Insecticide treatments and controls produced significantly more filled and less unfilled seeds per head in both years than did the bagged treatment (Table 3). Endosulfan sprays produced the most filled seeds per head in 1978 — 79 and with monocrotophos the most in 1979 — 80. Numbers of unfilled seeds per head were lowest after endosulfan and monocrotophos sprays in 1978 — 79 whilst in the following year there were no significant differences between insecticide treatments and controls.

Bagging significantly decreased the number of viable seeds whilst there were no differences between insecticides and controls (Table 4).

There was little differences between oil content of seeds except the bagged treatments were about 4% lower (Table 4).

Table 4. Effect of variation of pollinator activities by bagging flower heads and insecticidal treatment on viability and oil content of seeds.

Treatments	Number of viable seeds out of 100 seeds		Oil per cent in seeds	
	1978 — 79	1979 — 80	1978 — 79	1979 — 80
Control (untreated)	95.00	97.00	41.50	41.95
Bagged	87.00	93.00	38.00	37.05
Monocrotophos	97.00	98.00	42.00	42.00
Endosulfan	99.00	98.00	42.00	42.50
Quinalphos	96.00	97.00	41.00	43.00
S.Em ±	2.51	1.32	—	—
C.D. 5%	7.72	4.02	—	—

DISCUSSION

The restriction of pollinator activity to the middle part of the day supports the correlation between atmospheric temperature and bee visits to sunflower heads found by Desmukh and Nachane (1977).

The presence of pollinators has a beneficial effect on sunflower production especially in the production of filled seeds with higher seed weight and a reduction in the number of unfilled seeds/head. Longridge and Goodman (1974) also found that the number of seeds set increased significantly where bees had access to heads over those heads where bees were excluded. Pollination also increased viability of the seeds similar to the findings of Longridge and Goodman (1974). The decrease in oil content in "bagged" heads may be due to decreased lipid synthesis resulting from lack of effective pollination. Rao *et al.,* (1980) obtained a 6.9% increase in oil content resulting from bee pollination compared to where pollinators were absent.

Although all three chemicals gave some degree of control endosulfan must be rated as the best control. Even though after five days it was ineffective against whitefly it was the least harmful to pollinators and gave increased yield, increased seed weight, more filled and less unfilled seeds and good viability. Where whitefly is likely to be a problem either monocrotophos or quinalphos should be applied.

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EFFECT OF MALDISON (MALATHION ULV) ON SUNFLOWER INSECTS.

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ABSTRACT

Maldison is one of the commonly used insecticides for control of Rutherglen bug (*Nysius vinitor*) in sunflowers. Its effect on both beneficial and pest species was monitored on a sunflower crop sprayed aerially at 3 weeks post flowering. The treatments were Malathion ULV 450 mls and 900 mls of 118% product per hectare (530 gms a.i./ha and 1.06 kgs a.i./ha respectively) and an unsprayed control. Both rates of maldison gave excellent control of Rutherglen bug adults but had no effect at all on nymphs. In fact the nymphal survival rate (average daily number of nymphs surviving/egg laying female day) increased dramatically for both spray treatments compared to the control. This was no doubt due to the effect of the sprays on the predators. Malathion 450 and 900 were equally detrimental to *Geocoris lubra, Deraeocoris signatus, Camplyomma livida,* and spiders. Malathion was ineffective against *Heliothis* spp. larvae and white flies (*Trialeurodes vaporariorum*) but both rates were quite effective on leaf hoppers (*Austroasca viridigrisea*).

INTRODUCTION

Maldison and endosulfan are the two most commonly used insecticides on sunflowers. Endosulfan is used on infestations of Rutherglen bugs (*Nysius* spp.) and/or *Heliothis* spp. whereas maldison is used as a cheap alternative where Rutherglen bugs are the sole problem. It carries a current registration for control of Rutherglen bugs in sunflowers at the rate of 450 — 900 mls of the 118% ULV product per hectare (0.53 — 1.06 kgs a.i./ha). This trial was designed to demonstrate the effects of maldison on the whole insect fauna on sunflowers. The effect of an insecticide on both the beneficial and pest species is an important starting point of any pest management programme.

