EFFECT OF MOISTURE STRESS ON DAMAGE TO SUNFLOWERS BY RUTHERGLEN BUG (*NYSIUS VINITOR*).

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ABSTRACT

Severe Rutherglen bug *(Nysius vinitor)* infestations on identical dryland and irrigated sunflower blocks, allowed an evaluation of the effect of moisture stress on the economic damage caused by these bugs. In the irrigated crop, Rutherglen bugs reduced grain yield by 7.5%, oil content by 17%, linoleic acid by 13% and germination by 44%. In comparison the percentage reductions in the dryland crop were grain yield (33%), oil content (28%) linoleic acid (6.4%) and germination (97%). Hence Rutherglen bug control assumes critical importance in moisture stressed crops.

INTRODUCTION

The economic effects of Rutherglen bug feeding on sunflowers has been only scantily researched (Forrester, 1980; Broadley and Rossiter, 1980), with very little data being produced on actual damage levels. Quite often, this damage can be profoundly influenced by the moisture status of the host crop. Since Rutherglen bugs are a sucking type pest, it has been postulated in the past that sunflower crops, growing under ideal moisture conditions, would incur less damage than those suffering from moisture stress.

This trial was designed to test this theory and to document actual damage levels in relation to sunflower yield, oil content, oil quality and germination.

MATERIALS AND METHODS

Two identical blocks of sunflowers (Hysun 30) were sown on the Liverpool Plains Field Station, Breeza. Both blocks were sown on 18 September 1978; each block was 0.6 hectares; each block had 100,000 established plants/hectare; both blocks had 50 kg N and 12 kg P/hectare applied pre-plant, and both were planted on raised irrigation beds with 2 rows/bed (96 cms apart). The high sowing rate (2 to 4 times that normally recommended for dryland crops) was deliberately chosen to ensure that the dryland crop would be stressed even if normally adequate rainfall was experienced.

Both crops flowered in late December and had matured by mid February (see Table 2). Total rainfall received on both crops was 234 mm pre flowering (September 18 to December 28, 1978) and only 42.5 mm post flowering (all January and February). In addition to the rainfall, the irrigated block received 2 pre flowering and 3 post flowering irrigations. Average daily maximum and minimum air temperatures during the post flowering period, averaged 34.9°C and 16.7°C respectively. The four treatments were:

1) Bug free (Irrigated) — Fine muslin bags (37 cms long by 32 cms wide) were placed over the sunflower heads just before flowering. The heads were then cross pollinated to ensure adequate seed set. The bags were left on until harvest to exclude Rutherglen bugs and *Heliothis* spp. larvae. A total of 43 heads in the irrigated block were bagged.

2) Bug free (Dryland) — As above, except that the heads were chosen from the dryland block. A total of 44 heads were bagged.

3) Bug damaged (Irrigated) — The heads were left unbagged. They received the same cross pollination treatment as the protected heads. A total of 46 heads in the irrigated block were bagged.

4) Bug damaged (Dryland) — As above, except that the heads were chosen from the dryland block. A total of 38 heads were bagged.

The muslin bags proved quite effective in keeping out the extremely high numbers of Rutherglen bugs encountered in this trial. However, it was found that *Heliothis* spp. eggs were transferred onto the bagged heads during the cross pollination process. In fact, *Heliothis* spp. larvae had to be hand removed from both the bagged and unbagged heads every few days, so that the damage sustained could be attributed solely to Rutherglen bugs. *Nysius vinitor* and *Heliothis* spp. were the only significant pests occurring in this trial.

The bug population was monitored by sampling 30 heads every week from both the dryland and irrigated blocks. Adult and nymphal bugs were extracted from the heads by an aspirator attached to a vacuum pump. Small Rutherglen bug nymphs are not easy to detect and are difficult to extract, when they shelter among the base of the seeds. Consequently the nymphal numbers recorded are only approximate and would be conservative underestimates of the actual populations.

The characters that were compared were:—

1) Head Area — Head diameter was recorded on dried heads by measuring the distance between the outer rows of seeds (the dried floret remains having been removed). Two perpendicular diameters were taken on each head and averaged, to account for non-circular heads. Results are expressed as square centimetres where Area = πr^2. (r = radius).

2) Dry weight grain yield (gms)/100 sq. cms. head area — The heads were hand harvested and threshed, with the set seeds being oven dried for 24 hours at 105°C. The dry weight grain yield (0% moisture basis), of each individual head was then converted to a grain yield for a standard head area. The head area chosen was 100 square centimetres but this is merely an arbitrary figure. This was done to remove the variability in grain yields due to head size rather than that due to actual treatment differences. When sunflower grain yields are done on a small number of heads, head size variation can confound the results, as head size (and consequently the number of seeds and ultimately yield) varies as the square of the radius.

