POTENTIAL FOR PEST MANAGEMENT IN SUNFLOWERS IN AUSTRALIA.

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ABSTRACT

The key pests of sunflower production are Rutherglen bugs (*Nysius* spp.) and heliothis (*Heliothis* spp.). Research so far has looked at the seasonal abundance and natural enemies of both key pests. Currently pest management in sunflowers relies solely on the strategic use of insecticides. Future avenues for research could be:— a) Rutherglen bugs — a search for natural enemies in countries where *Nysius* spp. and sunflowers co-exist in a more harmonious relationship and an investigation into possible sources of host plant resistance. b) Heliothis — Sunflowers have a high tolerance for heliothis damage (more than 2 larvae per head spray threshold) and this should be exploited fully. The main problem with heliothis is the secondary fungal head rot (*Rhizopus* sp.) which follows heliothis damage. Breeding for resistance to the secondary fungus, would be a much better course to follow, than attempting to eliminate the primary pest. In addition the development of self fertility and self pollination in hybrid sunflowers is of critical importance in the development of a pest management programme for sunflowers. This would eliminate the necessity for bees, allowing spraying at flowering if necessary. It would also allow breeders the freedom to look for sources of host plant resistance such as nectar which is unattractive to heliothis moths.

INTRODUCTION

There have been numerous articles describing the main insect pests of sunflowers in Australia (Ingram, 1969; Broadley, 1978; Forrester, 1980a; and Broadley and Ironside, 1980). Various other articles have dealt with individual topics of interest to pest management in sunflowers, (Forrester, 1979 on natural enemies of *Nysius* spp.; Forrester, 1980b; Broadley, 1980a; and Broadley, 1980b on natural enemies of *Heliothis* spp.; Forrester 1980c on seasonal abundance of *Nysius* spp. and *Heliothis* spp. and Broadley, 1980c on economic injury levels of *Heliothis* spp. on sunflowers). However, there has been no effort to co-ordinate all this research and formulate a basic pest management programme or to identify possible fruitful areas for future research. This is the aim of this paper.

DISCUSSION

Pest management can be described as the art of keeping pest populations below economic injury levels. Some of the tools available to entomologists in this endeavour are:—

1) Chemical
— insecticides, pheromones (male sex attractants), kairomones (egg parasite attractants), moulting inhibitors, chemosterilants
2) Biological
— parasites, predators, pathogens (fungi, bacteria, viruses) sterile male technique, host plant resistance
3) Cultural
— e.g. early planting, trap cropping, crop rotation etc.

Only very few of these techniques have been utilised for pest management in sunflowers in Australia. Some useful work has been forthcoming on native biological control agents (Forrester, 1979; Forrester, 1980b; Broadley, 1980a; Broadley, 1980b; Attia, 1973; and Loudon and Attia, 1981). Work has also just begun to examine the possibility of screening for host plant resistance to certain insect pests. However, despite these efforts, pest management in sunflowers in Australia at present relies solely on the strategic use of insecticides. This is because the natural enemies of the key sunflower pests have been shown to be generally inadequate (Forrester, 1979).

Cultural control offers little hope of success either. Early sown crops are subjected to usually severe infestations of *Nysius* spp. and moderate infestations of *Heliothis* spp. Although later sown crops are not troubled greatly by *Nysius* spp. (Forrester, 1980c), they usually suffer severe damage by *Heliothis* spp. larvae.

The following proposed pest management programme for sunflowers in Australia will serve as a basic starting point to be refined as our knowledge increases. It is based on Singh *et al.*, 1978) concept of "co-integrated" pest management where "pest control packages are evaluated on pest complexes of units of crop phenology" rather than the classical American "re-integrated" concept where "separate controls for each major pest are developed and then integrated so they become, as far as possible, mutually non interfering".