MATERIALS AND METHODS

The trial area consisted of a block of dryland Hysun 30 sunflowers, 700 metres long by 120 metres wide, sown on the Liverpool Plains Field Station, Breeza, N.S.W. The crop was sown at 42,000 plants/ha in 96 cm rows on 27 November 1979, and sprayed once from the air, 3 weeks after flowering on 26 February 1980. There were three treatments;—

1. Malathion ULV 450 mls 118% W/V product/ha (530 gms a.i. maldison/ha).
2. Malathion ULV 900 mls 118% W/V product/ha (1.06 kgs a.i. maldison/ha).
3. Unsprayed control

These were arranged in a randomised complete block with two replications. Each plot consisted of 3 swath widths, each 18 metres wide by 120 metres long. All three swath widths were flown from the same direction (that is from north west to south east), to provide as even a distribution of insecticide as possible. Each plot was separated on either side by another 3 swath widths (54 metres) of unsprayed buffer. Only the middle swath was sampled for insects.

The trial was sprayed by an aircraft fitted with 4 micronaires. Spraying conditions were:—

Time of day 0900
Temperature 25°C
Wind speed 1 to 4 metres/second
Wind direction from the east

Leaf feeding insects were sampled at 1 day before and 6 days after spraying. Thirty leaves per plot were sampled, with ten each being taken from the top, middle and bottom of the plants. The leaves were washed in 80% ethanol to remove most insects and were then examined under a stereomicroscope for any insects left attached to the leaves, particularly white-fly nymphs and pupae.

Head feeding insects were sampled at 1 day before and 3, 7 and 14 days after spraying. Fifty heads per plot were sampled and all living insects were hand removed using an aspirator attached to a vauum pump. The adult *Nysius vinitor* were then dissected to determine percentage parasitism and female maturity. The nymphal survival rate was calculated as the average daily number of nymphs surviving per egg laying female day:—

nymphal survival rate at 3 days post spray =

$$\frac{1}{4}\,\frac{(\text{no. nymphs at 3 days post — no. nymphs at pre-spray})}{(4 \times \text{no. of egg laying females at pre-spray})}$$

nymphal survival rate at 7 days post spray =

$$\frac{1}{4}\,\frac{(\text{no. nymphs at 7 days post — no. nymphs at 3 days post})}{(4 \times \text{no. of egg laying females at 3 days post})}$$

nymphal survival rate at 14 days post spray =

$$\frac{1}{7}\,\frac{(\text{no. nymphs at 14 days post — no. nymphs at 7 days post})}{(4 \times \text{no. of egg laying females at 7 days post})}$$

These formulae allow for an egg incubation period of some 4 — 5 days.

The data were analysed as two factor split plot analyses of variance with assessment time being the split factor and insecticide treatment the other. All the data were transformed to log x or log x + 1 prior to analysis except for those of spiders and *Heliothis* spp. larvae, the analyses of which were performed on the untransformed data.

RESULTS

Effect of leaf feeders.

The results for these data are listed in Table 1. Although many beneficial and pest species were found on the sunflower leaves only white-fly (*Trialeurodes vaporariorum* (Westwood)) and the green leaf hopper (*Austroasca viridigrisea* Paoli) were in sufficient numbers to analyse statistically. Green leaf hopper adults had decreased naturally by 6 days post spray but the nymphs remained constant in the unsprayed control. The low rate of maldison (Malathion 450) killed 94% of the nymphs while the high rate (Melathion 900) was significantly better with 99% kill. Hence both rates of maldison were quite effective on this species.

Table 1. Effect of maldison on leaf feeding sunflower pests. Means, in the same rows or columns, followed by the same letter, are not significantly different at the 5% level.

