

ANNUAL REPORT

PROJECT NO: BJKU45, BJKU46, BJKU47, BJKU48

TITLE: Barley Yellow Dwarf Virus Effects on Wheat Water and Nitrogen Use Efficiency

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ACCOMPLISHMENTS:

A two-year greenhouse experiment was conducted with four nitrogen (N) supply rates and three BYDV infection treatments. Seeds of the winter wheat variety SY Ovation were germinated and kept in a growth chamber for 6 weeks for vernalization, and the seedlings were then transferred to experimental pots (6 in $\times$ 2 ft) with two plants per pot in the greenhouse. Pots were filled with soil collected from a small field area of a Declo sandy loam (Coarse-loamy, mixed, superactive, mesic Xeric Haplocalcids) at Aberdeen, ID, which contained approximately 50 lb N/ac measured as inorganic N. Urea was applied to the pots at 0, 120, 240, and 360 lbs N/acre (or total N supply of 50, 170, 290, and 410 lb N/ac from soil residual N and N fertilizers). Mesh cages (6 in $\times$ 2 ft) were installed on all experimental pots, and bird cherry-oat aphids were released into the experimental cages to feed on the plants and/or inoculate young seedlings with BYDV. The three BYDV infection treatments included were: control (no aphids released in the cages), BYDV (viruliferous aphids killed 10 days after release by insecticide spray), and BYDV + Aphids (viruliferous aphids maintained until harvest). Experimental pots were arranged in a randomized complete block design with 6 replicates for each treatment of N rate $\times$ BYDV infection. Individual pots were weighed weekly to determine water use where the amount of water used was added back to each pot. At the end of the experiment, the sum of weekly water use was calculated as the total water use. Plants were harvested between booting to heading stages, and the shoot biomass of each pot was dried in the oven for dry weight and subsequent measurements of N uptake. Root biomass was collected from each pot for the measurements of morphological characteristics and dry weight. Water use efficiency (WUE) was calculated as the dry weight of shoot biomass divided by total water use during the season. Nitrogen use efficiency (NUE) was calculated as the difference in total N uptake between fertilized and unfertilized pots divided by fertilizer N applied.

Summary of results from the two-year experiment

Shoot biomass increased with N supply in all three virus treatments of control, BYDV, and BYDV + Aphids. At each N supply rate, the treatment of BYDV + Aphids showed the lowest shoot and root biomass among the three virus treatments. Both BYDV and BYDV + Aphids had smaller root morphological parameters (e.g., root length density (RLD), root length per unit of soil volume that the roots occupy) than the control with the rank as control > BYDV > BYDV + Aphids.

At the N rate of 360 lbs N/ac, N concentration in shoot tissues of the control was significantly greater than the other two virus treatments, however, no differences were observed at other N rates. BYDV + Aphids had lower N content in shoot tissues than the other two treatments at all N supply rates except 0 lbs N/ac. NUE of the control plants was greater than plants subject to BYDV + Aphids, but not different from the BYDV treatment. In the treatment of BYDV + Aphids, N content in shoot biomass increased with aphid pressure.

Total water use was not different between virus treatments or N application rates. Due to the difference in shoot biomass, WUE of BYDV + Aphids was significantly lower than the control. In the treatment of BYDV + Aphids, total water used increased with aphid pressure.

The BYDV + Aphids treatment exhibited a greater disease symptom score and viral titer than the BYDV treatment (Figure 1), but neither of them responded to N application rates. Viral titer was not correlated with shoot biomass, but negatively correlated with root biomass and root to shoot ratio in the BYDV treatment. In the BYDV + Aphids treatment, similar linear relationships were observed despite of insignificance.

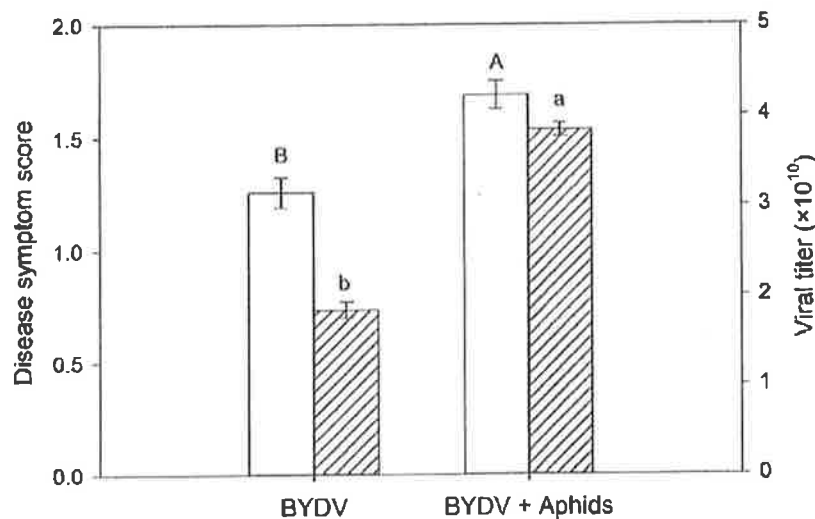


Figure 1. Disease symptom (white) and viral titer (shaded) in the treatments of BYDV and BYDV + Aphids. Means ($\pm$ SE) with different letters differ significantly by virus treatment in disease symptom score (capital letters) and viral titer (small letters) ($P \leq 0.05$). No differences were found among N application rates or virus infection $\times$ N rate.

The loss of root biomass due to BYDV infection was proportionally greater than shoot biomass, indicating the possibility of maintaining root growth and function in BYDV-infected host plants to sustain the host growth and to alleviate the disease damage. In addition, BYDV infection with the presence of aphids greatly reduced shoot and root growth, and N content in shoot tissue. While the current study did not result in harvested grain, it would be expected that reduced shoot N content would negatively impact grain protein levels. The presence of aphids facilitates virus spread and thus has a greater impact on the damage induced by BYDV to host plants, which is very common in field conditions. Furthermore, transmission of BYDV allow aphids to maintain higher fecundities compared with virus-free aphids. The severity of yield loss is thus more determined by the vector-pathogen system rather than BYDV itself, and in some scenarios, yield reduction could be minimized if aphid populations are controlled in N fertilized fields.

PROJECTIONS:

The results from this study provides needed information on the impact of BYDV and aphids on host plant growth, and water and N uptake and use efficiencies. The presence of aphids increases BYDV replication, and the control of BYDV should be considered in a vector-host-pathogen system. Results of this study will be communicated to growers and researchers through cereal schools, newsletters, websites, progress reports, conferences, and refereed journal publications.

PUBLICATIONS:

Conference abstract and presentation:

Liang X, Marshall JM, Rashed A, Rogers CW. Barley yellow dwarf virus effects on wheat water and nitrogen use efficiency. ASA-CSSA-SSSA Annual Meetings. Phoenix, AZ, Nov. 6-9 2016.