3) Oil Content — A 30 ml or 6.5 ml subsample (depending on sample size) was taken from each head and oven dried to remove all moisture. Oil content was determined on a Newport Instruments Nuclear Magnetic Resonator against standard sunflower oil samples, using the following formula:—

$$\%\ \text{oil content} = \frac{\text{(NMR signal from seed)}}{\text{(NMR signal from oil)}} \times \frac{\text{(Wt. of oil sample)}}{\text{(Dry Weight of seed)}} \times 100$$

4) Linoleic acid — Preparation of fatty acid methyl-esters. About 50 dehulled seeds from each head were ground in a coffee grinder. A 30 mg sample was then crushed in 3 ml petroleum ether in a 20 ml Quickfit stoppered tube. The tube was vigorously shaken on a Vortex mixer and allowed to stand at room temperature for 30 minutes. Sodium methoxide (1 ml) was then added and the tube gently shaken and allowed to stand. An aliquot (2 microlitres) of the top layer of petroleum ether was used for the analysis of the fatty acids. **Determination of fatty acids.** The fatty acids were determined by using a Varian model 2400 Gas Liquid Chromatograph equipped with a dual flame ionisation detector. Injection and detector temperatures were maintained at 270°C. Flow rates were 30 mls/min. for nitrogen (carrier gas), 20 mls/min. for hydrogen and about 250 mls/min. for air. Stainless steel columns (6ft. long x ⅛" outer diameter), packed with 5% diethylene glycol succinate (DEGS-PS) on 100/120 mesh Supelcopord, were operated isothermly at 190°C. Peak areas were determined by triangulation to calculate the percentage of each fatty acid (i.e. palmitic, stearic, oleic and linoleic). However, only the results for linoleic acid are reported in this trial.

5) Germination Percentage — A subsample of seed from each head was allowed to mature at room temperature for about 2 months after harvest, in order to break any natural dormancy. Fifty seeds from each head were then sown in 10 cm pots (25 seeds/pot) in a soil mixture of 50% sand: 50% black cracking clay soil. The pots were kept moist and held in a glasshouse at 23°C during the day (14 hours) and at 15°C during the night (10 hours). Young healthy seedlings were counted and removed when they reached about 5 cms in height. Pots were kept wet until all further emergence ceased.

The effect of Rutherglen bug feeding on the five characteristics mentioned above was determined by comparing the bug free and the bug damaged heads in non paired 't' tests. The comparisons were made only within irrigated and dryland treatments, as the effect of moisture stress itself on yield etc. was not considered an aim of this trial.

RESULTS

Effect on bug numbers. These data are listed in Table 2. Rutherglen bug numbers were quite high in this trial (up to 500 adults and 1500 nymphs/head), exerting considerable, (though not a typical) pest pressure on both crops. Generally, the irrigated crop had around 1.5 times as many adult bugs per head (nymphs were similar) as the dryland crop. However, the irrigated heads were around 1.5 times as big as the dryland heads (see Table 1). So if one takes into account the smaller heads of the dryland crop, then the number of bugs per unit head area (and hence pest pressure) would have been very similar in both crops. If anything, the irrigated crop would have had the greater pest pressure.

Effect on head size, grain yield, germination, oil content and linoleic acid.

The results for these data are listed in Table 1. Bug feeding had no effect on head size in either crop but significantly reduced the other characteristics by the following percentages:

	Irrigated	Dryland
grain yield/unit head area	28.21 to 26.10 = 7.5% decrease	19.4 to 12.99 = 33% decrease
oil content	51.5 to 42.7 = 17% decrease	43.9 to 31.7% = 28% decrease
linoleic acid	51.9 to 45.0 = 13% decrease	56.2 to 52.6 = 6.4% decrease
germination	99 to 55 = 44% decrease	96.6 to 3 = 97% decrease

Table 1. Economic effects of Rutherglen bug feeding on irrigated and dryland sunflowers at Breeza, N.S.W.

		Head Area (cm^2)	Dry weight grain yield (gms)/100 cm^2 head area	% Oil content	% linoleic	% germination
Irrigated	Bug free	144.1a	28.21a	51.5a	51.9a	99a
	Bug damaged	154.9a	26.10b	42.7b	45.0b	55b

Means in the same columns, followed by the same letter, are not significantly different at the 5% level.

Dryland	Bug free	111.4a	19.40a	43.9a	56.2a	96.6a
	Bug damaged	97.7a	12.99b	31.7b	52.6b	3b

Means in the same columns, followed by the same letter, are not significantly different at the 5% level.

Table 2. Seasonal abundance of *Nysius vinitor* adults and nymphs on unsprayed irrigated and dryland sunflowers at Breeza, N.S.W. (1978/79).

		1978 5 Dec	12 Dec	19 Dec	26 Dec	1979 2 Jan	9 Jan	16 Jan	23 Jan	30 Jan	6 Feb	13 Feb	20 Feb	27 Feb
Average No. of *Nysius vinitor* adults per head	Dryland	2	13	33	30	92	117	41	41	288	338	85	31	14
	Irrigated	2	20	57	36	133	146	71	26	495	509	184	57	32
Average No. of *Nysius vinitor* nymphs per head	Dryland	0	0	0	0	0	4	30	60	1500	300	300	300	100
	Irrigated	0	0	0	0	0	4	20	50	1500	300	300	500	500
Stage of Crop		3cm diameter buds	5cm diameter buds	buds just opening	flowering	petal fall	green		post petal fall, back of heads		yellow	harvest maturity	leaves drying	stems drying

DISCUSSION

Pest pressure was similar in both the irrigated and dryland crops, so the differences between the two blocks in relation to their reaction to Rutherglen bug feeding was due to their physiological status and not differing pest pressure. Furthermore, the physical effect of the bagging process itself has been shown not to affect the characters studied (Forrester, unpublished data).

Effect on grain yield and head size. The stressed crop suffered badly with a third of the potential yield lost compared to only a 7.5% loss in the irrigated crop. Lovett *et al.*, (1979), in a survey of the 1973 — 74 sunflower crop, found dryland yields ranged from 0.6 to 1.2 tonnes/ha whereas irrigated 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.