	Treatment (Factor A)	Days after spraying (Factor B)		Statistical significance at 0.05	
	Trialeurodes vaporariorum average no./30 leaves	−1	+6	Factor B	Interaction AB
nymphs	Malathion 530 gms a.i./ha	223	129		
	Malathion 1.06 kgs a.i./ha	130	284	n.s.	n.s.
	Control	56	127		
pupae	Malathion 530 gms a.i./ha	12a	97c		
	Malathion 1.06 kgs a.i./ha	70bc	122c	Yes	Yes
	Control	19ab	89c		
adults	Malathion 530 gms a.i./ha	1	12		
	Malathion 1.06 kgs a.i./ha	61	59	n.s.	n.s.
	Control	70	68		
	Austroasca viridigrisea average no./30 leaves				
nymphs	Malathion 530 gms a.i./ha	140a	8b		
	Malathion 1.06 kgs a.i./ha	134a	1c	Yes	Yes
	Control	203a	157a		
adults	Malathion 530 gms a.i./ha	74	1		
	Malathion 1.06 kgs a.i./ha	94	1	Yes	n.s.
	Control	169	47		

White-fly nymphs and adults remained unaffected after spraying in all treatments but the pupae showed a 4.7 fold increase for the control and 8.1 fold increase for Malathion 450. The number of pupae remained steady in Malathion 900. Hence both rates of maldison were quite ineffective in controlling white fly, except that Malathion 900 may have prevented an increase in pupal numbers by either killing some pupae on late stage nymphs. It would be more likely to be the latter as white-fly pupae are unaffected by most insecticides (French *et. al.,* 1973).

Effect on Rutherglen bugs.

The results for these data are listed in Table 2. *Nysius vinitor* Bergroth nymphs increased steadily in all treatments. Malathion 450 increased 41 fold over a two week period post spray while Malathion 900 increased 50 fold and the unsprayed control 60 fold. Hence both rates of maldison failed to prevent a nymphal buildup.

Table 2. Effect of maldison of Rutherglen bug *(Nysius vinitor)* on sunflowers. Means, in the same rows or columns, followed by the same letter, are not significantly different at the 5% level.

Nysius vinitor	Treatment (Factor A)	−1	Days after spraying (Factor B) +3	+7	+14	Statistical significance at 0.05 Factor B	Interaction AB
nymphs/50 head	Malathion 530 gms a.i./ha	12	21	43	489		
	Malathion 1.06 kgs a.i./ha	6	31	133	274	Yes	n.s.
	Control	8	72	224	474		
adults/50 heads	Malathion 530 gms a.i./ha	220a	13bc	5b	13b		
	Malathion 1.05 kgs a.i./ha	241a	11bc	6b	4b	Yes	Yes
	Control	49a	89ac	99a	14b		
nymphal survival rate (av. daily no. of nymphs surviving/50 heads/egg laying female day)	Malathion 530 gms a.i./ha	—	0.01a	0.23a	15.95b		
	Malathion 1.06 kgs a.i./ha	—	0.02a	2.72a	9.81b	Yes	Yes
	Control	—	0.19a	0.25a	0.16a		

N. vinitor adults gave quite a different result. By one week post spray, both Malathion 450 and Malathion 900 had reduced adult numbers by 98%, while at the same time, the control remained steady. However, by 2 weeks post spray, the control had begun to decrease naturally. Hence, both rates of maldison were equally effective on adults.

The nymphal survival rate remained steady in all treatments up to 1 week post spray. However, by 2 weeks post spray, although the control survival rate had still not changed, there was a dramatic increase in both of the spray treatments. The Malathion 450 survival rate had increased around 1600 fold while Malathion 900 had increased approximately 500 fold.

Effect on beneficials.

Although parasitism rates of *N. vinitor* by the tachinid *Alphora lepidofera* (Malloch) were collected, they were not sufficient to analyse statistically. Only the effect of the sprays on predators could be followed and these data are listed in Table 3.

