Status of Barley Yellow Dwarf and Cereal Yellow Dwarf Viruses Infecting Barley in Ethiopia

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Abstract

A survey for *Barley Yellow Dwarf Luteoviruses* (BYDVs) and *Cereal Yellow Dwarf Polerovirus* (CYDV) was carried out from 1997/98 – 2000/2001 main and 2001 short rainy seasons in barley growing areas of central, north, and west Ethiopia. Barley fields were inspected randomly at 5 km intervals and data related to altitude, growth stage, severity and incidence was recorded from each field. Tissue blot immunoassay was used to test samples against the BYDV and CYDV isolates. During the 1997/98 main rainy season, BYDVs and CYDV were prevalent and identified from 72% and 69% of the fields studied in Arsi and west Shewa zones, respectively. All isolates, singly or in mixed infection, were detected, with BYDV-PAV being the most and CYDV-RPV the least distributed. Similarly, all BYDVs and CYDV in Amhara, and only BYDV-PAV in Tigray regional states were identified in north Ethiopia during the 1998/99 and 1999/2000 main rainy seasons. In the Oromiya regional state in west Ethiopia, BYDV-PAV was detected rarely during the main rainy season of 2000. On the contrary, high BYDV-PAV prevalence and incidence was recorded in west Shewa zone, where it was detected in 93% of the locations and 74% plants tested. Disease severity score of 5 – 7 was recorded in 78% fields observed. BYDV-PAV was detected at low level in areas surveyed during the short rainy season of 2001.

Introduction

Barley (*Hordeum vulgare* L.) is the fourth most important cereal crop, both in area and production, in Ethiopia. The highlands of west and north Shewa, Arsi and Bale zones in the Oromiya regional state; Gonder, Gojam, Wello and north Shewa in the Amhara regional state; and south zone of the Tigray regional state are among the major barley growing areas in the country. The crop also grows in some areas of west, east and south Ethiopia. About 1.12 million tones of barley grains are produced from nearly 1.06 million ha with an average grain yield of 1ton/ha during the 1995/1996 cropping season (Central Statistical Authority 1998).

Barley yellow dwarf (BYD) is an economically damaging and the most widespread disease of cereals worldwide (Burnett 1984). The disease is known to cause a significant yield loss and severely infected crops often produce no grain. The disease is caused by a group of *luteoviruses* known collectively as barley yellow dwarf virus (BYDV). Based on the principal aphid species transmitting different isolates of BYDV, five strains were found in New York State, USA. The five BYDV isolates (PAV, MAV, RPV, RMV and SGV) characterized and designated by Rochow (1970) have been split into two groups according to their serological relationships.

More recently, the International Committee on Taxonomy of Viruses (ICTV) accepted the five barley yellow dwarf virus strains as distinct species in the family *Luteoviridae* (Van Regenmorted et al. 2000). The species BYDV-PAV and BYDV-MAV were placed in the genus *Luteovirus,* and BYDV-RPV were renamed as *Cereal yellow dwarf virus* (CYDV-RPV) and placed in the genus *Polerovirus*. The other two species, BYDV-RMV and BYDV-SGV are not assigned to any genus yet. The recent classification by ICTV and that of Rochow (1970) were used in this paper.

