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SOME INDIRECT BENEFITS OF THE USE OF PYRETHROID INSECTICIDES

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Summary The newer, light-stable pyrethroids are now well established as members of the crop protectionist's arsenal of chemicals, and in many outlets their performance as insecticides has rightly been described as 'outstanding'. In addition to excellent insect control, however, certain indirect benefits have been identified following the widespread use of these compounds, including unexpectedly high yields from pyrethroid-treated crops, and the suppression of aphid-transmitted plant viruses, such as those responsible for sugar beet yellows, barley yellow dwarf disease and potato leaf roll. It is suggested that the mechanism for suppression could be by the repellent activity exhibited by these compounds to the vectors. This paper presents some of the evidence gathered from trials carried out by many Shell Companies and their collaborators but suggests that there are still many opportunities for basic research with this group of active and interesting compounds.

Résumé Les pyréthrinoides photostables sont bien etablis dans l'arsenal du phytopharmacien et leur performance excellente a été réconnue en plusieurs débouchés. En plus de cette efficacité exceptionelle, des bénéfices indirects ont été constatés suite à l'emploi répendu de ces produits, y compris des rendements plus grands qu'attendus et la suppression des viroses transmises par les insectes, telles que la jaunisse de la betterave, la jaunisse nanisante d'orge et des virus de la pomme de terre. L'activité repulsive des pyréthrinoides aux insectes vecteurs des virus est proposé comme mécanism de cette suppression. Dans cette communication est présenté l'evidence des essais entrepris soit par des Sociétés Shell, soit par nos coopérateurs mais on suggére qu'il existe encore plusieures études à faire avec ce groupe de produits efficaces et intéressants.

INTRODUCTION

The newer, light-stable pyrethroids, patented by the National Research Development Corporation or by the Sumitomo Chemical Co. are now well established as members of the crop protectionist's arsenal of chemicals.

Whether they be research workers in industry or government agency, agrochemical salesmen or farmers and growers, all who have worked with these compounds recognise their outstanding performance in a wide range of crops and against a large number of insect pests. Indeed, the rapidity with which products have been brought to the market (cypermethrin and fenvalerate were screened in the laboratories of Shell Research Limited for the first time during 1974) is testimony to the high activity and consistency of the pyrethroids, as is the often heard comment from research workers - 'since the advent of the pyrethroids we have had to throw away our old standard materials'.

Accelerated development is not without its risks, however. The market place is an expensive experimental ground and companies have had to rely very heavily on their previous experience in the agrochemicals field and on their faith in the capability of the pyrethroids to control pests even though they have been applied at dose rates measured in terms of tens of grammes per hectare. One normally continues to learn about a compound as development progresses, and this has certainly been true of the pyrethroids. There have been many surprises, not least among these being the very low application rates at which they are active in the field. In addition, following the widespread use of these compounds, certain indirect benefits have been identified. I use the word 'identified' advisedly as effects have often been subjectively observed but not objectively assessed and it is therefore difficult to determine the mechanisms by which those effects were produced. A number of these effects can be broadly grouped under the heading of 'Plant Growth Regulant Effects'. There have been many reports of crops, particularly cotton, looking 'healthier' or 'greener' following treatment with pyrethroids, when these crops are compared with neighbouring crops treated with conventional compounds. Pyrethroid-treated cotton also appears to mature more rapidly and more uniformly than that treated with standard insecticides and, most important for the grower, pyrethroid treated crops show a tendency to yield unexpectedly well. This latter point is one to which I shall return shortly.

Another group of effects seems to be associated with the sub-lethal action of the pyrethroids, in that affected insects become hyper-active, behave abnormally and tend not to remain on treated foliage. Thus, the pyrethroids can be shown to be anti-feedants and have also been described as repellents. Care must be exercised when using this latter term, however, as traditional repellents act in the vapour phase and it must be remembered that pyrethroids, with their very low vapour pressures, can only be repellent once contact between the insect and the compound has occurred. Nevertheless this type of activity, for which "irritancy" might be a better term, does seem to be important in certain areas of crop protection and in the second part of this paper I would like to describe some results of trials against aphid vectors of plant viruses. In these trials, although aphid control has not always been outstanding, virus suppression has been good and it would appear, therefore, that repellency/irritancy has been an important factor.

