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THE BARLEY YELLOW DWARF VIRUS RESEARCH PROGRAMME AT CIMMYT

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ABSTRACT

Screening of cereal lines for barley yellow dwarf (BYD) resistance has begun in the CIMMYT wheat programme in Mexico. Currently the screening programme depends on testing cereal lines in small, space-planted plots that are exposed to naturally occuring epidemics of barley yellow dwarf virus (BYDV). Lines that show resistance in Mexico have been distributed to selected sites worldwide. There is a great deal of between-site variation in resistance, but some lines of wheat and barley are resistant at all sites. The number of test sites used has been limited.

KEYWORDS

Resistance, barley yellow dwarf virus, Mexico, CIMMYT, wheat, barley, triticale.

INTRODUCTION

Barley yellow dwarf (BYD), a ubiquitous cereal disease, is known to be caused by at least five related virus isolates of the luteovirus group, members of which cause the yellows diseases. These isolates of barley yellow dwarf virus (BYDV) are grouped according to their vector specificity. The principal vectors of BYDV are the aphids, *Rhopalosiphum padi, R. maidis, Sitobion avenae, Shizaphis graminum,* and *Metopolophium dirhodum.* However, many other aphid species can transmit BYDV. Comprehensive lists of aphid vectors have been published by A' Brook (1981) (23 species), and Jedlinski (1981) (18 species).

The symptoms of BYD vary in crop cultivars. The virus interferes with translocation by partially plugging the phloem. Leaves of affected wheat and oat plants are yellowed or reddened, respectively. Plants are stunted. They show an upright posture of thickened stiff leaves, inhibited root formation, delayed or no heading, and reduced yield. However, generally, the symptoms of BYD in bread wheat, durum wheat, and triticale are not particularly apparent and are often not well recognised even by experienced cereal workers.

BYD could be considered a secondary disease because its presence has been masked by other diseases, viz the rusts. Once resistance has been developed to these diseases, the effects of BYD are apparent.

There is little chance of the virus being eradicated by elimination of the host because the virus has an extremely wide host range among long-lived grasses. Perennial grasses play a role in the epidemiology of BYD (Latch, 1977; Fargett *et al.*, 1982).

BYD has been recorded from most areas of the world. In a workshop coordinated by CIMMYT in 1983 (Burnett, 1984), the distribution of the disease was well documented and the most recent technical information was assembled. As Plumb (1983) states, BYD is truly a global problem.

Losses caused by BYD vary and on an annual basis range from one to three percent but in some years may go as high as 20-30%. Burnett (1984) summarises the data available on yield losses due to BYD.

Until quite recently, the only method for diagnosing BYDV was transmission by aphids to indicator plants and development of typical disease symptoms. Recently, the enzyme-linked immunosorbent assay (ELISA) has been developed. However, in many parts of the world, diagnosis of BYDV still has to be carried out on the basis of symptoms alone.

In some regions, control of BYD can be partially effected by adjusting planting time to avoid the period when aphids are most likely to move into the seedlings of the cereal crops. Occasionally, partial control may be obtained by the judicial use of insecticides for aphid control, thereby limiting the spread of BYDV. In some countries, biological control of aphids has reduced the incidence of BYD. However, none of these methods are completely satisfactory and it is thought that the most effective control is plant resistance.

Germplasm development and distribution are two of the essential tasks of CIMMYT. Host plant resistance to BYD has been demonstrated for barley, initially in California and now in other countries, conditioned by a single resistance gene (Yd_2) transferred from Ethiopian landrace varieties. It was decided that this control method should be pursued in the CIMMYT programme. Similar resistance genes have not yet been identified in other cereals, but testing to date has not been exhaustive.

After the 1980 Barley Yellow Dwarf Workshop sponsored by CIMMYT at its El Batan headquarters in

Mexico, a proposal was prepared for the development of an international BYD research project. The objectives of the project in general are to:

- Conduct epidemilogical studies on BYD, looking in particular at the cropping systems used for wheat (both bread and durum), barley and triticale;
- Identify virus strains;
- Identify the species of aphids that are the vectors of BYD;
- Identify BYD-resistant germplasm by screening cereal collections. Included would be hybridisation of resistant lines and distribution to areas with particular BYD problems. The whole system would cycle with site-specific evaluations taken into account in the hybridisation;
- Evaluate cultivars and elite breeding lines for resistance to BYD, assuring free access to the material for co-operators and others with interest in the programme;
- Determine the genetic basis of BYD resistance;
- Run site-specific evaluations on materials selected for BYD resistance;
- Train researchers in BYD methodology, and
- Set up workshops and ensure information is disseminated through publications.