In Ethiopia, virus diseases of barley and wheat based on symptoms produced were first reported by Stewart & Dagnachew (1967). The first survey for BYDV, based on enzyme-linked immunosorbent assay (ELISA), was made in 1984 in Shewa and Arsi administrative regions, where PAV- and MAV-like isolates from wheat and barley plants were detected at Bekoji, Herero and Goffer state farms (Agranovsky 1986). The known aphid vectors of BYDV, namely *Rhopalosiphum padi, R. maidis, Sitobion avenae and Schizaphis graminium*, and other aphid species infesting cereals were recorded in Ethiopia (Crowe & Kemal 1983). Most of these aphid species are known as vectors of BYDV in other parts of the world (Jedlinski 1981). Subsequent studies conducted for *BYD luteoviruses* from 1985 to 1988 in central and southeast Ethiopia have showed the presence of BYDV-PAV and -MAV-like isolates in barley and PAV, MAV, RPV, RMV and SGV in wheat plants collected from Arsi, Shewa and Bale administrative regions (Agranovsky 1986, Abdulrazak et al. 1992, Dereje et al. 1993). During 1994 main rainy season, severe symptoms of the disease were observed in barley fields of west Shewa zone where BYDV was detected in 19 (76%) of the 25 locations surveyed and high disease incidence (40%) was recorded in some locations (Berhanu et al. 1995). In 1995 during main and in 1996 during short rainy season an extensive survey was carried out in the major barley growing areas of Arsi and Shewa administrative regions to determine the occurrence and relative distribution of BYDVs. The survey confirmed the occurrence and wide distribution of all the five known BYDV strains in both regions and seasons. In all studies cited above, the PAV type of BYDV persistently predominated in the Ethiopian barley growing areas (Agranovsky 1986, Abdulrazak et al. 1992, Berhanu et al. 2001). From the past surveys, it was concluded that BYD is becoming increasingly important for barley growing areas and regular monitoring of the disease was suggested, including areas not surveyed. This paper, therefore, reports results of a comprehensive survey conducted in the major barley growing areas of Ethiopia from 1997 to 2001.

Materials and Methods

Field inspections and sample collections

Field surveys were conducted in selected barley growing areas of Ethiopia during the 1997/98 - 2000/2001 main rainy seasons. The area includes central (Shewa and Arsi zones), northern (Gonder, Gojam, Wello and Southern Tigray zones) and western (Jima, Illubabor and east Wellega Zones) regions. In the short rainy season of 2001, barley growing areas of central (Shewa and Arsi) and west (East Wellega Zone) Ethiopia were surveyed (Fig. 1).

During the main rainy season of 1997/98, 92 fields were sampled in six barley growing districts of Arsi and West Shewa zones. In the main seasons of 1998/99 and 1999/2000, surveys for BYDVs and CYDV were extended to the northern part of the country, namely, Gojam, Gonder, Wello zones (Amhara Region) and southern zone of Tigray regional state. In this region, 72 barley fields in 30 districts were assessed. In the main rainy season of 2000/2001, 20 major barley growing districts of west Shewa, Jima, Illubabor and East Wellega Zone of the Oromiya regional state were surveyed. About 1600 barley samples were collected from 64 fields and tested for BYDV-PAV species. In Jima, Illubabor and East Wellega areas of west Oromiya regional state barley fields were surveyed during early December 2000. A total of about 5700 barley samples were collected from 228 fields of 56 districts in Arsi, West Shewa, Wello, Gojam, Gonder, Tigray, Jima, Illubabor and East Wellega zones during the main rainy seasons of 1997/98 - 2000/2001(Table 1).

Fig 1. Map showing BYDV survey areas and routs in Ethiopia

During the short rainy season of 2001, the survey covered the highlands of North Shewa, Arsi, West Shewa and East Wellega zones. Representative fields were sampled from 25 districts, and a total of 2684 plants from 109 fields were collected (Table 2). In this season, barley fields were visited in two periods depending on the crop growth pattern of respective areas in Shewa, Arsi and East Wellega. During the first period, the survey covered 2 districts of East Wellega (late January 2001) and 2 districts of West Shewa (late February 2001). Samples from two short rainy season barley growing areas of West Shewa, Dendi and Ambo districts, including seven varieties of barley, wheat and oat plants grown under irrigation at the Plant Protection Research Center (PPRC) were tested for BYDV-PAV (Table 2). In east Wellega, two short rainy season barley growing districts, Jima-Arjo and Leka-Dulecha, were inspected between altitudes of 2250–2500masl. 475 samples were collected from 19 representative localities. During the second period, barley fields in the 3 zones of the Oromiya regional state (Nnorth Shewa, Arsi and West Shewa), and North Shewa Zone of the Amhara regional state were inspected in mid June, 2001. In Arsi, inspection for BYDV-PAV was conducted in 10 locations of two accessible districts, 7 in Tena and 3 in Hetosa districts. Four districts of West Shewa Zone, three along the main road from Addis to Ambo, and one along the road from Holetta to Mugar, were surveyed for BYDV-PAV in mid June 2001. 250 barley samples from 10 localities in the study districts were collected and tested by TBIA against BYDV-PAV.

