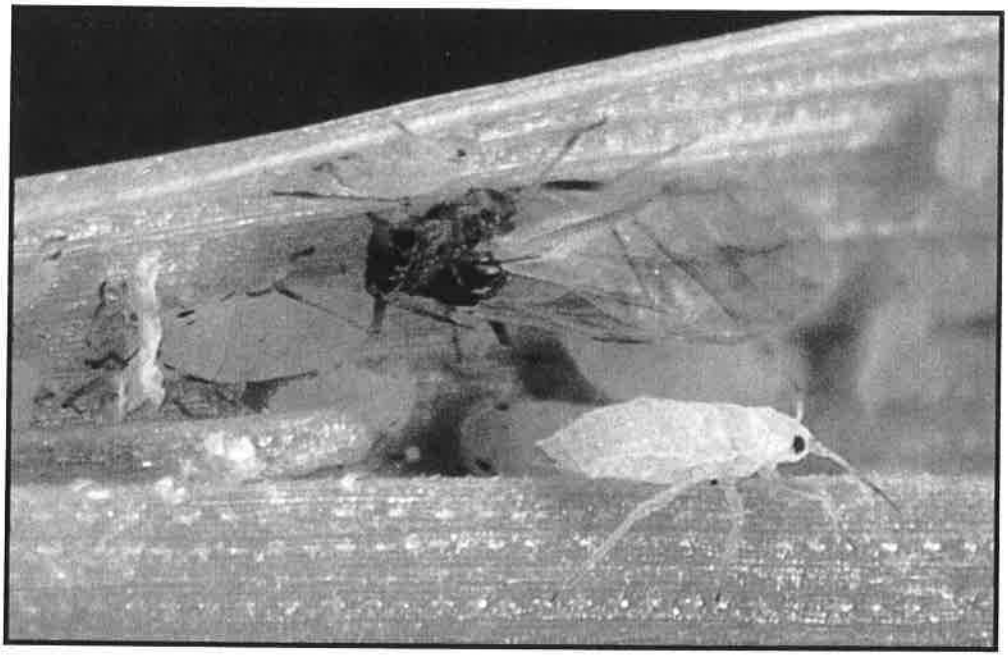
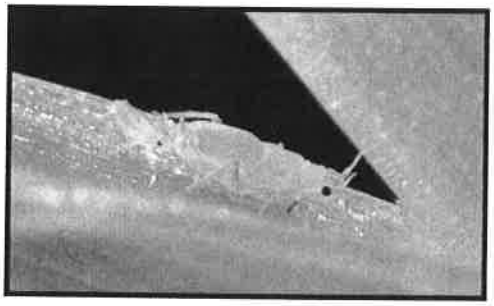
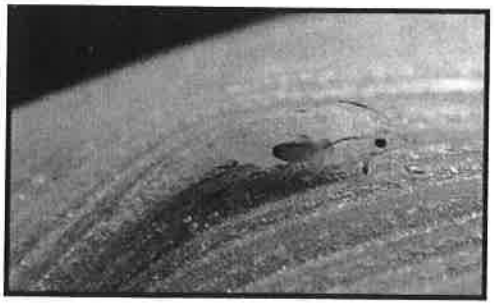
The Russian Wheat Aphid:
Identification, Biology and Management







