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Situation Review of Barley Yellow Dwarf Virus in West Asia and North Africa

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Abstract

*Symptoms of barley yellow dwarf (BYD) have been observed on cereals in nearly all countries of West Asia and North Africa. Its incidence, however, has varied during the last 15 years. Observations from field surveys are summarized. Since symptoms of barley yellow dwarf virus (BYDV) are of low diagnostic value, especially in wheat (*Triticum aestivum *L.), more precise qualitative and quantitative detection was derived by vector transmission and serology. In 1985 and 1986, preliminary surveys by enzyme-linked immunosorbent assay (ELISA) indicated that BYDV incidence in the regions surveyed in Syria, Morocco, and Tunisia was around 7, 22, and 24%, respectively. By vector transmission PAV-, RPV-, and RMV-like isolates of BYDV were identified in Morocco and the PAV-like isolate in Syria. By serology PAV-like isolates were identified in Ethiopia, Lebanon, Morocco, Syria, and Tunisia, and MAV-like isolates were identified from Morocco and Tunisia. The PAV-like type was the most common in all countries surveyed. Screening for BYDV resistance by natural infection has been carried out in a number of countries of the region during the last few years. Screening for resistance by aphid inoculation was initiated in Syria in 1986 at the International Center for Agricultural Research in the Dry Areas (ICARDA). Such screening is expected to follow in other countries of the region soon.*

Barley yellow dwarf virus (BYDV) occurs in most countries where wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L.) are grown. BYDV has been reported in a number of countries in West Asia and North Africa (Bremer 1974; El-Yamani 1980; Slykhuis 1962), but until recently no intensive research has been carried out.

General awareness of the economic importance of barley yellow dwarf (BYD) on cereals has encouraged researchers to intensify work in a number of countries of West Asia and North Africa. In addition, because the International Center for Agricultural Research in the Dry Areas (ICARDA) has a world mandate for barley improvement (delegated by the Consultative Group for International Agricultural Research, the CGIAR), its virus program has given high priority to BYDV. Collaboration with a number of national programs was initiated in 1986.

This paper reviews work done on BYDV in the ICARDA region and may be regarded as the first region-wide summary of information on the occurrence/incidence of BYDV, common vectors, strain identification, possible wild hosts, and selection for BYDV resistance.

Field Surveys

BYDV incidence was reported to differ among locations in each country and among countries of the region. Field observations revealed that BYDV incidence was low (0 to 5%) in Algeria, Egypt, Jordan, Lebanon, Libya, Syria, and Turkey, but was higher (10 to 30%) in Tunisia and Morocco (Abdel-Hak 1984; Bremer 1974; El-Yamani 1980; Kinaci and Yakar 1984; Mamluk and van Leur 1984; and observations of present authors).

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In Algeria, BYDV was observed annually at low incidence in a number of locations such as Guelma, Constantine, and Annaba. At Sidi Bel Abbas it was first observed in 1982. BYDV symptoms were found on the barley cultivars Saida and Tichdrett.

In Egypt, BYDV was first reported in 1962 (Slykhuis 1962) to be scattered in the delta area near Cairo. Slykhuis also reported the virus to infect barley in Jordan (Jarash area).

In Libya, BYD symptoms have been observed on cereals at a number of locations since 1970. Its incidence seems to be higher in irrigated than in rainfed regions. During the 1984/1985 growing season, higher BYD incidence than previous years was observed and yield losses due to the disease were recorded.

In Lebanon and Syria, BYDV incidence observed over the last few years has been low. Recent serological tests indicated that BYDV incidence in Syria varied between 2.5 and 22%, with an average of 7.1% (Table 1). However, the fields surveyed cover only a very small part of the cereal growing areas of that country.

BYDV has been reported in cereal crops in Tunisia and Morocco (El-Yamani 1980) for the last 15 to 20 years. Incidence during the 1985/1986 growing season averaged 21.8% in Morocco and 24.5% in Tunisia (Table 1). Such high incidences suggest that BYDV deserves further attention in these two countries.