***Geocoris lubra* Kirkaldy; big eyed bug.**

The control increased 1.5 fold by 3 days post spray and remained constant for 2 weeks. Malathion 450 reduced the population by 37% by 3 days post spray while the higher rate was similar with a 55% reduction. Numbers then remained low in both spray treatments until by 2 weeks post spray, they had increased to pre spray levels for the high rate and 1.6 greater than pre spray levels for the low rate. This increase, no doubt, was in response to the increase in host availability (mainly *N. vinitor* nymphs). Hence, both rates of maldison were equally detrimental to *G. lubra,* but these effects had disappeared by 1 to 2 weeks post spray.

***Deraeocoris signatus* (Distant); brown smudge bug.**

The control had remained steady by 1 week post spray, but both rates of maldison were equally detrimental to this species. Malathion 450 reduced numbers by 100% while Malathion 900 was similar with an 81% reduction.

***Camplyomma livida* Reuter; apple dimpling bug.**

The control numbers remained constant at 3 days post spray but had begun to decline naturally by 1 week post spray. Malathion 450 and Malathion 900 reduced the population by 98% and 89% respectively, by 3 days post spray. Hence both rates of maldison were equally detrimental on dimple bug adults.

***Orius* sp.; black flower bug.**

An examination of the raw data would suggest that both rates of maldison were equally detrimental to this species at 3 days post spray, followed by a natural decline thereafter. Unfortunately, this could not be validated statistically, as only the time factor proved significnt, indicating a natural decline in numbers post spray.

Spiders; these included a complex of species made up of as follows:—

Oxyopes spp. (lynx spiders)
Chiracanthium diversum Koch.; (yellow night stalker)
Clubiona sp.
Achaearanea veruculata (Urquhart); (tangle web spider)
Diaea spp. (flower spiders)
Family Argiopidae (orb web spiders)
Family Salticidae (jumping spiders)

The control increased significantly at each post spray sampling time and by 2 weeks post spray, was 14 fold greater than the pre spray levels. Malathion 450 and Malathion 900 did not reduce spider numbers, but kept them low for a week after spraying. By 2 weeks post spray, Malathion 450 and Malathion 900 had only increased by 3.1 and 2.7 fold respectively over pre spray levels. Hence, both rates of maldison were equally detrimental to the spider complex but this effect had disappeared between 1 and 2 weeks post spray.

Effect of *Heliothis* spp.

Heliothis spp. larval numbers decreased naturally in all treatments (Table 4). However, the sprayed treatments declined no faster than the control, which would tend to indicate that both rates of maldison had little or no effect on *Heliothis* spp. larvae. Subsequent rearing of larvae showed the population to be predominantly *H. armiger* (over 90% at pre spray) with the rest being *H. punctiger* (Wallengren).

Table 3. Effect of maldison on rutherglen bug and heliothis predators on sunflowers. Means in the same rows or columns, followed by the same letter, are not significantly different at the 5% level.

	Treatment (Factor A)	Days after spraying (Factor B) −1	+3	+7	+14	Statistical Significance at 0.05 Factor B	Interaction AB
Geocoris lubra (adults and nymphs/50 heads)	Malathion 530 gms a.i./ha	17.5a	11b	3.5c	28de	Yes	Yes
	Malathion 1.06 kgs a.i./ha	16.5a	7.5b	8bc	14ae		
	Control	15a	23b	23bc	24be		
Deraeocoris signatus (adults and nymphs/50 heads)	Malathion 530 gms a.i./ha	15a	—	0b	—	Yes	Yes
	Malathion 1.06 kgs a.i./ha	10.5a	—	2b	—		
	control	13a	—	9.5a	—		
Camplyomma livida (adults/50 heads)	Malathion 530 gms a.i./ha	43a	1b	0.5bc	0bc	Yes	Yes
	Malathion 1.06 kgsa.i./ha	27.5a	3b	0.5c	0.5c		
	Control	36a	19a	7d	1.5c		
Orius sp. (adults and nymphs/50 heads)	Malathion 530 gm a.i./ha	83	24.5	7	8	Yes	n.s.
	Malathion 1.06 kgs a.i./ha	119	38.5	15.5	7		
	Control	94.5	101.5	67	21		
Spiders (all stages/50 heads)	Malathion 530 gms a.i./ha	8.5a	9ac	9a	26b	Yes	Yes
	Malathion 1.06 kgs a.i./ha	6a	8ac	10.5ab	16b		
	Control	4.5a	25.5c	36d	62.5e		

Table 4. Effect of maldison on *Heliothis* spp. larvae on sunflowers.

