

# Intergeneric and Interspecific Barley Hybrids Show Tolerance to Barley Yellow Dwarf Virus

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## INTRODUCTION

Barley yellow dwarf virus, a disease transmitted to barley, oats, and wheat by several species of aphids, was identified by Oswald and Huston in 1951 (2). This disease in barley causes a yellowing of the leaves, stunted shoot and root growth, and partial to complete sterility. Other leaf spotting diseases (7) often may appear on the leaves of the yellow dwarf infected plants. The disease has been erroneously called "root rot." Yellow dwarf in wheat causes stunting, yellowing of the leaves, and decreased yield, whereas infected oat plants are stunted, sterile, and produce red leaves.

The age of the infected plant appears to influence or determine the severity of the symptoms and the effect on cereal crop yield. The disease is most severe on infected seedlings. R. Timian, virologist, USDA, North Dakota State University, reported (1) that a 20% loss of yield in barley can be expected when infection occurs as late as the boot stage. Earlier infection may decrease yields 40% or more. Murphy (1) reported that all winter cereals are affected by yellow dwarf virus on the eastern seaboard, particularly winter wheat. He stated that losses are difficult to see and estimate (1).

A transfer of disease resistance from the wild species of *Hordeum* to cultivated barley (*Hordeum vulgare* L.) has been reported previously by Schooler (7).

## MATERIALS AND METHODS

A hybrid was made between the "wild" barleys *Hordeum brachyantherum* L. and *H. bogdanii* Wilensky, which after colchicine treatment and chromosome doubling was crossed with autotetraploid cultivated barley, *H. vulgare*, (produced by doubling the chromosome number of the variety 'Traill' from 14 to 28). The embryo culture technique as described by Schooler (4, 5, 6) was used in the production of seedlings from the above crosses.

The grass genus *Elymus*, a distantly related genera of *Hordeum* and *Agropyron* grasses, (predominant pasture grass in western N. D.) was used in the generic cross with *Hordeum*. Autotetraploid two-rowed *H. vulgare* was crossed with a selected *Elymus mollis* type. Seedlings of these crosses were obtained also by embryo culture technique.

Varieties and lines used in the test included: 'Larker,' 'Beacon,' 'Traill,' 'Shabet,' 'Blackhulless' [(CI 666) a very susceptible line (3)], an interspecific line, and two intergeneric lines.

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The virus disease, yellow dwarf, was transferred to the test seedlings by aphids that had fed on infected Blackhulless seedlings. Infected Blackhulless seedlings containing the aphids were maintained in .45 m x .6 m flats in a growth chamber for testing the selected lines and varieties.

Seed of the material to be tested was planted in a .45 m x .6 m flats containing soil (5 cm deep) with 15 seeds per row and 5 rows per flat. The flats containing soil were watered and seeds allowed to germinate and grow for 10 days prior to inoculation with barley yellow dwarf virus. Five plants from each variety or line were transferred to six-inch clay pots containing soil and not inoculated. The remaining 10 seedlings were inoculated in a growth chamber. The aphids carrying the yellow dwarf virus were transferred to the healthy seedlings by cutting off the infected Blackhulless seedlings containing aphids and shaking them over the flats of soil containing the seedling to be tested. The aphids crawl on the plants to feed - infecting the plants. The transfer of the barley yellow dwarf virus by aphids to uninfected plants requires an incubation period of 12 to 48 hours. Following the incubation period of 48 hours, the flats containing the varieties and lines were removed from the chamber and sprayed with malathion to kill the aphids. The seedlings were transplanted with one seedling per six-inch pot of soil and placed in the greenhouse with non-inoculated seedlings for further growth and development. Photographs were taken as records of growth and maturity.

## RESULTS AND DISCUSSION

Plant performance of the infected plants was compared with the control plants (non-inoculated plants of each variety or line). Photographs of typical seedlings are presented in Fig. 1-A, B, C, and D. Plant No. FR 819-77-1 was an F<sub>3</sub> selection from a cross of Beacon and FR 497-77-1. FR 497-77-1 was obtained from a cross of autotetraploid *H. vulgare* and the *Elymus mollis* type. Plant growth and development, shown in Fig. 1, A-D, indicated that FR 819-77-1 and FR 497-77-1 were more yellow dwarf tolerant than Larker, Beacon, and Blackhulless. Larker and Beacon were slightly more tolerant than Blackhulless.

Photographs of more mature plants are shown in Fig. 2-E, F, G, and H. Stunted growth and a decreased number of tillers showed Larker to be affected more severely by the virus (Fig. 2-E and 2-F) than FR 819-77-1 or FR 586-77-1. FR 586-77-1 was a cross involving *H. brachyantherum* x *H. bogdanii* x autotetraploid *H. vulgare*. The selection was made in the F<sub>2</sub> of a cross and outcrossed with

another selection of the same cross x Dicktoo barley. F<sub>3</sub> seed of the latter cross was used in this test. Photographs showing the comparison between Traill and FR 819-77-1 (Fig. 2-G) and between Beacon and FR 586-77-1 (Fig. 2-H) are shown.

