TIMING OF INSECTICIDE APPLICATIONS AGAINST THE EGYPTIAN ALFALFA WEEVIL: CONTROL AND EFFECTS ON NON-TARGET INSECTS

Charles G. Summers
Division of Entomology and Parasitology
University of California, Berkeley
(U.C. Kearney Horticultural Field Station, Parlier)

and

Warren R. Cothran
Department of Entomology
University of California, Davis

INTRODUCTION

Pesticides, in spite of recent adverse publicity, remain one of our most useful tools in the management of insect pests (Smith, 1970). In our continuing effort to produce adequate amounts of quality food and fiber on an ever decreasing amount of land, our need to use pesticides will likely increase in the foreseeable future (Mrak, 1969). This continuing need for chemical pesticides does not, however, give continued license for their use on an infinitely increasing scope or without regard to their overall impact on the environment (Metcalf, 1972). No longer must insecticide evaluations be made solely on the basis of percent kill of the target organism(s) with total disregard for other members of the community complex which comprise the agro-ecosystem in question.

Insecticides are applied with the purposeful intent of disrupting a certain component of the agro-ecosystem, i.e. the pest in question, but extreme care must be exercised to minimize these disruptive actions on the remaining members of the system. Clearly what is needed are highly selective materials; materials that not only possess a high toxicity to invertebrates and a low toxicity to mammals but also show a differential toxicity within the Arthropoda (Smith, 1970). Unfortunately, insecticides with this high degree of selectivity have not yet been found, but there are indications that such materials can be developed. Some of the newer aphicides and acaricides show a much greater degree of selectivity than has heretofore been demonstrated. The development and use of microbial agents such as Bacillus thuringiensis Berliner, various virus preparations, and the exciting work with juvenile hormones, particularly in mosquito control, offer additional evidence that materials with a rather high degree of specificity can be developed. Until, however, such highly specific materials are found, we must rely on other methods of providing a selective action with the insecticides currently available.

Stern et al., (1959) discussed a number of approaches that are available for enhancing the selective activity of insecticides and these have been more recently reviewed by Nat'l. Acad. Sci., (1969), Smith, (1970), and Metcalf, (1972). Briefly, these techniques take advantage of the ecology and biology of the pest and its predators and/or parasites, by emphasizing selection of insecticide formulation, dosage rates, dilution, residual activity, proper timing of applications, and placement of toxicant.

Stern and van den Bosch (1959) showed Systox® to be less toxic to native predators in California alfalfa fields than parathion or malathion at rates needed to give economic control of the spotted alfalfa aphid. Stern, van den Bosch, and Reynolds (1960) found Dylox®, at 8 ounces or less active ingredient per acre to be quite selectively favorable to Hippodamia spp., Chrysopa spp. and Geocoris spp. Above 8 ounces per acre, the selectivity of Dylox decreased. Dylox also has a short toxic residue and thus emerging adult predators and parasites and adults migrating into the field after treatment appear to be unharmed. The use of seed-dressings for control of the rice water weevil, Lissorhoptrus oryzophilus Kuschell, and the grape colaspis, Colaspis flavida (Say), (on rice) requires only one-eighth to one-fourth the amount of insecticide necessary to control these pests by broadcast applications. Tobacco hornworms can be controlled by treating only the upper one-third of tobacco plants thus avoiding disruption of the community occupying the remainder of the plant (Nat'l. Acd. Sci. 1969; Guthrie et al. 1959) Hoyt and Caltagirone (1971) reported control of peach twig borer larvae with a dormant spray of oil plus diazinon. This made it possible to skip the early spring treatment for this pest which decimates populations of the predator mite Metaseiulus occidentalis (Nesbitt).

It is also important to understand that the ideal selective material, regardless of how the selectivity is achieved, is not one that eliminates all individuals of the pest species while leaving all of the natural enemies (Stern et al. 1959, Smith 1970). Such a situation would, of course, result in a crash of the beneficial population through either death or emigration. Hoyt and Caltagirone (1971) reported that populations of apple rust mite Aculus schlechtendali (Nalepa) as high as 355 per leaf did not cause significant foliage damage and populations of M. occidentalis increased rapidly on this prey in May and June and thus presented a strong factor against the increase of the more serious McDaniel mite, Tetranychus mcdanieli McGregor, later in the season. They recommend that on occasions when it is advisable to control populations of apple rust mite that low dosages of a selective acaricide be used so as to reduce but not destroy the population.