The only loss assessment in the region comes from Morocco. During the 1981/1982 growing season, an experimental assessment on crop loss was conducted at the Sidi El-Aydi Station (Chaouia). A local bread wheat variety (Nesma 149) was inoculated with a PAV-like isolate at two different stages of Feekes' scale (Stages 1-2 and 5-6). Losses of 44 and 30% resulted from the early and late inoculations, respectively. These data suggest BYD is a limiting factor in cereal production in the region. More work on assessment of potential losses induced by BYD in the cereal cultivars currently used in the region needs to be carried out.

Aphid Transmission and Strain Identification

The BYDV aphid vectors *Rhopalosiphum padi* (L.), *R. maidis* (Fitch), *Sitobion avenae* (Fabricius) and *Schizaphis graminum* (Rondani) were reported on cereals and wild grasses in all countries of West Asia and North Africa (Elnagar et el. 1980; El-Yamani 1980; Slykhuis 1962). Recently we observed *Metopolophium dirhodum* (Walker) on cereals in Syria. Based on vector specificity, PAV-, RMV- and RPV-like isolates of BYDV were identified in Morocco and PAV-like isolates in Syria. The aphid-nonspecific PAV-like isolate of BYDV was the most prevalent.

A study on transmission efficiency of three different PAV-like isolates from Syria revealed *R. padi* to be the most efficient vector, followed by *S. avenae*

Table 1. Incidence of BYDV in randomly collected leaf samples from cereal fields in Morocco, Syria, and Tunisia during the 1985/1986 growing season. Results were based on group testing of leaves by ELISA

Country	Number of fields surveyed	Number of leaves tested[a]	% of BYDV incidence Average	Range
Morocco	14	1590	21.8	1.4-50
Syria	10	4160	7.1	2.5-22
Tunisia	11	1375	24.5	2.2-100

[a] Samples were tested in groups of 5 leaves.

and *S. graminum*. However, transmission efficiency of these three isolates by *R. maidis* was high (30%) (Table 2). *R. maidis* was reported to transmit PAV-like isolates at an extremely low rate (2.4%) (Rochow 1982). *R. maidis* may therefore be important in the ecology of the virus in the region, especially in irrigated areas where maize (*Zea mays* L.) is grown during summer. In such areas, *R. maidis* is likely to transmit PAV-like isolates from cereals to maize in late spring and back to cereals during early fall.

Serology permits greater differentiation of BYDV types or strains than does differential transmission by aphids. In Syria, at least two serologically different PAV-like types were identified on the basis of reactivity with two BYDV antisera (Table 3). In addition, a BYDV isolate from Morocco, which reacted with an MAV monoclonal antiserum (MAC-M2) (L. Torrance, MAFF, Harpenden, England), did not react with an MAV polyclonal antiserum (Inotech F), which is unusual. Another group of BYDV isolates from Syria that reacted with the MAV polyclonal antiserum (Inotech F) did not react with the MAV or PAV monoclonals prepared against British BYDV isolates, which is also unusual.

Such variability among BYDV isolates has been recently reported elsewhere (Johnstone and Guy 1986). A BYDV isolate from Japan reacted strongly with a PAV-New York isolate antiserum in ELISA but not with an antiserum against a PAV isolate from Tasmania (0A6), even though PAV-NY and 0A6 are known to be serologically similar. Another case is the RMV-like isolate identified in Montana on the basis of vector specificity that did not react with the RMV-New York antiserum (Yount and Carroll 1983). The presence of more BYDV types than the five defined earlier (Rochow et al. 1987) increases the possibility of having mixed infections in field isolates, a problem which needs further work to clarify and resolve.

