Managing New Russian Wheat Aphid Biotypes

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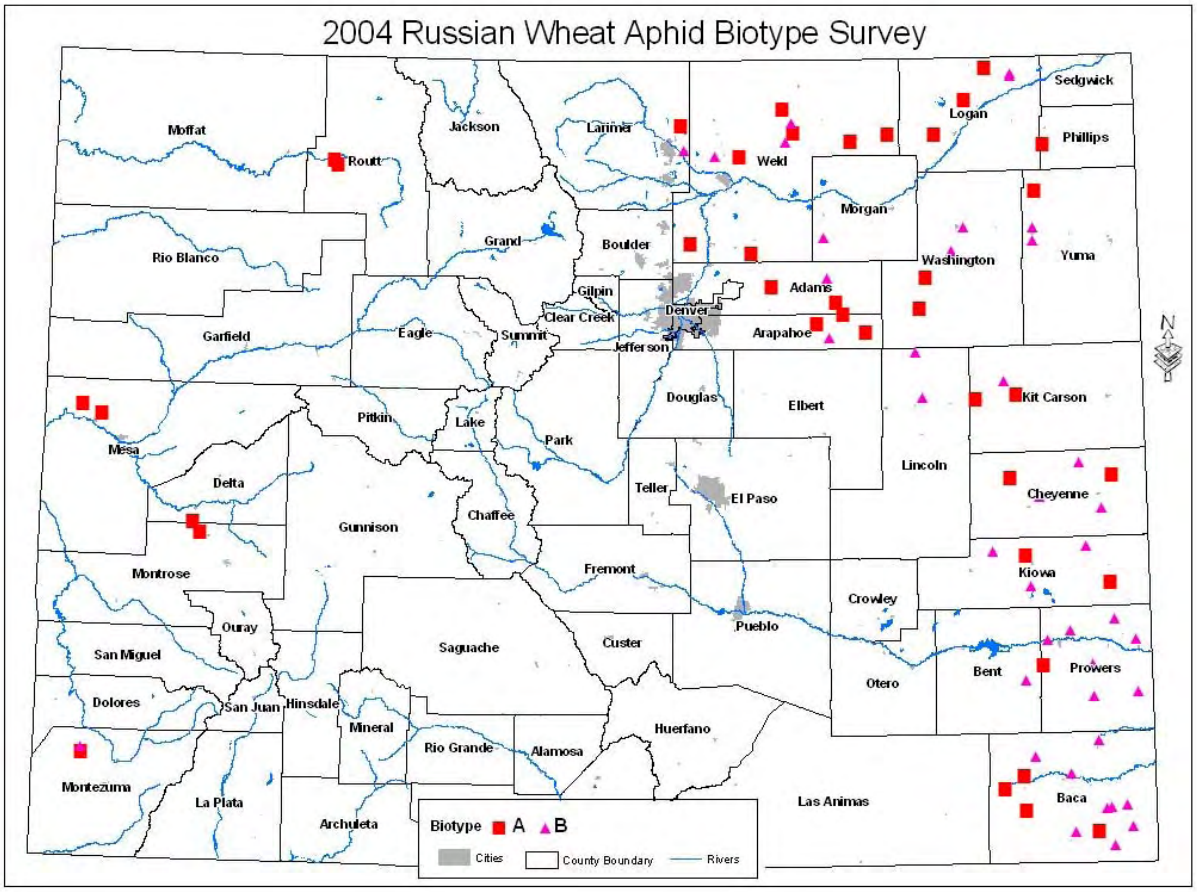
Background

Wheat varieties resistant to Russian wheat aphid have been available in Colorado for about 10 years, starting with Halt. Since then, resistant versions of several popular Colorado HRW wheats have been released (the variety name in parentheses is the original, susceptible variety from which the resistant variety was developed through the backcross process), including Ankor (Akron), Prairie Red (TAM 107), Prowers 99 (Lamar) and Yumar (Yuma). The resistance in all of these varieties is conferred by the gene Dn4. The sixth resistant variety, Stanton, is a wheat variety from Kansas with a different source of resistance. Together, Russian wheat aphid resistant varieties accounted for approximately 25% of Colorado's wheat acres in the 2002 and 2003 crop years, with higher percentages in counties with more consistent infestations.

In the spring of 2003 we received a number of reports of unusual Russian wheat aphid damage in resistant varieties. We were soon able to confirm that this damage was caused by a new Russian wheat aphid biotype that is unaffected by the sources of resistance currently in use. We use the term "Biotype A" to refer to the original aphid for which the resistant varieties were developed and "Biotype B" to refer the new aphid population that is able to overcome the resistance in available resistant varieties.