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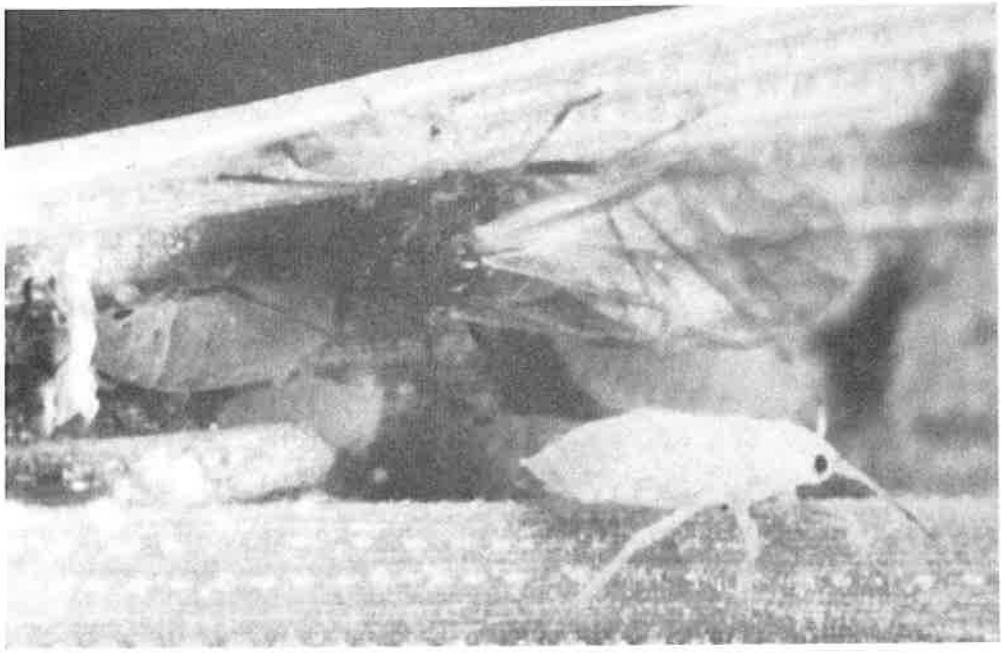
1. Side view of RWA showing forked tail. 2. RWA giving birth. 3. Winged aphid representing the migratory phase of this small grain pest. 4. Immature aphid with wing pads (developing wings). 5. Curled leaves - typical symptom of RWA infested plant.



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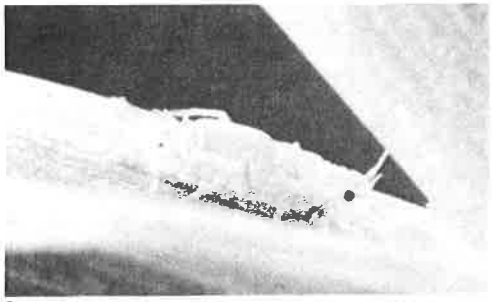

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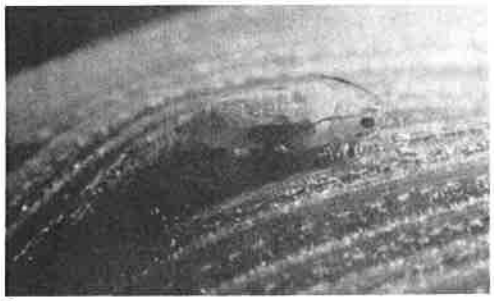

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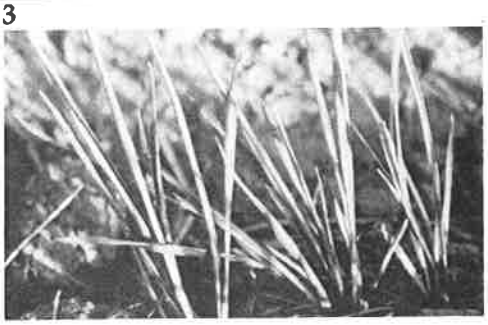

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Photo credits: Noah Poritz -1,2,3,4: Greg Johnson - 5.

The Russian Wheat Aphid:
Identification, Biology and Management

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Foreword

The pesticide information in this publication is intended as a guide for selecting the appropriate pesticide for use in controlling Russian wheat aphids. Extreme care was taken to assure content accuracy. However, pesticides are subject to changes in use and clearances at any time. The producer must be aware of any label modifications. County Extension agents, Extension specialists and dealers are advised of these changes.

Pesticides are listed in this bulletin in alphabetical order by trade name with common names in parentheses. This is done to facilitate product identification and is not intended as an endorsement by the Montana State University Extension Service. Products listed in this bulletin are registered by the Environmental Protection Agency and Montana Department of Agriculture.

The Russian Wheat Aphid: Identification, Biology and Management

Background

The Russian wheat aphid (RWA), *Diuraphis noxia* (Mordvilko), has been in the U.S. since 1986 and has cost small grain producers millions of dollars. Losses in yield and treatment costs were estimated at $53 million in 1987 and $120 million in 1988. (Great Plains Agricultural Council. 1988. Publication No. 124). It was estimated that 2.4 million acres were treated for RWA in 1987 with almost half of these treated acres in Colorado. Although fewer acres were treated in 1988, grain prices and yield losses were higher compared to 1987.