EFFECTS ON YIELD

Returning then to the subject of crop yields, it is true to say, of course, that the object of using all insecticides is to increase yield and, where appropriate, to improve quality, but until the advent of the pyrethroids, yield was not considered to be a major factor in judging the effectiveness of an insecticide. The pyrethroids, being very effective insecticides, give correspondingly large increases in yield when treated and untreated plots are compared (Table 1). What is much more interesting, however, is the comparison between crops treated with pyrethroids and those treated with conventional insecticides. Increases in yield that have been demonstrated following treatment with pyrethroids can, in many cases, be correlated with superior pest control (Table 1), but as experience with pyrethroids increases, there are more and more cases of yield increases in conditions where pest control on pyrethroid and conventionally treated areas are apparently very similar.

Table 1

Comparison of yields of marketable cabbages from treated and untreated plots

Treatment	Rate ppm a.i.	Mean pest damage index*	Mean weight (kg) of marketable cabbage heads in 15 plant samples
cypermethrin	50	0.02	11.70
fenvalerate	50	0.13	9.72
cyanofenphos	250	0.26	6.83
Untreated		1.08	0.25

*Mean of 4 assessments on each of 4 replicates. Index based on numbers of damaged leaves per plant using a 0-4 scale (0 - no damaged leaves, 4 - all leaves with holes)

Pest species were Plutella xylostella and Crocidolomia spp.

Tables 2 to 5 give some examples of hand-sprayed trials in Egypt, Malawi, Colombia and the USA where both pest counts and yield have been recorded.

Table 2

Comparison of pest control and yield of seed cotton resulting from applications of cypermethrin and of a standard non-pyrethroid insecticide

Treatment	Rate g a.i./ha	Mean* % of bolls infested with Pectinophora gossypiella larvae	Mean yield of seed cotton (kg/ha)
cypermethrin	240	5.6	2425
non-pyrethroid standard	1920 + 960	5.7	2275

*Mean of 7 assessments at weekly intervals on 100 bolls per treatment

In the Egyptian trial, three sprays were applied at fortnightly intervals using a knapsack sprayer with a volume application rate of 500 l/ha. Plots were 170 m^2 in area and the treatments were replicated four times. Infestations of pink bollworm (Pectinophora gossypiella) were assessed by examining 25 bolls/plot at weekly intervals during the spraying period and yield was assessed by picking cotton from a 25 m^2 area of each plot. Pest levels were essentially similar on the cypermethrin and standard-treated plots but the yield of seed cotton from the pyrethroid-treated plot was approximately 7% higher than that from the non-pyrethroid plot.

The trial in Malawi compared cypermethrin with a mixture of carbaryl and DDT. Sprays were applied at weekly intervals using a knapsack sprayer with a tailboom. Application rates of active material and spray liquid were increased as the cotton grew, the spray volume from 60-300 l/ha and the rates of active material as shown in Table 3. Plots were 140 m^2 in area and the treatments were replicated five times. Pest populations were monitored at regular intervals and mean infestation levels are given in Table 3. Although somewhat higher numbers of American bollworm (Heliothis armigera) were recorded on the cypermethrin-treated plots, the yield of seed cotton was approximately 12% greater than that from the standard plots. This trial also illustrates how the pyrethroids can improve the quality of cotton, in this case by controlling populations of cotton stainers (Dysdercus discolor). Only 7% of the cotton from the cypermethrin-treated plot was appreciably stained compared with 20% from the standard plot. Thus, in terms of unstained cotton, the pyrethroid plots outyielded the standard plots by some 30%.

Table 3

Comparison of pest control and yield of seed cotton resulting from applications of cypermethrin and of a carbaryl + DDT mixture in Malawi

Treatment	Rate g a.i./ha	Mean* number of Heliothis armigera larvae/plant	Mean number of Dysdercus discolor/ha	Mean yield of seed cotton (kg/ha) Total	Unstained
cypermethrin	25-100	0.15	1890	1681	1563(93%)
carbaryl + DDT	213+188 -850+750	0.07	2000	1498	1198(80%)

*Seasonal mean

Table 4 shows the results of a trial carried out in Colombia by the National Federation of Cotton Growers, in which fenvalerate and cypermethrin were compared with a mixture of camphechlor, DDT and parathion-methyl. Treatments were applied on the basis of pest thresholds and the pyrethroid-treated areas required only half as many applications as that treated with the standard. Yields of seed cotton, however, were doubled on the pyrethroid-treated plots.