Stage of crop:

Seedlings — Main pests are cutworms, true wireworms, false wireworms and crickets. All these pests are sporadic and are best dealt with by insecticides. There are no reliable economic injury levels available for these pests except for wireworms where a level of one wireworm or false wireworm per 900 square centimetres (1 square foot) warrants control (Forrester, 1980a). For cutworms surface sprays applied late in afternoon are best. Maldison-wheat baits are by far the most effective control for plague crickets. Wireworm control has to be applied at or before sowing, which necessitates a sampling programme to identify a wireworm problem before the crop is sown.

Budding Crops — Rutherglen bugs (*Nysius* spp.) are the main problem during budding. They congregate and feed on the stem, causing the head to either wilt and die, or become grossly malformed. Infestations should be controlled immediately when numbers of bugs begin to appear at the back of the buds (approximately 10 adult bugs per plant). Control of this pest is more critical in moisture stressed crops, (Forrester, 1980d). The bugs are well exposed on the stems at this stage, so spray contact is not a problem. If Rutherglen bugs are the only problem at budding, maldison (Malathion ULV) would be the most cost effective chemical. *Heliothis* spp. larvae can be a problem at budding also. However, it is more difficult to control them at budding as the larvae are often concealed within the buds and are virtually impossible to contact with insecticides. Under these conditions, it is best to delay spraying until the buds just begin to open and the yellow petals become visible.

Flowering — The necessity of bees for pollination of sunflowers is currently under close investigation but until any firm conclusions are drawn, it must still be assumed that bees are essential for adequate pollination in both hybrid and open pollinated crops. Currently recommended levels of bee activity for adequate pollination are 1 bee to every 3 — 4 heads. If this level is not being reached naturally, then introduction of hives is suggested (Forrester, 1980e). This requirement for bee pollinators severely limits the opportunities for spraying during flowering. Sometimes, *Heliothis* spp. or *Nysius* spp. might need to be controlled at flowering and in these circumstances, the best course of action is to spray late in the afternoon, after the bees have finished foraging. Of the registered products, endosulfan is the least detrimental to bees.

Petal Fall — Egg laying Rutherglen bug adults are attracted to the sunflower crop at flowering. The crop remains attractive to the bugs for 3 to 5 weeks after flowering, when large numbers of nymphs begin to appear on the heads. By this stage, the faces of the heads have turned over and the concealed bugs are very difficult to contact with insecticide. It is essential to spray these egg laying adults in the 2 — 3 week period between the end of flowering and the time when the heads turn over. Control measure should be implemented when bug numbers average about 25 adults per head. Once again, control of this pest is more critical in moisture stressed

crops. Correct timing of this post flowering spray is quite important as spraying too early may lead to further unnecessary sprays and spraying too late, can prove ineffective (Forrester, 1982). *Heliothis* spp. larvae begin to appear at about this stage as well. The moths are strongly attracted to the nectar at flowering and lay their eggs on the petals, bracts, florets and the back of the heads. The larvae eat leaves, petals, the tops of the developing seeds, or burrow into the back of the head. Damage to the developing seeds is usually slight unless infestations are particularly heavy. In fact, the recommended economic spray threshold for this pest on sunflowers (2 — 3 larvae per head) is quite high compared to other crops (Broadley, 1980c; Forrester, 1980a). However, caterpillars feeding on the back of the head can predispose the crop to secondary fungal head rots (*Rhizopus* spp.). Stressed dryland crops are more prone to secondary head rots than unstressed irrigated crops (Wong and Forrester, 1980). Rainfall is not necessary for these secondary rots to develop, as severe outbreaks (for example, 27% of plants infected) have occurred during dry periods (Forrester, 1980a). Spraying *Heliothis* spp. larvae to control head rot has often been suggested but this proposition could at best be described as extemely dubious. In situations where *Nysius* spp. and *Heliothis* spp. need to be controlled at the same time endosulfan is the recommended chemical. However, in late sown crops, endosulfan often gives poor control of heliothis due to the predominance of the insecticide resistant *Heliothis armiger* species late in the season. Under these circumstances, fenvalerate and methomyl are recommended for heliothis control and these two chemicals do give some measure of control of *Nysius* spp. Further work is continuing in this area, and some newer insecticides (e.g. Cypermethrin) have shown great potential in controlling both *Heliothis* spp. and *Nysius* spp.

