

Review of USAID Project No. 931-1318

Project Title: CONTROL OF BARLEY DISEASES FOR LDC's OF THE WORLD

Contractor: Montana State University

Reviewer: J. M. Poehlman, University of Missouri, Columbia

This review is based on information gained by attendance at the "Barley Diseases and Associated Breeding Methodology Workshop" held in Rabat, Morocco, 20-23 April 1981, and by visiting experimental plots and farmer's barley fields in Morocco, Tunisia, and Egypt.

The longterm objective of the project is to reduce the yield loss in barley caused by major barley diseases. The target area is, principally, North Africa, the Near and Middle East, and Korea. Implementation involves both educational and research efforts. The educational work is being conducted through graduate research assistantships for LDC students at Montana State University; a six-month training program involving laboratory and field study of barley diseases and breeding methodology, also at Montana State University; and barley disease workshops such as the one held in Rabat. Additionally, visits are made by Montana staff to share experiences and information with barley research workers in appropriate LDC countries. The research effort involves the accumulation of basic information on the prevalent barley diseases in the area and their pathogenic forms, identification of sources of genetic resistance to the major barley diseases, and the development of barley populations with multigenic resistance.

Importance of Barley in the Dry Areas

Barley is grown on about 10 million hectares in North Africa and the Near and Middle East, of which about 8.5 million hectares are grown with less than 400 mm of precipitation (Kamel¹). Under these low rainfall conditions wheat is unproductive and barley is the major cereal grain. Most of the subsistence farmers in the low rainfall area are dependent upon the barley crop for food and feed. These farmers do not benefit from projects concerned with wheat or other cereals.

Yield Loss from Disease

Barley diseases were prevalent and causing substantial yield reductions in every experimental nursery and farmer's field visited during this tour in Morocco, Tunisia, and Egypt. The major diseases observed were net blotch, stripe, scald, and barley yellow dwarf virus, but also present were powdery mildew, leaf and stem rust, bacterial leaf spots, and root rots. Although disease losses are difficult to estimate, it would appear, conservatively, that yields could be increased from 25 to

¹ Kamel, Ahmed H. 1981. Barley Diseases in the Dry Areas. Paper presented at Barley Disease Workshop, Rabat.

50%, in many fields, if diseases were controlled by use of resistant varieties, or other means. This project thus has the opportunity of substantially contributing to an increase in food production for subsistence farmers in the dry areas where barley is the major food crop.

Barley Disease Workshop

The barley Disease and Associated Breeding Methodology Workshop was held at Rabat, Morocco, 20-23 of April, 1981. The workshop was jointly sponsored by Montana State University and the International Centers, ICARDIA and CIMMYT. About 25 participants from national programs in North Africa, Near and Middle East, India, Korea, and Southern Europe attended. About an equal number from the sponsoring organizations, the USDA, University of Minnesota, University of California, and USAID participated. The workshop was well organized, presentations were timely and informative, and time schedules were adhered to. The current disease problems of barley in the area were discussed. Overall, it was a professionally conducted meeting for which the sponsors may be commended. Compared to the Barley Workshop held at Amman, Jordan, in 1977, which I also attended as a representative of USAID, participants from the national programs demonstrated by their questions and participation in discussions a greater awareness of the disease problems than in the earlier meeting.

Montana State Graduate Degree and Training Program

The Montana State educational program involves (a) graduate degree and (b) short-term non-degree training programs related to barley disease control and associated breeding methodology. Currently enrolled in the degree program is a Ph.D. candidate from each Tunisia, Morocco, and South Korea, and an M.S. candidate from each Turkey and Syria (ICARDIA). From the U.S.A., one Ph.D. and two M.S. students have completed degrees. The Ph.D. graduate is now employed on the USAID sponsored cereal project in Egypt. Requests are pending approval for a Ph.D. candidate from Tunisia, and M.S. candidate from Nepal and Algeria.

In the short-term training program, in 1979, trainees from each India and Turkey completed a 3-month program and a trainee from Syria completed a 6-month program. In 1980, two trainees from Morocco completed the 3-month program, and one trainee from each South Korea and Turkey completed the 6-month program. CIMMYT, ICARDIA, Tunisia, and possibly Morocco are planning to send trainees in 1981.

Montana State University is particularly well-qualified to conduct degree programs, as well as short term training programs, due to the diversity and expertise of their staff. Their staff has traveled extensively in barley growing areas of North Africa and the Near and Middle East. They are familiar with the barley diseases of the area. They have identified numerous virulence forms of the casual pathogens and sources of resistance. They are utilizing a unique procedure in attempts to develop multigenic resistance to the virulence forms present in the area. Neither CIMMYT nor ICARDIA conduct training programs in barley diseases.

Barley Disease Research

Barley disease research conducted by Montana State University has involved (a) the collection and examination of numerous isolates of the pathogens causing different barley diseases, (b) identification of different virulence strains among the isolates, and (c) identification of sources of resistance to virulence strains of each pathogen. The details of these studies for each pathogen, and for other basic research studies, are presented in the annual reports and in the new project proposal and need not be discussed here. These studies have been thorough and have been professionally conducted. They provide a substantial base of information for the initiation of breeding programs in a large production area where previously little information on barley diseases was available.