First detection of RWA in the U.S. occurred March, 1986 in the Texas panhandle. It was likely carried by prevailing winds from Mexico, where it has been a small grain pest since the early 1980's. Within three years, the RWA spread to 15 western states and three provinces in Canada. As of spring 1989, Nevada and North Dakota were the two western states in which RWA had not been detected.

In Montana, very low numbers of RWA were found in September, 1987 in Powder River county. The aphid successfully survived the 1987-88 winter and by April 1988, infested several thousand acres of winter wheat in Big Horn and Yellowstone counties. Dispersal of RWA was tracked by MSU entomologists during 1988 and by November, 1988 was found in 34 Montana counties. While the 1989 winter resulted in heavy RWA mortality, a few aphids survived in Big Horn and Yellowstone counties and in the southern part of Cascade county.

The impact and importance of this pest in Montana and other western states will likely increase in the immediate future. Individuals involved in small grain production need to understand RWA biology and management options. Information contained in this bulletin will help growers distinguish this aphid from other small grain aphid pests, recognize plant symptoms and damage, and become familiar with scouting techniques and economic thresholds. Information on currently registered insecticides will be presented.

Identification

Small grain aphid pests such as the corn leaf aphid, greenbugs and the English grain aphid are pear shaped with variations in body color. They have prominent antennae and conspicuous cornicles or "tailpipes". The RWA is markedly different from these aphids. Distinguishing characters of RWA shown in Figure 1 include:

* spindle shaped body
* uniform lime green color
* antennae less than half the body length
* absence of prominent cornicles or "tailpipes"
* presence of supracaudal process or "forked tail"

One aphid species that closely resembles RWA and occurs in Montana is the western wheat aphid (WWA) *Diuraphis tritici*. The WWA, which was first reported in Montana in the early 1900's, has each of the characteristics listed above except it lacks a " forked tail". The WWA will damage plants in a small area in a field but control probably is not necessary because it does

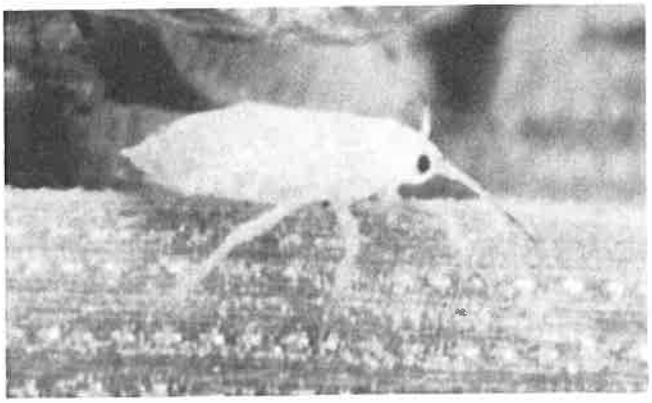


Figure 1.

not spread very rapidly in a field. Therefore, it is important to distinguish RWA from WWA. Since plant damage is similar, the presence or absence of the "forked tail" is the main distinguishing feature. If you have difficulty distinguishing the two aphids, take samples, including plant material, to your county Extension office. Growers also are encouraged to obtain a copy of "Small Grain Aphids in Montana" EB 39 for a complete description of common aphids that attack small grains in Montana.

Biology

Adult female RWA give birth to young (Figure 2). Young aphids, termed nymphs, resemble the adult except they are smaller. Approximately seven to 10 days are required for nymphs to mature to adults and begin reproducing. Each adult RWA can produce 40 to 50 nymphs during her lifetime of 40 days. A unique aspect of the RWA life cycle is that reproduction takes place without male fertilization (parthenogenesis). In fact, while there are some reports of male RWA in Russia, none have been found in North America. Male RWA could develop in the colder northern climates in the U.S. If this happens, then the production of eggs, an extremely cold tolerant stage, could also occur. In the U.S. the RWA overwinters as an adult female or late instar nymph, near the crown of a suitable host plant such as winter wheat or certain grasses.