During barley field inspection, data related to crop variables such as growth stage, variety, disease symptoms, aphid infestation, BYDV severity as well as altitude of each locations were recorded. The survey was conducted when most of the barley fields were likely at booting stage (41-49 Zadoks scale) (Zadoks et al. 1974), the stage at which the disease symptoms were most conspicuous (Agranovsky 1986). Barley fields were surveyed at 5 km intervals by walking along the diagonals of each field and collecting 25 plants at random.

Sample analyses

Stems of collected plants were cut using new razor blades and blotted on nitrocellulose membranes (NCM) for serodiagnosis against BYDVs and CYDV. Samples were tested by the tissue blot immunoassay (TBIA). A 1:1000 dilution of the BYDV and CYDV antisera were used as the primary antibodies and the TBIA procedure described by Makkouk & Comeau (1994) was followed. Samples collected from 1997/98–1999/2000 main seasons were tested against the five isolates at ICARDA Virology Laboratory using polyclonal antibodies provided by R Lister, Purdue University, USA. Samples collected during 2000/2001 main and 2001 short rainy seasons were tested only for BYDV-PAV at Plant Protection Research Center (PPRC) Virology Laboratory using BYDV-PAV antiserum provided by KM Makkouk, ICARDA, Syria, and goat antirabbit-alkaline phosphatase conjugate and enzyme substrates obtained from Sigma Chemical Company. In these seasons, samples were not tested for other four isolates due to lack of antisera. Reading of the processed membranes was done using a stereomicroscope at low (10x) magnification. Blots were considered positive or negative based on the presence or absence of purplish stain formed in the phloem tissue after enzymatic hydrolysis of nitroblue tetrazolium (NBT) substrates.

Results

1997/98 main rainy season

In Arsi Zone, the distribution of BYDVs and CYDV in the four districts surveyed are presented in Table 1. In 1997/98 cropping season, BYDV was identified from barley samples collected between altitudes of 2350 masl (in Asassa district) and 2870 masl (Bekoji district). Severe symptoms typical of BYD described for barley such as yellowing and stunting were commonly observed in most areas sampled in Kofole district between altitudes of 2520 and 2610 masl. BYDVs and CYDV were detected in 46 out of 64 (72%) fields assessed in this zone, either in single or mixed infections, and in 209 out of 1600 samples tested (13%). Among the four districts, high incidence of diseases was recorded in Asassa, Kofole and Tiyo, in order of importance, and least in Bekoji district. Results of TBIA demonstrated that all the five species (BYDV-PAV, -MAV, -RMV, -SGV and CYDV-RPV) were detected in samples collected from Asassa, Kofole and Tiyo districts of Arsi Zone. However, only three species (BYDV-MAV, CYDV-RPV and BYDV-SGV) were identified in samples collected from Bekoji district. BYDV-PAV was the most frequently detected virus in Arsi Zone (3.6% of the samples), followed by BYDV-RMV (3.5%), BYDV-MAV (3%), BYDV-SGV (2%) and CYDV-RPV (1%). Mixed infections of various combinations were recorded in all districts except Bekoji. In Arsi, out of 64 fields inspected, 20 were planted to malt barley, and 44 to food barley (20 local and 24 improved cultivars). In Asassa district, for example, BYDVs and CYDV were identified from 14 food barley varieties of which 9 were local Aruso variety and 5 were improved (Sheneka, HB-42, AHOR83/91). The disease was also identified from 2 fields planted to an improved malt barley variety 'Beka'. In the two districts of West Shewa Zone 39%, 32%, 21% and 7% of barley fields were at booting [Zadoks growth stage (GS) 49], milky (GS 71), flowering (GS 65) and heading (GS 83), respectively, at the time of survey. The altitudes of surveyed areas were between 2400 masl in Tikur Inchini district and 2525 masl in Shenen district. In Tikur Inchini, BYDV-PAV was the most common and identified from 5% of the samples tested, followed by BYDV-SGV (5%), -MAV (4%), -RMV (3%), and CYDV-RPV (2%). On the other hand, BYDV-MAV was the most widely distributed (4%), followed by BYDV-PAV and -SGV (3% each), CYDV-RPV (2%) and RMV (0.3%) in Shenen district. Overall, in west Shewa, the BYDV-PAV, -MAV and –SGV species were nearly equally distributed (4%), followed by CYDV-RPV and BYDV-RMV (2% each).