Biotype Survey

As of July 15, 2004 we have collected 100 Russian wheat samples from Colorado and the southern Nebraska Panhandle. The majority are from wheat producing areas of eastern Colorado. Infested tillers were collected from each site. Twenty young aphids were placed in a pot containing one plant each of TAM 107 and Prairie Red, which was then held in a cage in the greenhouse until the TAM 107 plant was heavily damaged. Aphids that damaged only TAM 107 were considered to be Biotype A, while those that damaged both varieties were categorized as Biotype B (or a mixture of both biotypes). The results of the 91 usable samples are summarized in the map and table below.



County	Total Samples	Biotype		County	Total Samples	Biotype	
		A	B			A	B
Adams	3	2	1	Morgan	1	0	1
Arapahoe	4	3	1	Otero	2	1	1
Baca	13	5	8	Park	1	1	0
Bent	2	0	2	Phillips	1	1	0
Cheyenne	5	2	3	Prowers	10	1	9
Delta	4	4	0	Pueblo	1	0	1
Kiowa	5	2	3	Routt	2	2	0
Kit Carson	2	1	1	Washington	6	3	3
Lincoln	2	0	2	Weld	10	7	3
Larimer	2	1	1	Yuma	2	1	1
Logan	5	3	2	Nebraska (all)	6	2	4
Montezuma	2	2	0	**TOTALS**	**91**	**43**	**48**

Roughly half (47%) of the samples we were able to classify were Biotype A, the original Russian wheat aphid. Biotype B was found throughout eastern Colorado. It was not found in the West Slope samples.

The range of Biotype B clearly has expanded since it was first observed in southeast Colorado last spring. However, it does not seem to have displaced Biotype A, and it is unknown whether this pattern will change over the next few years. Varieties resistant to Biotype A therefore remain an important Russian wheat aphid management tool.

How Many Biotypes?

When we started our survey, only two biotypes were known. However, on June 4, 2004 a USDA researcher informed us that he had identified at least three additional biotypes – two from Texas and one from Wyoming. At that point we modified our survey methods to allow us to detect one or more of these new biotypes. To avoid confusion, we have presented our results to show the number and location of Biotype A and B samples. Realistically, Biotype B samples should be considered as "non-A". However, our opinion is that the Biotype B designation is accurate in most cases. Nonetheless, it does appear that we encountered at least two additional biotypes after we changed our methods – one from Baca County similar to the USDA Texas isolate and a previously unknown type from Montezuma County.

Developing New Resistant Varieties

A common question is how soon will varieties resistant to both Biotype A and the new biotype(s) be available? This depends on where we find new sources of resistance. If resistance is found in advanced breeding material with good quality and agronomic traits, then the development period would be relatively short. This is highly unlikely and, in fact, screening of over 350 elite breeding programs from Great Plains programs failed to identify and useful resistance. The more likely scenario will be that resistance will be found in an unadapted, undesirable wheat, as was the case with Dn4. If this is the case, the development period will be substantially longer, perhaps as long as 10 years. Effective resistance to Biotype B has been identified in a few breeding lines from CSU and theUSDA-ARS in Stillwater, Oklahoma, and a collection of germplasm from the National Small Grains Collection (Aberdeen, Idaho). Agronomic and quality
evaluation of these materials is underway. However, no screening has been conducted with any of the newly discovered types so it is uncertain which, if any, of these accessions found to be resistant to biotype B will be resistant to the new biotypes.

We also have begun to screen for new sources of resistance. Most of the sources known to be resistant to Biotype A have proven to be susceptible to Biotype B. A promising exception is Dn7, which confers high resistance to both biotypes, but was transferred to wheat from rye and is generally associated with poor baking quality. Also some of the newly discovered biotypes are virulent to Dn7. In addition, we have evaluated more than 700 Biotype A resistant lines and have identified several promising new sources. We also have started to screen an additional 12,000 lines from the National Small Grains Collection, which should be completed in the fall of 2005. Lines resistant to Biotype B will be rescreened with Biotype A and with a Dn7-virulent type to identify promising lines for use in the development of varieties with broad resistance to as many Russian wheat aphid biotypes as possible.

Management of the New Biotypes

The resistant varieties mentioned above are still the most economical and effective management option for Biotype A. However, currently available resistance is not effective against Biotype B or the other newly discovered types, so they must be managed with the methods developed before resistant varieties were available. These include biological control, cultural controls, and judicious insecticide treatments based on appropriate scouting and economic threshold information.

Biological controls consist of (1) native natural enemies, such as lady beetles, lacewings, and spiders, which feed on a variety of insects including aphids; (2) exotic natural enemies collected from the Russian wheat aphid's native range and imported specifically for its control; and (3) commercially available natural enemies, which can be purchased and released in large numbers to control Russian wheat aphid. Each of these approaches may provide some control benefit in certain situations, but overall, biological control has not been sufficiently effective against Russian wheat aphid.

