University of Idaho
College of Agriculture

Cooperative Extension System
Agricultural Experiment Station



Current Information Series No. 884

# Sequential Decision Cards: A Tool for Russian Wheat Aphid Control

*Edward Bechinski and Hugh Homan*

Sequential sampling was developed for making quality control decisions in munitions factories during World War II. The method proved so effective that it was classified ''restricted'' until war's end.

What does this former military secret have to do with the Russian wheat aphid? Like quality control decisions in industry, pest control decisions in agriculture depend on classification. In particular, deciding whether to apply a foliar insecticide for Russian wheat aphid control requires classifying the infestation as either less than the economic threshold or greater than the threshold. You can use the sequential decision cards described here to decide if foliar-applied insecticides are needed to control Russian wheat aphids in wheat and barley. These cards are not valid for any other pest or crops.

## Advantages of sequential sampling: Speed and accuracy

''Sequential'' means that the number of plants you inspect is not set in advance. Instead, each time you inspect a plant, you make one of two decisions: (1) to classify the field as spray or do not spray or (2) to inspect an additional plant. When infestations are far above or far below the threshold, just a few samples can decide if control is warranted.

The sequential decision cards are 90 percent accurate. This means that when the card gives a spray recommendation, you can be 90 percent sure that the infestation is greater than the economic threshold. Likewise, when the card gives a do not spray recommendation, you can conclude with 90 percent confidence that the infestation is lower than the threshold. Chances are nil that the cards will give an incorrect recommendation when aphid populations are far below or far above the threshold.

Experience has also shown the cards to make conservative errors. They are much more likely to recommend spraying when control really is not needed than to recommend not spraying when the infestation is greater than the threshold.

## How to use the decision cards

**1. Select the correct card.** Each card can be used only during certain crop growth stages (Fig. 1). For winter wheat and winter barley in fall, use Card 1 from plant emergence to the first tiller stage. After the first tiller stage in fall, do not use the cards. Instead, apply insecticides only if the plants are stressed or there is danger of winterkill. The following spring, use Card 1 from green-up to the first node stage, Card 2 from first node to head emergence and Card 3 from head emergence to soft dough.

Use Card 2 for spring wheat and spring barley from seedling emergence to head emergence. At head emergence, switch to Card 3 and use it to the soft dough stage.

Field scouting after the soft dough stage is unnecessary because insecticide application this late provides little benefit. Refer to University of Idaho publication MS 118, *Growth Staging for Wheat, Barley and Wild Oat,* for more detailed descriptions of growth stages.

**2. Inspect the correct plant part.** When using Card 1, inspect entire plants. When using Cards 2 and 3, examine individual tillers rather than entire plants.

**3. Scout fields at weekly intervals.** Inspect fields at least once a week during the growing season, especially during the period from seedling emergence until the first tiller appears. Scout more frequently when these susceptible crop stages coincide with unusually warm weather. Russian wheat aphid populations can increase rapidly dur-