1998/99 and 1999/2000 main rainy seasons

The seasons in the surveyed areas were characterized by heavy precipitation. Disease symptoms, aphid infestation, BYDVs, and CYDV-RPV were rare. Most barley fields in these regions were sown to local varieties.

In Gojam, as shown in table 1, PAV, RPV & SGV species were not detected in any of the samples tested. However, results of TBIA indicated that two virus species, MAV and RMV, were detected in three of the 13 (23.1%) fields surveyed. MAV was identified from only two samples in one location, and RMV was detected in 10 samples in two locations. The three species (BYDV-PAV, -MAV and -RMV) were detected in 27% of the fields surveyed in Gonder, where PAV was identified at three locations in six samples (0.9%), RMV at five locations in 10 samples (1.5%), and MAV was detected only in one sample in one location. In Wello, BYDVs and CYDV were identified from seven samples collected from three locations. PAV was detected in samples from Dilba area in Guba Lafto district (North Wello) at an altitude of 3200 masl in two of the 500 samples tested. The other viruses detected in this zone include MAV and RPV, each from two samples at an altitude of 2500 and 2300 masl, respectively. SGV was identified from only one sample in Dilba area. Mixed infection of two types (PAV and SGV) was recorded in Dilba area of Guba Lafto district in north Wello (Table 1). In the southern Tigray regional state, however, only PAV was detected in one of the samples collected from Maychew area.

2000/2001 main rainy season

In west Shewa, the surveyed areas were above 2400 m. Most of the barley fields assessed showed typical symptoms of BYD with the highest severity score of 9 (1-9 scale) in some fields of Goban area in Chelia district. BYDV-PAV was detected in 25 out of 27 locations (93%) (Table 1), including neighboring Wayu district in East Wellega, and in 500 out of 675 (74%) plants tested. BYD severity score range was 5-9 (1-9 scale) in 21 of the 27 locations sampled. Of the 8 districts, assessed, high disease incidence was recorded in Tikur Inchini, Nono, Chitu, Wayu and Chelia (Table 1).

In West Ethiopia (Jima, Illubabor and East Wellega areas of West Oromiya regional state) barley fields at the time of sampling were at flowering (GS 61) (40 %), heading (GS 85) (20 %) and booting (GS 47) (40%) stages. Typical BYD symptoms were observed in a few locations visited such as in Kalita area of Sokoru district in Jima zone at an altitude of 1900 masl. BYDV-PAV was identified in 14% locations, and from 6 out of 925 (0.65%) samples tested (Table 1). BYDV was detected at altitudes between 1900 and 2400 m.

2001 short rainy season

In this season, nearly all barley fields were sown to local varieties that grow under low precipitation. Out of 250 barley samples collected from 6 locations in Dendi and 4 locations in Ambo districts, PAV was identified only in 2 (0.8%) samples. Disease incidence and severity were very low (1- 3) in most of the locations studied. Similarly, barley, wheat and oat varieties grown at PPRC for seed multiplication had low incidence and severity of BYDV-PAV except on a local barley variety collected from Meskale Darkina area in Bale and a wheat variety 'opta', which showed high (7) to medium (5) level of infection. In East Wellega, BYDV-PAV was recovered from only one sample in Jima-Arjo and two samples in Leka-Dulecha districts.

