 mg chlorpyrifos per block. See comment above under Birlane Granules.

Dose	1/2 x N Dursban 5G	=	3.9 mg chlorpyrifos/block
	1 x N Dursban 5G	=	7.8 mg chlorpyrifos/block
	2 x N Dursban 5G	=	15.6 mg chlorpyrifos/block
	4 x N Dursban 5G	=	31.2 mg chlorpyrifos/block

<u>Assessments</u>

1.	Time of germination	(days)
2.	Leaf area per plant	12 days after sowing
3.	Mean fresh weight of plant	16 days after sowing
4.	Total leaf area per plant	16 days after sowing
5.	Number of leaves per plant	16 days after sowing

RESULTS

Germination in all treatments occurred within 5 days of sowing. No treatment effect occurred.

Table 3 shows the mean leaf area per plant on day 12.

Table 4 gives the mean fresh weight of plants 16 days after sowing and Table 5 gives the total leaf area at the same time.

Table 6 shows the number of leaves present per plant for each treatment on day 16.

Results were analysed using analysis of variance and Duncan's Multiple Range Test.

TABLE 3 - Total Leaf Area N x 4 Day 12

Treatment	Leaf area (cm^2)
Birlane	37.75 ab
Cudgel	75.5 b
Dursban 4	33.25 a
Dursban 5G	38.5 ab
Control	69.5 ab
SED (12 df)	1.288

TABLE 4 - Average Fresh Weight of Courgettes (grammes)

Treatment	RATE			
	N x 1/2	N x 1	N x 2	N x 4
Birlane Granules	10.87 a	9.07 ab	7.72 a	7.50 ab
Cudgel	6.47 a	9.57 b	7.87 a	8.22 ab
Dursban 4	9.95 a	9.65 b	9.25 a	6.60 a
Dursban 5G	8.27 a	7.82 a	8.00 a	8.55 a
Control	10.88 a	9.97 b	9.05 a	9.27 b

The figures followed by the same letter within each column do not differ significantly at $P < 0.05$.

TABLE 5 - Total leaf area, day 16 (cm^2)

Treatment	RATE			
	N x 1/2	N x 1	N x 2	N x 4
Birlane Granules	248 a	361 a	418 a	314 ab
Cudgel	265 a	466 a	411 a	439 b
Dursban 4	242 a	387 a	381 a	219 a
Dursban 5G	223 a	322 a	373 a	321 ab
Control	387 a	425 a	456 a	424 b

Figures followed by the same letter within each column do not differ significantly at $P < 0.05$.

TABLE 6 - Total number leaves N x 2 day 16

Treatment		Leaf number
1	Birlane	11.5 b
2	Cudgel	10.5 ab
3	Dursban 4	9.75 a
4	Dursban 5G	11.0 ab
5	Control	11.5 b
SED (12 df)		0.856

Discussion of Results

Most factors showed no significant difference between treatments.

Dursban 4 was observed to cause some scorching at all but the lowest rate tested, this caused a significant reduction of leaf numbers and area at highest rate (Table 3 and 6).

The control group scored better than any other plants on all factors examined except in a few where Cudgel gave better results. However none of these differences were significant.

Increasing the dose to 4 times recommended did not appear to have affected growth badly except for the Dursban 4 where burnt leaves were seen.

Conclusion

Both chlorpyrifos treatments, (Dursban 4 and Dursban 5G) significantly affected some aspects of growth at the highest rate.

Chlorfenvinphos and fonofos (Birlane granules and Cudgel respectively) showed no significant differences from the control even at high dose levels.

There appears to be potential for fonofos or chlorfenvinphos to be further evaluated for bean seed fly control on courgettes raised in blocks. The lack of significant phytotoxicity with these insecticides should be reassessed and work should be done to evaluate the efficacy of control.

PART III - CHEMICAL CONTROL OF BEAN SEED FLY AND ONION FLY ON SALAD ONIONS

Materials and Methods

A single trial was carried out on salad onions (cv White Lisbon) at Stoulton, Worcestershire. Prior to drilling farm yard manure was incorporated to encourage egg laying by the bean seed fly.

Plots: Single row, 10 m long

Replication: Four fold

Design: Randomised block

Drilling: Single row Stanhay precision drill.