Seed Fill — If Rutherglen bugs are not controlled at the appropriate time, large numbers of nymphs and adults would be seething over the heads by this stage. Panic spraying is often attempted but not often effective. Spray coverage is the main problem at this stage, as aerial application is essential in fully grown sunflowers and by this time, the heads have turned over. The use of high mounted boom sprays with droppers and upwardly directed nozzles may be a solution to this problem.

Other minor pests can be a problem at seed fill. Green vegetable bug (*Nezara viridula)*, brown field cricker (*Teleogryllus lepidus*), and white fly (*Trialeurodes vaporariorum)* are all sporadic pests and are best controlled with insecticides.

FUTURE RESEARCH

There is obviously a great deal of work yet to be done on the development of a pest management programme for sunflowers in Australia. In addition, Australia is free of a large number of important exotic sunflower pests, and allowance must be made in any pest management programme for the possible introduction of these pests.

The following topics are listed as probably the most fruitful areas for future research into pest management in sunflowers:—

1) Natural enemies of *Nysius* spp. — Most of the natural enemies of *Nysius* spp. in Australia are ineffective. However, the little known egg parasite *Telenomus* sp. may be the reason why nymphal populations never really develop in late sown crops. More work should be done on the ecology of this parasite in order to understand, or even possibly enhance, its effectiveness.

Also a search should be made for natural enemies etc. of *Nysius* spp. in countries where these bugs occur and yet are not considered major pests of sunflowers (e.g. North America).

2) Plant resistance — Little work has been done in Australia on sunflowers so far, but overseas, resistance to certain insects has been claimed. For example, Beard *et. al.*, (1977) showed resistance in sunflowers to sunflower moth *Homoeosoma electellum* (Hulst) in California while some workers in Australia are looking at the possibility of resistance to Rutherglen bugs.

Another valuable avenue for plant resistance research is in the area of the secondary fungal head rots which follow heliothis damage. Yang *et. al.*, (1980) reported resistance in wild *helianthus* spp. to *Rhizopus* spp. head rot. Breeding for resistance to the secondary fungus, would be a much better course to follow, than attempting to eliminate the primary pest.

3) Pollination Studies — The development of self fertility and self pollination in hybrid sunflowers is of critical importance in the development of a pest management programme for sunflowers. This would eliminate the necessity for bees, allowing good seed set under adverse weather conditions and also allowing spraying at flowering if necessary. It would also give plant breeders the freedom to look for sources of host plant resistance such as nectar which is unattractive to heliothis moths.

4) Economic Thresholds — At present most of the thresholds for sunflower insects are derived from informed guesses. It is very important to determine accurate thresholds in both dryland and irrigated crops, particularly for the two key pests *Nysius* spp. and *Heliothis* spp.

5) Spraying techniques — The evaluation of new insecticides for the dual control of *Nysius* spp. and *Heliothis* spp. should be continued. The use of nuclear polyhedrosis virus (NPV) for *Heliothis* spp. control should be evaluated in sunflowers, particularly in late sown crops where the egg parasite *Telenomus* sp. is active. The effect of currently registered and potential insecticides on the parasites and predators of the two key pests should be investigated. This may allow the recommendation of a specific insecticide which has little effect on the parasites or predators but which is detrimental to the pest.

LITERATURE CITED

ATTIA, F.I. 1973, *Alophora lepidofera* (Diptera:Tachinidae). A native parasite of the Rutherglen bug, *Nysius vinitor* and the grey cluster bug, *Nysius clevelandensis* (Hemiptera:Lygaeidae) in Australia. *J. Aust. Ent. Soc.* 12:353 — 354.