As shown in Table 2, BYDV-PAV was not detected in any of the 625 samples collected from 25 localities in North Shewa Zone of the Oromiya Regional State. In Arsi, BYDV was identified in nine (5%) out of 175 plants sampled in Tena district, and was not detected in any of the 100 samples collected from Hetosa district (Table 2). In four districts of West Shewa Zone, results showed that BYDV-PAV was detected in 4 (5.3%) out of 75 samples collected from three locations in Addis Alem district, in two (2%) out of 100 samples in Dandi district, in two (4%) out of 50 samples in Ambo district and no BYDV was detected in samples collected from Adeaberga district (Table 2). In North Shewa Zone of the Amhara Regional State, BYDV-PAV was detected in 18 out of 700 (2.6%) samples collected from 25 localities in eight districts. Most of the BYDV positive samples were collected from Ankober district representing 12% of the 100 samples tested, followed by Keiyt district (16%), Bosana Werena (1%) and Debre Berehan (0.6%) (Table 2).

Table 1. BYDV and CYDV species detected infecting barley in central and north Ethiopia, during main rainy seasons, 1997/98 - 2000/2001.

Zone / District	No. of fields Surveyed	No. of samples tested	No. of samples tested positive for [a]				
			PAV	MAV	RPV	RMV	SGV
Central region (1997/98)							
Arsi							
Lemu-bilbilo	16	400	0	3(1)	1(1)	0	5(5)
Gedeb	16	400	24(11)	14(7)	12(8)	43(15)	12(5)
Kofale	16	400	20(10)	15(6)	5(4)	8(4)	12(6)
Tiyo	16	400	14(7)	10(6)	2(2)	5(5)	4(3)
Sub total	**64**	**1600**	**58(28)**	**42(20)**	**20(15)**	**56(24)**	**33(19)**
West Shewa							
Tikur Inchini	16	400	21(9)	14(9)	9(7)	13(7)	20(10)
Nono (Shenen)	12	300	8(6)	13(6)	7(4)	1(1)	8(6)
Sub total	**28**	**700**	**29(15)**	**27(15)**	**16(11)**	**14(8)**	**8(16)**
North regions (199899 – 1999/2000)							
Wello							
Dessie Zuria	8	200	–	1(1)	1(1)	–	–
Ambassele	1	25	–	–	–	–	–
Guba lafto	3	75	1(1)	–	–	–	1(1)
Muja	1	25	–	–	–	–	–
Gidan	1	25	–	–	–	–	–
Maket	6	150	–	–	–	–	–
Sub total	**20**	**500**	**1(1)**	–	–	–	**1(1)**
South Tigray							
Ofla	2	50	–	–	–	–	–
Korem	4	100	–	–	–	–	–
Maichew	2	50	1(1)	–	–	–	–
Kuha	1	25	–	–	–	–	–
Ambalage	4	100	–	–	–	–	–
Sub total	**13**	**325**	**1(1)**	–	–	–	–
Gojam							
Dejen	1	25	–	–	–	–	–
Dangila	3	75	–	–	–	–	–
Marawi	3	75	–	–	–	–	–
Behar dar	5	125	–	2(1)	–	10(2)	–
Kosober	1	25	–	–	–	–	–
Sub total	**13**	**325**	– **2(1)**	–	**10(2)**	–	
Gonder							
Behar dar	3	75	–	–	–	1(1)	–
Hamusit	1	25	–	–	–	–	–
Anbasmi	1	25	–	–	–	–	–
Libo Kamkam	1	25	–	–	–	–	–
Teda	5	125	3(1)	1(1)	–	6(2)	–
Tikl Dingai	2	50	–	–	–	1(1)	–
Kola Diba	1	25	1(1)	–	–	–	–
Woreta	1	25	–	–	–	–	–
Farta	3	75	2(1)	–	–	–	–
Gaint	4	100	–	–	–	2(1)	–
K/ Dega Damot	1	25	–	–	–	–	–
Dabat	1	25	–	–	–	–	–
Debark	1	25	–	–	–	–	–
Amba Giorgis	1	25	–	–	–	–	–
Sub total	**26**	**650**	**6(3)**	**1(1)**	**0**	**10(5)**	**0**
Main seasons total (1997/98 – 1999/2000)			**95 (48)**	**72(37)**	**36(26)**	**90(39)**	**42(36)**

