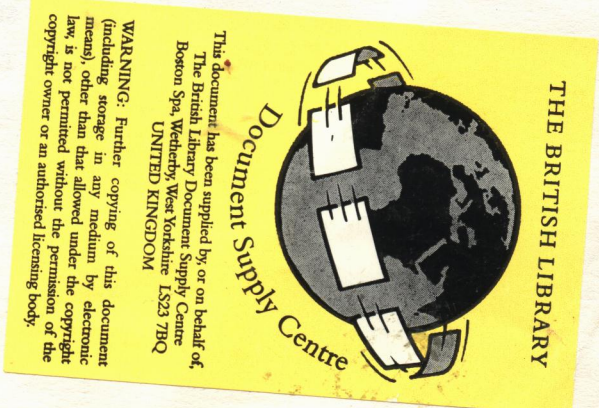

SOUTHWESTERN ENTOMOLOGIST
(USPS 324050)

Published by the

SOUTHWESTERN ENTOMOLOGICAL SOCIETY

Manuscripts for publication may be sent to the Editor, *Southwestern Entomologist*, Department of Entomology, Texas A&M University, College Station, TX 77843 or to any member of the Editorial Committee. Authors should refer to the "Instructions for Preparation of Manuscripts" which appears periodically in the *Southwestern Entomologist*. Articles are published in English and Spanish. Subscriptions, notice of change of address, and orders for back numbers should be sent to the Secretary-Treasurer. Checks and money orders should be made payable to the Southwestern Entomological Society.

The *Southwestern Entomologist* (ISSN 0147-1724) is published quarterly in March, June, September, and December by the Southwestern Entomological Society, 17360 Coit Road, Dallas, TX 75252-6599. Subscriptions are $10.00 and $20.00 per year for individuals and institutions, respectively. Second-class postage paid at Dallas, TX and additional mailing offices. POSTMASTER: Send address changes to Southwestern Entomologist, 17360 Coit Road, Dallas, TX 75252-6599.

SOUTHWESTERN ENTOMOLOGICAL SOCIETY

President: C. R. Ward, New
President-Elect: P. D. Lingre
Secretary-Treasurer: A. P. K
Member of Executive Commit

The objective of the Southwes
in the southwestern United St
free discussion among all ento
the dissemination of entomol
Southwestern Entomologist.

Membership is open to all pe
year, of which $9.00 goes to individual subscription to the Southwestern Entomologist.
Applications for membership can be obtained from the Secretary-Treasurer.

VECTOR RELATIONSHIPS OF FOUR BARLEY YELLOW DWARF VIRUS MEXICAN ISOLATES AND FOUR SPECIES OF CEREAL APHIDS[1] FOUND COMMONLY IN THE VALLEY OF MEXICO.

R. Ranieri[2], B. van Os[3], R. M. Lister[4]

Wheat Program, International Maize and Wheat Improvement Center (CIMMYT), Apdo. Postal 6-641, 06600 Mexico D.F., Mexico

ABSTRACT

Rhopalosiphum padi (L.), *Metopolophium dirhodum* (Walker), *Sitobion avenae* (Fabricius), and *Rhopalosiphum maidis* (Fitch) were compared as vectors of four Mexican barley yellow dwarf viruses, Mex-PAV, Mex-MAV, Mex-RPV and Mex-RMV, serotyped as PAV, MAV, RPV and RMV serotypes, respectively. Aphids were allowed a 5-day acquisition feed on infected "Centinela" barley plants, then transferred singly to each of about 250 plants for each aphid species, for a 5-day test feed. Infections among plants on which aphids survived the test feed (i.e., 100-145 plants for each aphid species) were assessed by double antibody sandwich, enzyme-linked immunosorbent assay. Mex-MAV was transmitted best by *M. dirhodum* (61% transmission) and *S. avenae* (37%); Mex-PAV by *R. padi* (54%), *M. dirhodum* (21%), and *S. avenae* (10%); Mex-RMV by *R. maidis* (39%) and *R. padi* (2%). Mex-RPV was transmitted only by *R. padi* and with very low efficiency (5%).