Head types (spikes) of some of the infected plants and their controls are presented in Fig. 3. Slightly more tolerance to the yellow dwarf virus was observed in Traill than Larker, Beacon and Blackhullless. This figure is presented as a comparison of Traill with the more tolerant types. In Fig. 3-I, kernels formed only near the base of the head in the infected plants of Traill, while FR-819-77-1 had kernels from the base to the top of the head. Fig. 3-J

gives a comparison of the heads of larker and Traill with no kernels forming on the head of Larker. FR 497-77-2, a sister selection of FR 497-77-1, is the tolerant parent of a cross with Beacon number FR 819-77-1 F<sub>3</sub> also showing kernel formation to the top of the head. The last photograph, Fig. 3-L shows head types from Shabet and Traill with kernel formation higher on the head of Shabet than Traill. A high to low yellow dwarf tolerance rating of the lines and varieties tested would be: FR 497-77-1 or -2, FR 819-77-1 F<sub>3</sub>, FR 586-77-1, Shabet, Traill, Larker, Beacon, and Blackhullless.

However, differences observed between Beacon and Larker, and also between some plants of FR 819-77-1 F<sub>3</sub> and FR 497-77-1 and -2 were negligible.

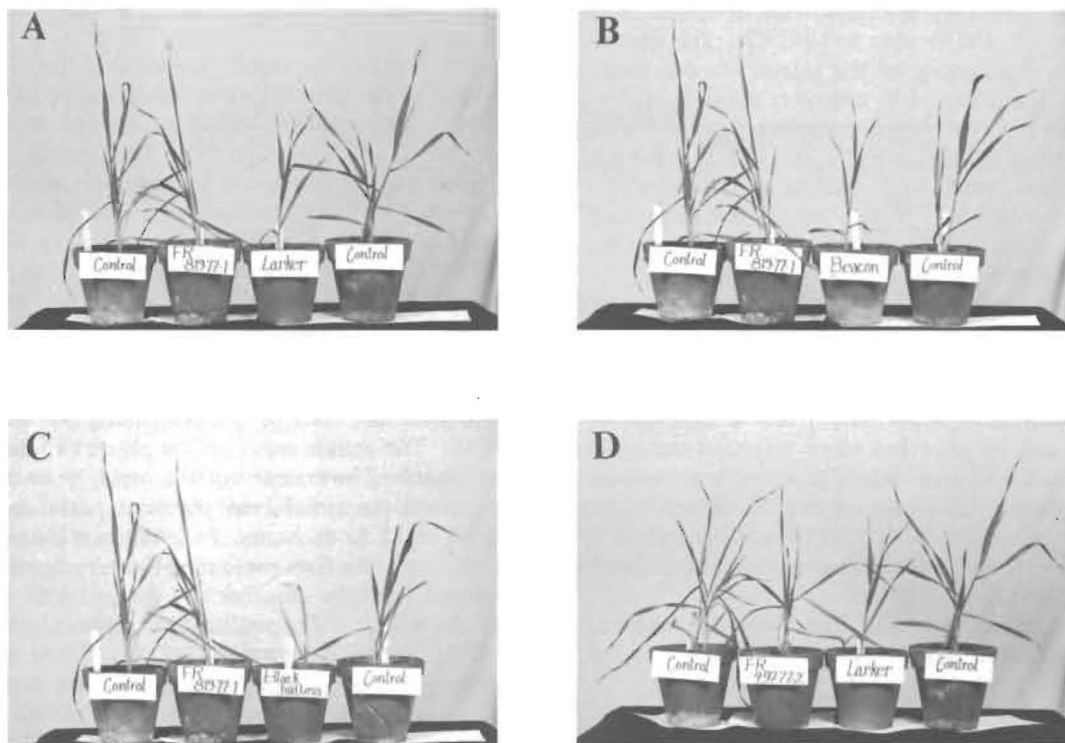


Fig. 1-A through D. Comparison of seedlings of lines and varieties inoculated with the yellow dwarf virus with their respective controls.

