Technical Report TR97-2

Agricultural Experiment Station | Department of Bioagricultural Sciences and Pest Management | Fruita Research Center | February 1997

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Alternate Host Plants of Russian Wheat Aphid in Colorado

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Technical Report

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The Russian wheat aphid (RWA), *Diuraphis noxia* (Mordvilko), was first reported in Colorado in 1986, and since that time has caused extensive damage to the small grain crop. RWA remains an annual threat to wheat and barley production in the western United States (Webster et al., 1994).

RWA populations vary greatly within a season, between geographic locations, and from year to year. Increases in RWA abundance occur when conditions are favorable for aphid reproduction and growth. These conditions include rapid vegetative growth of acceptable host plants, which provide shelter within rolled leaves and nutrients needed for aphid growth, and warm dry weather. Declines in RWA abundance in Colorado are due largely to mortality during two critical time periods. Winter mortality is due to environmental conditions, including excessive moisture and extended or extreme cold, and occurs mainly within the fall planted small grain crop. The other period of RWA mortality occurs in the time between small grain harvest in the summer and the emergence of the next crop in the fall. This time period is characterized by high temperatures and the lack of preferred host plants, wheat and barley, when RWA must survive on alternate host plants.

RWA infest alternate host plants as alate aphids fly from maturing small grain fields. RWA flights are monitored with several Allison-Pike suction traps throughout Colorado. These traps capture aphids that fly over a 12 inch diameter tube located 26 feet above ground level (Allison & Pike 1988). Figure 1 shows the results of suction trapping from 1988 to 1990 at three sites in Colorado. The earliest peak flights in the state occur in the southeast, where small grain matures earliest. Aphid catches cease by mid July in this area. If alternate hosts are not infested by then, oversummering of RWA will be minimal. RWA flights in northeastern Colorado begin several weeks later than those in southeastern Colorado, with trap catches occurring until August. RWA flights in the Grand Valley of western Colorado start at about the same time as those in southeastern Colorado and continue throughout the growing season, although captures decline after early August. RWA infest alternate host plants throughout the summer and fall in the Grand Valley, and fall infestations in small grain fields are typically more severe than other areas of the state.

The objective of this publication is to report the results RWA oversummering host plant surveys in different regions of Colorado. Two different approaches have been used elsewhere to determine RWA host preference and suitability. Greenhouse screening studies have examined seedlings of many grass and broadleaf species as potential host plants under controlled conditions (Kindler & Springer, 1989). Field surveys have examined established plants on roadsides, rangeland, Conservation Reserve Program (CRP) acreage, and seed production fields (Armstrong et al. 1991, Clement et. al 1990, Lajeunesse et al. 1988). Host plants utilized by RWA vary among regions and among years within regions. These differences may be explained by varying environmental conditions and genetic diversity within plant species.

Kindler & Springer (1989) tested potential host plants in a greenhouse study, and reported that RWA survived only on grasses. They did not survive on the 27 legumes and 17 forbs tested. RWA survived on seedlings of 47 of 48 cool season grass species and 18 of 32 warm season grass species during the 14 day study. The greatest reproduction was on cool season grasses, including species of *Agropyron*, *Elymus*, *Hordeum*, *Triticum*, *Bromus* and *Festuca*. Warm season grasses that RWA survived on for 14 days include species of *Leptochloa*, *Bouteloua Pennisetum*, *Eragrostis* and *Buchloë*. Host suitability varies greatly within genera and even species (Kindler et al.. 1993). Seedlings of 2371 plant accessions of perennial triticeae representing 8 genera, 60 species, seven subspecies and one released cultivar varied widely in RWA resistance ratings. *Leymus* and *Elytrigia* were considered moderately resistant, *Agropyron*, *Pseudoregenia*, *Elymus* and *Pascopyron* were considered tolerant to moderately susceptible, and *Hordeum* and *Thinopyron* were considered susceptible. Both Clement & Clement (1990) and Kindler & Springer (1991) demonstrated resistance to RWA in many species of *Hordeum* in greenhouse studies. Variation from susceptible to resistant exists in western wheatgrass (*Pascopyron smithii* (Rydb.) A. Löve) and slender wheatgrass (*Elymus trachycaulus* (Link) Gould ex Shinners) (personal communication, S. D. Kindler, USDA-ARS, 1301 N. Western, Stillwater OK 74075). Kindler et al. (1991a) reported a wide range of resistance to RWA in quackgrass (*Elytrigia repens* (L.) Nevski), and that the hybrids of quackgrass and susceptible wheatgrass species were resistant. Some of the resistance to RWA in *Festuca* spp. may be due to the presence of fungal endophytes (Kindler et al. 1991b). Russian wheat aphid survival was lower of endophyte infected perennial ryegrass (*Lolium perenne* (L.)) compared with uninfected plants of the same species and variety (Clement et al. 1992). Kindler et al.. (1992) used electronic feeding monitors to show that RWA feeding behavior was different on

susceptible and resistant accessions of slender wheatgrass.

Springer et al. (1992) reported that RWA preferred wheat to any of the three species of annual *Bromus* that are common weeds in wheat. Russian wheat aphids that fed on wheat had higher fecundity and weight. Fourteen of sixteen *Bromus* species tested were susceptible to RWA damage, while the two members of the sub-genus *Bromopsis* were resistant to RWA feeding.