[a] *figures in parenthesis indicates number of fields with BYDV positive*

Table 1. Continued

Zone District	No. of fields surveyed	No. of samples tested	No. of fields positive for*	
			BYDV - PAV	BYDV-PAV
2000/2001 main season				
Jima				
Sokoru	1	25	1	1
Sub total	**1**	**25**	**1**	**1**
Illubabor				
Dedessa	2	50	1	1
Gechi	1	25	-	-
Bedele	9	225	-	-
Sub total	**12**	**300**	**1**	**1**
East Wellega				
Jima-Arjo	2	50	-	-
Diga-leka	2	50	-	-
Gudaya Bila	1	25	-	-
Sayo	2	50	-	-
Jima Ganati	3	75	1	1
Shambu	8	200	2	1
Abay choman	4	100	-	-
Kombolicha	2	50	-	-
Sub total	**24**	**600**	**3**	**3**
West Shewa				
Chelia	4	100	88	4
Nono	4	100	96	4
Inchini	2	50	49	2
Chitu	4	100	96	4
Ambo	2	50	19	2
Jeldu	6	150	103	6
Adea berga	4	100	25	4
Wayu	1	25	24	1
Sub total	**27**	**675**	**500**	**27**
1997/98 -2000/2001 Total	228	5700	505	32

* = *Negative/absent*

Table 2. Occurrence of BYDV-PAV species on barley in central and western Ethiopia, during the short rainy season, 2001.

District	Crop	No. of fields Surveyed	No. of samples tested	No. of samples tested positive for BYDV-PAV*	No. of fields positive for BYDV-PAV*
North Shewa (Oromiya)					
Berehealeltu	Barley	4	100	-	-
Kimbibit	Barley	1	25	-	-
Abichu & Ghna	Barley	5	125	-	-
Mukaturi	Barley	4	100	-	-
Degem	Barley	4	100	-	-
Sululta-Mulo	Barley	7	175	-	-
Sub total		**25**	**625**	**-**	**-**
Arsi					
Tana	Barley	7	175	9	3
Hetosa	Barley	3	75	-	-
Sub total		**10**	**250**	**9**	**3**
West Shewa					
Addis Alem	Barley	3	75	4	2
Adeaberga	Barley	1	25	-	-
Dandi	Barley	4	100	2	1
Ambo	Barley	2	50	2	1
Sub total		**10**	**250**	**8**	**4**
North Shewa (Amhara region)					
Hagere Mariam	Barley	2	50	-	-
Chacha	Barley	4	100	-	-
Bosana Warena	Barley	4	100	1	1
D/Sina	Barley	5	125	-	-
D/Berhan	Barley	7	175	1	1
Ensaro & Wayu	Barley	1	25	-	-
Keiyt	Barley	1	25	4	1
Ankober	Barley	4	100	12	3
Sub total		**28**	**700**	**18**	**6**
East Wellega					
Jima-Arjo	Barley	12	300	1	1
Leka-Dulecha	Barley	7	175	2	2
Sub total		**19**	**475**	**3**	**3**
West Shewa					
Dendi	Barley	6	150	2	1
Ambo	Barley	4	100	-	-
PPRC	Barley	4	100	4	1
	Wheat	2	50	2	1
	Oat	1	25	1	1
Sub total		**17**	**425**	**9**	**4**
Total		**109**	**2684**	**47**	**20**

** = Negative/ absent*

Discussion

From the survey, it was evident that all BYDV species were distributed in, and identified from, almost all of the major barley growing areas in the country, particularly in central (Arsi and Shewa) and north (Gojam, Gonder and Wello)

