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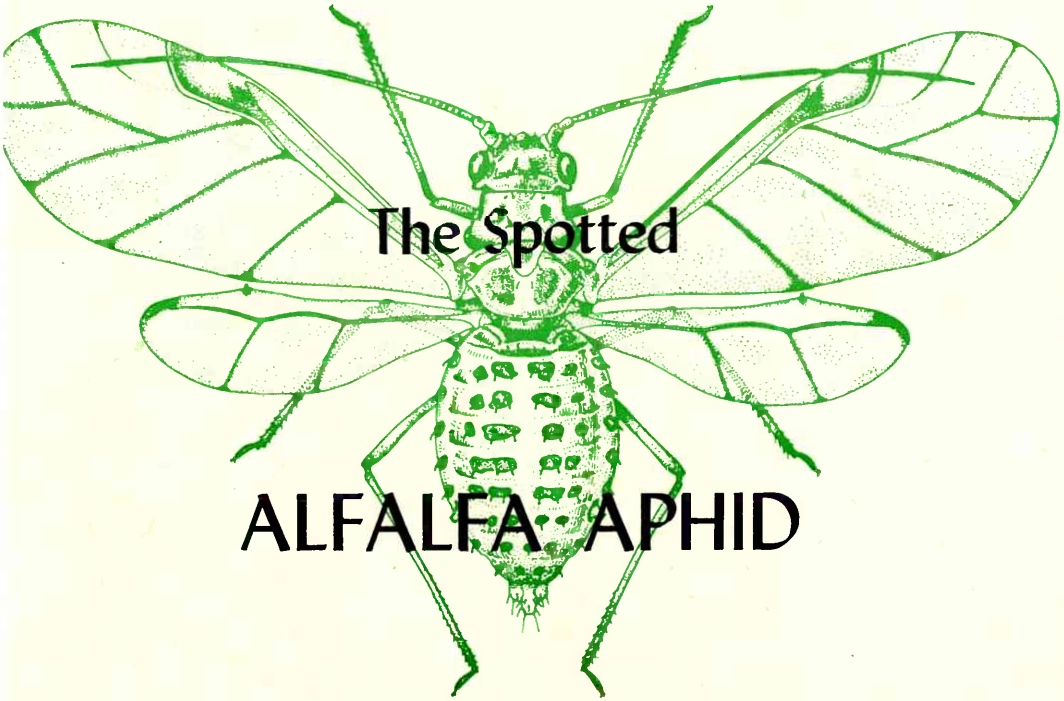

The Spotted ALFALFA APHID IN ARIZONA

Contents

FOREWORD

This bulletin is based on observations and experiments on the spotted alfalfa aphid in Arizona from 1954 to 1957. Work was centered at the Yuma Field Laboratory of the University of Arizona Agricultural Experiment Station and at the Tempe Field Station of the Cereal and Forage Insects Station, Field Crops Insects and Bee Culture Research Branch, Entomology Research Division, Agricultural Research Service, United States Department of Agriculture.

The work at Yuma emphasized investigations of biology and control of the aphid on new and established alfalfa stands, under the direction of D. M. Tuttle, tests of seed and soil treatments, under the direction of V. D. Roth and local observations of the activities of the aphid and its natural enemies.

The work at Tempe emphasized observations of the biology and habits of the aphid, under the direction of M. W. Nielson, and studies of native and introduced natural enemies, under the direction of O. L. Barnes. Studies of resistance of alfalfa varieties to aphid attack were begun in 1956 at Mesa and Yuma by M. H. Schonhorst.

The Spotted Alfalfa Aphid In Arizona

D. M. Tuttle,[1] O. L. Barnes,[2] M. W. Nielson,[2]
V. D. Roth[2] and M. H. Schonhorst[3]

HISTORY AND STATUS

The spotted alfalfa aphid, an important pest of alfalfa, was first found in the east-central part of New Mexico in February, 1954, and was first discovered in damaging numbers in Southwestern Arizona and in California in May and June of that year. Since these discoveries, the spotted alfalfa aphid spread rapidly, especially in the irrigated regions of the Southwest. Previously, this insect was known to occur in India, Israel, Italy and other Mediterranean countries.