INTRODUCTION

The barley yellow dwarf viruses (BYDVs) were originally differentiated as five biotypes (RPV, RMV, MAV, SGV, and PAV) by their aphid transmissibility (Rochow 1970). Isolates of each biotype, designated on the basis of vector specificity and their origin in New York state (Rochow 1984) are NY-RPV, transmitted specifically by *Rhopalosiphum padi* (L); NY-RMV, transmitted specifically by *R. maidis* (Fitch); NY-MAV, transmitted specifically by *Sitobion avenae* (Fabricius); NY-SGV, transmitted specifically by *Schizaphis graminum* (Rondani); and NY-PAV, transmitted nonspecifically by *R. padi* and *S. avenae* (Rochow 1969, 1970; Gildow 1990). Subsequent investigations of serological relationships showed a parallel separation into serotypes (Rochow and Carmichael 1979, Waterhouse et al. 1988) although it is increasingly clear that vector specificity need not correspond to serotype groupings among isolates. For example, an Australian MAV isolate is efficiently transmitted by *R. padi* (Lister and Sward 1987), a Californian RPV by *S. avenae* and *S. graminum* (Creamer and Falk 1989) and RMVs from Idaho and Montana by *R. padi* (Halbert et al. 1992, Brumfield et al. 1992). However, because serotype is more readily determined than vector specificity, serotyping is now widely used in surveys and assessments of the occurrence of BYDVs, but information relating serotypes to vector transmissibility is important in epidemiological studies.

Diseases probably due to BYDVs have occurred in Mexico for more than 30 years (Bruehl 1961, Navarro 1984), and Gilchrist (1986) showed *R. padi*, *R. maidis*, *S. avenae*

---

1 Homoptera: Aphididae

2 Present address: Botany and Plant Pathology Department, Purdue University, W. Lafayette, IN 47907, USA.

3 Present address: Instituut Voor Plantenveredeling, Wageningen Agricultural University, P.O. Box 386 6700 AJ Wageningen. The Netherlands.

4 Botany and Plant Pathology Department, Purdue University, W. Lafayette, IN 47907, USA.

and *Metopolophium dirhodum* (Walker) were vectors. However, little is known about vectors of Mexican BYDVs. Here, we present data for four BYDVs that occurred commonly in recent epidemiological studies carried out in the Valley of Mexico (Mezzalama and Burnett 1990a, Ranieri et al. 1993b). An abstract of preliminary results of this work has been published elsewhere (Van Os et al. 1992).

MATERIALS AND METHODS

Experiments were conducted at the El Batán station of CIMMYT (19 31'N, 98 50'W, 2249 m above sea level), in a greenhouse at 17-21°C, with a natural daylight photoperiod of 11-12 hours. *R. padi*, *R. maidis*, *S. avenae*, and *M. dirhodum* were tested as vectors of four Mexican BYDVs: Mex-PAV, Mex-MAV, Mex-RPV and Mex-RMV, identified as PAV, MAV, RPV and RMV serotypes, respectively, by double antibody sandwich, enzyme-linked immunosorbent assay (DAS-ELISA) with polyclonal antibodies prepared against the isolates P-PAV, MAV-PS1, NY-RPV, and NY-RMV (Fargette et al. 1982, Lister et al. 1985, Webby and Lister 1992). Cultures of the four viruses were established in seedlings of "Centinela" barley grown in 18-cm diameter plastic pots of greenhouse soil (soil:peat:sand; 2:1:1), enclosed in clear plastic tubes (38 cm x 10 cm) covered with fine mesh nylon. Seedlings were inoculated at growth stage 10 (Tottman and Makepeace 1979), i.e. at about 10-days old, with ten viruliferous aphids each. *R. maidis* was used as the vector for Mex-RMV, *M. dirhodum* for Mex-MAV, and *R. padi* for both Mex-PAV and Mex-RPV. Aphids were killed and removed by hand after a 2-day inoculation feed, so that the plants could be used within 7-10 days as sources of virus for acquisition by the aphids tested as vectors.

The aphids tested (apterous nymphs and adults) were allowed a 5-day acquisition feed before being transferred singly to individual test plants for a 5-day inoculation feed. Single aphids were used to give an accurate estimate of the number of viruliferous insects (Thompson 1962, Shallow 1985). Test plants were 10-day old "Centinela" barley seedlings grown in plastic flats (30 cm x 23 cm x 8 cm), thinned to 24 seedlings per flat. They were individually enclosed during the test feed period in clear plastic tubes (24 cm x 4 cm) covered with fine mesh nylon. After the 5-day inoculation feed, aphid survival was checked, and plants were sprayed with Pirimor (2% v/v) insecticide. After another 11 days, a peak period for virus production under these conditions (Ranieri et al. 1993a), plants were tested by DAS-ELISA as previously described (Ranieri et al. 1993a, Webby et al. 1993). Extracts for ELISA were prepared using a juice press with smooth rollers (Meku Press, E. Pollahne, Germany) from about 100 mg of leaves of plants on which aphids survived the test feed period. This included 100-150 seedlings in each of 4-8 experiments involving the 16 combinations of vectors and virus serotypes tested. Experiments were conducted during a 4-month period (August-November 1991) and included a total of 1906 seedlings.