Table 4

Comparison of pest control and yield of seed cotton resulting from applications of fenvalerate, cypermethrin or a mixture of camphechlor + DDT + parathion-methyl in Colombia

Treatment	Rate g a.i./ha	Number of applications	Mean* % of squares damaged by Heliothis larvae	Yield of seed cotton (kg/ha)
fenvalerate	150	11	4.9	2500
cypermethrin	100	10	4.5	2530
camphechlor + DDT + parathion-methyl	1000+ 500+ 730	21	5.2	1220

*Seasonal mean

Finally, in Table 5, the results of a trial on sweet peppers are presented, in which fenvalerate was compared with methamidophos and methomyl for the control of aphids and corn earworm (Heliothis zea).

Table 5

Comparison of pest control and yield of green peppers resulting from applications of fenvalerate, methamidophos or methomyl in the USA

Treatment	Rate g a.i./ha	% of peppers infested with *Heliothis zea* larvae 9/8	11/9	Yield of peppers (tonnes/ha)
fenvalerate	112	2	7	19.7
methamidophos	1120	1	0	17.7
methomyl	1120	1	1	17.2

Sprays were applied using a hand sprayer at weekly intervals from mid-July to mid-September. Plots consisted of three 12m lengths of row and treatments were replicated three times. Although fenvalerate was apparently somewhat less effective than the standards in terms of infested fruits, the yield obtained on the pyrethroid-treated plots was 12 and 14% greater than that on plots treated with methamidophos and methomyl respectively.

There would, thus appear to be some evidence to suggest that pyrethroid-treated crops do give yields higher than might be expected from examination of pest counts. Why should this be? Several reasons have been proposed but only further research will give a definite answer. It has been suggested that pyrethroids, as well as controlling the major pests, whose populations are those that are monitored, also give control of many other insects that are generally regarded as economically unimportant. However, it is difficult to see why conventional compounds should not similarly be having at least some effect on these other insects. On the other hand, there is evidence (Plapp and Vinson 1977), Plapp and Bull (1978) and Wadill (1978) to suggest that at commercially used dosages some pyrethroids are less hazardous to parasites and predators than are standard compounds. Increased yields could thus be the result of integration of chemical and biological control.

Finally, yield increases could be due to direct effects, or lack of effects, on the crop. It is known that conventional insecticides can have deleterious or beneficial effects on yield (Chapman and Allen 1948), Brown *et al* (1962). Thus, depending on the conventional material with which the pyrethroid is compared, increased yield could simply be the result of growing crops free from restraint imposed by a particular conventional compound, or be truly due to a stimulating effect of the pyrethroid on the crop.

What is certain is that if we wish to fully explain the effects that have been observed, then more research is required, and such research will need to be of a multi-disciplinary nature involving both entomologists and plant physiologists.

PLANT VIRUS SUPPRESSION

At the 1977 British Crop Protection Conference, Peters (1977) in a paper on the use of oil to prevent the spread of virus disease stated "Since the probes do not last long enough for the aphid to acquire a lethal dose of insecticide, control of disease caused by these viruses cannot be achieved by killing their vectors. Therefore, it is evident that the control of these diseases has to be achived by other measures". In the same session, Russell (1977) discussing the results of experiments on the effects of benzimidazole compounds on the transmission of beet yellows virus by peach-potato aphid (*Myzus persicae*) made the following comments: "The restless behaviour of *M. persicae* on benzimidazole-treated plants and the high rate of 'walk-off' by aphids from them indicates that thiabendazole and benomyl are feeding deterrents for *M. persicae* rather than insecticides ...... feeding deterrents and chemicals which increase the restlessness of aphids may be more effective than insecticides in preventing virus transmission by aphids".

The behaviour of aphids on pyrethroid-treated plants would appear to be very similar to their behaviour on benzimidazole-treated plants and it is perhaps not surprising, therefore, that there is evidence to suggest that the pyrethroids have an important role to play in the suppression of disease caused by insect-transmitted plant viruses.

