Tall Fescue as a Natural Host and Aphid Vectors of Barley Yellow Dwarf Virus in Missouri

K. F. GRAFTON, Research Associate, Department of Agronomy, North Dakota State University, Fargo 58105; J. M. POEHLMAN, Professor Emeritus, Department of Agronomy, OM P. SEHGAL, Professor, Department of Plant Pathology, and DALE T. SECHLER, Professor, Department of Agronomy, University of Missouri, Columbia 65211

ABSTRACT

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Eighty-one of 136 symptomless tall fescue plants (59.6%) collected from 90 Missouri counties were infected with a virus that was transmitted by *Rhopalosiphum padi* and produced symptoms typical of infection by barley yellow dwarf virus on Grundy oat seedlings. Purified preparations from the infected oat plants contained discrete isometric particles (diameter, 25–30 nm). *R. padi* acquired and transmitted the virus to Grundy oat seedlings after feeding on purified preparations. *R. padi, R. maidis,* and *Schizaphis graminum* naturally colonizing small grain plants in the field during 1977–1980 were also found to be viruliferous. These results indicate the presence of a large natural reservoir of barley yellow dwarf virus in tall fescue in Missouri and identify three local aphid vectors of the virus.

Barley yellow dwarf virus (BYDV) is a damaging and widespread pathogen of small grains. Diagnostic BYDV symptoms on small grains have been described by Bruehl (2). Rochow (8) listed 84 species of Gramineae that are susceptible to at least one BYDV isolate. Many common wild and cultivated grasses can serve as natural BYDV reservoirs from which the virus may be transmitted to susceptible cultivars of small grains. For instance, in Great Britain, perennial ryegrass (*Lolium perenne* L.) has been shown to be a field source of BYDV (4).

Tall fescue (*Festuca arundinacea* Schreb.) is a major forage grass in the southern U.S. corn belt, where BYDV incidence in small grains has been increasing in recent years. Tall fescue was confirmed as a symptomless host of a California BYDV isolate transmitted by *Rhopalosiphum prunifoliae* Fitch (syn. *R. fitchii* Sand.) (6) and of two Washington isolates, one transmitted by *Macrosiphum granarium* Kirby and the other by *R. fitchii* (3). Preliminary evidence based on a small sample at one location indicated that tall fescue may harbor BYDV in Missouri (12). This research was initiated to determine the BYDV incidence in tall fescue in Missouri and to identify insect vectors involved in field spread of the virus.

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MATERIALS AND METHODS

BYDV incidence. During the summer and fall of 1978, 136 tall fescue plants were collected from fields and roadsides in 90 counties in Missouri. Samples per county varied from one (56 counties) to five (two counties). These plants, which showed no obvious barley yellow dwarf symptoms, were transplanted and maintained in a greenhouse at temperatures ranging from 18 to 35 C without supplemental light until used in the transmission tests. Plants were regularly sprayed with 0.5% malathion and fumigated with nicotinamide or parathion to prevent accidental aphid infestations. At no time were aphids observed on these plants.

Virus-free *R. padi* L., originally obtained from H. Jedlinski (University of Illinois, Urbana), were maintained with regular transfers on healthy *Avena sativa* L. 'Grundy' oat seedlings in a plant growth chamber.

Tall fescue plants were tested for BYDV using *R. padi* as the vector and Grundy oat seedlings as the test host. Plants were trimmed and new leaf growth obtained before a 10- to 14-day acquisition feeding by *R. padi*. Five aphids were transferred to each of four Grundy seedlings in the three-leaf stage, maintained on these plants for 5 days, and then destroyed by being sprayed with 0.5% malathion. Transmission experiments were conducted in a growth chamber programmed for a 10-hr day length at 20 C. Inoculated plants were routinely examined for BYDV symptoms, notably leaf discoloration and plant stunting. For every five to six fescue

plants tested, four comparable Grundy seedlings were exposed to nonviruliferous aphids as controls. Virus was subsequently transmitted from infected to healthy Grundy oat seedlings as described above.