RESULTS AND DISCUSSION

Table 1 summarizes the percentage transmission obtained with each vector-isolate combination. Also included, for comparison, are previously published data from other work on the transmission of isolates from other geographical locations that were classified as PAV-, MAV-, RPV- or RMV-BYDV types. *R. padi* was the most efficient vector of Mex-PAV, and while *S. avenae* and *M. dirhodum* were less efficient, both were much more efficient vectors than *R. maidis*. Both *S. avenae* and *M. dirhodum* were very efficient vectors of Mex-MAV, while *R. padi* and *R. maidis* were very poor vectors of this isolate. *R. maidis* was by far the most efficient vector of Mex-RMV; Mex-RMV was not transmitted by *S. avenae* or *M. dirhodum* and was only poorly transmitted by *R. padi*. Mex-RPV was transmitted very inefficiently by its best vector, *R. padi*, very poorly by *M. dirhodum* and not at all by *R. maidis* or *S. avenae*.

Even though most of the previously published data were obtained using more than one aphid per plant, there is reasonable consistency regarding the relative efficiency of the vectors in transmitting isolates of the different virus types, with the notable exceptions of *R. padi* and *S. avenae* as vectors of the RPV and PAV serotypes, respectively. Thus, although *R. padi* was an efficient vector of RPV in Canada, New York state and California, it was quite inefficient in our tests. Similarly, *S. avenae* transmitted PAVs efficiently in tests done

elsewhere, but not in Mexico. Among other comparisons, our results with *M. dirhodum* corresponded almost exactly with those obtained by Gildow and Rochow (1983) with Californian isolates.

TABLE 1. Percent Transmission of Barley Yellow Dwarf Virus Isolates from Mexico, Canada, New York State, California and Montana in Tests with *R. padi, R. maidis, S. avenae and M. dirhodum.*

Vector/isolate	Percent transmission				
	Mexico[a] (present work)	Canada[a] (Paliwal, 1980)	N. York[b] (Rochow, 1969)	California[a] (Gildow & Rochow, 1983)	Montana[c] (Brumfield et al., 1992)
R. padi/PAV	54 (5; 107)	71	100	68	-
R. padi/MAV	1 (6; 106)	0	3	0	-
R. padi/RPV	5 (6; 145)	63	100	84	-
R. padi/RMV	2 (6; 113)	2	11	0	-
R. maidis/PAV	1 (4; 108)	0	3	-	0
R. maidis/MAV	3 (5; 113)	0	0	-	0
R. maidis/RPV	0 (4; 100)	0	0	-	0
R. maidis/RMV	39 (6; 118)	51	90	-	32-70
S. avenae/PAV	10 (5; 104)	60	79	65	-
S. avenae/MAV	37 (5; 137)	88	100	81	-
S. avenae/RPV	0 (6; 108)	0	0	0	-
S. avenae/RMV	0 (7; 118)	0	6	0	-
M. dirhodum/PAV	21 (5; 124)	-	-	30	-
M. dirhodum/MAV	61 (7; 143)	-	-	58	-
M. dirhodum/RPV	1 (8; 140)	-	-	0	-
M. dirhodum/RMV	0 (6; 120)	-	-	0	-

[a] One aphid/plant. Numbers in brackets for the Mexico results are the numbers of experiments conducted using a particular vector/virus combination and the total numbers of infections detected with each combination.

[b] Ten aphids/plant.

[c] Twenty aphids/plant.

In studies of the seasonal occurrence of BYDVs in wheat and barley during 1987-1991 at CIMMYT's Atizapan station in the Valley of Mexico (Ranieri et al. 1993b), RPV serotypes were generally much less common than other serotypes. However, in contemporaneous investigations (Mezzalama and Burnett 1990b), *R. padi* was a predominant species among insects captured in suction traps. Our results suggest that one reason for this may be that, in contrast to the situation elsewhere, RPV-Mex is not efficiently transmitted by *R. padi* collected locally, or by any other vector tested.

ACKNOWLEDGMENT

The authors wish to acknowledge financial support provided by the Dipartimento Cooperazione Allo Sviluppo (DCAS) of the Ministry of Foreign Affairs of the Republic of

Italy. Special thanks are given to P. A. Burnett for useful discussion and to J. Segura for his technical assistance.

LITERATURE CITED

Bruehl, G. W. 1961. Barley yellow dwarf, a virus disease of cereals and grasses. Monograph no. 1. American Phytopathological Society.

Brumfield, S. K. Z., Carrol, T. W., and Gray, S. M. 1992. Biological and serological characterization of three Montana RMV-like isolates of barley yellow dwarf virus. Plant Dis. 76:33-39.

Creamer, R., and Falk, B. W. 1989. Characterization of a nonspecifically aphid-transmitted CA-RPV isolate of barley yellow dwarf virus. Phytopathol. 79:942-946.

Fargette, D., R. M. Lister, and E. L. Hood. 1982. Grasses as a reservoir of barley yellow dwarf virus in Indiana. Plant Dis. 66:1041-1045.