The first evidence of virus suppression came from trials carried out on sugar beet in Belgium during 1976.

Although the level of infection with virus yellows was not high, cypermethrin and fenvalerate applied at 75 g a.i./ha on four or five occasions, depending on the trial, appreciably reduced the number of plants showing symptoms of the disease and were, in one trial, equivalent to the standard pirimicarb in this respect. Table 6 shows these results together with counts of *M. persicae* made earlier in the season from which it can be seen that the reduction in virus incidence on pyrethroid-treated plots was achieved in spite of the fact that the degree of aphid control was inferior to that given by pirimicarb.

Table 6

Infestations of *Myzus persicae* on sugar beet and subsequent incidence of virus yellows disease following treatment with fenvalerate, cypermethrin or pirimicarb - Belgium 1976

		TRIAL 1			TRIAL 2*
		Mean no. of *M. persicae*/ 10 plants		Mean no. of plants/plot showing virus yellows symptoms	Mean no. of plants/plot showing virus yellows symptoms
Treatment	Rate g a.i./ha	10/6	22/6	20/9	17/9
fenvalerate	75	7.8	3.0	15.8	15.8
cypermethrin	75	10.3	5.0	15.3	18.0
pirimicarb	200	2.5	0	16.5	13.3
Untreated		14.3	10.3	28.4	21.5

*No assessments of aphid numbers were made in this trial

In subsequent years virus yellows infections have been very low and no effects were observed in 1977. In 1978, however, some additional results were obtained. Cypermethrin and fenvalerate were again applied five times at 75 g a.i./ha and the results given in Table 7 are similar to those obtained in 1976.

Table 7

Infestations of Myzus persicae on sugar beet and subsequent incidence of virus yellows disease following treatment with fenvalerate, cypermethrin or pirimicarb - Belgium 1978

Treatment	Rate g a.i./ha	Mean no. of M. persicae/10 plants on 14/7		Mean no. plants/ plot showing virus yellows symptoms	
		Trial 1	Trial 2	Trial 1 (28/9)	Trial 2 (26/9)
fenvalerate	75	0	0	4.5	12.3
cypermethrin	75	0.3	0	8.0	23.0
pirimicarb	200	0	0.3	9.8	28.0
Untreated		1.3	0.3	17.0	23.0

Further field trials on sugar beet have been undertaken during 1979 in Belgium d France both by Shell agrochemicals development staff and by collaborators. In me of these trials treated plants have been artificially infested with viruli-rous aphids in an attempt to increase both the levels of yellows infection and e precision of the experiments.

Infection of seedling winter barley plants with Barley Yellow Dwarf virus n be so severe in parts of France that the crop has to be ploughed in. The sease can be transmitted by a number of different cereal aphids but the principal ecies involved during the autumn is the bird-cherry aphid (Rhopalosiphum padi). is aphid can be controlled by conventional aphicides but persistence of effect limited and repeated applications are often necessary, particularly when the tumn weather is mild.

In a replicated trial carried out in France by Bayon (1978), the effects of ngle or double applications of fenvalerate were compared with similar appli-ations of other aphicides, including dimethoate. The yields of barley obtained e given in Table 8. In all cases, fenvalerate was superior to dimethoate, and th two applications, one month apart, the yield on the pyrethroid-treated plots as 2½ times that on the control plots and twice that on the plots treated twice th dimethoate.

Similar, though less marked, results were obtained by Vidal *et al* (1978). single application of fenvalerate at 25 g/ha gave a 17.3% increase in yield er untreated plots whereas a treatment with dimethoate at 400 g/ha on the ame date gave only a 3.3% increase in yield.

Table 8

The effect on yield of winter barley, of applications of fenvalerate and dimethoate to control Rhopalosiphum padi

Treatment	Rate g a.i./ha	Date of application	Yield kg/ha	Increase in yield over control
fenvalerate	37.5	18/10	940	+ 107%
fenvalerate	25.0	3/11	1675	+ 206%
fenvalerate	37.5	18/10)	2565	+ 235%
	+ 25.0	3/11)		
dimethoate	600	18/10	250	- 43%
dimethoate	400	3/11	967	+ 71%
dimethoate	600	18/10)	917	+ 20%
	+ 400	3/11)		

Potatoes present a third crop in which suppression of aphid-transmitted virus is of great importance and again encouraging results have been achieved. Table 9 gives the results of trials carried out in Germany during 1977 using fenvalerate and cypermethrin to suppress infections of potato leaf roll virus.