Ethiopia. In an earlier work in Ethiopia, the occurrence of only BYDV-PAV and BYDV-MAV were reported from Arsi, Shewa and Bale Zones in barley, wheat and oats (Agranovsky 1986, Abdulrazak et al. 1992). In subsequent studies conducted in 1988 and 1995 main rainy seasons, and 1996 short rainy season, all BYDVs and CYDV-RPV were identified in wheat samples collected from Bekoji and Kulumsa (Arsi Zone), and in barley samples collected from Shewa and Arsi Zones (Dereje et al. 1993, Berhanu et al. 2001). Until then, no information was available regarding the status of BYDV and CYDV in other barley growing areas in the country, other than Arsi, Shewa and Bale areas. However, this study showed that all BYDVs and CYDV-RPV are prevalent in north Ethiopia, particularly in the Amhara regional state (Gojam, Gonder and Wello areas). In addition, BYDV-PAV was detected in East Wellega, Illubabor, Jima and West Shewa Zones of the Oromiya regional state during the main rainy season of 2000. The disease incidence was very low in surveyed areas of western Ethiopia, but an exceptionally high BYDV-PAV incidence and severity recorded in west Shewa during the main season of 2000 is an indication of BYDV importance, and calls for consideration of appropriate control measures. The low level of BYDV-PAV in west Oromiya (East Wellega, Illubabor and Jima) does not represent the status of other BYDVs and CYDV. If the samples collected from these areas were tested against all BYDVs and CYDV-RPV, the situation might have been different. In general, it can be concluded that, BYDVs and CYDV incidence and distribution was very low in west and north Ethiopia compared to central Ethiopia (Shewa and Arsi). This might be due to (i) extended period of high precipitation during the surveyed seasons in west and north zones, which might have affected the activity and population of aphid vectors, which in turn limits secondary spread of the virus; and (ii) in these areas, as compared to central Ethiopia, farmers do mainly plant local landraces which might have the buffering effect and/or inherent resistance to the disease than the improved ones.

In studies carried out from 1997-1999 main rainy seasons in Arsi, West Shewa and 4 zones of North Ethiopia, the most common viruses detected were BYDV-PAV followed by BYDV-RMV, -MAV, -SGV and CYDV- RPV. BYDV-PAV and BYDV-MAV were reported earlier to be predominant in Ethiopian barley varieties (Abdulrazak et al. 1992, Agranovsky 1986, Berhanu et al. 2001), as it does elsewhere in the world (Burnett 1990). However, it is interesting to note the relatively high occurrence of the BYDV-RMV in Ethiopia during the 1997-1999 main rainy seasons. More recently, Berhanu et al. (2001) reported a relatively wide distribution of BYDV-SGV in Ethiopia during the 1995 main rainy season and 1996 short rainy season, which similar to RMV has a limited distribution elsewhere in the world. Variability in the relative importance of the different BYDVs across and within countries has been reported earlier. In the USA, for example, PAV is considered predominant in winter cereals, followed by MAV and RPV (Gildow 1990). However, the incidence of the different viruses differs from region to region and from year to year (Rochow 1979). In Mexico, MAV was reported predominant all over the country (Burnett & Mezzalama 1990). In the UK (Barker 1990) the predominant viruses are BYDV- PAV and -MAV. In Portugal, BYDV-PAV is predominant, but in some years MAV and RPV are also important (Pereira 1990).

During the survey in the short rainy season of 1996, all BYDVs and CYDV-RPV were reported to occur in barley plants tested from the two North Shewa zones of the Amhara and Oromiya regions. In the short rainy season of 2001, BYDV-PAV was not detected from the 625 barley plants collected from 25 locations in North Shewa zone of the Oromiya regional state, and was at low incidence in other areas studied, in spite of large number of samples collected and more locations covered as compared to 1996, where all BYDVs and CYDV, with PAV and SGV the most frequent, occurred in barley plants in north, and four species in West, Shewa zones (Berhanu et al. 2001). Nevertheless, the low level of BYDV-PAV detected during the short rainy season of 2001 does not necessarily mean that the incidence of other BYDVs and CYDV were low or absent as the samples were tested only against BYDV-PAV.

Generally, BYD and CYD are widely distributed in Ethiopia and becoming diseases of economic concern in some localities such as Goban and Inchini areas in West Shewa, and Bekoji, Asassa and Kofole districts in Arsi administrative zone. Hence, for a safe and affordable control of the disease resistant genotypes should be sought from a local germplasm sources to develop BYDV resistant barley varieties through breeding.

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