Target drilling rate, 100 seeds per m.

Drilled on 5 May 1988.

Although the site has a history of severe onion fly and bean seed fly attacks, onion fly eggs were artificially inoculated on 25 May and 7 June. They were inoculated at approximately one egg per plant and at this rate a significant level of damage could be expected. Eggs were collected from an artificialy reared population and were inoculated using a technique similar to fluid drilling developed at the National Vegetable Research Station (now HRI, Wellesbourne).

Treatments

1. Untreated.

2. Bromophos 25% w/w, Captan 25% w/w and Thiabendazole 3% w/w (as Bromotex T seed dressing) applied at 25 g ai per kilogramme of seed.

3. Polycote Pedigree seed coating - applied commercially by Seedcote Systems (active ingredient iodofenphos, with benomyl and metalaxyl).

4. Chlorfenvinphos 10% granules (as Birlane granules), 7.0 g ai/100 m row applied as a surface band immediately in front of the drill.

5. Diazinon 40% wp (as Basudin 40 wp), 1,000 g ai/ha applied as a soil spray and incorporated pre-drilling.

6. Chlorpyrifos 48% ec (as Dursban 4) 960 g ai/ha in 2,000 l of water applied as a plant drench at the crook stage.

7. Chlorfenvinphos 24% ec (as Birlane 24) 2352 g ai/ha applied as a soil spray and incorporated pre-drilling.

Assessments

1. Seed viability, by germination test in the laboratory.

2. Number of plants per m of row 31 May.

3. Number of plants per m of row 7 June.

4. Number of plants per m of row 14 June.

5. Number of plants per m of row 27 June.

6. Mean fresh weight of plants per m of row at harvest 25 July.

Results

Table 1 gives the results of the laboratory germination tests.

Table 2 gives the mean maximum number of plants per metre of row and the percentage of plants damaged at each assessment date. Plants recorded as damaged on each occasion would probably not have been recorded in subsequent assessments. Therefore the number damaged at each date can be summed to give an estimate of the total amount of damage. Table 3 records the weight of onions harvested from each treatment.

In Tables 2 and 3 the results of an analysis of variance and the Duncans Multiple Range Test are expressed using suffix letters. In each column treatments not sharing the same suffix letters are significantly different from each other (at $P < 0.05$).

Identification of larvae in plants showed that the great majority of the larvae responsible for damage were those of onion fly and that infestation by bean seed fly was minimal.

TABLE 1 - Laboratory Germination Test

Treatment	Germination at 4 days (%)	Days to reach maximum germination	Maximum germination (%)
Untreated	84	7	98
Bromophos	32	25	86
Polycote Pedigree	76	10	98

Test not applicable to other treatments.

TABLE 2 - Plant count and percentage of plants damaged on each assessment date

Treatment	Maximum no of plants emerged per metre of row	Percentage of plants damaged		
		7 June	14 June	27 June
Untreated	64.6 a	3.0 b	10.1 b	14.2 c
Bromophos	177.0 b	0.2 a	1.4 a	0.6 a
Polycote Pedigree	72.4 a	0 a	0 a	0.5 a
Chlorfenvinphos granules	75.0 a	0.6 a	2.1 a	0.6 a
Diazinon	64.0 a	0.4 a	0 a	1.8 a
Chlorpyrifos drench	67.0 a	0.4 a	0.9 a	4.9 b
Chlorfenvinphos drench	79.0 a	0.4 a	0 a	1.4 a
SED		0.910	2.206	1.105
CV%		232.7	193.6	58.5

(The percentage plant damage analyses were carried out on angular transformations of the results. Untransformed data is recorded in the table.)