Table 9

Infection of 'eye cuttings' with leaf roll virus following treatment of potato haulms with fenvalerate, cypermethrin or methamidophos

Treatment	Rate g a.i./ha	Number of eye cuttings: Taken		Number of eye cuttings: Infected with leaf roll virus		% infected cuttings	
		Var. 1	Var. 2	Var. 1	Var. 2	Var.1	Var.2
fenvalerate	120	389	409	17	14	4.4	3.4
cypermethrin	160	388	384	27	14	7.0	3.6
methamidophos	600	379	390	48	21	12.7	5.4
Untreated		405	409	143	139	35.3	34.0

Var. 1 = Clivia

Var. 2 = Sieglinde

In this case, the dosages applied were high enough to give good aphid control, equivalent to that given by the standard, methamidophos, but the pyrethroids were nevertheless more effective than the standard in reducing the infection of the potatoes with virus. Similar results were obtained for cypermethrin at 90 g a.i./ha in Germany during 1978 and have been reported from Canada for fenvalerate at 67 g a.i./ha.

CONCLUSIONS

The results presented in this paper show that the use of cypermethrin and fenvalerate can result in unexpectedly high yields from treated crops and that these two pyrethroids have an important role to play in the suppression of aphid-transmitted plant viruses. It is hoped that others will be stimulated to undertake further studies with the pyrethroids, a very interesting and exciting new group of chemicals.

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FIELD EVALUATION OF TIMED APPLICATIONS OF PYRETHROID INSECTICIDES FOR THE CONTROL OF PEA MOTH (CYDIA NIGRICANA)

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Summary Experiments comparing several formulations of pyrethroid insecticides and one organo-phosphorus insecticide for the control of pea moth damage in commercial crops of dry harvest peas, were carried out in 1978 and 1979. The results showed that, when insecticides were applied at forecasted dates obtained from commercial pea moth pheromone trapping systems, all treatments resulted in similar reduction of moth damage, significantly different from the amount recorded on the untreated plots. There was no significant difference in effectiveness of control between any of the pyrethroids or triazophos and all treatments were very effective. A single spray applied to the earlier-maturing variety Vedette, was as effective as the two sprays applied to the later-maturing variety, Maro.

Sommaire Des experiences comparant plusiers formules d'insecticides pyréthroides et un insecticide dérivé de l'acide phosphorique destinés à contrôler les dommages causés par la teigne du pois aux récoltes commerciales de pois secs se sont déroulées en 1978 et 1979. Les résultats ont montré que, lorsque les insecticides étaient appliqués à des dates calculées grâce a des systèmes commerciaux de prise au piège des teignes par les phéromones, tous les traitements avaient pour résultat une réduction semblable des dommages dûs à la teigne, réduction qui differait très sensiblement des quantités relevées sur les parcelles non traitées. Il n'y avait aucune différence significative en ce qui concern l'efficacité du contrôle entre toutes les pyréthroides et le triazophos, et tous les traitements etaient très efficaces. Une seule pulverisation appliquée à la variété Vedette à maturité plus precose, était aussi efficace que les deux pulverisations appliquées a la variété Maro à maturité plus tardive.

INTRODUCTION

Damage caused by the larvae of the pea moth (Cydia nigricana) occurs annually in the UK and the pest is considered to be one of the most important insects attacking the pea crop. Peas for harvesting dry are more seriously affected as the crop remains in the field for the duration of larval development and this has caused high, localised populations of moth to build up in areas where they have been grown for many years. Vining peas, harvested green for freezing and canning, can also be affected, but the damage is often much lower. The crop is harvested before the completion of larval development and damage occurs as a result of migrants from nearby fields where dried peas were grown the previous year. However, even small amounts of damage may result in total crop rejection because of the difficulty in removing damaged peas from the factory picking line. Some estimates of the economic importance of pea moth in the UK have been made by Bardner (1978).