The primary mode of aphid dispersal is by winged individuals (Figure 3). Winged RWA can only fly short distances, but they are capable of riding long distances on prevailing winds. Not all RWA have wings. An adult female may give birth to young with or without the ability to grow wings (Figure 4). Factors which influence wing development include temperature, day length, growth stage of host plant, crowded conditions on plants and nutritional value of the host plant. Dispersal on wings is a very effective method of migration. For instance, from April to July, 1988 RWA spread from Big Horn county to Liberty county, Montana; a distance of several hundred miles.

Native grasses and volunteer small grain plants serve a very important role in RWA survival. Once spring grains mature, RWA will leave these plants and can be found on Conservation Reserve Program (CRP) grasses and volunteer grains. When fall seeded winter wheat emerges, the aphids will move from CRP grasses and volunteer to the newly emerged winter wheat. CRP grasses and volunteer grains are referred to as "oversummering hosts," because they bridge the time between spring grain harvest and winter wheat emergence.

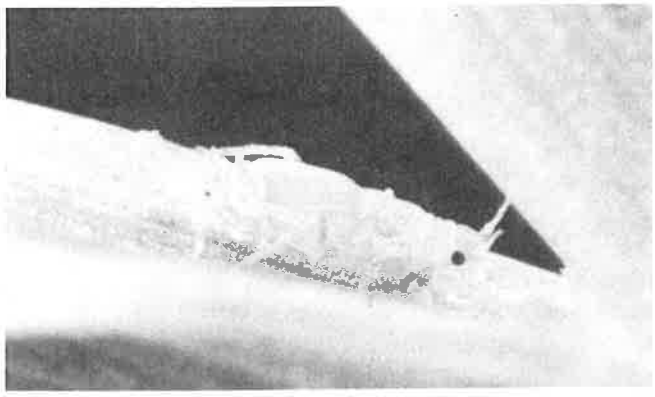


Figure 2.

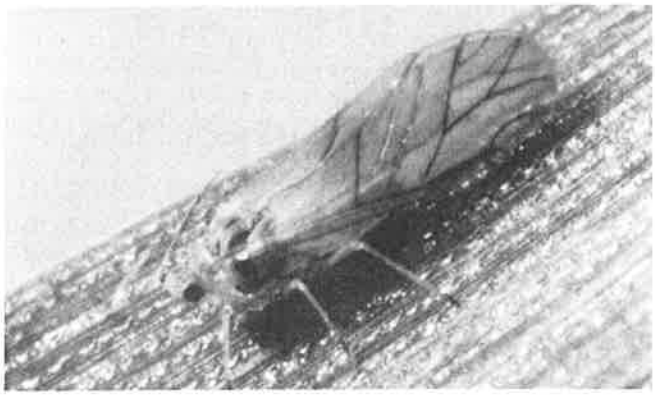


Figure 3.

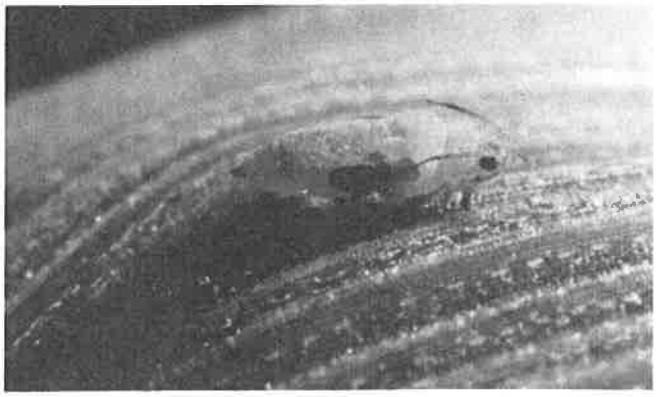


Figure 4.

Symptoms and Damage

RWA feeding has a noticeable effect on small grain plants. Typical RWA symptoms include white and/or yellow streaks running the length of the infested leaf. Under some conditions, infested plants will have a purplish color. Feeding by RWA causes the leaves to remain curled longitudinally forming a hollow tube (Figure 5). Inside this leaf curl, aphids feed and reproduce. They are protected from insect predators and parasites and, to some extent, insecticides. As shown in Figure 5, infested leaves are tightly rolled up and have lost much of their green color. Growth of aphid infested plants will also be stunted.

Figure 5.