BEARD, B.H., CARLSON, E.C., WAISS, A.C. Jr., ELLIGER, C., KLISIEWICZ, J.M., JOHNSON, A. and CHAN, B. 1977. Sunflower resistance to the sunflower moth. *California Agriculture* 3(11):17 — 19.

BROADLEY, R.H. 1978. Insect pests of sunflower. *Q'ld Ag. Journal* 104(4):307 — 314.

BROADLEY, R.H. 1980a. Parasitoids of *Heliothis* spp. larvae collected from sunflowers in south-east Queensland. *Workshop on Biological Control of Heliothis* spp. *Toowoomba,* Q'ld. pp. 66 — 68.

BROADLEY, R.H. 1980b. Possible arthropod predators of *Heliothis* spp. eggs and larvae in sunflowers in south-east Queensland. *Workshop on Biological Control of Heliothis spp. Toowoomba,* Q'ld. pp. 82 — 85.

BROADLEY, R.H. 1980c. Preliminary investigations towards establishing economic injury levels of *Heliothis* spp. larvae in sunflowers. *4th Australian Sunflower Workshop, Shepparton,* Vic. 4 — 31 to 4 — 36.

BROADLEY, R.H. and IRONSIDE, D.A. 1980. Insect pests of sunflower part 2. *Queensland Ag. Journal 106(6)*: xxxi-xxxiv.

FORRESTER, N.W. 1979. Studies on the natural enemies of *Nysius vinitor* and *Nysius clevelandensis* on sunflowers. *Australian Applied Entomological Research Conference, Gatton,* Q'ld. pp. 7 — 13 to 7 — 15.

FORRESTER, N.W. 1980a. Insects pests of sunflower. *The Agric. Gaz. of N.S.W.* 91(5): 34 — 37.

FORRESTER, N.W. 1980b. Biological control agents of *Heliothis* spp. on sunflowers. *Workshop on Biological Control of Heliothis spp. Toowoomba* Qld. pp. 49 — 53.

FORRESTER, N.W. 1980c. Seasonal abundance of Rutherglen bugs on early and late sown sunflowers in northern N.S.W. *4th Australian Sunflower Workshop, Shepparton* Vic. pp. 4 — 17 to 4 — 20.

FORRESTER, N.W. 1980d. Economic effects of Rutherglen bug feeding on sunflowers. *4th Australian Sunflower Workshop, Shepparton,* Vic. pp. 4 — 21 to 4 — 24.

FORRESTER, N.W. 1980e. Bees important to pollination of sunflowers. *The Agric. Gaz. of N.S.W.* 91(5):33.

FORRESTER, N.W. 1982. Effect of maldison (Malathion ULV) on sunflower insects. *10th International Sunflower Conference, Surfers Paradise,* Qld. (in press).

INGRAM, B.F. 1969. Insect Pests of sunflowers. *Queensland Agr. Journal* 95(10): 703 — 704.

LOUDON, B.J. and ATTIA, F.I. 1981. The immature stages of *Alophora lepidofera* (Diptera:Tachinidae), a native

parasite of Lygaeidae (Hemiptera) in Australia. *Aust. Ent. Mag.* 7(5):61 — 67.

SINGH, S.R., van EMDEN, H.F. and AJIBOLA TAYLOR, T. 1978. Pests of Grain Legumes. Ecology and Control (pp. 329 — 335). Academic Press, London: pp. 454.

WONG, P.T.W. and FORRESTER, N.W. 1980. Incidence of Rhizopus head rot and charcoal stem rot in irrigated and dryland sunflowers. *4th Australian Sunflower Workshop, Shepparton,* Vic. pp. 4 — 16 to 4 — 17.

YANG, S.M., MORRIS, J.B. and THOMPSON, T.E. 1980. Evaluation of *Helianthus* spp. for resistance to Rhizopus head rot. *9th International Sunflower Conference, Cordoba,* Spain:5b (28).

INSECT AND MITE PESTS OF QUEENSLAND SUNFLOWERS.