Field studies of natural RWA occurrence on alternate host plants have been completed in several areas. Hewitt et al. (1984) reported that rescue grass (*Bromus willdenovii* Kunth) and wild oat (*Avena fatua* L.) were oversummering host plants in South Africa. Clement et al. (1990) found RWA infestations in orchard grass (*Dactylus glomerata* L.), tall fescue (*Festuca arundinacea* Schreb.) and standard crested wheatgrass (*Agropyron desertorum* (Fisch. ex Link) in Pullman and Central Ferry, Washington. Orchardgrass was an unsuitable host in plots at Parma and Kimberly, Idaho while the greatest aphid densities were observed on crested wheatgrass and mountain rye (*Secale montanum*). Intermediate wheatgrass (*Thinopyrum intermedium* subsp. *intermedium* (Host) Barkw & D.W. Dewey) and pubescent wheatgrass (*Thinopyrum intermedium* subsp. *barbulatum* (Schur) Barkw & D.W. Dewey) were also consistently infested. Established grass stands were less infested than plants in their first year of establishment (Halbert et al. 1988). Lajeunesse et al. (1988) reported intermediate and crested wheatgrasses were the most consistent host plants in 1988 surveys of central and south central Montana CRP fields . Within northeastern Colorado, Armstrong et al. (1991) reported crested wheatgrass and Canada wildrye (*Elymus canadensis* (L.)) as the dominant oversummering hosts.

RWA HOST PLANT STUDIES IN COLORADO

Surveys of potential RWA host grasses were conducted in different small grain producing regions of Colorado in 1988, 1989 and 1990. Survey methods varied between regions and years. The 1988 and 1989 surveys targeted many potential host plants while the 1990 survey focused on those species identified as important hosts in previous surveys. The survey methods are outlined separately for each region. Grass species sampled in each region are listed in Table 1.

Northeastern Colorado RWA alternate host plants were surveyed in 1988, 1989 and 1990 in Lincoln and Washington counties. The 1988 and 1989 data are presented in Armstrong et al. (1991), and again in this publication. Twenty five grass species were sampled on a weekly basis in 1988 and 1989 from the same roadside, CRP, wheat fallow and rangeland sites. Two sites were monitored in 1988, and one in 1989. Grasses were collected from three random spots within each site. Enough of each species was collected to fill a one gallon Ziplock® bag. Aphids were extracted from grass plants in Berlese funnels for 24 h., and then counted. The 1990 sampling used the same methods, except the ten species of grass listed in Table 5 and 6 were sampled from two locations, one near Akron (Washington County), and the other about eight miles WNW of Sterling (Logan County).

Southeastern Colorado Grasses were sampled for RWA in four locations in Prowers County from late July through August 1989. These sites included three CRP sites and one roadside ditch site. During the summer of 1990, grasses were sampled from mid June through September at five sites in Baca, Bent and Prowers Counties. These sites included two CRP sites, two roadside ditch sites, and a Soil Conservation Service Demonstration Grass Plot. Sampling consisted of collecting enough plant material to fill a one gallon Ziplock© bag for each individual grass species. Samples were weighed, placed in Berlese funnels for 24 h to extract aphids, and then oven dried for 48 h to obtain dry weights. Plant growth stages were noted at the time of sampling. Insects extracted from plant samples were identified, and during 1990 evaluations, RWA were grouped into immature life stages (instar I-III, and instar IV-V).

North Central Colorado

Grasses were sampled in Larimer and Weld counties during the summers of 1989 and 1990. The 1989 survey was designed to sample as many grasses as possible to determine which species were being utilized by RWA. The more important grasses identified in 1989 were sampled on a regular basis at several sites in 1990. Approximately one gallon of plant material per species was collected from each site. The grasses were oven dried and weighed after aphids were extracted in Berlese funnels for 24 h.

Western Colorado

Field surveys were completed in 1988, 1989 and 1990 in the small grain producing areas of northwest (Moffat, Routt, Rio Blanco and Garfield counties), southwest (Montezuma and Dolores counties) Colorado, and the Grand Valley (Mesa county).

In 1988, as many grass species as possible were sampled. Sample sites were chosen near small grain fields. Enough plant material to fill a one gallon paper bag was cut at ground level, and taken to the laboratory, where aphids were extracted in Berlese funnels for 24 hours. Aphids were examined, and the relative abundance (one, few, many, abundant), and range of life stages (Aalbersberg et al..1987) were noted.

1989 samples were taken near small grain fields and as many grass species as possible were sampled. Sampling was done in the same manner as in 1988, but plant material was weighed before placing in Berlese funnels, and then oven dried and weighed again after aphids had been extracted. Aphids were sorted according to instar (Aalbersberg et al. 1987) and counted.

1990 sampling utilized the same methods as in 1989, but nine species were sampled at the same site on a regular basis throughout the summer. The species were chosen by their relative importance, in terms of local abundance and suitability as RWA host plants in previous surveys in each area. Plants were sampled in the Grand Valley (Mesa County) and in southwestern Colorado (Montezuma County). Sampling in the Grand Valley was within five miles of the Fruita Research Center, and that in southwestern Colorado was within ten miles of the Southwest Colorado Research Center, near Yellow Jacket.

RESULTS

Table 1 lists the grass species sampled in each region of Colorado. Tables 2-13 summarize regional survey results. The consistency of collection is considered more important than absolute numbers of aphids collected. A single collection of many RWA from a grass species is less likely to indicate an important oversummering host than consistent collections of lower numbers of RWA throughout the oversummering period. The presence of mature apterae also indicated good host plant suitability. If all or most RWA recovered from a grass species were immature, it is possible that they were not capable of completing their life cycle on that plant. Winged female RWA may lay young on many different plants. If the plant was an unsuitable host, these aphids may have fed and molted several times, but never matured. Our criterion for host suitability was reproduction as evidenced by the collection of all apterous life stages from a given plant sample. The more suitable hosts were those with consistent RWA collections throughout the oversummering period.

The data were variable for many reasons. Sample size varied with plant availability, size of the grasses, growth stage and moisture content. Differences between sites within a region were due to moisture, soils, exposure and many other factors. These environmental differences play a role in the variability of the data.

The following discussion of plants that appear to be good hosts is organized first according to taxonomic groups, and then by geographic area.