In feeding, aphids penetrate plant tissue with lancet-shaped stylets, remove plant fluids and inject a toxic saliva. Plant damage is believed to be caused by a virulent toxin injected into the plant with aphid saliva. The toxin, consisting of a degradative enzyme(s), attacks and destroys plant chloroplasts which are essential for photosynthesis. In the absence of chloroplasts, photosynthesis will cease, and the plant will begin to show steaking and discoloration where RWA's were feeding.

The degree of plant damage and the influence on yield depends on the level of infestation and development stage of the plant. Plants are especially susceptible to RWA damage from seedling to first joint stages. Tillers infested with 10 to 20 RWA will die if left untreated. Equally critical is protecting the flag leaf. A curled up flag leaf can trap an emerging head resulting in a fish-hooked, partially filled head. When the plant begins to senesce, RWA will leave the host in search of a more succulent food source.

Feeding Preference

Small grains, especially wheat and barley, are primary host plants for RWA. Speltz and triticale have been infested with RWA with similar damage as with wheat and barley. For a reason yet to be determined, tame and wild oats are infested by RWA, but they are not damaged. Legumes and row crops are not suitable hosts for RWA.

A number of grass species, including intermediate, pubescent, crested and tall wheatgrass are suitable hosts for RWA. Of these, intermediate wheatgrass appears most frequently infested. Grasses that do not serve as good host plants include green needlegrass, smooth bromegrass, wild ryes, blue grama, orchardgrass and tall fescue.

MSU entomologists in central and south central Montana in 1988 observed that RWA did little damage to established CRP grass stands. Rarely was any streaking observed on the leaves of mature plants. However, RWA infestations on seedlings may be more damaging. Recently emerged grass seedlings will show streaking and curled leaves and might require an insecticide treatment depending on time of year, soil moisture, etc. Scouting newly seeded CRP stands is the best method to determine if a problem exists.

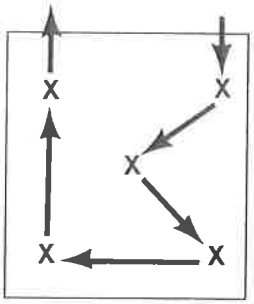
Scouting Techniques

Effective management of RWA depends on early detection. Consequently, when scouting a field for RWA, it is very important to make a representative survey of the field to have an accurate indication of RWA infestation severity. Walking fields is the best method for field scouting. An ATV can be used to travel from one sampling location to another but should not be ridden while attempting to survey for aphids. Problems spotted doing a "windshield" survey through a pickup truck at 45 mph usually have gone too far to be corrected.

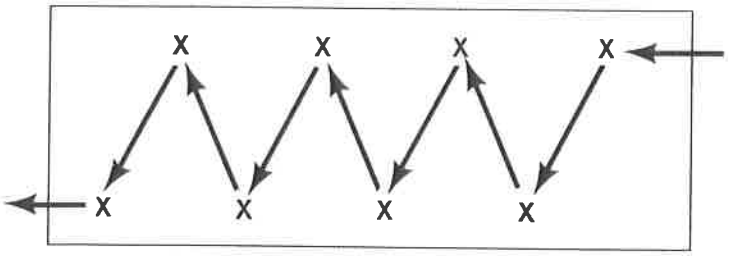
RWA infestations do not occur uniformly in the field; they frequently occur in 'hot spots'. Surveying a small area may lead to a wrong conclusion regarding RWA infestation levels and thus making the wrong treatment decision. The techniques listed below are designed to assist producers in getting accurate scouting results. A few essential items when scouting a field include a note pad, plastic bags and a 10X hand lens.

* **Scout weekly**. Scout fields at least once per week starting from seedling to soft dough stage. If RWA are detected in the field, then it is necessary to return to the field more frequently (every three to four days).

* **Scouting pattern**. Choose sampling locations randomly in a field. The two line drawings below suggest different ways to sample a field.



Method 1.



Method 2.

Include typical areas in the field, e.g. flat and uniform. In the spring, pay particular attention to south facing slopes. In Big Horn County, RWA have been found to survive the winter along these slopes. The number of sampling locations within a field varies based on the size of the field. Sample enough locations in the field so that you have a reasonably good idea of what is going on in that particular field.