The spread of the aphid since 1954 has been phenomenal. The ability of this species to reproduce under a wide variety of conditions and to produce numerous winged females are two reasons for this rapid spread. To date the spotted alfalfa aphid has been reported from 31 states in an area extending from the Pacific to the Atlantic Coast and south into Mexico. It appears destined to spread to all the alfalfa growing sections of the United States.

The currently accepted scientific name of the spotted alfalfa aphid is *Therioaphis (Pterocallidium) maculata* (Buckton). When first discovered in the United States, it was erroneously confused with the yellow clover aphid, *Therioaphis (Myzocallis) trifolii* (Monell).

DESCRIPTION, LIFE HISTORY AND HABITS

The spotted alfalfa aphid is a small, yellowish-green insect with 4 to 6 rows of small black spots and spine-like setae on the dorsal surface of the thorax and abdomen, thus giving it the characteristic name. The wings are also netted or spotted and usually lie roof-like over the body at rest. The wingless females are slightly larger than the winged females and do not vary appreciably in color. The young are ivory-colored when first born but gradually turn yellowish to yellowish-green when mature. The aphid is gregarious and rarely occurs singly.

Studies on the life history of the spotted alfalfa aphid in California

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[1] Assistant Entomologist, University of Arizona Agricultural Experiment Station.
[2] Entomologist, Entomology Research Division, Agricultural Research Service, U. S. Department of Agriculture.
[3] Assistant Agronomist, University of Arizona Agricultural Experiment Station.

indicated that the insect required 14 to 21 days for nymphal development in November and 9 to 10 days in May. In southern Arizona, during summer and fall in 1955 and 1956, the period of development was considerably less due to higher temperatures, requiring 5 to 7 days in July and 7 to 8 days in October. The results suggest that 30 to 40 generations a year may be produced in southern Arizona.

In Arizona the spotted alfalfa aphid has four nymphal instars. Each instar requires about the same developmental period, which varies according to the temperature. The optimum temperature for development and reproduction was in the range of 90°-100° F. Within this range, the aphids produced an average of 4 to 5 young per day and as many as 14 in one day. Mature aphids live from 2 to 4 weeks, producing young most of the time. The most prolific period occurs in the first 15 to 17 days of the female's life. Thereafter reproduction gradually decreases until death.

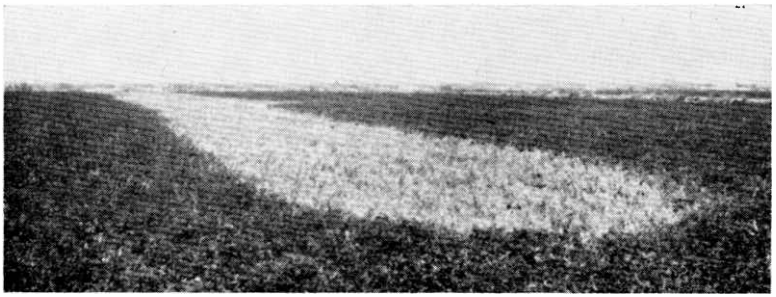
In southern Arizona, the spotted alfalfa aphid produces living young without mating throughout the year. A few males and oviparous (egg-laying) females have been found but egg production has not been observed. The oviparous females were first observed in December, 1955, near Yuma. Subsequent examination of 1,000 adults revealed 289 viviparous (females bearing living young) winged forms, 689 viviparous wingless forms and 22 oviparous wingless forms.

The spotted alfalfa aphid prefers alfalfa, often occurs on bur clover, and is occasionally found on sour clover, sweetclover and berseem. Initial infestations are started by migrating winged females, which usually become established on the upper portions of alfalfa plants and begin producing young. Most of these young aphids soon migrate to the lower portions of the plants where they feed on the under sides of the leaves. Under favorable conditions, populations increase to the extent that they kill the lower leaves. This forces the aphids upwards on the plant, which they eventually kill if left unchecked. The most severe damage occurs on young seedlings.

The aphid has a habit of jumping when disturbed. This is particularly noticeable during cooler times of the year. This serves for local dispersion and presumably for escape from parasites and predators. Dispersion is accomplished mainly by the winged forms. When aphids become extremely numerous, overcrowding occurs from lack of sufficient food to support the existing population. This forces the production of winged forms which disperse and infest other alfalfa fields. In addition, winged aphids promptly disperse outward from alfalfa hay fields as they are cut. Thus, a continuous dispersal and influx of aphids occurs between fields throughout the season in infested alfalfa growing areas.