Wheatgrasses

The wheatgrasses are important drought tolerant plants throughout Colorado on rangeland, roadsides and CRP acreage. Virtually all wheatgrasses supported RWA in Kindler & Springer's (1989) greenhouse study, and we found RWA, to some extent, on all species surveyed in Colorado (Tables 2-13).

Crested wheatgrass, an introduced grass native to northern Eurasia, was the most important of the wheatgrasses as a RWA oversummering host plant except in the Grand Valley and southeastern Colorado. High temperatures coupled with low precipitation cause crested wheatgrass to go dormant by mid-June in most years in those areas. It also went dormant early in the 1988 season in northeastern Colorado, accounting for the low survey numbers, but was an excellent oversummering host plant for RWA during the wetter summers of 1989 and 1990. Crested wheatgrass supported RWA populations in north-central Colorado and in the higher elevations of western Colorado in both 1989 and 1990.

Pubescent and intermediate wheatgrasses, also introduced Eurasian species, are commonly found in CRP plantings and used on roadsides for erosion control in many areas of the state. These grasses are absent from the southeastern portion of Colorado. Pubescent and intermediate wheatgrasses were good oversummering hosts, although the late season success of RWA populations on these grasses was highly dependent upon local temperature and moisture conditions. Hot, dry conditions in late July and August reduced the host quality of these plants.

Western wheatgrass is the dominant native wheatgrass statewide. It was a poor host because of phenology. Growth of western wheatgrass occurs early

in the season, and new growth is not present in most cases by the time RWA flight to oversummering plants occurs. If weather is extremely hot, western wheatgrass will go dormant. Greenhouse studies have shown extreme variability in seedling western wheatgrass susceptibility to RWA. The cultivar 'Arriba', widely planted in CRP, has shown considerable resistance to RWA (personal communication, S. D. Kindler, USDA-ARS, 1301 N. Western, Stillwater, OK 74075). Although large numbers of RWA are not typically found on western wheatgrass, populations can occasionally be found on this grass early in the summer before it goes dormant.

Other wheatgrasses, including slender, thickspike, tall, and bluebunch are not as widely distributed in the state as crested, pubescent, and intermediate. These grasses did not support consistent RWA populations throughout the season in any surveys.

Wildryes and Related *Elymus*

Two species of *Elymus*, Canada wildrye and foxtail barley (*E. multisetus* (J.G. Smith) Davy) were excellent oversummering host plants wherever they occurred in Colorado. Both are native species, widely distributed on roadsides and disturbed areas. Foxtail barley can be a problem weed in irrigated pastures. Both supported season long, consistent populations of RWA in our surveys because of their phenology. Canada wildrye begins growth in the late spring, and remains green throughout the summer. Foxtail barley remains green for extended periods of time in seeps and along irrigation ditches. Plants growing in drier areas respond to moisture with new growth.

Other wildryes including Russian (*Psathyrostachys juncea* (Fisher) Nevski), basin (*Leymus cinereus* (Scribn. & Merr.) A. Löve) and mammoth wildrye (*Leymus racemosus* (Lam.) Tzvelev) are not widely distributed in Colorado, but have hosted oversummering RWA on occasion. Seed production fields of Russian wildrye near Delta (Delta County), for example, supported considerable numbers of RWA when managed as a hay crop after seed was harvested. New seedings of all wildrye species we have observed have supported large RWA infestations at times.

Bottlebrush squirreltail (*Elymus elymoides* (Raf.) Swezey) has occasionally supported RWA in Colorado. This native grass is found statewide on rangeland and roadsides. However, it usually makes seed and goes dormant before the critical oversummering period of RWA.

Perennial Brome Grasses

Mountain brome (*Bromus marginatus* Nees) was the only perennial *Bromus* species hosting oversummering RWA in Colorado. It is widespread in the higher elevations of the state, and large numbers of RWA have been collected from seed production fields and CRP acreage. Mountain brome is also an excellent host plant for two native *Diuraphis* species: *D. tritici* Gillette (the western wheat aphid) and *D. nodulus* Richards (unpublished data, RWH). We did not find RWA consistently on other perennial brome grasses, including smooth (*B. inermis* Leyss.), meadow (*B. riparius* Rehmann) and nodding brome (*B. anomalus* Rupr. ex Fourn.).

Other Host Plants

Several other grasses were observed to harbor oversummering RWA in Colorado on an irregular basis. RWA were collected from sand lovegrass (*Eragrostis trichoides* (Nutt.) Wood) throughout the summer of 1990 in the Logan county survey. Although tall fescue (*Festuca arundinacea* Schreb.) was an important host plant in the Pacific Northwest (Clement et al. 1990), few RWA were collected on it in the Grand Valley. Many RWA were collected from indian rice grass (*Oryzopsis hymenoides* (R & S) Ricker) in a single collection from a very dry site in Dolores County in 1988. Only a few RWA were found on sand dropseed (*Sporobolis cryptandrus* (Torr.) Gray) in most cases, but they were abundant in two collections. This common roadside grass may be an important host plant at times. RWA cannot survive on most oat (*Avena fatua* L.) cultivars, but many were collected from wild oat in northwestern Colorado. Wild oat matures too early to be an oversummering host in warmer parts of the state.

Winter Annuals

Several species of winter annual grasses are good alternate host plants of RWA, but they are dead during the summer months. Species include jointed goatgrass (*Aegilops cylindrica* Host.), downy brome (*Bromus tectorum* L.), cheatgrass (*B. secalinus* L.), annual wheatgrass (*Eremopyron triticheum* Gaertn.) and hare barley (*Hordeum leporinum* Link). Many RWA were observed overwintering on annual wheatgrass, jointed goatgrass and hare barley in Mesa County during the spring of 1990.

Volunteer Grains

Volunteer wheat and barley are considered the most important source of oversummering RWA in the

state. These plants germinate from seed left in the field after harvest. If seedlings are present during flights of RWA, they will become infested. RWA reproduce rapidly on these young, rapidly growing plants, and if left uncontrolled, will infest the new small grain crop as it emerges. Volunteer grain is present wherever small grain is grown, and control of these plants is a widely recommended method of cultural control of insects and disease pests.