BYDV purification. Virus transmitted from a tall fescue plant collected at the Agronomy Research Center, University of Missouri-Columbia, was propagated in *A. byzantina* Koch 'Coast Black' oats and purified according to the method of Brakke and Rochow (1). Appropriate fractions from centrifuged sucrose gradients were recovered and examined with a JOEL 100 electron microscope after staining with uranyl formate. Southern bean mosaic virus was used as a marker because its sedimentation coefficient is identical to that of BYDV (10).

Nonviruliferous *R. padi* were allowed to feed on the viral preparation as follows. Virus preparations containing 20% sucrose were placed between two layers of stretched Parafilm so that the upper layer rested on the surface of the sample. Thirty aphids were placed in each of six feeding chambers, allowed to feed on the preparation for 20 hr at 15 C, and then transferred to the test seedlings (15 aphids per plant). After an inoculation access period of 5 days, the aphids were destroyed and plants were maintained for symptom production. Aphids that fed on 20% sucrose solution only served as controls.

Aphids colonizing small grains and BYDV transmission. Aphids feeding on small grain plants at the Agronomy Research Center, Columbia, were monitored over a 3-yr period. For each sampling, an aphid colony was collected from each of 10 widely dispersed, fall-seeded barley or wheat plants at 7- to 10-day intervals during the fall (1977–1979) and from 10 spring-seeded oat plants during the spring (1978–1980). A total of 210 aphid colonies was collected. Aphids were identified with the assistance of W. S. Craig, Extension Entomologist, University of Missouri-Columbia. Five aphids from each colony were placed on each of four Grundy oat seedlings. After a 5-day access period, aphids were destroyed by being sprayed with 0.5% malathion, and the plants were maintained in a growth chamber.

RESULTS

BYDV incidence. Eighty-one of 136 tall fescue plants (59.6%) collected were virus infected (Table 1). Within 2–3 wk after inoculation, Grundy oat test plants developed leaf yellowing or reddening, leaf curling, and plant stunting. Virus was subsequently transmitted from 80 infected Grundy plants by *R. padi* (100% efficiency) using five aphids per plant. Control seedlings that were exposed to nonviruliferous aphids remained symptomless.

BYDV purification. When clarified preparations from diseased Coast Black oat plants were subjected to sucrose (linear, 10–40%) gradient centrifugation (1 hr; 5 C; SW 50.1 rotor, Beckman), a distinct light-scattering zone was observed about 2.4 cm from the meniscus, which produced a sharp peak when scanned at 254 nm (ISCO, UA-5 monitor). This band was located at the same position as southern bean mosaic virus, which sedimented in a companion tube. The 280/260 ratio of the gradient purified virus was 0.56; yield of the virus from 560 g of tissue was 0.47 A_{260} unit. The purified preparation contained discrete isometric particles, diameter 25–30 nm.

R. padi acquired and transmitted virus from the preparations. Four of six Grundy oat test plants were infected using aphids that had fed on the preparation before the sucrose gradient centrifugation step, whereas six of six plants were infected using aphids that fed on the gradient purified virus. None of four test plants exposed to aphids that had fed only on the 20% sucrose developed any symptoms.

Aphids colonizing small grains and BYDV transmission. *R. padi, R. maidis* (Fitch), and *Schizaphis graminum* (Rondani) were collected during all sampling periods, except that *S. graminum* was not observed during the fall of 1979 nor *R. maidis* during the spring of 1980 (Table 2). Aphids from 208 of 210 such colonies (99%) transmitted a virus that produced typical BYDV symptoms on Grundy oat seedlings.

DISCUSSION

The virus in the field-collected tall fescue plants was tentatively identified as BYDV based on transmission by *R. padi* and induction of typical BYDV symptoms in a test host. Additionally, the fescue isolate resembled BYDV in structure (10) as well as in its acquisition from liquid suspensions and subsequent transmission to indicator plants (7).

Only *R. padi* was used to transmit the virus from the field-collected fescue plants; however, three aphid species were colonizing small grain plants in the field and all three transmitted virus efficiently. At least five BYDV strains have been distinguished on the basis of vector specificity (5,9). The identity of the BYDV strain infecting small grains and fescue plants in Missouri is unknown. Some of the BYDV-negative fescue plants may have been infected with a strain that was not transmissible by *R. padi.*

Virus-infected tall fescue plants were collected throughout Missouri; at least one plant from 65 of 90 counties sampled was virus infected. We do not know whether fescue plants were the source of local BYDV inoculum or whether local infections in small grains resulted from aphids blown in from greater distances. Both may occur. Wallin et al (11) reported that aphids are carried along low-level jet winds, resulting in BYDV infection of small grains in areas where aphids cannot overwinter as adults.

