yields ranged from 1.2 to 2.5 tonnes/ha. Assuming an average price of $250/tonne for sunflower seed, and average yields of 2.0t/ha, irrigated and 0.7 t/ha, dryland (the Australian Bureau of Agricultural Economic's average Australian sunflower yield for the past 4 years), it can be shown that a 7.5% decrease in the irrigated yield would cost $38/ha whereas a 33% decrease in the dryland yield would cost $58/ha. These losses are well within the cost of 1 or 2 sprays. ($12 — $24/ha).

Since head size was not affected by Rutherglen bug feeding, grain yield per unit head area proved a satisfactory and valid measure of overall yield.

Effect on oil content. Rutherglen bugs caused quite significant drops in oil content in both crops, but particularly so in the dryland crop. This type of damage is very important as growers' oil content premiums could be discounted quite severely. Previous work (Forrester, 1980; Broadley and Rossiter, 1980) had not demonstrated such drastic effects on oil content. These results may demonstrate that the bugs can actually feed on the oil itself as well as on the precursors being directed to the developing seed.

Effect on linoleic acid. Linoleic acid was not particularly high in any of the treatments but this was expected due to the high temperatures experienced during maturation. Both crops experienced significant decreases in linoleic acid due to bug feeding. This type of damage has not previously been reported (Broadley and Rossiter, 1980).

Effect on germination. Germination, as determined by a seedling emergence pot test, was very substantially reduced by Rutherglen bug feeding, particularly in the dryland crop. Broadley and Rossiter, (1980) found similarly that bug feeding on the exposed ends of the seeds, though not affecting the viability of the protected embryo, still managed to significantly reduce germination in unsprayed crops.

Although this finding may not be of interest to oilseed crushers, it would be of considerable importance to hybrid seed production companies.

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SUNFLOWER SEED YIELD AS INFLUENCED BY POLLINATION AND INSECT PESTS.

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ABSTRACT

Results of the experiment conducted during winter seasons of 1978 — 79 and 1979 — 80 at Kalyani, West Bengal revealed that (i) spraying endosulfan at 0.07% significantly increased seed yield; number of filled seeds/head and 1000 seed weight over control (ii) application of insecticides tended to increase the oil percentage in seeds over bagged and no application of insecticides, (iii) spraying of insecticides like endosulfan significantly decreased the population of injurious insects and proved less injurious to pollinating insects especially bees, (iv) pollinating insects play a much greater role in enhancing seed yield and in providing better yield attributes, (v) flower heads when bagged before opening to prevent insect pollination, produced far less yield of seed, lower seed weight, low viability and lower oil content.

INTRODUCTION

Sunflower, introduced into India in 1969, provides an alternative to other oil-seed crops for the production of edible oil. In order to assess the potential of this crop in West Bengal aspects of the effects of pollinators and insect pests were investigated.

MATERIALS AND METHODS

A randomized block design incorporating plots of 4 m x 4 m and four replications was used to assess the effects of five treatments:

(i) Control — no insecticide and natural pollination;
(ii) Bagging — no insecticide and pollinators excluded;
(iii) Monocrotophos — at 0.04%;
(iv) Endosulfan — at 0.07%; and
(v) Quinalphos — at 0.025%.

Insecticides were applied in 500L of water/ha with sprays at initiation of flower opening and 10 and 20 days thereafter.

The variety E.C.68414 (Peredovik) was sown at Kalyani in mid November 1978 and 1979 and harvested the following mid March. The experiment was sown into a sandy loam with pH of 7.6, organic carbon of 0.46%, total N of 0.061%, available P_2O_5 of 35 kg/ha and available K_2O of 120 kg/ha. The crop received 60 kg of N/ha, 40 kg of P_2O_5/ha and 40kg of K_2O/ha and normal agronomic practices were observed.