REGIONAL SURVEYS

Northeastern Colorado

Few RWA were collected at the Washington county sample site in 1988 (Table 2). Some RWA were found on several grasses in early August, but results were inconsistent after that time. RWA were found consistently, but at low levels on Canada wildrye. Aphid numbers were sightly larger at the Lincoln county sample site in 1988 (Table 3) where they were found consistently only on Canada wildrye. More RWA were collected at the Washington county sample site during the 1989 season than in 1988 (Table 4). RWA were found consistently at high levels only on Canada wildrye and crested wheatgrass. In 1990, RWA were extracted at consistently high levels from Canada wildrye, crested wheatgrass and sand lovegrass (Table 5). Many RWA were also collected from other grasses during heavy aphid flights in late June, but not during July and August.

Canada wildrye and crested wheatgrass were the most important oversummering host plants in northeastern Colorado, although sand lovegrass was occasionally important.

North Central Colorado

Foxtail barley, crested, western, pubescent, slender and intermediate wheatgrasses, and sideoat (*Bouteloua curtipendula* (Michx.) Torr.) and blue grama (*Bouteloua* gracilis (H.B.K.) Lag ex Steud) all had more than one collection containing many RWA in 1989 (Table 8). In 1990, Canada wildrye, foxtail barley and crested and pubescent wheatgrasses were consistent oversummering hosts for RWA (Table 9).

Southeastern Colorado

During the summer of 1989, Canada wild rye was the only alternate host from which RWA were collected, and then only in low numbers. In 1990, RWA were collected from a wider range of plant species. These were, in respective importance, on Canada wildrye, sand bluestem ((*Andropogon gerardii* var. *paucipilus* (Nash) Fern.), western wheatgrass, and crested wheatgrass. Western wheatgrass, a native species, was a more suitable host in this area than crested wheatgrass, an introduced grass found in a limited number of plantings. The suitability of western wheatgrass as an alternate host was limited because it tends to become dormant during July and early August.

In 1990, the largest RWA populations were found on alternate host plants from late June through July due to alate flights occurring early in the summer (mid-May to mid-June) (Figure 1). Because these flights occur earlier in southeastern Colorado than in other areas of the state, it means that RWA must spend a longer period of time on alternate hosts while awaiting emergence of the next wheat crop. The period between wheat harvest and the emergence of the next crop is characterized by a hot, dry climate. Therefore, RWA alternate host plants found in CRP, rangeland and roadside ditches do not pose a serious threat to adjacent wheat acreage in southeastern Colorado. Additionally, the economic benefit which these species provide in erosion control and early grazing greatly outweigh the risks of their serving as potential alternate host plants for RWA in southeast Colorado.

Western Colorado

Many species of potential alternate host plants were discovered during the 1988 and 1989 west slope surveys (Table 10). While crested wheatgrass supported substantial populations of RWA in the northwest and southwest portions of the state, they were not found on crested wheatgrass growing in the Grand Valley after it went dormant in early June in 1989 and 1990. Many RWA were found on wild oat while plants remained green. Mountain brome was a good host plant in the northwest and southwest in 1988, but drier weather in 1989 stopped aphids from utilizing it. Canada wildrye was utilized more by RWA in the Grand Valley in 1988 than in 1989. Aphids were also found on it in both years in northwestern Colorado. Foxtail barley collections contained intermediate to abundant levels of RWA in all infested areas of the west slope. Intermediate and pubescent wheatgrass occasionally supported RWA during the summer months in the north and southwest. Canada wildrye also had smaller numbers of aphids throughout the season (Table 12). Foxtail barley, crested and pubescent wheatgrass and sand dropseed collections all contained RWA during the summer of 1990 in the southwest (Table 11).

DISCUSSION

Several factors affect suitability of alternate host plants for oversummering RWA. Weather conditions are extremely important. If grasses are water stressed as RWA disperse from small grain, they are less likely to become infested. For example, in the Grand Valley there was some available soil moisture in 1988, when RWA moved out of small grain fields and infested tall wheatgrass and Canada wildrye. The summer of 1989 was hot and dry, and these grasses were not colonized. Many RWA were found on foxtail barley in both years where it was never under any water stress, such as where it grows in seeps, along irrigation ditches, or in poorly drained areas.

The amount of volunteer grain in an area is very important to RWA oversummering. Volunteer wheat and barley are generally more abundant and are superior hosts than most other grasses. Control of volunteer small grains is highly recommended. The control of volunteer grain is not only important in RWA management, but also in the management of other small grain pests, including mites, other aphids, and the viral diseases they transmit. The amount of time between harvest and planting is also important. In southeastern Colorado, there are usually two months of hot, dry weather between harvest and planting that force the aphids to survive on alternate hosts. Oversummering success is thus comparatively poor. In northwestern Colorado, there may be weeks, or less, between the harvest of spring wheat and the planting of fall grain. Survival through this short time period is good and many RWA infest the fall wheat crop.

CONCLUSIONS

1. Sixty grass species were sampled from 1988 to 1990. Russian wheat aphids were collected from 40 of these.
2. Of the 40 grass species from which RWA was collected, 10 were considered to be potentially important oversummering hosts of RWA.
3. Regional differences were found in plant species utilized as alternate host plants by RWA. This variation occurs because of differences in plant species distribution, growth status of plant species during RWA migration, and climactic conditions between regions.
4. Canada wildrye, foxtail barley, pubescent and crested wheatgrasses, and volunteer wheat and barley were considered to be the most important hosts for oversummering RWA during the period of the study.