Cultural controls are changes in crop production practices that result in a crop environment that is less favorable for the pest or more favorable for natural enemies. Several cultural controls are known to provide some control benefit for Russian wheat aphid. Delayed planting of winter wheat and early planting of spring grains can help reduce initial aphid infestations. Crop diversification by producing winter wheat in rotation with summer crops is thought to enhance biological control activity, as well as providing a number of other economic and pest management benefits. Finally, any practice that results in a healthier and more vigorous crop should help minimize Russian wheat aphid problems, which often are worse in stressed portions of the field.

The important considerations in chemical control of Russian wheat aphid are what product to use and when to use it. We have tested a number of insecticide treatments since Russian wheat aphid first appeared in Colorado. It is convenient to compare treatments based on their consistency in achieving very good control (better than 90% control at three weeks after treatment). These results, summarized in Table 1, indicate that one pint of Lorsban 4E has been our most consistent treatment. Other available treatments, which we have not tested as extensively, include Cruiser and Gaucho seed treatments, Di-Syston and Furadan soil treatments, and Mustang Max foliar treatment.

Table 1. Control of Russian wheat aphid with hand-applied insecticides in winter wheat, 1986-2003[1].

PRODUCT	LB (AI)/ACRE	TESTS WITH > 90% CONTROL	TOTAL TESTS	% TESTS
LORSBAN 4E	0.50	23	39	59
DI-SYSTON 8E	0.75	16	41	39
LORSBAN 4E	0.25	7	21	33
DIMETHOATE 4E	0.375	7	33	21
DI-SYSTON 8E	0.50	2	10	20
PENNCAP M	0.75	3	19	17
WARRIOR 1E	0.03	2	12	17

[1]Includes data from several states.

The presence of other pests may have a bearing on the most appropriate treatment choice. For example, if cutworms are present in addition to Russian wheat aphid, a pyrethroid insecticide such as Mustang Max or Warrior would be a better choice than Lorsban 4E. The pyrethroids are highly effective against cutworms and moderately effective against Russian wheat aphid, while Lorsban is highly effective against the aphid but not effective against cutworms at the label rate.

See Table 2 for simple treatment guidelines for deciding whether a Russian wheat aphid treatment should be made. If one tiller shows damage, then the plant should be considered damaged. Aphids can be very difficult to find during cold weather, so base treatment decisions on damage alone under such conditions.

Table 2. Treatment guidelines for Russian wheat aphid by crop stage.

Crop Stage	**Level at which aphids should be treated[1]**
FALL	
Any growth stage	10-20% damaged plants
SPRING	
Regrowth to early boot	5-10% damaged and infested tillers
Early boot to flowering	10-20% damaged and infested tillers
After flowering	More than 20% damaged and infested tillers

[1]Based on a 100 plant or tiller sample.

An alternative threshold for the period from spring regrowth to heading, which takes into consideration control costs and expected crop value, is as follows:

$$\% \text{ Infested Tillers} = \frac{\text{Control Costs (\$/acre)} \times 200}{\text{Expected yield (bu/acre)} \times \text{Expected price (\$/bu)}}$$

For example, the % infested tillers above which treatment should be considered for $15 control costs, 34 bu/acre expected yield and $3.50 would be calculated as follows:

$$25\% \text{ Infested Tillers} = \frac{\$15.00 \times 200}{34 \times \$3.50}$$

Increases in crop value or reduced control costs result in less infestation required to justify treatment, while the reverse is true for decreased crop value or increased control costs. For example, if the price of wheat were lower it would take more aphid damage to justify an insecticide expenditure.

$$32\% \text{ Infested Tillers} = \frac{\$15.00 \times 200}{34 \times \$2.75}$$

If the percentage of infested tillers calculated in this manner is less than the percentage of infestation observed in a 100-tiller sample from the field being evaluated, then a treatment should be considered. After heading, use a factor of 500 rather than 200 in the numerator.

Further Information

The ***High Plains Integrated Pest Management Guide for Colorado, western Nebraska, Wyoming, and Montana*** provides on-line management information for Russian wheat aphid and the other pests and diseases of small grains, as well as most other crops grown in the region.

http://www.highplainsipm.org/

The Colorado State University fact sheet ***Aphids in Small Grains*** summarizes management information for Russian wheat aphid as well as other aphids that attack wheat and similar crops in Colorado.

http://www.ext.colostate.edu/pubs/insect/05568.pdf

Areawide Pest Management for Wheat: Management of Greenbug and Russian Wheat Aphid is a cooperative project between USDA-ARS and several states, including Colorado. This project is designed to improve the management of these key wheat pests through diversified cropping, resistant varieties, remote sensing, and other pest management tools. New pest management information is being developed through economic surveys, field research, and grower focus groups. Colorado research sites are located at Walsh, Lamar, and Briggsdale.

http://www.pswcrl.ars.usda.gov/AWPM2/index.htm