Stern and van den Bosch (1959) reported a situation involving a population of spotted alfalfa aphid resistant to all tested materials. Systox was applied and gave poor initial kill but the natural enemies of the aphid which survived continued their attack on the resistant aphids and eventually effected complete control of the infestation. In the same experiment where parathion and malathion were used all of the aphid's enemies were eliminated and the infestation of the pest actually increased after the treatment.

The foregoing discussion has served to illustrate that selective action can be obtained from many presently available pesticides. However, such data are not easy to obtain. Large plots, indeed whole fields or orchards, must be employed to obtain such information. Sampling must be extensive and carefully carried out. Because of the cyclic nature of some pests, several years may be required to reach a thorough understanding of a particular chemical's impact on the agro-ecosystem.

This paper reports the results of our initial studies into the impact on non-target organisms of chemicals used in Egyptian alfalfa weevil, Hypera brunneipennis (Boheman), control. By necessity, the scope of this initial research was somewhat limited but it has served to establish trends and guidelines for the continuation of more detailed studies during the next few years.

METHODS AND PROCEDURES

Two study sites, one in Yolo County and one in Tulare County, were selected to provide differences in climatic conditions and hence differences in population trends of the various non-target organisms under study. In Yolo County, the experiment was conducted in Lahonton, a semi-dormant to dormant variety of alfalfa while in Tulare County a non-dormant variety (variety unknown) was chosen.

In Yolo County, the plots were 13 acres in size and replicated 4 times; replications I and II were in one field and replications III and IV in a second field about one mile away. In Tulare County, the plots were 10 acres in size, with 4 replications, each replication being located in a separate field. All fields in the Tulare County experiment were within a 5 mile radius.

All insecticides were applied by fixed wing aircraft. Applications in Yolo County were made at 7 1/2 gallons of finished spray per acre and those in Tulare County were made at 10 gallons of finished spray per acre. Table 1 lists the materials, rates and application dates used in these experiments.

Insect populations were sampled using both the standard sweep net (180^{o} sweeps) and the D-Vac. The sweep net samples were placed in alcohol and returned to the laboratory for counting. D-Vac samples were processed through modified Berlese funnel separators and the recovered arthropods then stored in alcohol for later counting in a manner similar to that of Stern (1961).

A 40 x 40 ft. tarp was used to cover a small portion of the field on the last application date to give an untreated area from which to sample alfalfa weevil populations

RESULTS

Tulare County Experiments - Weevil Control:

Sweep samples were taken on March 20 and 24 to determine the effectiveness of the materials relative to Egyptian alfalfa weevil (EAW) control. The results are presented in Table 2. By March 24, one week after the recommended treatment level of 20 larvae per sweep had been reached, the January application of Furadan was beginning to break down. However, control remained satisfactory up to the first cutting (March 28, 29 on all plots) and observations on the regrowth indicated no need for a second (stubble) treatment on any of the plots.

Effects on Non-Target Organisms:

D-Vac samples were taken on 24 March to determine the effects of these treatments on a number of non-target organisms. Because of the destructiveness of the EAW it was not possible to leave a large enough area untreated for the evaluation of non-target organisms in the absence of insecticides; therefore, the results and discussion presented here will reflect differences between the various chemical treatments.

The March 7 application of Furadan® (12 oz. a.i./A), while providing the best weevil control (Table 2), was the most disruptive treatment to the alfalfa ecosystem. Seventeen days after treatment, populations of *Nabis ferus* (L.), *Orius* spp., *Lygus* spp., and miscellaneous Hymenopterous species were zero. Coccinellids[1/] and *Aphidius smithi* Sharma and Rao fared only slightly better with 0.01 individuals per square foot. *Chrysopa* spp., and spiders averaged 0.1 and 1.5 individuals per square foot respectively. The pea aphid *Acyrothosiphon pisum* (Harris), survived this treatment better than any of the non-target species examined, but populations averaged only 3 individuals per square foot.

The January 24 application of Furadan (16 oz. a.i./A) was considerably less disruptive to non-target species than the March treatment. In most cases, there was little, if any, difference between the January 24 Furadan application and the March 17 methoxychlor treatment. Populations of *N. ferus*, *Orius* spp. and *A. smithi* were slightly higher in the methoxychlor treated plots while *Chrysopa* spp., miscellaneous Hymenoptera, and spiders showed slightly higher levels in the Furadan plots. Coccinellids were least affected by the January 24 Furadan application. Populations in these plots were 4 times higher than those in the methoxychlor plots and 70 times higher than those in the March 7 Furadan plots.

