

ANNUAL REPORT

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Title: Grassy weeds, aphid population and BYDV spread, with a particular emphasis on perennial grasses

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Accomplishments:

We have successfully addressed all of our proposed objectives. With the exception from one experiment, we have reported completed results in this and previous reports. We showed previously that foxtail barley (*Hordeum jubatum*), green foxtail (*Setaria viridis*), downy brome (*Bromus tectorum*) and corn can all host *Barley yellow dwarf virus* (BYDV) and that the bird cherry-oat aphids are capable of both inoculating and acquiring BYDV from these hosts. Successful transmission into winter wheat (cv. SY Ovation) ranged between 45 and 95%. Aphid monitoring continued in corn and winter wheat; samples collected from a single field in eastern Idaho tested positive for BYDV in 2019. This indicates that there have been no repeated outbreaks since 2017. We have also caged patches of naturally present foxtail barley and infested them with the BYDV-infective aphids. These plants tested positive in the subsequent season, indicating that perennial grasses must be considered as sources of infection, especially since we demonstrated effective transmission from these hosts to winter wheat by the bird cherry-oat aphid. Results of host choice and reproduction success experiments with the infective aphids were presented in the 2018-2019 report. Here, we are presenting study results with clean aphids as well as host choice and aphid reproduction when exposed to water stressed plants (with BYDV-infected aphids).

Determine cereal aphid species and their movement from wild BYDV reservoirs to winter wheat

Aphid populations in corn and wheat crops have been monitored in the past 4 years. Drop in aphid numbers and BYDV incidence (especially in eastern Idaho) has prevented us to provide direct evidence for the role of corn in BYDV outbreaks. We however demonstrated that the bird cherry-oat aphids can colonize both corn and wheat and effectively transmit the virus between the two crops (previously presented). This objective helped with discovery of the newly invasive species of aphid *Metapolophium festucae cerealium* in eastern Idaho, which has kept expanding its range for the past few years. Conflicting information exists on the ability of this aphid species to transmit BYDV; if funding allows, I would be interested in testing its efficiency in transmitting the pathogen.

Evaluate foxtail barley as a potential overwintering host for BYDV

To minimize chances of accidental release of the aphid and BYDV we decided to conduct field inoculations in cages at the station only. This has limited the number of plants that could be experimented. Three foxtail barley plants were infested with the virus infected aphids in October 2018. All plants tested positive for BYDV in April 2019 (ELISA). Thus, foxtail barley is an overwintering host of BYDV. This highlights the importance of studying other perennial grasses in the region.

Evaluate aphid survival and reproduction on grassy weed species

Survival and reproduction of the BYDV-infected aphids were presented in the 2018-2019 report. Here, we present results for infected and uninfected bird cherry-oat aphid survivorship on different hosts. To generate experimental plants weed seeds were germinated in flat trays and seedlings were transplanted into pots of 3*3*8 inch. Winter wheat SY Ovation was seeded in pots of the same size. All plants were maintained under well-watered conditions.

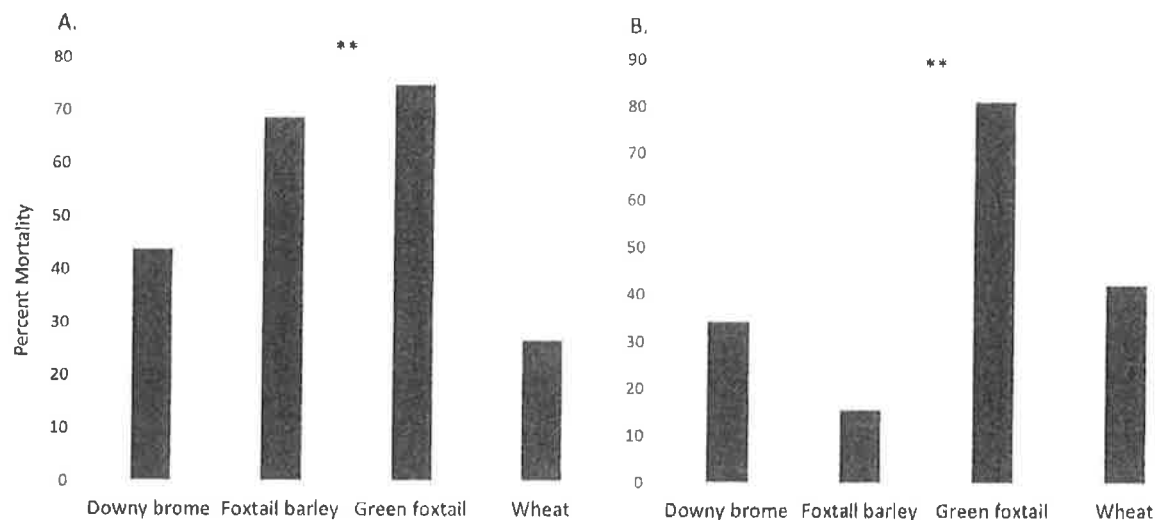


Figure 1. A) Significant variation (GLMM: $F_{3,59} = 4.4$, $P = 0.007$) was detected in the percent mortality of the BYDV-infected aphids on different host types. The greatest mortality was observed on the green foxtail host and the least mortality was reported on cultivated wheat. B) Significant differences were also detected (GLMM: $F_{3,59} = 6.0$, $P = 0.001$) in percent mortality of the clean aphid on various host types. Foxtail barley appeared as a suitable host for the aphids. Green foxtail appeared to be a nonoptimal host for the bird cherry-oat aphids.