Alternate Hosts

Wild grasses, which act as the main hosts for BYDV and its vectors, play an important role in the ecology of BYDV (Coon 1959; Paliwal 1982). Little work has been conducted in the region to identify such natural sources of inoculum. In Morocco, using artificial inoculation, the following species were found susceptible to BYDV and thus may be potential reservoirs of the virus: *Cynodon dactylon* (L.) Pers., *Dactylis glomerata* L., and *Lolium italicum* A.

Table 2. Efficiency of transmission of three PAV-like isolates of barley yellow dwarf virus (BYDV) from Syria by four aphid vectors

Isolate	Vector	Ratio of number of plants infected to number of plants inoculated	% BYDV infection
Isolate 1	*R. padi*	51/69	73.9
	S. graminum	14/32	43.7
	S. avenae	23/53	43.3
	R. maidis	9/40	22.5
Isolate 2	*R. padi*	31/40	77.5
	S. graminum	15/44	34.0
	S. avenae	17/41	41.5
	R. maidis	13/43	30.2
Isolate 3	*R. padi*	31/47	66.0
	S. graminum	9/9	100.0
	S. avenae	33/44	75.0
	R. maidis	8/13	61.5

Braun (symptomless carriers); *Bouteloua curtipendula* (Michx.) Torr., *Bromus inermis* Leyss., *B. mollis* L., *Festuca arundinacea* Schreb., *Lolium perenne* L., and *Phleum pratense* L. (hosts with symptoms). In Egypt, the wild plants *Bromus catharticus* Vahl, *Hordeum murinum*, and *Panicum* sp. were found to be natural BYDV hosts (Elnagar et al. 1980). More work is needed on the ecology of BYDV in the region.

In rainfed areas, graminaceous crops and wild grasses that can survive the hot dry summer are scarce and are not likely to significantly contribute to the onset of BYDV epidemics in the fall when cereals are sown. However, in irrigated areas the situation is different. The presence of maize, found susceptible to a PAV-like isolate in Syria and Tunisia, and sorghum (*Sorghum vulgare* Pers.), found susceptible in Tunisia, is likely to increase the inoculation pressure of BYDV with time, as has been reported earlier from eastern Washington (Brown et al. 1984) and South Dakota (Stoner 1977). Both crops are grown as irrigated summer crops in cereal growing areas. The role of such crops in irrigated areas on BYDV spread to winter cereals in the region should be monitored over the coming few years.

Testing for BYDV Resistance

Resistant varieties appear to offer the best practical approach for BYDV control. In most current breeding programs selection is by submission to natural BYDV infection. Since incidence of natural infection is variable (2 to 100%) in the region (Table 1) and inconsistent, the proportion of plants escaping infection may be high. To overcome this problem, lines of barley, bread wheat (*Triticum aestivum* L.), and durum wheat (*Triticum turgidum* L. var. *durum*) were tested in collaboration with Laval University/Agriculture Canada, using aphid inoculation. Few barley and wheat lines seem to have good resistance to BYDV. During the 1985/1986 growing season, screening for BYDV resistance using artificial inoculation with aphids started at the ICARDA station near Aleppo, Syria. Breeding material tested there is also tested in Canada. Some of the breeding lines expressed BYDV resistance in both locations. More screening work under uniform and well-defined infection pressure is expected to be carried out in a number of countries in the region during the coming few years.

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Table 3. Three PAV-like isolates from Tunisia and Syria with different binding characteristics when tested by direct and indirect ELISA

Sample Code	Country	Host	Sample A405/Healthy A405: Direct ELISA (F polyclonal)	Sample A405/Healthy A405: Indirect ELISA (MC 32-39)[a]
SW 27-86	Syria	Wheat	22.7	0.7
TO 3-85	Tunisia	Oats	6.5	3.2
SW 9-85	Syria	Wheat	0.6	59.2

[a] In indirect ELISA, samples were added to the wells directly without IgG coating. PAV monoclonal antiserum used was provided by Dr. S. Wyatt, WSU, Pullman, Wash., USA.

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