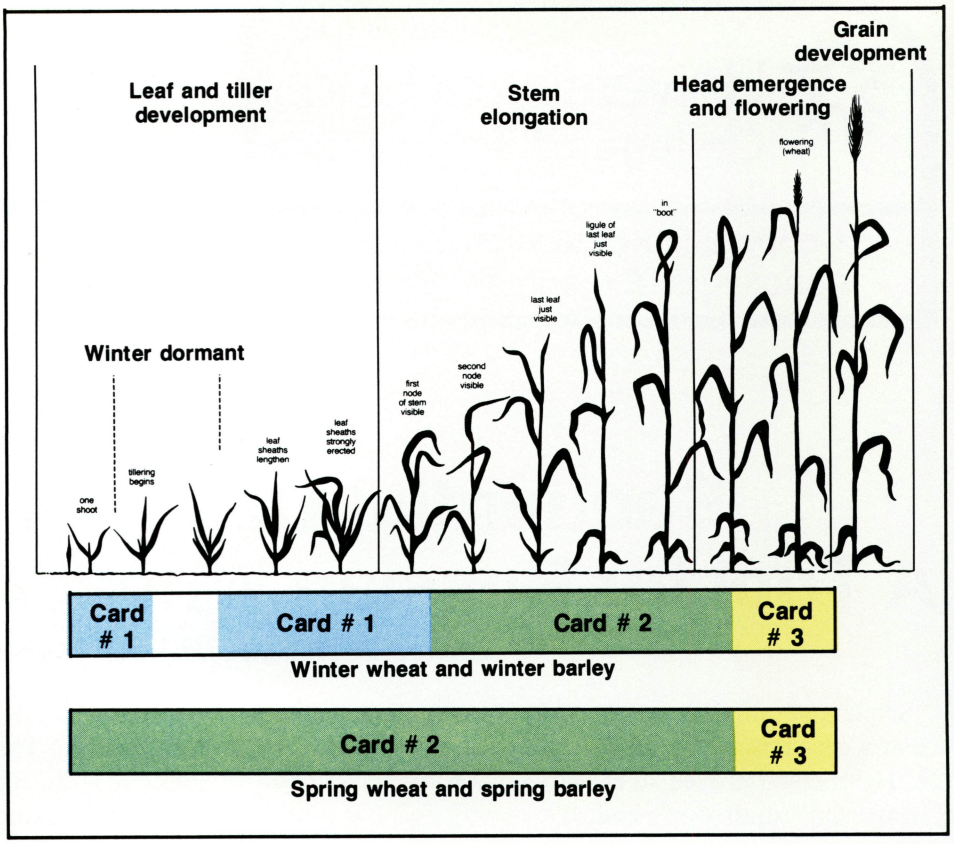



**Fig. 1. Choose decision cards based on the developmental stages of wheat and barley. Field scouting is unnecessary after the soft dough stage because insecticide treatment has little economic benefit at later stages.**

ing warm weather, and weekly scouting may give inadequate warning of impending crop injury.

**4. Take samples randomly.** Field inspections absolutely must be made at random. Random sampling means that each plant is just as likely as any other to be examined. Do not intentionally single out uninfested plants or plants with obvious symptoms of Russian wheat aphid injury.

Intentional selection of infested or uninfested plants gives a biased picture of actual infestation levels. It will result in an incorrect control decision. It would be less trouble and just as accurate to make control decisions by flipping a coin than by sampling nonrandomly.

Sample randomly by walking an M, X or similar zigzag pattern across the field (Fig. 2). Spread out the samples across the entire field to ensure that your results represent overall field conditions. Walk a different path each week.

At intervals of 20 to 40 paces, stoop down, and without looking, select a plant or tiller. Take care in seedling stands not to dislodge aphids. You can avoid the natural tendency to select discolored or unusual plants by looking toward the horizon as you zigzag through the field and as you select each plant.

Russian wheat aphids seldom occur uniformly across fields. Infestations often begin along field edges downwind from previously infested fields and Conservation Reserve Program lands. Experience also suggests that infestations vary with stand density, weediness, field elevation and directional aspect. South-facing slopes particularly seem prone to infestation as do areas where plant density is sparse.

Subdivide highly variable fields into uniform areas and sample randomly within each (Fig. 2). Use a separate card for each field subdivision and make a separate control decision for each. Subsampling fields can pinpoint areas that actually require insecticide treatment. Unsprayed areas will conserve the beneficial natural enemies that help keep Russian wheat aphids and other pests in check.

**5. Record your results.** Visually inspect the tiller or plant to see if at least one Russian wheat aphid is present. Do not count individual Russian wheat aphids, only the number of aphid-infested plants or tillers. Pay particular attention to rolled leaves where colonies occur. Record your results on the decision card as the running tally of plants or tillers with at least one living Russian wheat aphid. Do not tally uninfested plants that show damage from earlier infestations.

Russian wheat aphids frequently occur with other aphids. In the field, they can be confused with the greenbug and other species. The Russian wheat aphid is distinguished from other species by (1) its very short, difficult-to-see cornicles, (2) its elongate, spindle-shaped, green body without noticeable hairs or spots and (3) its two-tailed appearance in side view (Figs. 3 and 4).