The abundance of the spotted alfalfa aphid is influenced largely by climatic conditions and to a lesser extent by natural enemies, cultivation, irrigation and plant succulence. Peaks of abundance have occurred in Arizona twice a year in the spring and fall. In 1957, an additional or unusual peak occurred in July. The peaks and other population trends appear to be correlated with temperature and other climatic factors. During February and March, the population increases and reaches a peak in April or early May. It gradually recedes during June and July and finaly drops to a low level in August. In September the population starts upward again and by November reaches a second or fall peak, then dropping again to a low level in January. This overall trend may vary from 4 to 6 weeks in different fields and in different years.

INJURY



Spotted alfalfa aphid injury is shown in this photo. The brown, thin and dying area in the center is a strip which was missed when the remainder of the field was treated with an insecticide for aphid control.

Small alfalfa seedlings are killed in 10 to 12 days by one or two spotted alfalfa aphids and their progeny feeding per plant. In addition to extracting plant juices, the insect apparently injects a poisonous substance which causes stunting and chlorotic mottling, particularly in seedlings. Complete or partial loss of stands may necessitate replanting. Some fields have been replanted as many as three times before satisfactory stands were obtained.

This aphid affects alfalfa hay crops by reducing plant growth and vigor, by causing a shedding of the lower leaves (producing "stemmy" hay) and by its copious excretion of honeydew, making baling almost impossible. If hay is very sticky it must be baled dry, causing most of the leaves to fall off the stems. Exposed portions of such bales soon appear darkened from a black fungus growing on the honeydew. Such hay is less attractive and may sell for as much as $10 per ton less than normal hay. Recent research shows that protein and carotene content is reduced in hay infested with high aphid populations. Yields are reduced, growth is usually slow and stands become readily thinned out. Some larger plants may be killed by repeated attacks of the aphids.

CULTURAL CONTROL

Cultural and management practices have been useful in holding the spotted alfalfa aphid in check.

Alfalfa plantings made during October and November in 1955 and 1956 became well-established before the fall attacks of the spotted alfalfa aphid began. This time of planting also conforms with the approved practice of securing a well-established plant for spring growth. Alfalfa planted after February was severely attacked by the aphid and stands were poor.

Mowing and pasturing of alfalfa cause high aphid mortality. Many

aphids, especially immature and wingless forms, are destroyed when hay crops are cut and dried. Close pasturing by sheep during the winter months also kills aphids.

Maintaining alfalfa stands in good vigor may at times help to ward off attacks of the spotted alfalfa aphid. Sufficient irrigation promotes rapid and healthy growth. Frequently dry or neglected fields have been observed as sources of high infestation. The proportion of winged individuals is greater in such places. Adequate fertilizing, particularly with phosphates, also appears to be helpful in reducing aphid damage.

VARIETAL RESISTANCE

Soon after the spotted alfalfa aphid was observed in Arizona it became apparent that all alfalfa varieties commonly grown in the southwest were extremely susceptible to the aphid. Many seedlings of African, Chilean, and Hairy Peruvian were completely destroyed shortly after emergence. Older stands were also damaged severely.

Research was started in the fall of 1956 to evaluate many varieties of alfalfa for their reaction to the spotted alfalfa aphid. Observations indicated that a complete range from resistance to susceptibility existed among these varieties as measured by the amount of plant injury produced by heavy aphid populations under natural field conditions. Of the entries tested only five appeared to have a high level of aphid resistance. These were Lahontan, Moapa, New Mexico 16, Bam and Sirsa. The last two varieties were introduced from Iran and India, respectively.

Of these resistant alfalfas, Moapa appears to be the best adapted for the irrigated valleys of Arizona. This variety was developed from nine resistant clones selected from the susceptible variety African by U.S. Department of Agriculture entomologists and plant breeders. Moapa was released jointly by the Arizona, California and Nevada Agricultural Experiment Stations and the U.S.D.A. in August, 1957.

In Arizona, plantings of Moapa have been under observation since October, 1956. This variety has successfully withstood heavy populations of the spotted alfalfa aphid from seedling to mature plant stages. In growth habit, Moapa is non-winter-dormant, similar to its parent, African. Forage production tests comparing Moapa with other Southwestern varieties were begun in the spring of 1957. These tests indicated that the new variety compared favorably with African under low aphid populations.