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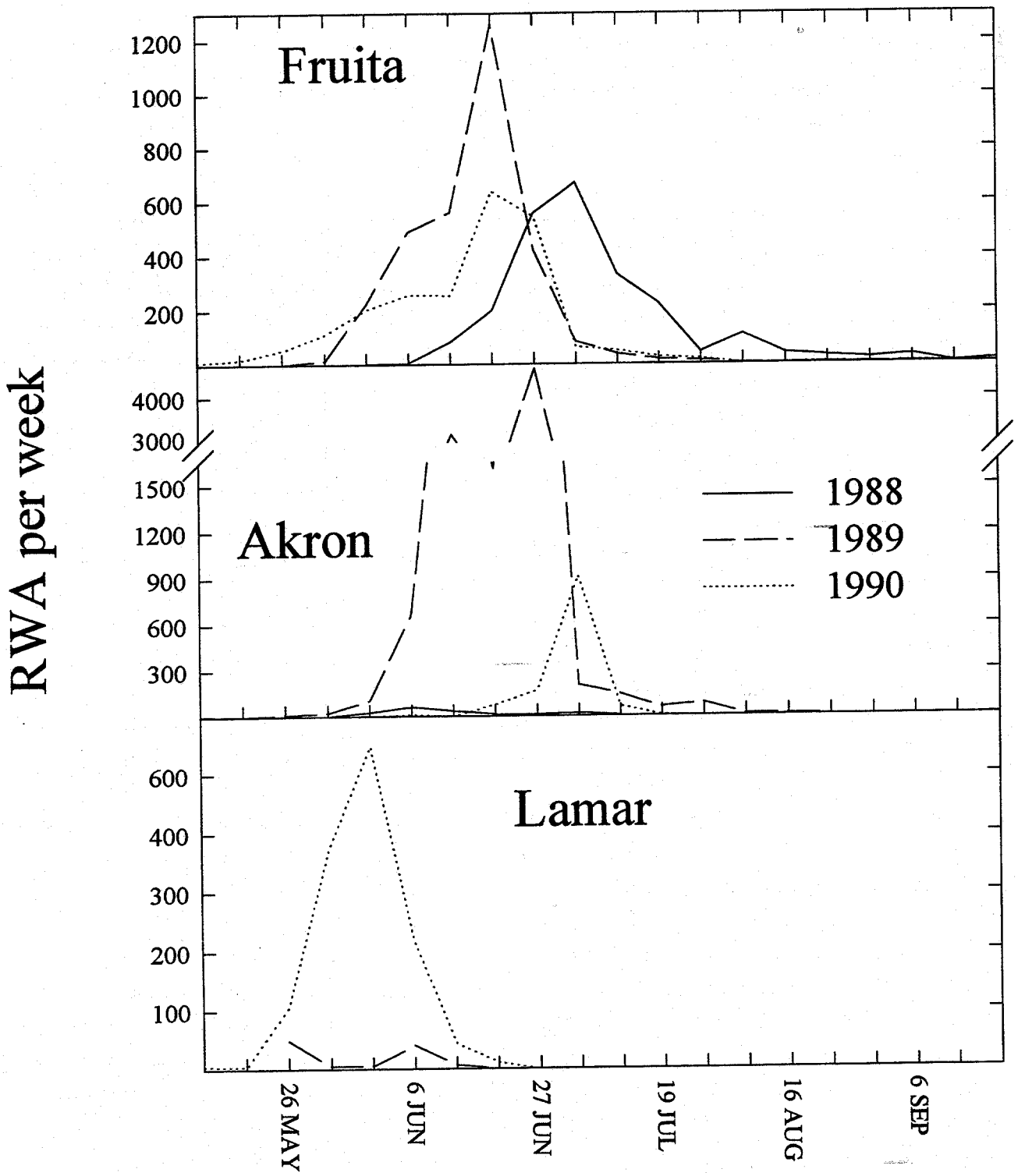

Figure 1. Weekly collection of RWA in suction rtaps at three locations within the state. Note the variations in RWA flights between years and locations.

Table 1. Grass species sampled in field surveys in different areas of Colorado from 1988 until 1990. Scientific nomenclature of the perennial Triticeae is according to Barkworth & Dewey (1985), all other according to Harrington (1964). X's denote sampling of the species within a region sometime in the three year sampling period. NE=Northeast, SE=Southeast, NC=North central, GV=Grand Valley, NW=Northwest, SW=Southwest

Common name	Scientific name	NE	SE	NC	GV	NW	SW
Jointed goatgrass	*Aegilops cylindrica* Host.	X	X		X		
Crested wheatgrass	*Agropyron cristatum* (L.) Gaertn.	X	X	X	X	X	X
Big bluestem	*Andropogon gerardii* Vitman	X	X				
Sand bluestem	*Andropogon gerardii* var. *paucipilus* (Nash) Fern.		X				
Prairie three awn	*Aristida oligantha* (Michx.)	X	X				
Wild oat	*Avena fatua* L.				X	X	
Blue grama	*Bouteloua gracilis* (H.B.K.) Lag *ex* Steud.	X	X		X		X
Sideoats grama	*Bouteloua curtipendula* (Michx.) Torr.	X	X				
Silver bluestem	*Bothriochloa saccharoides* (Sw.) Rydb.		X				
Nodding brome	*Bromus anomalus* Rupr. ex Fourn						
Smooth brome	*Bromus inermis* Leyss.	X	X		X	X	X
Japanese brome	*Bromus japonicus* Thunb.	X					
Mountain brome	*Bromus marginatus* Nees					X	X
Meadow brome	*Bromus riparius* Rehmann						X
Cheatgrass	*Bromus secinalus* L.						
Downy brome	*Bromus tectorum* L.	X			X		
Buffalo grass	*Buchloë dactyloides* (Nutt.) Engelm.		X				
Prairie sandreed	*Calamovilfa longifolia* (Hook.) Scribn.	X					
Sandbur	*Cenchrus longispinus* (Hackel) Fern.	X			X		
Orchardgrass	*Dactylus glomerata* L.		X		X	X	
Alkali grass	*Distichilis stricta* (Torr.) Rydb.				X		
Barnyardgrass	*Echinochloa crusgalli* (L.) Beauv.	X			X		
Canada wildrye	*Elymus canadensis* L.	X	X	X	X	X	
Bottlebrush squirreltail	*Elymus elymoides* (Raf.) Swezey	X	X			X	X
Thickspike wheatgrass	*Elymus lanceolatus* (Scribn. & Smith) Gould	X					X
Foxtail barley	*Elymus multisetus* (J.G. Smith) Davy	X	X	X	X	X	X
Slender wheatgrass	*Elymus trachycaulus* (Link) Gould *ex* Shinners subsp.					X	X
Sand lovegrass	*Eragrostis trichodes* (Nutt.) Wood	X	X				
Stinkgrass	*Eragrostis cilianensis* (All.) E. Mosher	X	X				
Annual wheatgrass	*Eremopyron triticheum* Gaertn.				X		
Tall fescue	*Festuca arundinacea* Schreb.				X		
Galleta	*Hilaria jamesii* (Torr.) Benth.		X				