**Fig. 5. How to compute running tallies and make control decisions using Card 3.**

| tiller no. | field 1 RWA present? yes | no | tally |
|---|---|---|---|
| 1 | X | | 1 |
| 2 | X | | 2 |
| 3 | X | | 3 |
| 4 | X | | 4 |
| 5 | | | |

| tiller no. | field 2 RWA present? yes | no | tally |
|---|---|---|---|
| 1 | ✓ | | 1 |
| 2 | | ✓ | 1 |
| 3 | ✓ | | 2 |
| 4 | ✓ | | 3 |
| 5 | | ✓ | 3 |
| . | | | |
| . | | | |
| 18 | | ✓ | 3 |
| 19 | ✓ | | 4 |
| 20 | ✓ | | 5 |
| 21 | ✓ | | 6 |
| 22 | | | |
| 23 | | | |

Russian wheat aphid sequential decision cards[1]

Current Information Series No. 884C
March 1991

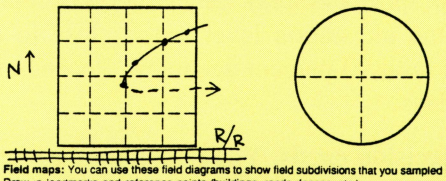
## Card 3 Winter and spring grain from head emergence to soft dough

Field/subdivision ID: FIELD 1-W Crop: OWENS Growth stage: PRE-MILK Date: 7/11/91

| Number of tillers examined | DO NOT SPRAY if tally is less than | RUNNING TALLY (no. tillers with ≥ 1 RWA) | SPRAY if tally exceeds | Number of tillers examined | DO NOT SPRAY if tally is less than | RUNNING TALLY (no. tillers with ≥ 1 RWA) | SPRAY if tally exceeds |
|---|---|---|---|---|---|---|---|
| 1 | ■ | 1 | ■ | 26 | 2 | ____ | 6 |
| 2 | ■ | 2 | ■ | 27 | 2 | ____ | 6 |
| 3 | ■ | 3 | ■ | 28 | 2 | ____ | 6 |
| 4 | ■ | 4 | 3 | 29 | 2 | ____ | 6 |
| 5 | ■ | STOP | 3 | 30 | 2 | ____ | 7 |
| 6 | ■ | AFTER 4TH | 3 | 31 | 2 | ____ | 7 |
| 7 | ■ | FILLER | 3 | 32 | 2 | ____ | 7 |
| 8 | ■ | SPRAY | 3 | 33 | 3 | ____ | 7 |
| 9 | ■ | ____ | 4 | 34 | 3 | ____ | 7 |
| 10 | ■ | ____ | 4 | 35 | 3 | ____ | 7 |
| 11 | ■ | ____ | 4 | 36 | 3 | ____ | 7 |
| 12 | ■ | ____ | 4 | 37 | 3 | ____ | 8 |
| 13 | ■ | ____ | 4 | 38 | 3 | ____ | 8 |
| 14 | ■ | ____ | 4 | 39 | 3 | ____ | 8 |
| 15 | ■ | ____ | 4 | 40 | 4 | ____ | 8 |
| 16 | ■ | ____ | 5 | 41 | 4 | ____ | 8 |
| 17 | ■ | ____ | 5 | 42 | 4 | ____ | 8 |
| 18 | ■ | ____ | 5 | 43 | 4 | ____ | 8 |
| 19 | 1 | ____ | 5 | 44 | 4 | ____ | 9 |
| 20 | 1 | ____ | 5 | 45 | 4 | ____ | 9 |
| 21 | 1 | ____ | 5 | 46 | 4 | ____ | 9 |
| 22 | 1 | ____ | 5 | 47 | 5 | ____ | 9 |
| 23 | 1 | ____ | 6 | 48 | 5 | ____ | 9 |
| 24 | 1 | ____ | 6 | 49 | 5 | ____ | 9 |
| 25 | 1 | ____ | 6 | 50 | 5 | ____* | 9 |

■ Means that a decision is not possible; continue sampling.

*If tally = 5 to 9 infested tillers after 50 tillers have been inspected, the infestation is borderline; recheck field in 3 to 5 days.




**Field maps:** You can use these field diagrams to show field subdivisions that you sampled separately. Draw in landmarks and reference points (buildings, roads, fences, etc.).