Imidan® was the least disruptive of the insecticides tested. *N. ferus* populations in the Imidan plots were 3 times those in the methoxychlor plots, while *Orius* spp. and Coccinellids were 4 times more abundant. *Chrysopa* spp. were present in about equal numbers in all treatments (except the March 7 Furadan treatment). *A. pisum* populations were identical in the Imidan and methoxychlor plots, 108 per square foot, but *A. smithi* populations were slightly higher in the Imidan plots indicating this material was slightly less toxic to that species.

Yolo County Experiment - Weevil Control:

Sweep samples were taken on March 27 to determine the effectiveness of the materials in EAW control. The results are presented in Table 3.

The population peak in the experimental fields as indicated by the untreated check was low and only slightly into what is presently considered to be the economic loss range (15-20 larvae/sweep). However, due to the replication and sample size significant

---

1/ "Coccinellids" is used throughout this paper to refer to *Hippodamia* spp. and *Coccinella* spp.

conclusions relative to treatment effectiveness can be drawn. All applications reduced the population level to below the economic level although in the face of higher base populations this would possibly not have been the case for the January 24 Furadan treatment. Population monitoring data suggest that a significant portion of the adult weevils moved into the fields in the two weeks intervening between the January 24 and February 7 Furadan treatments. This would explain the higher larval counts eventually obtained in the earlier plot. The February 7th treatment gave significant control when compared to the check plots. Furadan, Supracide®, and Guthion®, applied March 20, all gave satisfactory control although control with Furadan was slightly better than with the other two materials.

Effects on Non-Target Organisms:

D-Vac samples were taken on March 28 to determine the effects of these treatments on a number of non-target organisms. As in the Tulare County experiment, it was not possible to leave a large untreated area so the tarp technique was used to provide an untreated area from which to sample weevil populations and the discussion of insecticide effects on non-target organisms will be restricted to a comparison between the materials used.

Guthion was generally the most disruptive of the insecticides used in this experiment. With the exception of Lygus spp. and A. pisum, it was more disruptive than Furadan and even here, the differences were small. Supracide and the January Furadan treatment were the least toxic to Coccinellids, populations averaging 0.1 individuals per square foot in both treatments. Both the February and March Furadan treatment were more toxic to Coccinellids, but not as toxic as Guthion. Only slight differences in Toxicity to Chrysopa spp., was observed among the materials and application dates tested but again, Guthion was more toxic than the others.

DISCUSSION

The data obtained in these experiments and that reported by Summers and Cothran (1972) show that the Egyptian alfalfa weevil can be controlled by a number of currently recommended insecticides. Furadan, at rates of 16 oz. a.i./A gave adequate control when applied as early as January. However, marked differences in the selectivity of these materials to a number of non-target organisms exists. Furadan, applied in March, at 1 larva per sweep in Tulare County and 20 larvae per sweep in Yolo County, was shown to be very disruptive to the alfalfa agro-ecosystem. Populations of N. ferus, Orius spp., Lygus spp., and miscellaneous Hymenoptera were still zero, 17 days after a March 7 treatment. This is not totally unexpected due to the residual activity of Furadan. Chrysopa spp. and spiders made the best recovery following the Furadan application. Both of these groups had the best tolerance to any of the insecticides used in both the Tulare and Yolo County tests.

Guthion (Yolo County only) was also very disruptive to the non-target fauna. Again, Chrysopa spp. made the best recovery.

The January and February applications of Furadan were generally much less disruptive than the March application. Davis (1970) reported that early season treatments of Furadan in Utah had little or no effect on Bathyplectes curculionis (Thomson), a parasite of the alfalfa weevil, Hypera postica (Gyllenhal).

Coccinellids were not observed moving into the fields for several weeks after these early applications and were thus not directly affected by them. It is also likely that many of the non-target species were in a less susceptible stage during this time of the year. Stern and van den Bosch (1959) reported that the aphid parasite, Praon palitans Mues., was unaffected by parathion, malathion, or Systox when it was in the cocoon stage.

Imidan (Tulare County only) was the most selective of any of the materials tested. With the exception of Lygus spp. populations in the Imidan plots were much higher than those in the methoxychlor plots. This was most noticeable with Coccinellid populations which were 4 times greater in the Imidan plots.

Supracide (Yolo County only) also appears to be somewhat selective although populations of non-target Arthropods were generally too low to draw any real conclusions.

REFERENCES CITED

Davis, D. W. 1970. Insecticial control of the alfalfa weevil in Northern Utah and some resulting effects on the weevil parasite Bathyplectes curculionis. J. Econ. Entomol. 63:119-25.