Pollinators were collected from one day after insecticide application at 3-day intervals until completion of pollination. Collections were made at 2-hourly intervals from 06.00 to 16.00 by 5 sweeps over each plot with a standard sweep net. Pest species were recorded 1 and 5 days after insecticide treatment. Jassids and whiteflies were counted on 5 leaves of each of 5 plants per plot and caterpillars on all of the 5 plants per plot.

Oil content was determined after ether (60 — 80°C B.P.) extraction using Soxhlet's apparatus. The TZ test, using 2, 3, 5 — triphenyl tetrazolium chloride, was used to determine seed viability.

RESULTS

Effect on pollinators.

Pollinators comprised honey bees (especially *Apis dorsata* F.) and a negligible number of butterflies. Major activity was between 10.00 and 14.00 with virtually no bees before 08.00.

Insecticides reduced the number of pollinators (Table 1) but endosulfan was less harmful than either monocrotophos or quinalphos.

Effect on pest species.

Insecticides significantly reduced the populations of the jassid *Amrasca kerri* Pruthi, the white-fly *Bemesia tabaci* L. and the semilooper *Plusia orichalcea* F. at the one-day count (Table 1). After 5 days pests in all treatments were still significantly lower except whiteflies in endosulfan treatments.

Table 1. Effect of insecticides on population of pollinators and insects pests of sunflowers.

Treatments	No. of bees per 30 sweeps (Mean of 4 replication)	Mean population of insect per plant					
		One day after treatments			Five days after treatments		
		Jassid	White-fly	Semi-looper	Jassid	White-fly	Semi-looper
Control (untreated)	44.25	13.25	60.25	15.25	16.25	79.25	10.00
Bagging of head	—	12.50	56.00	18.00	13.00	65.50	11.25
Monocrotophos	10.50	1.75	7.00	3.00	1.00	8.00	2.00
Endosulfan	31.50	4.00	30.00	3.00	5.00	72.75	2.75
Quinalphos	8.25	4.50	9.75	3.50	3.75	7.50	7.00
S. Em ±		1.87	9.31	1.62	1.33	14.55	1.78
C.D. 5%		5.72	28.40	4.95	4.06	44.38	5.43

Effect on yield.

Yield was significantly higher in all treatments where pollinators were not excluded in comparison to where heads were bagged (Table 2). In 1978 — 79 insecticide treatments significantly improved yield over the control plots but in 1979 — 80 only endosulfan significantly increased yield (Table 2).

In 1978 — 79 only endosulfan and quinalphos increased the weight of 1000 seeds over that in the bagged treatment whilst in 1979 — 80 all insecticides increased yield over the bagged treatment but the quinalphos treatment was not significantly different from the control (Table 3).

Table 2. Effect of exclusion of pollination and insecticidal treatments on seed yield of sunflower during winter season of 1978 — 79 and 1979 — 80.

Treatments	Seed yield (q/ha) 1978 — 79	Seed yield (q/ha) 1979 — 80
Control (untreated)	11.60	13.86
Bagged	4.29	4.10
Monocrotophos	19.19	12.41
Endosulfan	21.87	19.00
Quinalphos	18.45	16.55
S. Em ±	1.68	1.49
C.D. 5%	5.17	4.59

Table 3. Effect of activity of pollinators and pesticides on different yield attributes of sunflowers.

Treatments	1000 seed weight (gm)		No. of filled seeds/head		No. of unfilled seeds/head	
	1978 — 79	1979 — 80	1978 — 79	1979 — 80	1978 — 79	1979 — 80
Control (untreated)	59.57	60.25	288.12	303.12	267.00	164.25
Bagged	56.75	58.50	76.75	86.00	452.00	369.82
Monocrotophos	60.88	62.75	404.32	340.30	211.87	123.50
Endosulfan	64.98	63.75	470.25	428.80	190.62	141.50
Quinalphos	62.99	62.25	394.25	336.80	243.00	143.50
S.Em ±	1.89	0.70	37.33	18.74	16.24	33.80
C.D. 5%	5.81	2.14	114.57	57.51	49.84	103.09

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*).