Under heavier aphid populations, Moapa's level of resistance insures continued high stand survival and hay yields, whereas, in susceptible varieties stands and yields decrease. A limited amount of seed of Moapa will be available for commercial plantings by late summer and fall of 1958. By 1959 sufficient seed should be produced to meet the needs of Arizona farmers.

Lahontan, a winter-dormant variety, was developed for resistance to stem nematodes and bacterial wilt. When the spotted alfalfa aphid became a serious pest in 1954, it was discovered that Lahontan was also resistant to this insect. Due to its winter-dormant growth habit, Lahontan makes little vegetative growth during late fall and winter months in southern Arizona. The winter dormant period for Lahontan is similar to that previously observed for northern varieties, such as Buffalo and

Ranger, in Arizona. Seed of Lahontan is available for commercial hay plantings. This variety is recommended for nothern Arizona and higher elevations where the non-hardy varieties winterkill.

The other three varieties (New Mexico 16, Bam, and Sirsa) which have a high level of aphid resistance are being tested further although seed is not currently available for commercial use.

In other susceptible non-winter-dormant alfalfa varieties, a few aphid-resistant plants have been found on which young aphids were unable to mature and reproduce. These plants will be used to incorporate resistance into other commercial alfalfa varieties adapted for use in the Southwest.

NATURAL ENEMIES

In south-central Arizona during 1955, 1956, and 1957, lady beetles were by far the most numerous and effective of all predators, although *Collops* adults, lacewing fly larvae, syrphis fly larvae, various predaceous hemipterous insects, and predaceous mites were present and of some value in reducing aphid population. The convergent lady beetle eliminated heavy aphid infestations in some fields, but not before severe damage had occurred. In many instances, high populations of predators were virtually destroyed or reduced by applications of insecticides for aphid control.

The seasonal abundance of the convergent lady beetle followed a trend similar to the abundance of the aphid. The population gradually increased from February through April and reached a peak in late April or early May, then declined during the summer to a very low point in August or September. It rose slightly in the fall and receded again in late December. In the spring, the peak of abundance of the predator lagged behind that of the aphid population, but in the fall the aphid peak was behind that of the predator.

In cooperation with the Entomology Research Division, Agricultural Research Service, U. S. Department of Agriculture, and the University of California Agricultural Experiment Station, approximately 184,000 small, wasp-like parasites of three introduced species were released between November 1955 and July 1957 in spotted alfalfa aphid-infested fields in the Salt River Valley and Florence areas. Additional parasites were released in the Yuma area.

The species were *Aphelinus semiflavus* Howard, *Praon palitans* and *Trioxys utilis* Muesebeck. Each parasite species has been recovered in small numbers in parasitized aphids at or near several of the release sites. All of the species survived the summer of 1957 and at least two of them, *A. semiflavus* and *P. palitans*, survived the winter of 1956-57 under field conditions in the Salt River Valley. *A. semiflavus* has been recovered up to half a mile, and *P. palitans* up to 2¾ miles, from the nearest point of release. To October 1957 the parasites have not increased or spread sufficiently in the Salt River Valley and Florence areas to be of economic consequence in controlling the aphid. The heaviest aphid parasitization, 14 percent, mainly by *T. utilis*, was observed early in October 1957 in small field plots at Tempe.

Several species of fungi have been recovered from diseased spotted alfalfa aphids in southern Arizona. In the Salt River Valley and Florence areas they have killed a large percentage of the aphids in many fields

during July and August, and have been observed at times during the fall, winter and spring. Winter mortality was the highest late in February and during March in 1957. In the Yuma area, fungi have been most frequently observed during the winter months. All active stages of the aphid are attacked. Aphid mortality has been highest on the lower portions of the plants, particularly in tall, dense stands after rain or irrigation.

Releases of two species of lady beetles and one species of lacewing fly from India were made during July 1957 in aphid-infested alfalfa fields in the Salt River Valley. The introduced predators were obtained from the U. S. Insect Identification and Parasite Introduction Laboratories, Moorestown, New Jersey. No field recovery of any of the species had been made up to October 1957.

The relative abundance of insect predators during the fall was determined in 1955 for the principal agricultural areas of Yuma County. These surveys revealed that nabid bugs and green lacewings were numerous and very active at that time of the year.