This project was initiated in 1985 and is funded for three years, but with possible extensions by the Diapartimento Cooperazione Allo Svilluppo (DCAS) of the Republic of Italy.

Initial efforts concentrated on screening germplasm, in particular the advanced lines produced by the breeding programmes of CIMMYT and selected materials from various co-operators. Preliminary work on identifying the aphid vectors of BYD and virus isolates has also been initiated through co-operation with Dr R.M. Lister of Purdue University, Indiana, USA. Funds have been provided allowing CIMMYT to support national BYD research efforts in developing countries where the disease is a problem. CIMMYT aims at developing a network of BYD co-operators in both the developed and developing world and to be a clearing house for both information and germplasm for these co-operators. Germplasm that is found to be resistant in different sites will be freely available to any interested party.

MATERIALS AND METHODS

Since the 1980 BYD workshop, CIMMYT has screened winter and spring material at Toluca because natural epidemics of BYD occur here. BYD observations are taken on the breeders plots in winter because of space limitations. In 1984 and 1985, it was found that Toluca can be used as a spring BYD screening site if the material for testing is sown as spaced plants (15-20 cm apart) later in the growing season (around the middle of June). The spacing of the plants increases the intensity of BYDV infection. In the spring planting, entries are hand seeded in two-row plots of 1 m with five to six seeds per metre. Plots are separated by 1 m and two replicates are planted. We also experimented with single rows of 2 m, but the two-row plots proved to be superior in our environment. Fungicides are applied to prevent the masking of BYD symptoms by other foliar pathogens. Symptoms are scored using the 0-9 scale (Qualset, 1984). Currently, we are concentrating on screening advanced lines of the CIMMYT breeding programme plus materials which have been reported resistant to BYD elsewhere. Nurseries of selected entries which showed resistance at Toluca were distributed to other co-operating countries where BYD is a problem for screening.

RESULTS

Spring bread wheat

The preliminary spring bread wheat nursery for BYD was produced by initial screening in Toluca during the winter cycle of 1981/82. The nursery contained 89 entries that appeared resistant. Two susceptible check varieties were included every 20 entries. This nursery was distributed to six sites, but useable data was obtained from only three sites: Canada, A. Comeau; New Zealand, J.M. McEwan; and USA, C.O. Qualset. The eight lines that appeared to have resistance at all sites were FLN/ACC/ANZA, PRL "S" (2 lines), Jup/Emu "S"//GJO "S" (3 lines), DODO "S", ERA/MN69146//PUM "S". There was variation in resistance at different sites. Many lines that appeared to be resistant at one site were susceptible at another. This accentuates the need for multi-site testing for BYD resistance.

Screening of advanced bread wheat lines began in Toluca in the summer of 1984 and 228 advanced lines were selected from about 700 lines. These selected lines were also screened in Davis, California where BYD notes were taken in May and June of 1985. Of the 228 selected lines in Mexico having some level of resistance to BYD, 102 were selected in Davis. All lines that had average scores of less than five were accepted.

These 228 lines have now been tested for their reaction to BYD in Mexico and the 93 best lines have been selected. Of the lines selected in Mexico, 47 are common with those selected in Davis.

A second bread wheat BYD nursey containing 146 lines has been assembled for distribution to selected sites where BYD is usually present. This nursery is composed of selections from the original BYD nursery plus selections from the 228 advanced lines that showed resistance in Toluca in 1984. Screening has continued at Toluca and in 1985 about 2500 lines were screened and about 300 were advanced for further testing.

Winter wheat

Many nurseries have been screened for their symptomatic resistance to BYD in Toluca (Table 1). These lines and others that look promising will be distributed in a special BYD winter wheat screening nursery in 1986 for testing at various sites. The best lines will be used as parents in Mexico for making winter x spring wheat crosses to transfer BYD resistance to spring wheats.

Table 1. Winter wheat lines that have shown resistance to BYD at Toluca (Scale 0-9).

Line or cultivar	Score 1984/85	1983/84	1981/82	1980/81
NS974/NB69565 711068	4	4	4	4
PYN CI 17717 78ST 621	4	3	3	3
OK 77164 78LA 168	4	4	3	3
SDY	4	3	2	3
NR 72.837	5	3	5	3
F44 72	5	5	3	2
ANZA/SUT//CTK C0810001	3	5	3	
ANZA/SUT//CTK C0810002	4	4		

Durum wheat

The first major screening of advanced lines was carried out in Toluca during the 1984 summer cycle and only 29 lines showed any promise. These have been distributed to selected sites for further testing. Resistance to BYD is not apparent in durums. A wider range of germplasm needs to be screened before durum resistance may be identified.