Significant differences were also detected in aphid preference with both infected and uninfected aphids, both of which avoided green foxtail. Overall, wheat emerged as a preferred host for the bird cherry-oat aphids.

Reproduction of BYDV-infected aphids on wheat and grassy weeds under different water regimes

Plants were prepared as previously mentioned. When plants were about 4-inch tall, two water regimes were initiated: well-watered and drought-stressed. Well-watered plants received water as needed, while plants subject to drought stress were watered when wilting occurred. When leaf wilting was visible, one one-inch leaf cage was placed on a single leaf of each plant, including weeds and winter wheat (cv. SY Ovation). Three adult aphids were released into each cage, and the number of nymphs were estimated 3 days after the release. The experiment was repeated twice in 2019 and there were 10 plants/species in each of the repeats.

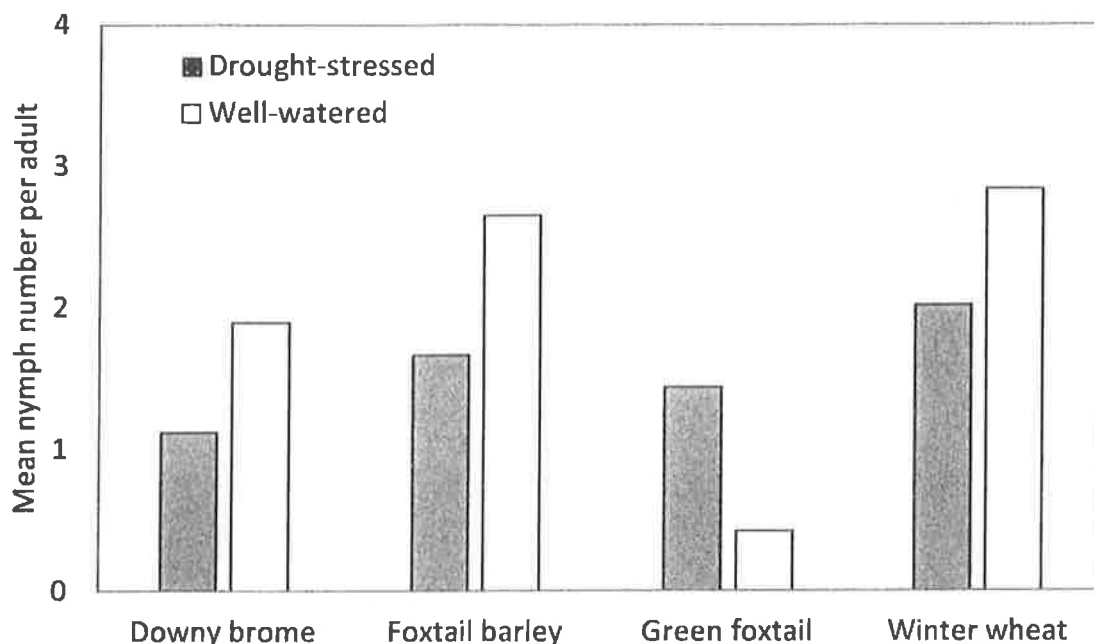


Figure 2. Under well-watered conditions, the number of nymphs produced on winter wheat was greater than green foxtail (GLMM: $t = 4.38$; $P < 0.001$). Under drought-stressed conditions, the number of nymphs produced on winter wheat was not significantly different from downy brome, foxtail barley, or green foxtail. The number of nymphs produced on green foxtail under drought stress was greater than well-watered conditions (GLMM: $t = 2.73$; $P = 0.010$), while water regimes did not affect the number of nymphs produced on the other host plants.

Projections:

The host choice experiment (in the presence of drought stress) has yet to be completed. We will proceed to complete this task in 2020. We have also showed that aphids can survive and reproduce on three species of wild hosts, although these three wild species were less preferred, by the bird cherry oat aphids, than winter wheat. Likewise, wheat emerged as the optimal reproductive host for the bird cherry-oat aphid. This may explain why aphids start to move into winter wheat upon its emergence, and the preference may be condition dependent. Finally, we provided evidence that foxtail barley can be an overwintering host for BYDV and additional studies are needed to investigate the role of other perennial grasses as BYDV overwintering hosts.

Publications:

Rashidi, M., Cruzado, R.K., Nikoukar, A., Hutchinson, P.J.S., Marshall, J., Bosque-Perez, N.A., Rashed, A. Barley yellow dwarf virus transmission by the bird cherry-oat aphid *Rhopalosiphum padi* L. (Hem., Aphididae): Can corn and grassy weeds contribute to regional BYDV outbreaks? Entomological Society of America, Entomological society of America Annual Meeting. Vancouver, BC, November 2018.

Rashidi, M., Cruzado, R.K., Nikoukar, A., Hutchinson, P.J.S., Marshall, J., Bosque-Perez, N.A., Rashed, A. Barley yellow dwarf virus transmission from wild grassy weeds to winter wheat. *To be submitted to Weed Science*.