Sprays aimed at reducing damage are applied to approximately half the dried pea crop and about 14% of the vining pea crop (Umpelby and Sly, 1977). Usually two sprays are applied at 14 day intervals and it is important for the timing of these applications to be correct (Biddle, 1977).

Timing of the first of these sprays used to be made following a warning, issued by ADAS and PGRO, based on the system of forecasting developed by Gould and Legowsky (1964). This involved the detection of moth eggs laid in pea crops growing in previously infested areas. On the date calculated for maximum hatch to occur pea crops in full flower, or which had already flowered, were treated with an insecticide. Larvae leaving the eggs travel to young pods, which they would penetrate, but they are killed after contacting insecticides which have been applied to the plant. A second spray 10-14 days later protects newly set pods from larvae hatching from eggs laid later.

This system, however, is not always accurate and the detection of eggs is in any case a difficult and time consuming task. A more efficient and accurate method of forecasting was developed by Rothamsted Experimental Station in conjunction with ADAS and PGRO. The system is based on catches of male moths in pheromone-baited traps, to indicate peak adult flights and subsequent egg laying periods. (Greenway et al., 1976). The system has been available commercially since 1978 (Stafford, 1978) and it enables each grower to assess accurately the correct time for spraying crops on his own farm, thereby replacing and improving upon the previous broad-area issued by post. The system also indicates the necessity of spraying, as an absence of moth catches denotes the absence of a population sufficiently great to warrant treatment.

Alongside the introduction of the forecasting system, there have been developments with the synthetic pyrethroid insecticides in the control of pea moth. During 1978 and 1979, field evaluation of some of these materials has been carried out by PGRO. The sprays, applied in conjunction with the pheromone trapping system, were carried out in commercial dried pea crops in England and the work is described in this paper.

METHODS AND MATERIALS

In each commercial dried pea crop, a pheromone trapping system (OECOS, Kimpton, Herts., U.K.) was installed at the end of May each year. A system comprised two traps, each of which was placed on an adjacent headland within the pea crop. The sticky plates of each trap were examined every second day throughout the trapping period and the number of male moths caught was recorded on each occasion. A 'threshold' catch was reached when 10 or more moths were caught on one or other of the traps over a two day period and was verified by a similar threshold catch, two days later. In 1978, the first spray was applied 10 days after the date of the first threshold, as this was an estimate of the time taken for pea moth eggs to develop fully prior to hatching. In 1979, a modification was made to the system enabling a more accurate spray date to be calculated utilizing the daily maximum and minimum temperatures. These were recorded immediately following the first threshold date and were converted to a pea moth egg development curve using a simple calculator supplied with each system. In 1978, one experiment was carried out in Maro dried peas at Leighton Bromswold (Cambs.) and in 1979, the experiments were made in a crop of Maro peas at Moulton Eaugate (Lincs.) and in a crop of Vedette peas at Staunton (Notts.).

In 1978, the first spray was applied to the Maro crop, which was in full flower, on 28th June, 10 days after the first threshold catch of moths was recorded. The second application was made on 10th July. Flowers were still present at the top of the plants, but most plants had set pods at 6 nodes. The weather during this period was cool with some rain falling on most days.

In 1979, the Vedette crop was sprayed on 1st July, 12 days after the threshold catch was reached, when the percentage egg development, calculated from daily maximum and minimum temperatures, had reached 100. The traps in the Maro crop at Moulton Eaugate caught a threshold number of moths on the 19th June and the first spray was applied on 5th July, in conjunction with maximum egg development.

In both years, each experiment was in the form of a fully randomised small plot field trial with three replications. The individual plots measured 5m x 2m. Sprays were applied using a Van der Weij plot sprayer at 2.1 kg/cm^2 pressure in 560 l. water/ha.

Each of the Maro crops received a second application of sprays between 10 and 14 days after the first, but the Vedette, because it was earlier maturing and had most of its pods set at the time of the first spray, did not receive a second application. (PGRO, 1979).

In each experiment, several pyrethroid insecticides were compared with the organo phosphorus material, triazophos and an untreated control. In 1978, dimethoate was added to the triazophos and pirimicarb to permethrin for added aphid control. Details of the treatments and rates of application are shown in Table 1.