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ABSTRACT

A survey of insect and mite pests of commercial sunflower crops in the Darling Downs region of Queensland (roughly differentiated by latitudes 27° and 28°S, and longtitudes 151° and 152°E) was conducted between 1977 and 1981. Hand collection and vacuum sampling (D-vac type machine) techniques were employed. The pest complex included one species of mite, and forty-five species of insects in seven orders. In addition, the pest status of a further four phytophagous Hemiptera (Miridae) requires clarification.

Major pest species included *Heliothis armiger* (Hubner), *Heliothis punctiger* Wallengren, *Nysius vinitor* Bergroth, *Nysius clevelandensis* Evans, *Pterohelaeus darlingensis* Carter, *Pterohelaeus alternatus* Pascoe, *Gonocephalum macleayi* (Blackburn), *Nala lividipes* (Duf.) and *Cosmozosteria bicolor* Shaw. The Queensland sunflower pest spectrum was compared with the one existing in North America, and it was shown, with the exception of a few cosmopolitan species, that the faunistic composition of each was highly dissimilar.

INTRODUCTION

Rapid expansion (54,000 hectares in 1971 — 72 to 159,000 hectares in 1979 — 80) has occurred in the Queensland sunflower industry during the last decade. The gross value is now estimated to be approximately $30 million dollars per annum. Coincident with this expansion has been the recognition that many more insect species than the seven listed by Ingram (1969), are injurious to sunflowers. This paper details the pest complex currently recognized from sunflowers, and in addition each pest is rated according to its economic importance.

MATERIALS AND METHODS

Collections of pests were primarily made from commercial sunflower crops grown in the Darling Downs region of south Queensland (roughly differentiated by latitudes 27° and 28°S, and longtitudes 151° and 152°E), although limited records were obtained from central Queensland. Both hand collection and vacuum sampling (D-vac machine) methods were employed. Pests were subjectively classified as being of major, minor, or very minor importance.

RESULTS

Species of insects and mites collected, and their pest status, are shown in Table 1. One species of mite, and 45 species of insect in seven orders were considered to be pests. Of the latter, it was considered that *Heliothis armiger, Heliothis punctiger, Nysius vinitor, Nysius clevelandensis, Gonocephalum macleayi, Pterohelaeus darlingensis, Pterohelaeus alternatus, Nala lividipes,* and *Cosmozosteria bicolor* were the most damaging species. *Heliothis* spp., and *Nysius* spp. are pests in the post establishment phase of crop development, while *Gonocephalum macleayi, Pterohelaeus* spp., *Nala lividipes* and *Cosmozosteria bicolor* form a soil dwelling complex which feed on germinating seed and young seedlings.

The pest status of four species of Miridae in sunflowers has not been quantified. All are commonly found in flowering crops.

Table 1. Insect and mite pests of Queensland sunflowers.