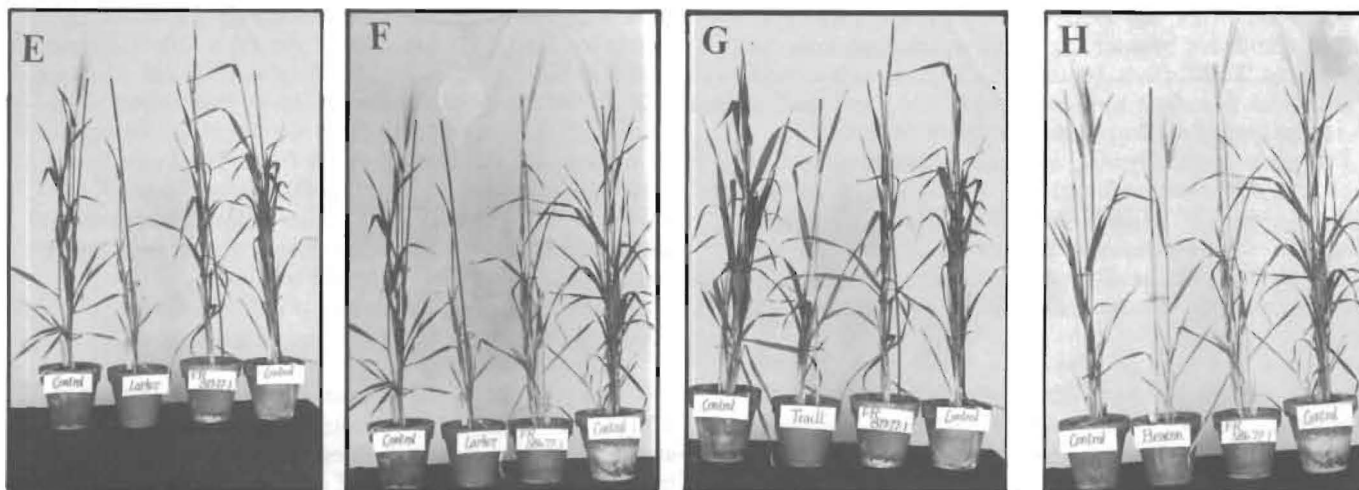


Fig. 2-E through H. Comparison of more mature lines and varieties inoculated as seedlings with the yellow dwarf virus with their respective controls.

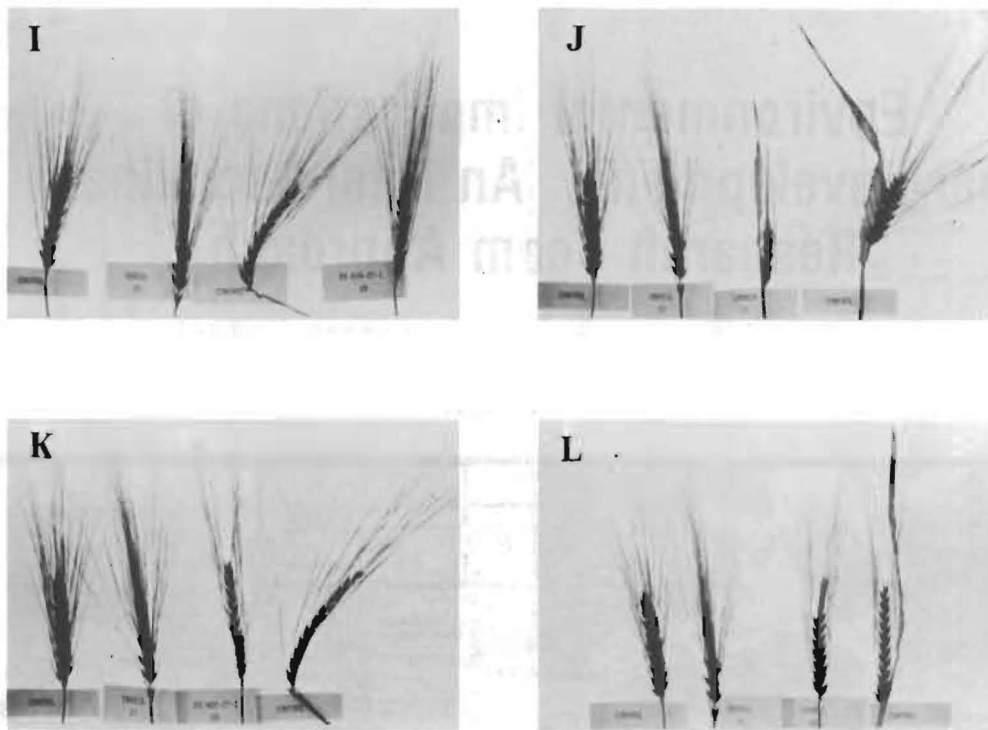


Fig. 3-I through L. Comparison of head types and seed set of lines and varieties inoculated as seedlings with yellow dwarf virus with their respective controls.

### CONCLUSIONS

Lines of barley highly tolerant to the barley yellow dwarf virus have been obtained from crosses of cultivated barley with wild species of *Hordeum* and *Elymus*. These lines will be useful in the development of new commercial yellow dwarf tolerant barley varieties.

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