TABLE 3 - Mean fresh weight of plants per metre of row at harvest

Treatment	Weight (grammes)	Percentage of untreated
Untreated	552 a	100
Bromophos	Not assessed - see text	
Polycote Pedigree	867 b	157
Chlorfenvinphos granules	815 b	148
Diazinon	760 b	138
Chlorpyrifos drench	750 b	136
Chlorfenvinphos drench	712 ab	129

Discussion

Laboratory germination tests (Table 1) clearly showed that Polycote Pedigree did not greatly delay germination or the potential for final plant stand, when compared with untreated seed. However, bromophos did delay germination and had a lower maximum germination. These results were reflected in the field plant counts where emergence of bromophos treated seed was delayed by at least 8 days compared to other treatments. The major problem encountered with bromophos was uneven seed rate, a problem frequently encountered under commercial conditions. This resulted in extremely high plant counts caused by the seed treatment clogging the metering belt and allowing extra seed to pass between the belt and the drive rollers. For this reason the bromophos treated crop was unmarketable due to the small size of individual plants. Crop weight at harvest was therefore not recorded. None of the other treatments had a significantly different plant count compared with untreated seed.

The percentage of plants damaged at all assessments were significantly lower on all treatments compared to the control. In the first two assessments there were no significant differences between other treatments but Polycote was the only treatment where no damage was recorded.

The total percentage of plants damaged was greater on the third assessment and this resulted in differences between chemical treatments becoming apparent. Least damage was present on the Polycote, bromophos and both chlorfenvinphos treatments. Slightly more damage was recorded on diazinon treatment but none of these differences were significant. Significantly more damage was present when a chlorpyrifos drench was used.

As stated previously it is possible to take account of the cumulative totals of plants attacked. This indicates that Polycote was the most successful treatment with very few plants infested. The total amount of plant damage was similar with the other chemical treatments except where a chlorpyrifos drench was used. This was applied at the same time as the first egg inoculation and it is possible that eggs from the second inoculation did not hatch for some time and so escaped the full effects of the treatment.

The effects of treatment are most clearly seen in the yields at harvest. All recorded yields were higher on treated than untreated plants. This difference was significant on all except the chlorfenvinphos drench treatment. No significant differences were recorded between any of the chemical treatments. Seed treated with Polycote gave the highest yield which corresponds with the minimal amount of damage recorded.

In a comparison of treatments on grounds other than that of efficacy further important distinctions can be made. The problems of applying bromophos as a dry or slurry treatment became apparent during the experiment, resulting in the clogging of the seed drill. The benefits of a seed coating treatment such as Polycote are not only that it enables improved flow through the drill but that the insecticide is in close proximity to the seed. This results in good targeting and minimal side effects on the environment. It also overcomes the problems of timing of treatment which may have contributed to the increased damage on the chlorpyrifos drench treatment on 27 June. From the grower's point of view seed coating also eliminates the need for additional operations such as spraying, applying granules or incorporation into the soil which were required for the other treatments. Salad onions are sold primarily through supermarkets who specify minimum bunch weight and approximate number of onions per bunch. Therefore the improvements resulting from the best treatments were not only statistically significant but represented tangible commercial benefits.

Conclusion

Under the high pest population pressure created by the artificial inoculation technique all treatments gave excellent control of onion fly and bean seed fly. Polycote Pedigree suffered least damage and was the highest yielding treatment. It was also more convenient that the other chemical treatments used.

OVERALL DISCUSSION AND CONCLUSION

The uncertainty of a bean seed fly attack in any season should not reduce the perceived importance of this pest. When attacks occur they often cause major, and sometimes complete, crop loss. Many of the crops damaged are the highest value early drilled crops where re-drilling or planting is not economic as the benefits of high early season prices are totally lost.

Although the studies reported were only partially successful in achieving their objectives there were some very useful indications of the insecticides most likely to give control on the different susceptible crops and of the risks of crop damage caused by the treatments themselves.

The withdrawal of certain pesticides by manufacturers for commercial reasons or the loss of approval for specific uses or even for the insecticide itself puts extra pressure on growers. They already have a very restricted choice of pesticides for some "minor" pests and even less where attacks occur on "minor" crops. Since this work was done two of the insecticides used have become unavailable.

In order that effective and approved control measures can be available to growers a concerted effort should be made to establish the best treatments which can be applied to a range of crops. The work reported goes some way to addressing this.

RECOMMENDATIONS

1. Work on crops attacked by bean seed fly should be co-ordinated.

2. Treatments should be common to all susceptible crops where possible (including seed treatments).

3. Risk of phytotoxicity should be evaluated in the field.

4. Studies on control should be initiated on an annual basis, with the stipulation that "no pest" results in immediate suspension of work for that season. Costs of future work should be agreed on this basis.

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