Order	Family	Species	Pest Status
Lepidoptera	Noctuidae	*Heliothis armiger* (Hubner)	Major
		Heliothis punctiger Wallengren	Major
		Chrysodeixis eriosoma (Doubleday)	Minor
		Diachrysia orichalcea (Fabricius)	Minor
		Agrotis ipsilon (Hufnagel)	Minor
		Agrotis sp.	Minor
	Pyralidae	*Cryptoblabes adoceta* Turner	Minor
		Loxostege affinitalis (Lederer)	Minor
Hemiptera	Lygaeidae	*Nysius vinitor* Bergroth	Major
		Nysius clevelandensis Evans	Major
		Oxycarenus luctuosus (Montr. and Sign)	Very minor
	Pentatomidae	*Nezara viridula* (Linnaeus)	Minor
		Plautia affinis Dallas	Very minor
	Pyrrhocoridae	*Dysdercus cingulatus* (Fabricius)	Very minor
	Miridae	*Camphylomma livida* Reuter	Unknown
		Taylorilygus pallidulus (Blanchard)	Unknown
		Creontiades dilutus (Stal)	Unknown
		Cyrtopeltis sp.	Unknown
	Aleyrodidae	*Trialeurodes vaporariorum* (Westwood)	Minor
	Cixiidae	*Oliarus lubra* Kirkaldy	Very minor
	Cicadellidae	*Austroasca viridigrisea* (Paoli)	Minor
		Cicadulina bimaculata (Evans)	Very minor
		Orosius argentatus (Evans)	Very minor
		Idiocerus sp.	Very minor
	Aphididae	*Macrosiphum euphorbiae* (Thomas)	Very minor
		Myzus persicae (Sulzer)	Very minor
		Aphis gossypii Glover	Very minor
		Aphis citricola van der Goot	Very minor
Coleoptera	Tenebrionidae	*Gonocephalum macleayi* (Blackburn)	Major
		Pterohelaeus darlingensis Carter	Major
		Pterohelaeus alternatus Pascoe	Major
	Scarabaeidae	*Pseudoheteronyx* sp.	Minor
	Cermabycidae	unknown larvae	Very minor
	Curculionidae	*Graphognathus leucoloma* (Boheman)	Minor
	Chrysomelidae	*Chaetocnema* sp.	Very minor
	Elateridae	unknown larvae	Minor
Orthoptera	Gryllidae	*Teleogryllus commodus* (Walker)	Minor
		Teleogryllus lepidus (Walker)	Minor
	Cryllotalpidae	*Gryllotalpa africana* Palisot de Beauvois	Minor
	Acrididae	*Austracris guttulosa* (Walker)	Very minor
	Pyrgomorphidae	*Attractomorpha crenaticeps* (Blanchard)	Minor
	Tettigoniidae	*Polichne* sp.	Minor
Blattodea	Blattidae	*Cosmozosteria bicolor* Shaw	Major
		Dermozosteria cincta Schelford	Minor
Dermaptera	Labiduridae	*nala lividipes* (Dufour)	Major
Thysanoptera	Thripidae	*Thrips tabaci* Lindeman	Minor
		Thrips imaginis Bagnall	Minor
		Microcephalothrips abdominalis Crawford	Minor
	Phlaeothripidae	*Haplothrips froggatti* Hood	Minor
Acarina (mites)	Tetranychidae	*Tetranychus urticae* Koch	Minor

DISCUSSION

The sunflower *(Helianthus annuus* L.*)* is native to North America (Schulz 1978). It is therefore not surprising to find that 48 pest species have been collected in Texas alone (Phillips, Randolph and Teetes, 1973). The biology and importance of many of these species has been discussed by Schulz (1978). A moderate diversity (45 insect species and 1 mite species) has also been found to be associated with Queensland sunflower crops (Table 1). However, with the exception of a few cosmopolitan species such as *Trialeurodes vaporiarorum* (Westwood) and *Tetranychus urticae* Koch, the faunal compositions of the North American and Queensland pest spectra are entirely different. This is probably due to the fact that the North American insects evolved simultaneously with their sunflower host. Co-evolution may also explain the specialized feeding and breeding habits of many North American species, which may be found within seeds, capitula and stems. The Australian species tend to be more generalized in their feeding habits. Strict quarantine procedures are therefore essential to prevent establishment of exotic species in Australia.

The four species of Miridae, whose pest status remain an enigma, are known to feed on plant tissues. However, field observations tend to indicate that some of these also feed on other insects.

LITERATURE CITED

INGRAM, B.F. 1969. Insect pests of sunflowers. *Queensland Agricultural Journal* 95:703 — 705.

PHILLIPS, R.L., RANDOLPH, N.M. and TEETES, G.L. 1973. Seasonal abundance and nature of damage of insects attacking cultivated sunflowers. *Texas Agricultural Experimental Station Publication* MP-1116, 1 — 7.

SCHULZ, J.T. 1978. Insect Pests. In Carter, J.F. (Editor). *Sunflower Science and Technology* 169 — 223.