Spring barley

Barley lines to be included in the initial BYD barley nursery were also selected in Toluca. The first nursery consisted of 169 entries (129 spring and 40 winter barleys) and was distributed in 1982. Useable data was received from three co-operators: Canada, A. Comeau; New Zealand, J.M. McEwan; and Spain, J. Hernando Velasco. Table 2 lists the spring materials that exhibited resistance at all sites. Again, there were many notable reversals which stresses the need for multi-location testing.

Table 2. Lines from the first BYD barley screening nursery that appeared resistant at three sites: Sainte Foy, Quebec; Palmerston North, New Zealand; and Madrid, Spain.

PROMESA
CACO "S"
SUTTER
BEN 4D
CHINO "S"
ASSE/NACKTA//VILLA ROBLEDO/3/PYO
OJL "S" (2 lines)
LIGNEE 640
API-CM67//APM/IB65/3/API/CM67//11266 L2696669 /4/BEN
ORE "S"//API/CM67
ORE "S"//INDIAN DWARF/CM67
API/CM67//AGER
ALAMOS "S"

Table 3. Lines from the second BYD barley screening nursery that appeared resistant at five sites: Tunis, Tunisia; Palmerston North, New Zealand; Montpellier, France; Madrid and Lleida, Spain.

PROMESA
79W41762
NIGRINUDUM
TERAN 75
LIGNEE 640
DUCHICELA
ASSE/NACKTA//VILLA ROBLEDO//PITAYO
GAW125.5 48K FINCHA
P12325/MAGNIF 102//COSSACK
APM/GVA//ASPA ABN/3/F3 BULK HIP
GB 134/APM//CI08971/3/API/11012.2//P7186
CH W12190/3/PYO/CAM//AVT/RM 1508
BREA/CEL//F3 BULK HIP

The second, third, and fourth BYD nurseries have been distributed. The second nursery consisted of 43 barley lines not known to have the Yd_2 gene. The third and fourth nurseries are a mixture of materials with and without Yd_2.

Table 3 lists entries from the second BYD nursery showing resistance in the five sites that provided useful data. Screening will continue at CIMMYT and, as more results become available a nursery consolidating lines with resistance across sites will be distributed.

Winter barley

During the last two winter cycles at Toluca (1983/84 and 1984/84) about 50 barley lines were identified that had BYD scores in both years of five or less. Some of these lines are known to be resistant to BYD in other areas of the world but are not known to contain the Yd_2 gene, e.g. 'Post' a winter barley from Missouri. These lines will be crossed with those known to contain the Yd_2 gene in an effort to combine both types of resistance.

Triticale

Currently, about 170 triticales have been selected that initially showed some level of resistance to BYD in the 1984 summer cycle in Toluca. These are also being tested at various sites. There appears to be good resistance available in triticale but confirmation testing is required.

Wide crosses

The material produced by Dr M. Kazi's programme at CIMMYT has been screened and some lines involving crosses with *Elymus giganteus* showed promise. However, results are preliminary and further testing is required.

DISCUSSION AND CONCLUSION

The winter cycle testing site at Toluca has been successful for bread wheats and barley. Infestation by the aphid *Diuraphis noxia* was so severe in the winter of 1983 that symptoms of BYD were completely masked in all crops. However, it is hoped that by the selective use of insecticides, it will be possible to eliminate this aphid and still obtain BYD symptoms.

El Batan is being tested as a possible winter screening site but again, there are problems with infestations of *D. noxia*. The advantage of this site over Toluca in the winter is that two complete cycles of plant growth could be completed in one year. Toluca is too cold for this to be possible but it would be a big advantage for the BYD programme because the Cd. Obregon site where all the crop programmes are located during the winter cycle of production, is not a particularly good site for BYD selection.

At present, selection for BYD resistance is based on plant symptoms. Studies to relate BYD symptoms to yield losses are planned.

CIMMYT is in a unique position to coordinate germplasm screening and also act as a clearing house for distributing material for further BYD screening.

Screening at different sites is very important because there appears to be much between-site variation in resistance to BYD. Resistance sources from different sites should be inter-crossed and subsequently distributed for further testing. Further testing is required at a greater range of sites before reliable data can be collected. The true strength of the CIMMYT BYD programme depends on feedback from cooperators screening the nurseries.

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