SAMPLING METHODS

The leaf count method is the most efficient, practical and accurate way of estimating spotted alfalfa aphid populations to determine when insecticide applications are needed. This method consists of counting the aphids on 30 trifoliate alfalfa leaves which are selected at random from the top, middle and bottom portions of each of 10 alfalfa plants, spaced across the field at intervals of 20 to 50 walking steps. Care should be taken during the sampling to minimize loss of aphids from the leaves. Best results are obtained by grasping the leaf petiole by the thumb and forefinger and slowly turning it until the under side of the leaf is clearly visible.

Since young seedlings are very susceptible, sampling should start as soon as the plants are visible and continue every 5 to 7 days until treatment becomes necessary. One seedling plant is considered comparable to three trifoliate leaves; therefore 30 plants would be a sufficient sample in a newly planted field. When populations reach an average of 0.5 to 1 aphid per plant, insecticides should be applied at once to seedlings.

CHEMICAL CONTROL

The spotted alfalfa aphid has been economically controlled by careful use of properly applied chemical treatments. Growers must depend to some extent on chemical controls until suitable resistant varieties become commercially available or imported parasites and native predators become more effective. Native predators and fungi have been very helpful, but not sufficiently effective for complete control.

The best results from chemical treatments are obtained when all growers in an area cooperate in a community-wide control program. One or two uncontrolled fields suffice to continually infest an entire area.

The proper time for application of insecticides is usually determined by experience. Seedling alfalfa treatments may be needed one or two days after emergence. After plants reach a height of five or six inches, they are capable of withstanding the attack of several aphids. Established stands should be treated when 5 to 10 aphids are present per trifoliate leaf and certainly when honeydew becomes noticeable. If plants are sticky with honeydew, it is probable that a considerable amount of damage has already occurred. It is usually unnecessary to use insecticides against low aphid infestations in established plantings where predators are active. Such applications are expensive and reduce the effectiveness of the predators.

Soil and Seed Treatments — Control of the spotted alfalfa aphid on seedlings has been a major problem of Arizona alfalfa growers. One or two aphids and their progeny can kill a small seedling in 10 to 12 days. Larger seedlings are stunted and sometimes killed by relatively few aphids feeding actively. In some cases it has been necessary to replant fields two or three times to get a satisfactory stand. Reseeding in alfalfa fields to increase stands is difficult because aphids move from older plants and attack the seedlings.

Beginning in 1955, soil and seed treatments were tested at the University of Arizona Experiment Station at Yuma. Application of insecticides by ground or air equipment for control of aphids on seedlings is expensive and not always possible. Repeated applications are sometimes necessary to protect early stages of plant growth. Frequent irrigations and unfavorable weather interfere with ground applications. Of the many insecticides tested, systemic organic phosphorus compounds gave best results.

Soil treatments were made by applying dust in the seed furrows and spreading granular materials in or on the soil. With larger amounts of insecticide, some aphid control was obtained by these methods.

Seed treatments were more satisfactory and efficient than soil treatments. In preliminary tests, the seed was soaked in dilute emulsions of insecticides, but this method proved unsatisfactory. In addition to difficulty in drying the seed, there was some evidence of phytotoxicity and germination of the seed embryo prior to planting. Dusts applied to the seed have given good control but present difficulties in application and use. A high concentration of the toxicant must be used to reduce the volume of material necessary and a sticker must be added to keep the dust on the hard, smooth alfalfa seed coat. With dust treatments some phytotoxicity to seed was observed in laboratory germination tests but was not observed in outdoor plantings.

Results of recent tests with emulsion concentrates seem very promising. The concentrates were applied directly to the seed, using relatively little material. After mixing the seed and the concentrate thoroughly, the treated seed was dried by adding a small quantity of dust diluent, such as pyrophyllite. This method of application is simple and effective but further testing is necessary to determine any resulting phytotoxicity.

Aphid Control in Established Plantings: Both sprays and dusts have been used effectively for aphid control in established alfalfa plantings in Arizona. In dense stands dust formulations are usually more effective than sprays because the commonly used power dusters have a greater blast for driving the insecticide down through the dense plant growth. Most sprayers used to date for forage treatments are of the low-gallonage and low-pressure type.

When systemic insecticides are used, however, thorough coverage on the undersides of leaves is not essential.