	Treatment (Factor A)	Days after spraying (Factor B) −1	+3	+7	+14	Statistical Significance at 0.05 Factor B	Interaction AB
No. of *Heliothis* spp. larvae/50 heads	Malathion 530 gms a.i./ha	56	30.5	12	5	Yes	n.s.
	Malathion 1.06 kgs a.i./ha	46.5	20.5	13	5		
	Control	37.5	23	14	6		

DISCUSSION

Effect on leaf feeders.

Maldison was effective on the green leafhopper *A. viridigrisea,* even showing a slight, but significant rate response. However, it was ineffective against white fly *T. vaporariorum,* except perhaps for some slight activity at the high rate. Green leafhoppers are not considered a problem in sunflowers whereas white fly are a minor pest. However, in some years, they are particularly troublesome causing severe damage and proving very difficult to control (Forrester, 1980).

A. viridigrisea (along with white fly) are found on the underside of sunflower leaves, particularly the lower ones. The fact that maldison was effective against *A. viridigrisea* indicates that the sprays did contact the underside of even the bottom leaves, despite the fact that due to heliotropism, the tops of the leaves would have been angled into the wind. Thus failure of maldison to control white fly in this trial, would be due to the failure of the chemical itself and not the application.

Effect on Rutherglen bugs.

Both rates of maldison effectively removed the adult bugs but had no effect whatsoever on the nymphs or subsequent hatchings. Malathion 450 was just as good on adults as Malathion 900, but it must be borne in mind that the pest pressure in this trial was low (4 — 5 adults/head) and that the higher rate could be better under heavier pest pressure.

An examination of the nymphal survival rate clearly indicates an explosion in nymphal survival in the sprayed areas at 1 — 2 weeks post spray. This is no doubt due to the removal of the predatory pressure in the sprayed areas.

This trial shows quite clearly the importance of timing sprays for Rutherglen bug control. This trial was sprayed at 3 weeks after flowering by which time nymphs were just beginning to appear on the heads. This is too late to expect good results. The sprays may have removed the adults but by this stage, most of the eggs had been laid anyway. In addition, the sprays removed most of the predators, allowing greater survival of subsequent hatchings. Although nymphal numbers were low in this trial (about 10/head), in a moderate infestation, there can be thousands of nymphs per head causing severe economic damage. It is essential to prevent this nymphal buildup, by spraying the egg laying adults in the immediate post flowering period. Both rates of maldison would be quite effective for this purpose. Spraying after nymphs begin to appear on the heads, as happens in many field situations, can be seen to be a fruitless endeavour.

Effect on Beneficials.

Both rates of maldison were equally detrimental to the facultative predators *Geocoris lubra, Deraeocoris signatus, Camplyomma livida* and the spider complex. The effect on *Orius* sp. was less clear. These detrimental effects had disappeared after 1 — 2 weeks post spray for *G. lubra* and the spider complex, indicating about a one week residual control period for these predators. No conclusions could be drawn for the other predators due to naturally declining populations.

The detrimental effects of maldison on the predators were not entirely unexpected as four of the five predatory groups monitored in this trial (along with the main host *N. vinitor)* were small heteropterans. Such a situation does not augur well for a pest management programme.

Effect on *Heliothis* spp.

Although the trial was performed on a declining population the indications were that both rates of maldison were ineffective against *Heliothis* spp. This was not unexpected as maldison has never been regarded as a particularly useful insecticide against either *Heliothis* sp.

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