Breeding for Disease Resistance

The breeding method being utilized in the project to accumulate genes for resistance is recurrent selection with male-sterility introduced to eliminate emasculation and facilitate crossing. The product of each cycle of crossing is designated a "recurrent selection population" (RSP). Six-row and two-row RSP's are being developed for resistance to scald, net blotch, leaf rust, and bacterial (Xanthomonas) blight. These are in various cycles of selection. It is planned to combine resistances to two or more diseases and to initiate new RSP's for additional diseases. Lists of base varieties used in the RSP's, sources of resistant germplasm, and the current selection cycle are detailed in the new project proposal. The RSP's are grown in LDC countries and selection is made there for resistant plants, which are then harvested and intercrossed in the next cycle. This procedure is followed so that selection may be made for resistance to the virulence strains that may be present at the separate locations.

RSP's were seen at Rabat, Morocco, and LeKef, Tunisia. Seed for RSP's was sent to Egypt but apparently was lost in the mail. I also had the privilege of assisting with the selection of resistant plants at the two locations. Plants within the populations varied in the degree of resistance or susceptibility.

Some discussion comments made during the workshop were (a) critical of the RSP breeding methodology, and (b) concerned whether the best adapted base varieties had been utilized. Because the RSP procedure departs from traditional breeding procedures, some of the criticism may be due to lack of understanding of the method. At Rabat the RSP's were lodged. However, the base varieties were not lodged, so some of the lodging may have been due to location effect rather than to the genetic background of the RSP. The RSP's looked good at the location in Tunisia.

The RSP approach is innovative. Its success cannot be judged until additional cycles are completed and resistant plants isolated and progeny tested. The success of recurrent selection as a procedure for accumulating genes for quantitatively inherited characters is well documented. However, the identification of plants in a RSP population in which two or more major genes are present may be more difficult, unless the genes confer resistance to different virulence strains of the pathogen and these specific virulence strains are present.

Professional Approach of the Montana State Staff

Workshop participants, representing both national programs and the International Centers expressed high regard for the professional approach utilized by the Montana State staff. It is clear that the Montana State staff have accumulated a lot of information about the barley disease problems in the area, that they share this information freely with barley breeders in the LDC's, that they are considerate and helpful in answering questions arising in the LDC's on barley diseases, and that the graduate study and training programs are professionally conducted.

Recommendations

1. The Montana State University project on control of barley diseases for LDC's should be continued. It is directed toward assisting a large group of farmers in the dry areas where barley is the major cereal and who are not reached by programs with other cereals. This is a productive project. Much knowledge about the disease problems of barley in North Africa and the Near and Middle East has been accumulated. It is being shared with national barley research workers and those in CIMMYT and ICARDIA through training programs, workshops, and visits from Montana State staff persons. A program for development of disease resistant germplasm has been initiated. If followed through to completion, with development of disease resistant varieties, the project will bring credit to Montana State University and USAID. Terminating the project at this time would greatly delay at best, and possibly preclude, resistant varieties reaching the farmer.
2. A major problem in most LDC's is a shortage of educated persons. The training of national staff persons with expertise in barley diseases and breeding for resistance could well be the major long-term contribution of the project. Without trained persons in the national programs the barley disease research will not go forward when the MSU/USAID program is terminated. Montana State staff have unique capabilities to conduct graduate study and training programs since they are familiar with the barley disease problems of the area and can tailor study programs to fit the student and the problems he confronts at home. This phase of the project should receive continued support.
3. The Montana State University staff should make a special effort to communicate with their graduates and trainees after they return to their country and to visit them at least once each year as long as the project is continued. Suggestions and encouragement received through these visits can be extremely helpful to the young scientist as he formulates a breeding program for his country. Consideration should be given to funding some visitation even after other phases of the program are terminated.
4. Through the RSP's a significant start has been made to develop breeding materials with multigenic disease resistance. Because the breeding methodology is nontraditional the ultimate outcome cannot be predicted with certainty. However, there is a high probability that genes can be pyramided more quickly than by traditional breeding procedures. Additional cycles of selection and crossing are needed to complete the program and to integrate resistance genes for two or more diseases. Unless continued,

the progress made to date will be largely lost.

5. Some objections were voiced to the source of the base varieties, suggesting a preference for a Mariout background instead. My observations were too limited to make a judgement on this question. California Mariout is one of the base varieties. Perhaps the Montana staff should consider if it is desirable and feasible to introduce additional Mariout, or other base germplasm, into the RSP's.

6. The procedure thus far has been to grow the RSP's for a particular disease at those locations where that disease occurred most frequently. The limited observations made on this trip suggest that diseases at specific locations tend to differ from season to season. For maximum disease exposure, consideration should be given to growing all RSP's at as many locations as seed, cooperation, and other resources permit.

7. Observations in farmer's fields in Morocco and Tunisia on this trip suggested that barley yellow dwarf virus (BYDV) may be a more damaging disease than previously thought. In addition to the Y₂ gene for resistance, general resistance to BYDV appears to be present in many of the winter type barleys grown in the U.S.A. and perhaps other sources. A population with different sources of resistance to BYDV has been assembled in Arizona. Consideration should be given by the Montana staff as to whether this population may be an adequate source of resistance, or whether an additional RSP for BYDV resistance should be initiated.