Common name	Scientific name	NE	SE	NC	GV	NW	SW
Hare barley	*Hordeum leporinum* Link						
Prairie junegrass	*Koeleria cristata* (L.) Pers.	X					
Basin wildrye	*Leymus cinereus* (Scribn. & Merr.) A. Löve					X	X
Mammoth wild rye	*Leymus racemosus* (Lam.) Tzvelev						
Ring muhly	*Muhlenbergia torreyi* (Kunth) Hitchc *ex* Bush	X					
Indian rice grass	*Oryzopsis hymenoides* (R&S) Ricker		X				X
Witchgrass	*Panicum capillare* L.	X	X		X		
Vine mesquite	*Panicum obtusum* H.B.K.		X				
Switchgrass	*Panicum virgatum* L.	X	X				
Western wheatgrass	*Pascopyron smithii* (Rydb.) Löve	X	X		X	X	X
Reed canarygrass	*Phalaris arundinacea* L.				X		
Timothy	*Phleum pratense* L.					X	
Kentucky bluegrass	*Poa pratensis* L.				X	X	
Russian wildrye	*Psathyrostachys juncea* (Fisher) Nevski		X		X		
Bluebunch wheatgrass	*Pseudoregenia spicata* (Pursh) A Löve subsp. *spicata*					X	
Little bluestem	*Schizachyrium scoparium* (Michx) Nash	X	X		X		
Rye	*Secale cerale* L.	X					
Green foxtail	*Setaria viridis* L.	X	X		X		
Johnsongrass	*Sorghum halpense* (L.) Pers.		X				
Sand dropseed	*Sporobolus cryptandrus* (Torr.) Gray	X	X	X	X	X	X
Alkali sacaton	*Sporobolus airoides* Torr.				X		
Columbian needlegrass	*Stipa columbiana* Macoun.					X	
Needle and thread	*Stipa comata* Trin. & Rupr.	X	X			X	
Green needlegrass	*Stipa viridula* Trin.	X				X	
Intermediate wheatgrass	*Thinopyrum intermedium* (Host) Barkw. & D.W.	X	X				X
Pubescent wheatgrass	*Thinopyrum intermedium* subsp. *barbulatum* (Schur)	X	X			X	X
Tall wheatgrass	*Thinopyrum ponticum* (Podp.) Barkw. & D.W. Dewey				X		

Table 2. RWA recovered from grass species at Washington County sample site, summer 1988. Grasses that did not support RWA at any time during the season are not shown (See Table 1.)

Grass species	August					September	
	2	9	15	22	29	5	13
Canada wildrye	6	0	1	0	0	2	9
Crested wheatgrass	0	0	0	0	0	17	0
Prairie sandreed	0	10	0	0	0	0	0
Barnyardgrass	4	0	0	0	0	0	3
Green foxtail	2	0	0	0	0	0	5
Western wheatgrass	5	0	0	0	0	0	0
Witchgrass	2	1	0	0	2	0	0
Blue Grama	0	1	0	0	0	0	0

Table 3. Grass species from which RWA was recovered at Lincoln County site, summer, 1988. Grasses that did not support RWA at any time during the season are not shown (see Table 1).

Grass species	August					September	
	3	10	16	23	29	5	14
Canada wildrye	28	6	33	6	1	0	7
Crested wheatgrass	0	0	5	1	0	0	2
Downy brome	0	0	0	7	1	0	0
Blue grama	7	0	0	1	0	0	0
Barnyardgrass	0	0	3	0	0	0	2
Western wheatgrass	5	0	0	0	0	0	0
Witchgrass	2	0	0	0	1	0	0
Green foxtail	0	0	0	0	0	0	3
Sand dropseed	1	0	0	0	0	2	0
Stinkgrass	2	0	0	0	0	0	0
Green needlegrass	2	0	0	0	0	0	0
Sideoats grama	0	0	0	1	0	0	0

Table 4. Grass species from which RWA were recovered in Washington County, summer, 1989. Grasses that did not support RWA at any time during the season are not shown (See Table 1).

Grass species	July	August					September	
	26	2	9	16	23	30	6	13
Crested wheatgrass	154	115	121	23	32	4	1	4
Canada wildrye	13	107	125	157	20	4	11	3
Pubescent wheatgrass	29	8	0	3	0	0	0	0
Western wheatgrass	0	23	2	0	0	0	0	0
Intermediate wheatgrass	4	13	1	0	0	1	2	2
Stinkgrass	0	1	21	0	0	0	0	0
Prairie threeawn	8	0	0	0	0	0	0	0
Squirreltail	8	0	0	0	0	0	0	0
Sand dropseed	0	1	5	0	0	0	0	0
Blue grama	0	0	5	0	0	0	0	0
Barnyardgrass	0	3	1	0	0	0	0	0
Switchgrass	0	4	0	0	0	0	0	0
Green foxtail	0	0	1	0	1	0	0	0
Needle-and-thread	2	0	0	0	0	0	0	0
Sideoats grama	0	0	0	1	0	0	0	0

Table 5. Russian wheat aphids extracted from grasses collected in Logan County, summer, 1990. Blank cells within table indicate dates on which no collections were made.