Gilchrist, S. L., R. R. Montessoro, and P. A. Burnett. 1986. La toxemia causada por *Diuraphis noxia* (Mordv.) y su importancia como vector de virus en Mexico. Agrociencia. 66:141-153.

Gildow, F. E. 1990. Barley yellow dwarf virus-aphid interactions associated with virus transmission and vector specificity, p. 111-122. *In* P. A. Burnett [ed.] World Perspectives on Barley Yellow Dwarf. CIMMYT, Mexico, D.F., Mexico.

Gildow, F. E., and W. F. Rochow 1983. Barley yellow dwarf in California: Vector competence and luteovirus identification. Plant Dis. 67:140-143.

Halbert, S. E., Connelly, B. J., Lister, R. M., Klein, R. E., and Bishop, G. W. 1992. Vector specificity of barley yellow dwarf virus serotypes and variants in southwestern Idaho. Ann. Appl. Biol. 121:123-132.

Lister, R. M, D. Clement, M. Skaria, and J.A. McFatridge. 1985. Stability of ELISA activity of barley yellow dwarf virus in leaf samples and extracts. Plant Dis. 69:854-857.

Lister, R. M., and R.J. Sward 1988. Anomalies in serological and vector relationships of MAV-like isolates of barley yellow dwarf virus from Australia and the U.S.A. Phytopathol. 78:766-770.

Mezzalama, M., and P. A. Burnett. 1990a. Vector relationships of isolates of barley yellow dwarf virus in Mexico, p. 296-299. *In* P. A. Burnett [ed.] World Perspectives on Barley Yellow Dwarf. CIMMYT, Mexico, D.F., Mexico.

Mezzalama, M., and P. A. Burnett. 1990b. Cereal aphid transmission of barley yellow dwarf virus in the high valleys of Mexico. CIMMYT. Barley Yellow Dwarf Newsletter 3:41-42. Mexico, D.F.

Navarro, M. 1984. Situation reports: Mexico. p. 180. *In* Barley Yellow Dwarf. A Proceedings of the Workshop. CIMMYT, 1984.

Paliwal, Y. C. 1980. Transmission of barley yellow dwarf virus isolates by the cereal root aphid Rhopalosiphum rufiabdominalis. Can. J. of Plant Pathol. 2:90-92.

Ranieri, R., R. M. Lister, and P. A. Burnett 1993a. Relationships between barley yellow dwarf virus titer and symptom expression in barley. Crop Sci. In press.

Ranieri, R., M. Mezzalama, P. A. Burnett, and R. M. Lister. 1993b. The seasonal occurrence of barley yellow dwarf virus serotypes in small grain cereals in the Valley of Mexico. Plant Dis. In press.

Rochow, W. F. 1969. Biological properties of four isolates of barley yellow dwarf virus. Phytopathol. 59: 1580-1589.

Rochow, W.F. 1970. Barley yellow dwarf virus, No. 32. *In* Descriptions of Plant Viruses. Comm. Myc. Inst./ Assoc. Appl. Biol., Kew, Surrey, England.

Rochow, W.F. 1984. Appendix 1, p. 204-205. *In* P.A. Burnett [ed.] Barley Yellow Dwarf. Proc. Workshop, CIMMYT, Mexico D.F. 6-8 Dec., 1983. CIMMYT .

Rochow, W.F., and L. E. Carmichael. 1979. Specificity among barley yellow dwarf viruses in enzyme immunosorbent assays. Virol. 95: 415 - 420.

Shallow, W. H. 1985. Group testing for estimating infection rates and probabilities of disease transmission. Phytopathol. 75:882-889.

Thompson, K. H. 1962. Estimation of the proportion of vectors in a natural population of insects. Biomet. 18:568-578.

Tottman, D.R., and R.J. Makepeace. 1979. An explanation of the decimal code for the growth stages of cereals, with illustrations. Ann. Appl. Biol. 93:221-234.

Van Os, B., R. Ranieri, R. M. Lister, and P. A. Burnett. 1992. Vector specificity of Mexican barley yellow dwarf virus isolates. Phytopathol. 82:1073 .

Waterhouse, P.M., F.E. Gildow, and G.R. Johnstone. 1988. Luteovirus group. No. 339. *In* Descriptions of Plant Viruses. Assoc. Appl. Biol., Wellesbourne, Warwick, UK.

Webby, G.N., and R.M. Lister. 1992. Purification of the NY-RMV and NY-SGV isolates of barley yellow dwarf virus and the production and properties of their antibodies. Plant Dis. 76:1125-1132.

Webby, G.M., R.M. Lister, and P.A. Burnett. 1993. The occurrence of barley yellow dwarf viruses in CIMMYT bread wheat nurseries and associated cereal crops during 1988-1990. Ann. Appl. Biol. In press.