For hay crops only those insecticides having a short residual period of effectiveness can be used safely. Malathion and parathion have filled this requirement in addition to giving outstanding control. Low amounts of these insecticides per acre have given good control of the aphid. More recently two newer phosphorus insecticides, Systox and Trithion, have been used with good results. Experience has demonstrated that an insecticide treatment must be almost 100 per cent effective to prevent rapid reinfestation by the spotted alfalfa aphid.

On seed crops malathion or parathion may be used prior to bloom. Thereafter, the spotted alfalfa aphid is adequately controlled by any of the insecticides commonly applied for control of other pests, such as Lygus bugs, stink bugs, and worms.

Growers should use only those insecticides which have been registered by the state chemist, and in accordance with the federal insecticide, fungicide and rodenticide act and the Miller Pesticide Amendment to the Federal Food, Drug and Cosmetic Act for use at the rates recommended. Not only will the recommended rates be more economical but also a sufficient amount of time will be provided for the weathering or breakdown of the toxic residues prior to harvest. Tolerances have now been set for most of the commonly used insecticides and recommended dosages and approved periods of time after application and before harvest are based on these figures. DDT, toxaphene, BHC, chlordane, and dinitro compounds, for instance, are no longer recommended for use on alfalfa hay crops.

Although many insecticides have been tested for spotted alfalfa aphid control on established plantings grown for hay or seed, only a limited number of materials may be suggested for safe and effective use by growers at this time. Approved and registered insecticides, with suggestions for their proper and effective use in Arizona, are shown in the following table.

PRECAUTIONS IN USING INSECTICIDES

Insecticides are poisonous to man and other animals. Use common sense in handling and storing insecticides. The recommendations and precautions on the labels should be followed explicitly. Use protective clothing and wear an approved respirator. Be especially careful when using highly toxic phosphorus compounds. After spraying or dusting remove clothing and bathe thoroughly before changing in to clean clothes. Do not smoke or eat while making applications of insecticides.

Apply insecticides under favorable conditions and with equipment that will minimize drift into adjacent fields and areas. Some crops are injured by certain insecticides and others may be contaminated. Insecticides may also drift into colonies of honey bees located in or near fields that are treated. If honey bees are working in fields, avoid treatments during daylight hours and treat them when bees are absent. Avoid early morning applications of parathion or malathion. These insecticides are toxic to bees entering fields for the first few hours after treatment.

Empty insecticide containers should be destroyed. Do not burn those which have had highly toxic phosphorus compounds in them. Perhaps the easiest method of disposal is burying the containers. It is also wise to render containers unfit for other use.

TABLE 1. APPROVED MATERIALS AND METHODS FOR THE INSECTICIDAL CONTROL OF THE SPOTTED ALFALFA APHID IN ARIZONA.

	When to Treat	Formulation	Rate per Acre	Method of Application	Remarks
Seedlings	When aphids reach an average of ½ to one aphid per plant.	Malathion Dust 4-5%	12-15 lbs.	Ground	BHC should not be used on fields that may be planted to root crops within 5 years.
		Malathion E.C.* 5 lbs./gal.	1 pint	Ground or Air	Do not feed alfalfa treated with BHC to dairy animals or animals being finished for slaughter.
		BHC Dust 2%	12-15 lbs.	Ground	Treat seedling fields promptly. Dilute the emulsion concentrates with 6-10 gallons of water per acre.
		Parathion Dust 2%	12-15 lbs.	Ground	
		Parathion E.C.* 4 lbs./gal.	1 pint	Ground	
Hay Crops	In the absence of sufficient predators and parasites, treat when counts reach 5-10 aphids per trifoliate leaf.	Malathion & Parathion		As above	Do not apply malathion within 7 days of cutting, parathion within 14 days or demeton within 21 days. Apply only in late afternoon or evening to reduce hazards to bees.
		Demeton E.C.* 2 lbs./gal.	1 pint	Ground or Air	
Seed Crops	If counts increase to 10-15 aphids per trifoliate leaf.	Any of the materials listed above may be used prior to bloom, in addition to:			Ordinarily the insecticides used to control other pests of alfalfa seed crops will also control the spotted alfalfa aphid. If control is necessary during bloom, demeton is preferable. See Precautions. Do not feed alfalfa treated with Trithion to animals.
		Trithion E.C.* 4 lbs./gal.	¾-1 pint	Ground or Air	

* "E.C." refers to an emusifiable concentrate, containing the indicated weight of actual toxicant per gallon.

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