Grass species	June			July				August				September		
	7	21	29	11	17	24	31	7	14	21	29	5	12	19
Volunteer wheat	120	3275	908				0	0	0	0	13	0	0	0
Crested wheatgrass	38	692	42	68	56	14	526	25	13	8	1	2	0	2
Canada wildrye	5	8	85	30	26	47	78	62	299	85	49	8	0	0
Foxtail barley	57	556	283	90	1	0	0							
Japanese brome			529	10	0									
Volunteer rye	0	178	341	3										
Sand lovegrass			184	20	41	32	62	25	26	6	2	9	6	4
Needle and thread	0	46	221	0	0	0	0	0	0	0	0	0	0	0
Jointed goatgrass	0	0	116	91	0	0								
Western wheatgrass	3	77	8	13	17	2	1	0	0	0	0	0	0	0
Green needlegrass			75	3	0	0	0	0	0	0	0	0	0	0
Thickspike wheatgrass	7	8	7	1	0	2	0	3	3	0	0	0	0	3
Barnyardgrass			0	0	0	0	12	19	0	0	0	0	0	0

Table 6. Russian wheat aphids extracted from grasses collected in Washington County, summer, 1990. Blank cells within table indicate dates on which no collections were made.

Grass species	June		July			August				September		
	5	19	17	25	31	7	16	23	29	5	12	19
Volunteer wheat	30	628										
Crested wheatgrass	11	52	5	6	71	71	0	0	0	0	4	0
Canada wildrye	2	11	1	0	0	0	5	8	0	0	0	0
Foxtail barley	18	5	0	0	0	0	0	0	0	0		
Western wheatgrass	2	9	0	3	0	0	0	6	0	0	0	0
Needle and thread	0	4	0	0	2	0	0	0	0	0	0	0
Intermediate wheatgrass	3	0	0	0	0	0	0	0	0	0	0	0
Little bluestem			3	0	0	0	0	0	0	0	0	0
Switchgrass			2	0	0	0	0	0	0	0	0	0

Table 7. Grasses surveyed in southeastern Colorado (Prowers county), summer, 1989. All collections of RWA from Canada wildrye were in low numbers, although mature apterae were present in all but one sample.

Grass species	# of collections	Collections w/ RWA
Buffalo grass	6	0
Sand dropseed	7	0
Smooth brome	3	0
Canada wildrye	4	3
Green foxtail	5	0
Johnson grass	3	0
Big bluestem	5	0
Vine mesquite	5	0
Side oats grama	4	0
Bottlebrush squirreltail	5	0
Prairie three awn	4	0
Stinkgrass	2	0
Witchgrass	2	0

Table 8. Grasses surveyed in southeastern Colorado (Baca, Bent and Prowers counties), summer, 1990. Collections supporting RWA are separated into early instar (I-III) and late instar (IV-V).

Grass species	# of collections	# of collections with RWA	Collections with I-III	Collections with IV-V
Volunteer wheat	13	7	2	6
Canada wildrye	9	5	4	4
Galleta	9	5	5	4
Crested wheatgrass	7	4	4	4
Sand lovegrass	5	3	2	2
Yellow bluestem	5	3	3	1
Western wheatgrass	11	3	3	3
Big bluestem	5	3	3	2
Sand bluestem	5	3	3	1
Indian ricegrass	4	2	2	0
Needle & thread	5	2	1	1
Sideoats grama	10	2	2	2
Switchgrass	8	2	1	1
Foxtail barley	2	2	2	0
Little bluestem	9	2	2	1
Green foxtail	5	2	2	2
Witchgrass	2	2	2	0
Smooth brome	1	1	0	1
Intermediate wheatgrass	1	1	0	1
Buffalograss	2	1	1	1
Blue grama	4	1	1	1
Russian wildrye	1	1	1	2
Silver bluestem	2	1	1	1
Orchardgrass	1	0	0	2
Pubescent wheatgrass	1	0	0	2

Table 9. Grasses surveyed in Larimer and Weld counties, summer, 1989. The last column, labeled RWA > 0.1/gm, is the number of collections with more than 0.1 RWA per gram (dry matter) of the grass material collected.

Grass species	# Collections	W / RWA	RWA >0.1/gm
Foxtail barley	5	5	4
Crested wheatgrass	6	5	3
Sand dropseed	6	4	1
Western wheatgrass	4	2	2
Pubescent wheatgrass	3	3	2
Slender wheatgrass	7	7	5
Intermediate wheatgrass	6	4	4
Sideoats grama	14	12	7
Blue grama	10	9	5
Green foxtail	5	5	3
Needlegrass	4	3	1
Downy brome	1	1	1
Salt grass	2	2	0
Witchgrass	1	1	0
Wild oat	1	1	0
Smooth brome	3	2	1
Red three awn	2	1	0
Stinkgrass	2	1	1
Timothy	1	1	1
Canada wildrye	1	0	0

Table 10. Russian wheat aphid extracted from grasses sampled in Larimer and Weld Counties, summer, 1990. Each row within the table represents samples taken from one site throughout the season. Blank cells within table indicate dates on which no collections were made.