[1]Instructions for use of the sequential decision cards are in University of Idaho Current Information Series no. 884, *Sequential Decision Cards: A Tool for Russian Wheat Aphid*

Russian wheat aphid sequential decision cards[1]

Current Information Series No. 884C
March 1991

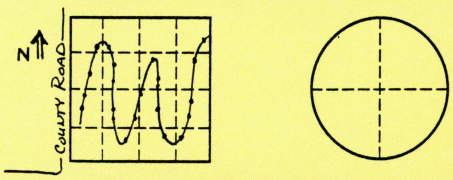
## Card 3 Winter and spring grain from head emergence to soft dough

Field/subdivision ID: SEC 2 Crop: TWIN Growth stage: EARLY FLOWER Date: 6-27-91

| Number of tillers examined | DO NOT SPRAY if tally is less than | RUNNING TALLY (no. tillers with ≥ 1 RWA) | SPRAY if tally exceeds | Number of tillers examined | DO NOT SPRAY if tally is less than | RUNNING TALLY (no. tillers with ≥ 1 RWA) | SPRAY if tally exceeds |
|---|---|---|---|---|---|---|---|
| 1 | ■ | 1 | ■ | 26 | 2 | ____ | 6 |
| 2 | ■ | 1 | ■ | 27 | 2 | ____ | 6 |
| 3 | ■ | 2 | ■ | 28 | 2 | ____ | 6 |
| 4 | ■ | 3 | 3 | 29 | 2 | ____ | 6 |
| 5 | ■ | 3 | 3 | 30 | 2 | ____ | 7 |
| 6 | ■ | 3 | 3 | 31 | 2 | ____ | 7 |
| 7 | ■ | 3 | 3 | 32 | 2 | ____ | 7 |
| 8 | ■ | 3 | 3 | 33 | 3 | ____ | 7 |
| 9 | ■ | 3 | 4 | 34 | 3 | ____ | 7 |
| 10 | ■ | 3 | 4 | 35 | 3 | ____ | 7 |
| 11 | ■ | 3 | 4 | 36 | 3 | ____ | 7 |
| 12 | ■ | 3 | 4 | 37 | 3 | ____ | 8 |
| 13 | ■ | 3 | 4 | 38 | 3 | ____ | 8 |
| 14 | ■ | 3 | 4 | 39 | 3 | ____ | 8 |
| 15 | ■ | 3 | 4 | 40 | 4 | ____ | 8 |
| 16 | ■ | 3 | 5 | 41 | 4 | ____ | 8 |
| 17 | ■ | 3 | 5 | 42 | 4 | ____ | 8 |
| 18 | ■ | 3 | 5 | 43 | 4 | ____ | 8 |
| 19 | 1 | 4 | 5 | 44 | 4 | ____ | 9 |
| 20 | 1 | 5 | 5 | 45 | 4 | ____ | 9 |
| 21 | 1 | 6 | 5 | 46 | 4 | ____ | 9 |
| 22 | 1 | STOP- | 5 | 47 | 5 | ____ | 9 |
| 23 | 1 | SPRAY | 6 | 48 | 5 | ____ | 9 |
| 24 | 1 | ____ | 6 | 49 | 5 | ____ | 9 |
| 25 | 1 | ____ | 6 | 50 | 5 | ____ | 9 |

■ Means that a decision is not possible; continue sampling.

*If tally = 5 to 9 infested tillers after 50 tillers have been inspected, the infestation is borderline; recheck field in 3 to 5 days.




**Field maps:** You can use these field diagrams to show field subdivisions that you sampled separately. Draw in landmarks and reference points (buildings, roads, fences, etc.).

[1]Instructions for use of the sequential decision cards are in University of Idaho Current Information Series no. 884, *Sequential Decision Cards: A Tool for Russian Wheat Aphid*

**Spray.** If your tally is **greater than** the values in the spray column, the infestation is greater than the threshold. Stop sampling; apply one of the insecticides recommended for Russian wheat aphid control. Note that Cards 1 and 2 have no value in the spray column for the first plant or first tiller and that Card 3 has no values for the first three tillers. Again, these are safeguards to ensure the accuracy of control decisions. When Russian wheat aphids are abundant, it is possible to reach a spray decision after the second sample with Cards 1 and 2 and after the fourth tiller with Card 3.