Guthrie, F. E., R. L. Rabb, T. G. Bowery, F. R. Lawson, and R. L. Baron. 1959. Control of hornworm and budworms on tobacco with reduced insectide dosage. Tob. Sci. 3:65-68

Hoyt, S. C., and L. E. Caltagirone. 1971. The developing programs of integrated control of pests of apples in Washington and peaches in California. p. 395-421. In C. B. Huffaker [ed.] Biological Control. Plenum, New York. 511 pp.

Metcalf, R. L. 1972. Development of selective and biodegradable pesticides. p. 137-56. In Pest control strategies for the future. Nat'l. Acad. Sci. Washington, D. C. 376 p.

Mrak, E. (Chairman). 1969. Report of the Secretary's Commission on pesticides and their relationship to environmental health. U. S. Dept. of Health, Education, and Welfare, Washington, D. C.

National Academy of Sciences. 1959. Insect-pest management and control. Principles of plant and animal pest control. Vol. 3, 508 pp.

Smith, R. F. 1970. Pesticides: Their use and limitations in pest management. p. 103-13. In R. L. Rabb and F. E. Guthrie [eds.] Concepts of pest management. North Carolina State Univ., Raleigh, N. C. 242 p.

Stern, V. M. 1961. Further studies of integrated control methods against the Egyptian alfalfa weevil in California. J. Econ. Entomol. 54:50-55.

Stern, V. M., R. F. Smith, and R. van den Bosch. 1959. The integration of chemical and biological control of the spotted alfalfa aphid. Part I. The integrated control concept. Hilgardia 29(2):81-101.

Stern, V. M., and R. van den Bosch. 1959. The integration of chemical and biological control of the spotted alfalfa aphid. Part II. Field experiments on the effect of insecticides. Hilgardia 29(2):103-30.

Stern, V. M., R. van den Bosch, and H. T. Reynolds. 1960. Effects of Dylox and other insecticides on entomophagous insects attacking field crop pests in California. J. Econ. Entomol. 53:67-72.

Summers, C. G., and W. R. Cothran. 1972. Egyptian alfalfa weevil: Winter and early-spring treatments for control in California. J. Econ. Entomol. 65:1479-81.

Table 1. Insecticides, rates, and application dates used in Yolo and Tulare Counties, 1972.

Location	Insecticide	Formulation	Rate a.i. per Acre	Application Date	Pre-treatment Count Larvae/Sweep
Yolo Co.[a]	Furadan	4 F	16 oz.	24 Jan.	0
	Furadan	4 F	16 oz.	7 Feb.	0
	Furadan	4 F	8 oz.	20 Mar.	20
	Supracide	2 EC	8 oz.	20 Mar.	20
	Guthion	2 EC	8 oz.	20 Mar.	20
Tulare Co.	Furadan	4 F	16 oz.	28 Jan.	0
	Furadan	4 F	12 oz.	7 Mar.	1
	Imidan	50 WP	16 oz.	17 Mar.	20
	Methoxychlor	50 WP	16 oz.	17 Mar.	20

a/ All plots in the Yolo County study were treated with Oil/Dinitro (by ground) Jan. 10-15, 1972.

Table 2. Evaluation of 4 insecticide treatments for control of the Egyptian alfalfa weevil. Tulare County, California, 1972.

Insecticide	Rate oz. a.i./A	Application Date	Mean No. Larvae/Sweep on[a] 20 March	24 March
Furadan	16	28 Jan.	3.3 a	13.3 a
Furadan	12	7 Mar.	1.4 a	0.7 a
Imidan	16	17 Mar.	7.5 a	1.4 a
Methoxychlor	16	17 Mar.	4.9 a	1.8 a
Untreated			52.0 b	120.5 b

a/ Means followed by the same letter are not significantly different at the 5% level of probability.

Table 3. Evaluation of 5 insecticide treatments for control of the Egyptian alfalfa weevil. Yolo County, California, 1972.

Insecticide	Rate oz. a.i./A	Application Date	Mean No. Larvae/Sweep on [a/] 27 March
Furadan	8	20 Mar.	2.2 a
Supracide	8	20 Mar.	3.7 ab
Furadan	16	7 Feb.	4.0 ab
Guthion	8	20 Mar.	4.7 ab
Furadan	16	24 Jan.	16.3 c
Untreated	-		25.3 d

a/ Means followed by the same letter or letters are not significantly different at the 5% level of probability.