* **Choose tillers**. At each location choose 10 to 20 tillers (one tiller per plant) at random and examine for RWA symptoms and live aphids. When selecting a tiller to examine, it is human nature to select only those that are infested or show symptoms. One method to prevent this sampling bias is to toss an object, e.g. dirt clod, rock or hat (only on a calm day), and examine a tiller on the plant closest to the tossed object. This will result in a true estimate of the percent infestation. Another method is to examine consecutive plants, such as 10 or 20 tillers in a row at various locations in the field.

* **Identify aphids and not symptoms**. As previously stated symptoms cannot be used as an identification tool since WWA causes identical damage. Therefore, aphids must be identified. Look for the "forked tail" using a 10X hand lens. If positive identification cannot be made, then place plant material and aphids in a plastic bag and take them to your county Extension Office.

* **Determine percent infestation**. Record the number of tillers examined and the number of tillers infested. The percent infestation can be determined by dividing the number of tillers examined into the number of tillers infested. Remember an infested tiller consists of one aphid.

$$\frac{\text{Number of RWA Infested Tillers}}{\text{Number of Tillers Examined}} = \%\ \text{infestation}$$

* **Look for unusual spots in the field**. Uneven growth patterns, yellow plants, dying or stunted plants, and typical RWA symptoms, e.g. streaking and curling of leaves deserves attention. These areas may be the start of an infestation.

* **Keep an eye on the weather**. RWA prefer hot, dry conditions. Their populations can increase dramatically under these conditions.

Economic Injury Levels and Treatment Guidelines

Small Grains (Wheat and Barley)

The current treatment threshold used in the U.S. was developed in South Africa where RWA have been a problem for more than 10 years. Insecticide treatments in the spring/summer are justified when 1) at least 15 to 20 percent of the tillers are infested with live RWA, 2) grain heads are not visible, and 3) the infestation appears field wide.

Problems can arise if a field is treated too early or too late. A field treated too early, i.e.

TABLE 1: Foliar Insecticides Registered for RWA Control in Small Grain

Insecticide	Crop	Rate (lb a.i./acre)***	Remarks	Recommended Application Method(s)
Cygon 400 (dimethoate)	Wheat	1/2 to 3/4 pint (0.25-0.375)	Grazing restriction: 14 days Harvest interval: 35 days	Ground or air
Di-Syston 8* (disulfoton)	Wheat	1/4 to 3/4 pint (0.25-0.75)	Do not graze treated fields Harvest interval: 30 days	Air only
	Barley	1/2 to 1 pint (0.5-1.0)		
Furadan 4F* (carbofuran) + Methyl parathion*	Wheat Barley	1/3 to 1/2 pint (0.16-0.25) + 1/2 pint (0.25)	Do not graze treated fields Apply before heads emerge from boot	Air only
Lorsban 4E** (chlorpyrifos)	Wheat	1 pint (0.5)	Grazing restriction: 14 days Harvest interval: 21 days Do not feed straw from treated wheat within 28 days after application	Ground or air
6-3 Parathion (parathion)	Wheat Barley	1/3 pint (0.37)	Harvest interval: 15 days	Air only
Parathion 8-E* (parathion)	Wheat Barley	1/4 to 3/4 pint (0.25-0.75)	Harvest interval: 15 days	Air only
Penncap M* (micro-encapsulated methyl parathion)	Wheat Barley	1 to 2 pints (0.25-0.5)	Harvest interval: 15 days	Ground or air
Thiodan 3EC (endosulfan)	Wheat Barley	1 1/3 pints (0.5)	Do not apply after heads begin to form. Do not feed treated forage to livestock.	Ground or air

* Restricted Use Pesticide

** For use until October 18, 1989, under EPA emergency exemption pursuant to Section 18 of the Federal Insecticide, Fungicide and Rodenticide Act as Amended.

*** Lower rates should provide effective control in the fall, full rates will likely be necessary to control rapidly expanding spring populations.

before the infestation exceeds the treatment threshold, may require re-treatment. A field treated too late may already have been damaged by RWA and the crop will not benefit from the application. If an accurate scouting report reveals only a portion of the field is infested, then it might be possible to treat only the infested area. However, the likelihood of only a portion a of field needing treatment is slim.

A list of insecticides registered for RWA control in small grains is presented in Table 1. When applying an insecticide by aircraft, have the recommended amount of chemical mixed with sufficient water to provide a minimum of two gallons of finished spray per acre. For ground application, apply recommended amount of pesticide in a minimum of 10 gallons of water per acre. Growers are urged to wear the proper protective clothing when mixing, loading and applying any pesticides. Follow label directions for reentry intervals, harvest and grazing restrictions and container disposal.

