Grant Code:	New
Title:	Evaluating the impact of an Idaho invasive cereal aphid, *Metopolophium festucae cerealium,* on wheat production
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Justification/Rationale: Halbert et al. (2013) reported the presence of a newly invasive exotic aphid, *Metopolophium festucae cerealium* (herein, *Mfc*), in wheat systems of the PNW. Initially detected in Oregon (Halbert and Sandvol, 1995), *Mfc* recently rapidly expanded its range to northern Oregon, Washington, eastern Idaho (near Aberdeen), and Montana (Rashed and Eigenbrode, unpublished). Although it is rare in southern Idaho, *Mfc* has become the most abundant aphid in wheat in northern Idaho (Halbert et al. 2013; Eigenbrode et al., unpublished). In 2018, *Mfc* was detected for the first time in Kansas (P. Michaud, personal observation). The aphid therefore appears to be extending its invaded range with the potential to become an abundant and serious pest of wheat in North America. While most cereal aphids are of greatest concern when they transmit viruses such as *Barley yellow dwarf virus* (BYDV), some cause significant damage through direct feeding. For instance, although Russian wheat aphid (RWA) is unable to transmit BYDV, it is one of the most damaging wheat aphids because its salivary toxins cause severe stunting, distortion, and yield loss. Based on preliminary greenhouse trials, *Mfc* can be as injurious as RWA through its direct feeding (Eigenbrode et al., unpublished) and its infestations in the field cause chlorotic staining of wheat leaves. Sadeghi et al. (2017) reported that *Mfc* is not a vector for BYDV, but that was based on a single isolate of BYDV, leaving uncertain whether *Mfc* can transmit other BYDV strains to Idaho wheat varieties. Finally, recent studies have demonstrated that *Mfc* feeding promotes population increase of the bird cherry-oat aphid (Foote et al. 2017) which is a highly efficient vector of BYDV, suggesting that *Mfc* could contribute indirectly to BYDV spread. *Mfc* is abundant in wheat but can feed and reproduce on Idaho fescue and blue bunch wheatgrass (Davis et al. 2014) and has been collected from meadow foxtail (*Alopecurus pratensis*) in Idaho (Sadeghi, unpublished). Since *Mfc* is expected to become abundant throughout Idaho, research is needed to delineate the risks it poses to wheat production. We propose five objectives for a two-year study to address this need. As the only team investigating *Mfc* in the USA, we will collect original data on its economic impact as a direct pest and virus vector, and we will assess the relative susceptibility to *Mfc* of spring and winter wheat varieties widely grown in Idaho.

Hypotheses & Objectives:
Hypothesis 1 - *Mfc* is distributed in both northern and southern Idaho and its abundance is increasing throughout the state.

Hypothesis 2 - *Mfc* causes significant economic damage to wheat through direct feeding and contributing to BDYV spread.

Objectives

I. Conduct a two-year, statewide aphid survey to determine current range of *Mfc* in Idaho.
II. Determine the direct effect of *Mfc* on yield of winter wheat in comparison to Russian wheat aphid and bird cherry-oat aphid.

III. Determine the relative susceptibility of spring and winter wheat varieties widely grown in Idaho to direct injury from *Mfc* feeding.
IV. Confirm or rule out *Mfc*'s role as a vector of prevalent BYDV strains.
V. Evaluate the effect of *Mfc* presence on population growth of bird cherry-oat aphid, the most efficient BYDV vector in Idaho.

Procedures/Plan of work: To address *Objective I*, we will sample a total of 100 wheat fields located in northern and southern Idaho, following the detection methods used by Halbert et al. (2013). Based on our results from the BYDV/aphid reservoir project (AN2638), heavy aphid infestation in wheat is expected in July and August (spring wheat). In winter wheat, aphid infestations have also been reported in mid to late September. Starting June 15, wheat fields will be sampled by conducting a standardized 150 sweeps in a zigzag pattern, starting from the edge of the field toward the center on a monthly basis. Collected samples will be identified, and growers will be notified of findings. *Mfc* samples will be preserved at -80°C for later genetic analyses to identify population structure (future direction), using microsatellites. To address *Objectives II* and *III*, 5(l)x5(w)x4(h)-ft field mesh cages constructed from PVC frames will be used. Each year, the four commonly planted winter wheat varieties SY Ovation, WB1529, Brundage and Puma will be screened, in 12 cages per variety (48 cages, total). For each variety, there will be four *Mfc*-infested, four- RWA-infested, and four non-infested control cages (i.e. zero aphid control). To infest, one hundred and sixty aphids from a laboratory colony of *Mfc*, or RWA, will be released into each aphid treatment cage, two (n= 80) and three (n= 80) weeks post emergence (fall planting). Ten random leaf samples will be removed, from each cage, in October and November 2019, and in April and May, 2020. Aphid numbers and feeding damage will be recorded. Average yield and aboveground biomass at harvest, from each aphid infested variety will be compared to the RWA and the zero-aphid controls (of the same variety). Two-year data on yield (and/or foliar biomass) and aphid number will be used to determine relative susceptibility/tolerance of the evaluated wheat varieties. Following our previously-used transmission study protocol, to address *Objective IV*, we will first cage *Mfc* aphids on BYDV-infected (BYDV-PAV and at least one more strain, depending on availability) plants. Then, we will transfer aphids and expose them to individual healthy plants of SY Ovation (10 aphids/plant), using leaf clip cages. All plants will be tested with qPCR. For *Objective V*, we will test the effect of previous and concurrent infestations of *Mfc* on the growth of Bird cherry-oat aphid populations on individual plants of SY Ovation in a greenhouse experiment in year 1. In year two, we will conduct a similar experiment with caged plants in the field. We will also use aphid survey counts obtained under *Objective I* to look for statistical associations between bird cherry-oat aphid and *Mfc* populations across Idaho. We will determine the effect of *Mfc* presence/absence and abundance on bird cherry-oat aphid.