**Continue sampling.** If your running tally is **equal to or between** the values in the do not spray and spray columns, you cannot make a control decision. Continue to inspect randomly selected plants and tally your results until either (1) the card gives a spray or do not spray recommendation or (2) you have inspected a total of 50 randomly selected plants or tillers. If your tally remains between the do not spray and spray values after 50 samples, stop sampling; the infestation level is too close to the threshold to call with 90 percent accuracy. Recheck the field in 3 to 5 days.

**7. File your decision cards.** You may find it useful to keep a file of your decision cards. Compiled over time, your cards are a detailed record of Russian wheat aphid infestations in each field. Use them as an aid for judging the effectiveness of control decisions this year and as a planning reference for next year.

## Examples

Hypothetical examples of how to keep running tallies and make control decisions are shown for Card 3 in Fig. 5. The tally column in the table to the left of the decision card contains the running total number of tillers with at least one Russian wheat aphid. The no and yes columns refer to tillers with zero or at least one living Russian wheat aphid, respectively, and are included only to illustrate how to compute tallies. In practice, make tallies of infested tillers directly on the decision card rather than on a separate table.

To illustrate, consider field 1. The first tiller examined was infested with Russian wheat aphids. This observation was recorded as 1 in the running tally column of Card 3. The entry would have been the same if this tiller had been infested with 1, 10 or 100-plus aphids. Had there been no Russian wheat aphids on this tiller, a 0 would have been entered on the card. Because no values were listed in the spray or do not spray columns for the first tiller, another tiller was chosen at random.

The second tiller likewise was infested, so a 1 was added to the running tally, giving a new tally of 2. If this tiller had been uninfested, the tally would have remained at 1. As before, there were neither spray nor do not spray values on Card 3 for the second tiller so a third tiller was chosen at random. It too was infested, bringing the tally to 3. Again, there were no critical decision values so a fourth randomly selected tiller was examined. This tiller also was infested, so the running tally increased from 3 to 4. Although there still was no critical value in the do not spray column, the spray value was 3. Because the running tally of 4 was greater than the critical spray value, the card signalled to stop sampling and conclude with 90 percent confidence that control was required. There was no need to examine another tiller.

## Final cautions

The decision cards are no better than the economic thresholds on which they are based. Although the cards classify infestations with 90 percent accuracy, control decisions will be wrong if the thresholds themselves are wrong. The cards are based on the following thresholds:

Card 1 — 10 percent of plants infested with Russian wheat aphids

Card 2 — 10 percent of tillers infested with Russian wheat aphids

Card 3 — 20 percent of tillers infested with Russian wheat aphids

These values have little basis in research. Instead, they represent the collective, subjective wisdom of entomologists working throughout the West and Great Plains. Consider these thresholds as the best information currently available, though subject to revision based on future research. If the thresholds change, the cards will no longer be valid.

**The authors** — Edward Bechinski is Extension IPM coordinator and Hugh Homan is Extension entomologist, both in the University of Idaho Department of Plant, Soil and Entomological Sciences, Moscow.