At harvest, plants from each plot were pulled by hand and threshed in a Garvie plot viner, assessments of moth damage being made from 1,000 g of produce from each plot. The weight of the damaged peas from each plot was recorded.

RESULTS

In all experiments, the overall level of moth damage was low, ranging from 51.6 g to 8.51 g of damage in 1000 g of produce taken from the untreated plots. The variability in the experiments was always high, but the outstanding level of control achieved by the insecticides was such that statistical significance at the 5% level was obtained in all cases. The detailed results are shown in Table 1.

In all experiments, the insecticide treatments significantly reduced damage compared to the untreated controls. The pyrethroid materials resulted in control equal to that given by triazophos, there being no statistically significant difference in effectiveness of control between any of the treatments.

DISCUSSION

On all sites, the recording of moth numbers and some of the daily temperatures was carried out by the growers who provided the trial sites and this did not present difficulties in either identifying the first moths or keeping accurate records. In 1978, the cool temperatures prevailing during the time of egg development would have prolonged the time taken to reach the hatching stage, but good levels of control of damage were achieved, possibly resulting from the second application of the insecticides which coincided with main egg hatch and linked with the persistence of the materials on the plant.

In 1979 the capture data showed that the threshold numbers of moths were achieved on the same date at both sites but the differences in temperatures between the sites meant that complete egg development in Lincolnshire was later than in Nottinghamshire.

Table 1

Effects of insecticides on the amount of pea moth damage

Material	Formulation	Rate kg a.i./ha	1978 (Cambs.) g. damage in 1000 g	1978 (Cambs.) % control	1979 (Lincs.) g. damage in 1000 g	1979 (Lincs.) % control	1979 (Notts.) g. damage in 1000 g	1979 (Notts.) % control
permethrin (+ pirimicarb in 1978)	25% E.C. (50% D.G.)	0.050(+0.050)	4.1	92	1.12	87	1.30	94
cypermethrin (JF 5705F)	10% E.C.	0.025	-	-	0	100	1.12	95
" "	"	0.030	-	-	0.71	92	1.78	92
cypermethrin (WL 43467)	10% E.C.	0.025	3.0	94	0.63	93	2.64	89
fenvalerate (S.5602)	10% E.C.	0.025	7.6	85	1.61	80	3.32	86
NRDC 161	2.5% E.C.	0.0125	4.4	92	1.94	77	2.75	88
triazophos (+ dimethoate in 1978)	40% E.C. (40% E.C.)	0.34(+0.17)	5.4	90	0.17	98	1.42	94
Untreated control		-	51.6	0	8.51	0	22.87	0
S.E. as % general mean			46		57.8		40.7	
LSD @ p = 0.05			13.9		2.05		3.25	

E.C. = emulsifiable concentrate, D.G. = dispersible grain.

The experiments demonstrated the effectiveness of the pyrethroid materials compared with the organo-phosphorus compound, triazophos which previous work had shown to be the most effective material in commercial use to date Biddle (1979). The results obtained from the Vedette crop, where only a single application was used, indicated that the pyrethroid insecticides remained active over a similar length of time as triazophos. However, the growth stage of the crop at the time of application was such that the plants were vulnerable to damage for a shorter period than the less developed, and later-maturing variety Maro, at the other site.

It was also interesting to note that this late drilled crop of Vedette was susceptible to moth damage, as this variety, when drilled at a normal sowing date in early March, usually escapes damage. This is due possibly to the fact that there are no flowers present at the time of peak moth flights, which would attract the females emerging from the overwintering sites.

The accuracy of the pheromone trapping system was also demonstrated in these experiments, in that excellent control of pea moth damage was obtained at all sites under different conditions of temperature and crop stage. This degree of consistency was not always obtained with the warning method based on egg counts Biddle (1977).

Although the most frequently used insecticides to date are very effective, a major disadvantage is the time interval which is required to lapse between application and harvest. This is especially relevant to vining peas which are harvested at a much earlier maturity than dried peas. Triazophos, for example requires an interval of 21 days. In the case of permethrin and NRDC 161, however, no interval is required and it is likely that the other pyrethroid materials will be the subject of similar recommendations. This advantage, coupled with the high activity against the pest and with less damaging environmental effects, make pyrethroid insecticides a more preferable choice.

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