Duration: The funding request is for the first year of an anticipated two-year project.

Cooperation/Collaboration: Proposed research is being carried out collaboratively among Dr. Eigenbrode, Dr. Rashed and Mr. Stokes (Extension faculty) programs, in cooperation with several Idaho wheat growers.

Anticipated Benefits, Expected Outcomes and Impacts, and Transfer of Information: The University of Idaho is the only institution studying this invasive cereal aphid, which makes this and all future study findings original. Results will be used as preliminary data for requesting federal funding in 2021. Quantifying *Mfc* injury level and severity is critical for recommending effective management practices. Findings from monthly aphid surveys will be communicated to

the involved growers (text messages and phone calls). Acknowledging support from the Idaho Wheat Commission, our findings will be communicated to growers and the scientific community through cereal schools, conferences and, at least, one extension publication. A minimum of two refereed journal publications is expected from this work.

Literature Review:

Metopolophium festucae cerealium is a new addition to the aphid fauna of North America that is quickly expanding its range across several states (Halbert et al. 2013, Eigenbrode et al. unpublished). Surveys show *Mfc* can become the most abundant aphid PNW wheat systems. Unlike most other cereal aphids, considerable feeding damage has been reported in association with *Mfc*. Damaged plants are distinguished by the presence of red spots at the point of feeding, which later develops into extensive chlorosis and reduced above- and below-ground biomass (Dent and Wratten 1986, Davis et al. 2014). Earlier studies have shown that wheat is indeed one of the preferred hosts of *Mfc*, and that wheat is more susceptible to the aphid feeding compared to barley, corn and oats (Davis et al. 2014). Although *Metopolophium festucae* (subspecies not specified) has been listed as a vector of BYDV (Plum 1974), recent work found that *Mfc* collected in Idaho was unable to transmit BYDV (PAV strain) (Sadeghi et al. 2016), leaving its capacity as a vector in Idaho uncertain. *Mfc* potentially indirectly contributes to BYDV spread by enhancing by up to 46% the population growth of the bird cherry-oat aphid, which is the most efficient vector of BYDV in Idaho (Foote et al. 2017).

References Cited:

Davis, TS, Wu, Y, Eigenbrode, SD. 2014. Host settling behavior, reproductive performance, and effects on plant growth of an exotic cereal aphid, *Metopolophium festucae* subsp *cerealium* (Hemiptera: Aphididae). Environmental Entomology 43: 682-688.

Dent, DR, and Wratten, SD. 1986. The host-plant relationships of apterous virginoparae of the grass aphid *Metopolophium festucae cerealium*. Annals of Applied Biology 108: 567-576.

Foote, NE, Davis, TS, Crowder, DW, Bosque-Pérez, NA, Eigenbrode, SD. 2017. Plant water stress affects interactions between an invasive and a naturalized aphid species on cereal crops. Environmental Entomology 46: 609-616.

Halbert, SE, Sandvol, LE. 1995. New or unusual pests in Idaho in 1994. Oregon State University Research Reports, p. 71.

Halbert, SE, Wu, Y, Eigenbrode, SD. 2013. *Metopolophium festucae cerealium* (Hemiptera: Aphididae), a new addition to the aphid fauna of North America. Insecta Mundi 301: 1-6.

Plum, RT. 1974. Problems and possibilities for control of BYDV in Britain. Mikrobiologija 11: 41-47.

Sadeghi, SE, Bjur, J.L., Ingwell, L, Unger, L, Bosque-Pérez, NA and Eigenbrode, SD. 2016. Interactions between *Metopolophium festucae cerealium* (Hemiptera: Aphididae) and *Barley yellow dwarf virus* (BYDV-PAV). Journal of Insect Science 16: 1-6.

FY2020

IDAHO WHEAT COMMISSION - BUDGET FORM

Principal Investigator: Sanford Eigenbrode

Allocated by	**Idaho Wheat Commission**	**during FY 2018**	**$ -**
Allocated by	**Idaho Wheat Commission**	**during FY 2019**	**$ -**

REQUESTED FY2020 SUPPORT:

Budget Categories	(10) Salaries (*staff, post-docs, etc.*)	(12) Temp Help	(11) Fringe	(20) Travel	(30) OE	(70) Graduate Tuition/ Fees	TOTALS
Idaho Wheat Commission	$ -	$ 12,300	$ 468	$ 2,900	$ 4,100	$ -	$ 19,768

TOTAL BUDGET REQUEST FOR FY 2020: **$ 19,768**

BREAKDOWN FOR MULTIPLE SUB-BUDGETS:

Budget Categories	*Eigenbrode*	*Rashed*	*Stokes*
(10) Salaries	$ -	$ -	$ -
(12) Temp Help	$ 9,000	$ 3,300	$ -
(11) Fringe Benefits	$ 342	$ 126	$ -
(20) Travel	$ 400	$ 2,000	$ 500
(30) Other Expenses	$ 1,000	$ 3,000	$ 100
(70) Graduate Student Tuition/F	$ -	$ -	$ -
TOTALS	$ 10,742	$ 8,426	$ 600

Total Sub-budgets **$ 19,768**

Explanatory Comments:

Fall 2018 Version