Because both fall- and spring-seeded small grains are grown in Missouri, both fall and spring BYDV infections of young plants can occur. It has not been established to what extent aphids carry the virus from locally grown small grains

Table 1. Barley yellow dwarf virus infection of tall fescue in Missouri

Crop reporting district	Counties where plants collected (no.)	Plants infected/tested (no.)[a]	Plants infected (%)
Northwest	8	2/8	25.0
North central	10	6/17	35.3
Northeast	6	6/6	100.0
West	9	7/9	77.8
Central	19	15/24	62.5
East	12	21/28	75.0
Southwest	5	4/5	80.0
South central	13	12/29	41.4
Southeast	8	8/10	80.0
Total	90	81/136	59.6

[a] In transmission tests with Grundy oat seedlings and *Rhopalosiphum padi* as vector.

Table 2. Aphids infective with barley yellow dwarf virus collected from small grains at the Agronomy Research Center, Columbia, MO, 1977-1980

Sampling period	Colonies collected (no.)			Total colonies transmitting BYDV (no.)
	Rhopalosiphum padi	*R. maidis*	*Schizaphis graminum*	
1977, fall	16	11	13	40
1978, spring	17	6	7	30
1978, fall	3	2	25	30
1979, spring	20	7	13	40
1979, fall	15	25	0	40
1980, spring	13	0	17	28

to tall fescue in adjacent fields. BYDV-infected fescue plants were present in geographic areas where small grain production is limited. We found that *R. padi* fed reluctantly on mature tall fescue plants in the growth chamber but fed readily on new leaf growth. Tall fescue is perennial in growth habit, which allows the virus to overwinter. Thus, the proportion of infected plants would be cumulative.

LITERATURE CITED

1. Brakke, M. K., and Rochow, W. F. 1974. Ribonucleic acid of barley yellow dwarf virus. Virology 61:240-248.
2. Bruehl, G. W. 1961. Barley yellow dwarf. Monograph 1. Am. Phytopathol. Soc. St. Paul, MN. 52 pp.
3. Bruehl, G. W., and Toko, H. V. 1957. Host range of two strains of the cereal yellow-dwarf virus. Plant Dis. Rep. 41:730-734.
4. Catherall, P. L. 1963. Transmission and effect of barley yellow-dwarf virus isolated from perennial ryegrass. Plant Pathol. 12:157-160.
5. Johnson, R. A., and Rochow, W. F. 1972. An isolate of barley yellow dwarf virus transmitted specifically by *Schizaphis graminum*. Phytopathology 62:921-925.
6. Oswald, J. W., and Houston, B. R. 1963. Host range and epiphytology of the cereal yellow dwarf disease. Phytopathology 43:309-313.
7. Rochow, W. F. 1960. Transmission of barley yellow dwarf virus acquired from liquid extracts by aphids feeding through membranes. Virology 12:223-232.
8. Rochow, W. F. 1961. The barley yellow dwarf virus disease of small grains. Adv. Agron. 13:217-248.
9. Rochow, W. F. 1969. Biological properties of four isolates of barley yellow dwarf virus. Phytopathology 59:1580-1589.
10. Rochow, W. F. 1975. Barley yellow dwarf virus. No. 143. Descriptions of plant viruses. Commonw. Mycol. Inst./Assoc. Appl. Biol. Kew, Surrey, England. 4 pp.
11. Wallin, J. R., Peters, D., and Johnson, L. C. 1967. Low-level jet winds, early cereal aphid and barley yellow dwarf detection in Iowa. Plant Dis. Rep. 51:527-530.
12. Weerapat, P., Sechler, D. T., and Poehlman, J. M. 1972. Host study and symptom expression of barley yellow dwarf virus in tall fescue (*Festuca arundinacea*). Plant Dis. Rep. 56:167-168.