At this time economic injury levels for winter and spring wheats and barley are the same. As we learn more about RWA effects on yield, modifications to the existing economic threshold will occur. These modifications will take place because of differences in wheat and barley susceptibility to RWA toxin, a higher cash value of a crop will dictate a lower threshold, and different climatic conditions in the various geographic regions will necessitate different thresholds.

In addition to foliar sprays, two granular insecticides are registered for RWA control (Table 2). Granules can be applied in spring or fall at seeding or as a post-emergence broadcast. There are a couple of concerns regarding the use of granular insecticides. First, one does not know if RWA will be present in economic numbers to justify their expense when applied with the seed. Second, post-emergence applications require moisture before the granules will be activated and carried to the root zone of the plant. Without adequate moisture the granules will not be effective.

TABLE 2: Granular Insecticides for RWA Control in Small Grains

Insecticide	Crops	Rate (lb a.i./ac)	Remarks
Di-Syston 15G* (disulfoton)	Wheat Barley	6.7 lbs/acre (1.0)	Harvest interval: 60 days Do not graze treated fields
Thimet 20G* (phorate)	Wheat	1.2 oz/1000' (0.5, in furrow)	Grazing restriction: 45 days
		4.9 lbs/acre (0.98, broadcast)	Harvest interval (grain): 70 days Grazing restrictions: 28 days

* Restricted Use Pesticide

Grass seed production and CRP acres present a special problem regarding insecticides available for RWA control. Insecticides listed in Tables 3 and 4 are not specifically registered for RWA control for these sites, however, their uses are permissible exceptions under FIFRA as Amended Section 2EE which states that although the target pest is not specified on the label the crop is specified on the label. For this purpose CRP acres are defined as pasture or rangeland.

Newly seeded CRP acres may need to be protected from RWA, since established stands appear to be more tolerant. In making a decision to spray CRP, growers need to remember that insecticide treatments will eliminate existing beneficial insect populations while providing two to three weeks control of RWA.

TABLE 3: Foliar Insecticides Registered for RWA Control in Grass Grown for Seed

Insecticide	Rate(lb a.i./acre)	Remarks	Recommended Application Method(s)
Malathion 57EC (malathion)	1 1/2 to 2 pints (1.94 - 1.25)	No harvest restrictions	Ground or air
Parathion 8E* (parathion)	1/4 to 1/2 pint (0.25 - 0.5)	Harvest/grazing interval: 15 days	Air only
Penncap M* (microencapsulated methyl parathion	2 - 3 pints (0.5 - 0.75)	Harvest/grazing interval: 7 days	Ground or air

* Restricted Use Pesticide

TABLE 4: Foliar Insecticides Registered for RWA Control in CRP Acres

Insecticide	Rate (lb a.i./acre)	Remarks	Recommended Application Method(s)
Sevin XLR Plus, 4 Oil, 80S, 5OW (carbaryl)	1 to 1 1/2 quarts (1.0 - 1.5)	See label for specific directions	Ground or air
Parathion 8-E* (parathion)	1/4 to 1/2 pint (0.25 - 0.5)	Harvest/grazing interval: 15 days	Air only
Diazinon 500-AG	3/4 to 1 pint (0.375 to 0.5)	Harvest interval: 21 days	Ground or air
Malathion 57EC	1 1/2 to 2 pints (0.94 - 1.25)	No harvest restrictions	Ground or air
Orthene 75S	1/8 to 1/6 lb (0.094 - 0.125)	Harvest interval: 21 days	Ground or air

* Restricted Use Pesticide

Additional Management Strategies

Both short- and long-term management strategies will be necessary for control of this small grain pest. Short-term management plans involve insecticide treatments and agronomic practices to reduce infestation levels and crop damage. However, it is a commonly shared belief that reliance on pesticides as the sole management tool has limitations, i.e. RWA resistance, insecticide costs, environmental impacts. Consequently, a long-term management approach includes biocontrol, breeding for plant resistance and agronomic practices. These approaches, supplemented by prudent use of insecticides, will be the most effective RWA management program.

Acknowledgements

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