Grass Species	June		July			August				September			
	8	20	5	17	25	4	13	21	30	6	13	20	26
Barnyardgrass											0	0	0
Canada wildrye				9	21	279	78	9	2	3	0	0	0
Canada wildrye				120	12	0	15	0		0			
Canada wildrye						252	82	137	157	85		0	
Cheatgrass	1	1											
Cheatgrass	14	18											
Cheatgrass	1	9											
Crested wheatgrass	109	94	1049	2102	12	1	58	2	2	2	0	0	1
Crested wheatgrass				36	3	40		2	3	2		10	0
Crested wheatgrass						146	15	23	8	0		6	0
Crested wheatgrass							127	2	14	4		0	
Foxtail barley	0	5	32	88	293	79		14	7	7	1	2	14
Foxtail barley		2	51	164	142	17	4	53	269	0	0	0	1
Foxtail barley			7	81	27					0			
Pubescent wheatgrass	70	34	12	198	31	7	16	0	24	0	0	0	0
Pubescent wheatgrass	6	3	21	4	7	0	3	0	4	0	0	0	0
Pubescent wheatgrass	0			0	1	2	9		0	0		0	13
Pubescent wheatgrass						251	1781	1	13	1		0	
Sand dropseed	4	1	14	1	0	0	0	0	0	0	0	0	0
Sand dropseed						0	0	1	0	0		0	0
Smooth brome	2	0	4	1		0	0	4	0	0	0	0	0
Smooth brome			4			1	1	0	1	0	0	0	0
Smooth brome						0	0	0	0	0		1	
Stinkgrass									0				
Volunteer wheat											0	1	
Volunteer wheat			11		137								
Volunteer wheat								0	2	0	0	1	0
Volunteer wheat	13	59	4555	397	1	2	0	0	2	0			
Volunteer barley											4	1	1
Volunteer barley									0			0	1
Western wheatgrass	0	7	21	21	17	0	0	0	0	0	0	0	0
Western wheatgrass				23	4	1	0	0	0	1		0	0

Table 11. Russian wheat aphids in grass samples from Western Colorado in 1988 and 1989. 1989 samples were separated into early instar (I-III) and late instar (IV-V).

Grass Species	1988 Total Samples	Samples with RWA	1989 Total Samples	Samples with I-III Only	Samples with IV-V
Jointed goatgrass	1	1	2	0	2
Crested wheatgrass	23	22	33	7	15
Wild oat	1	1	5	0	4
Blue grama	0	0	6	3	0
Smooth brome	4	0	9	4	1
Mountain brome	4	4	3	0	1
Downy brome	1	1	4	2	1
Sandbur	2	0	2	0	0
Orchardgrass	1	0	2	0	0
Alkali grass	0	0	6	0	0
Barnyardgrass	5	1	6	0	0
Canada wildrye	14	8	34	9	6
Bottlebrush squirreltail	0	0	3	0	1
Thickspike wheatgrass	3	3	0	0	0
Foxtail barley	4	3	39	5	28
Slender wheatgrass	2	1	2	1	1
Intermediate wheatgrass	2	0	13	2	2
Pubescent wheatgrass	4	3	8	1	4
Tall wheatgrass	7	4	35	7	6
Annual wheatgrass	0	0	5	0	5
Tall fescue	2	0	6	1	1
Basin wildrye	3	1	4	0	2
Indian ricegrass	2	1	5	1	0
Witchgrass	0	0	9	1	0
Western wheatgrass	5	1	7	3	0
Reed canarygrass	1	0	6	2	0
Timothy	2	0	2	0	0
Kentucky bluegrass	1	0	1	0	0
Russian wildrye	2	2	4	2	1
Little bluestem	0	0	1	0	0
Green foxtail	0	0	5	0	0
Sand dropseed	0	0	31	2	2
Alkali sacaton	0	0	2	0	0
Green needlegrass	6	1	2	0	0

Table 12. RWA recovered from grass sampling in southwestern Colorado , summer, 1990. Blank cells within table indicate dates on which no collections were made.

Grass Species	May	June				July			August	
	18	04	11	19	26	03	12	20	08	17
Crested wheatgrass	51	19	62	2	12	19	124		7	114
Foxtail barley	8	32	20	65	78	132	71	41	15	164
Intermediate wheatgrass	7	3		148	39	353	10	0		
Pubescent wheatgrass	39	5	42	1	12				0	7
Pubescent wheatgrass	624	46	65	13	89	1	13		13	16
Sand dropseed			31	3	2	16	71	0	7	11
Thickspike wheatgrass	4			9	0	0	0		0	
Western wheatgrass									0	15

Table 13. Russian wheat aphid recovered from bi weekly grass sampling in Grand Valley, summer, 1990. Each row within the table represents sampling at the same site throughout the season.

Grass species	May		June		July		August					Sep
	14	30	11	24	9	26	1	8	16	21	28	5
Crested wheatgrass	6	72	0	0	0	0	0	0	0	0	0	0
Canada wildrye	3	1	2	4	0	2	1	1	12	139	15	4
Foxtail barley	92	439	42	722	280	6	4	16	37	153	79	400
Smooth brome	6	2	0	6	0	0	0	0	0	0	0	0
Sand dropseed		0	3	6	8	0	0	0	0	0	0	0
Tall fescue	10	6	6	6	0	0	0	0	0	0	0	0
Tall wheatgrass	22	18	19	6	0	0	0	1	1	6	0	0
Volunteer barley	134	291	531	395					3	2	59	35
Western wheatgrass	1	32	42	2	2	1	0	0	0	1	0	0

Acknowledgments

We would like to thank the following people for their assistance in different phases of this project. Fred Judson (Fruita Research Center)assisted in the Grand Valley surveys. Dave Sanford (Southwest Colorado Research Center) assisted in the southwest Colorado samples. Jeff Rudolph assisted in the North Central Colorado surveys. Mike Koch assisted in the northeastern Colorado surveys. Deb Harn assisted in the southeastern Colorado surveys. Gary Noller (Upper Colorado Environmental Plant Center) assisted in identification of grass voucher specimens. Gary Noller and Eric Rechtel reviewed a previous version of this manuscript.