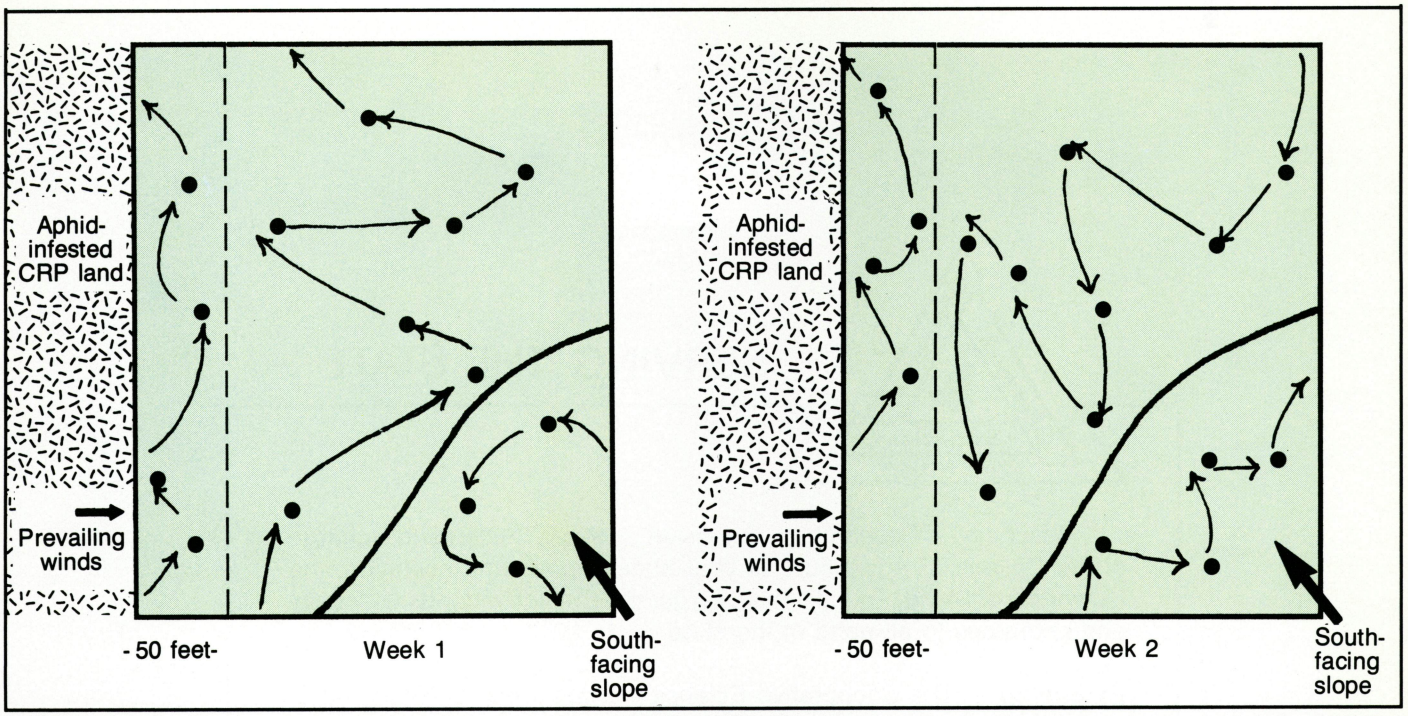



**Fig. 2. Sample randomly by walking a zigzag pattern across the entire field. Walk a different path each week. Examine field edges separately. Subdivide highly variable fields into uniform subsections, use a separate decision card in each subsection and make separate control decisions in each.**

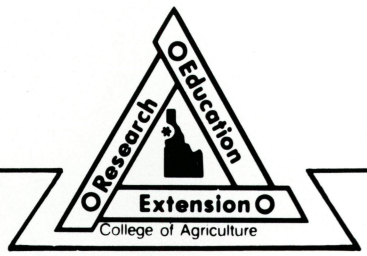
**Fig. 3. A Russian wheat aphid colony feeds in a rolled leaf.**


**Fig. 4. Diagnostic features of the Russian wheat aphid include an elongate, spindle-shaped body; short cornicles; and a two-tailed appearance.**

Diagnostic features of other common cereal aphids can be found in University of Idaho publications MS 109, *Keys to Damaging Stages of Insects Commonly Attacking Field Crops in the Pacific Northwest;* CIS 816, *Aphids Infesting Idaho Grain and Corn;* and CIS 817, *Russian Wheat Aphid,* and in *Biology, Damage and Management of Russian Wheat Aphid* (a PNW publication in press). These publications combine excellent color photos with technical drawings and pest descriptions.

**6. Make a decision.** After each plant or tiller inspection, compare your running tally with the values in the columns on the decision card labelled "do not spray" and "spray." Then make one of the following three decisions:

**Do not spray.** If your tally is **less than** the value in the do not spray column, the infestation is below the threshold. Stop sampling; insecticide application is not needed. Note that no values are listed in the do not spray column for plants 1 through 17 on Card 1, for tillers 1 through 17 on Card 2 or for tillers 1 through 18 on Card 3. These are safeguards that ensure 90 percent accuracy by preventing premature classification. You must examine at least 18 plants before Card 1 can signal with 90 percent accuracy that control is not needed. Similarly, at least 18 and 19 tillers must be examined before Cards 2 and 3, respectively, reliably can recommend not spraying.

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