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ANNUAL REPORT on Control of Barley Diseases for Lesser Developed Countries of the World

August 1, 1979-August 1, 1980
Report No. 2-Annual Report
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on

CONTROL OF BARLEY DISEASES
FOR LESSER DEVELOPED COUNTRIES OF THE WORLD

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Report No. 2

NOT FOR PUBLICATION

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A. Narrative Summary

In August of 1978, a new contract with the U. S. Agency for International Development and Montana State University was finalized to decrease losses caused by the major diseases of barley particularly in the developing countries. Development under this contract includes a number of facets. First, it was necessary to know the major diseases of barley in the target areas. This information was obtained largely by onsite visits, workshops and discussions with plant pathologists in the area. Several of our people have visited the Middle East area and have become familiar with problems of barley culture. It is also necessary to know the races or strains of pathogens in the target areas and to this end a number of disease isolates have been collected and are used in our evaluation programs in the Plant Pathology Department. These isolates of the different pathogens have been used for identifying genes for resistance in the barley cultivars. Different resistant sources to specific diseases have been sought among the world barley collection and based upon reports in the literature where a specific barley cultivar has been reported to be resistant at some time or place to a specific disease organism.

Other fundamental information is necessary before the resistant sources can be effectively utilized. This includes determining best artificial medium for spore production, best mass inoculation methods and criteria for disease evaluations.

After the fundamental studies have been completed it is possible to effectively utilize the information for developing germ plasm. Male sterile facilitated recurrent selection populations have been used for pyramiding genes for resistance to specific diseases. A base of 15 barley cultivars is used for each 2 row and 6 row barley. The entrees used as bases were selected to represent diverse but widely adapted types. The different resistant sources are then crossed into this base population utilizing male sterility. In the case of minor gene accumulation it is believed that additive gene action for greater resistance can be selected from recombinations within the original base population. Each cycle of recurrent selection consists of two parts: (1) selection for disease resistance and (2) recombination. The disease nurseries are grown at several locations in the U. S. as well as in the semi-arid areas of the Middle East and S. Korea. Seed from resistant plants in the nurseries is returned for further recycling in the RSP's. The recombination portion of the cycle consists of growing the resistant portions of the populations in Arizona during the winter and then harvesting only from male-sterile plants thus assuring recombination. By this method we can easily obtain 30,000 or more seeds developed through recombinations. This is a huge amount of recombination at realtively little cost. Each cycle of recurrent selection requires one year. Although recurrent selection populations have been assembled for seven different diseases of barley, five (scald, net blotch, leaf rust, xanthomonas streak and barley yellow dwarf virus) are receiving major emphasis. We have close working relations with CIMMYT and ICARDA and evaluate their crossing block materials each year for several diseases as well as furnishing resistant stocks for their programs.

In addition to development of resistant germ plasm in barley a training program in barley diseases and associated breeding is being conducted. This past year 4 trainees from three different LDC's participated and 3 foreign graduate students are also being supported by the barley-AID program. One of our graduates (M.S. degree) has also been hired as a plant pathologist in cereal diseases with ICARDA at Aleppo, Syria. Details on the various aspects mentioned in this summary are presented in the following sections.

B. Project Objectives

1. Different sources of resistance to the major diseases of barley and linkage relationships will be determined.

2. Barley populations, both 2 row and 6 row, with broad based major gene resistance and minor gene resistance to specific diseases will be developed.

3. Resistances to different specific diseases will be combined into barley stocks.

4. Assistance will be given in establishment of serodiagnosis programs for detection of barley stripe mosaic virus (BSMV) in barley stocks at the International Centers for barley improvement - CIMMYT and ICARDA.

C. Accomplishments to Date

1. Introduction

Accomplishments on the project will be discussed within the specific diseases. In some cases fundamental information is being obtained which is prerequisite to identifying different sources of resistance and their incorporation into RSP's. In other cases, the fundamental work has been completed and different resistances are being actively incorporated into RSP's to form broad-based resistance. For scald and net blotch caused by *Rhynchosporium secalis* and *Pyrenophora teres* respectively a number of resistance genes have been identified and many of these have already been incorporated into the RSP's.

2. Recurrent Selection Populations for Disease Resistance

The development of germplasm with multi-genic resistance utilizing male sterile-facilitated recurrent selection populations is progressing well for several of the important diseases of barley. Following is a description of the RSP's receiving major emphasis and their present status.

a. RSP-5 Rrs: 6-row population for scald resistance

This was the first RSP established and is the most advanced. Four-and-a-half cycles of recurrent selection have been completed. Under conditions of natural infection in Montana the population contains about 95% of resistant plants. In California, where scald infection commonly reaches high levels, still only a small proportion of the plants are resistant. Resistant plants have been selected at other locations, including Turkey, Tunisia, Mexico, France, and Korea. This population is being registered as Composite Cross XXXVI by the Crop Science Society of America.

b. RSP-4 Rrs: 2-row population for scald resistance

This population is currently in the second cycle of recurrent selection. Selection has been done at Bozeman. Levels of resistance are still low (75% susceptible in 1980).

c. RSP-5 Rpt: 6-row population for net blotch resistance

Three-and-a-half cycles of recurrent selection have been completed. Under conditions of natural infection in Montana about 95% of the plants are resistant. However, under California conditions a much lower percentage is resistant. Resistant plants have also been selected in Morocco, Tunisia, Egypt, Mexico, and Korea.

d. RSP-4 Rpt: 2-row population for net blotch resistance

Currently in the second cycle this population has been selected at Bozeman and contains about 75% resistant plants.

e. RSP-5 Rph: 6-row population for leaf rust resistance

One cycle of recurrent selection has been completed. Plants have been selected in Morocco, Egypt, Turkey, and Mexico. A major effort is under way to locate and study new sources of resistance and add these to the population.

f. RSP-5 Rxt: 6-row population for Xanthomonas resistance

Two-and-a-half cycles of recurrent selection have been completed. Severe selection for resistance has been done at field locations in Montana and Turkey and in the greenhouse. At present only low levels of resistance are found in the population. A search is under way to locate new sources of resistance.

g. RSP-5 Reg: 6-row population for powdery mildew resistance

One cycle of recurrent selection has been completed. No selection was done at Bozeman in 1980 due to an unexpected absence of the disease.

h. RSP-4 Rrs minor and RSP-4 Rpt minor: 2-row populations for additive, minor gene resistance to scald and net blotch.

These are basically susceptible populations in which "less susceptible" plants are selected. After one-and-a-half cycles the populations are still susceptible, but the percentage of plants showing slower disease development has increased significantly. Selection in 1980 was based on the degree of movement of symptoms upward in the plant.

i. Combining RSP-5 Rrs and RSP-5 Rpt

To date RSP's have been developed separately for a number of diseases. However, two or more diseases may be important in a specific barley-growing region. In the winter 1980-81 (recombination nursery) two populations will be combined: RSP-5 Rrs (scald) and RSP-5 Rpt (net blotch). In preparation for this combination RSP-5 Rrs was selected for net blotch resistance and RSP-5 Rpt was selected for scald resistance at Bozeman in 1980.

Note: Table 1 shows the locations of disease nurseries.
Table 2-5 shows additions made to several populations.

Disease Reaction of International Barley Nurseries

Entries from the 9th Preliminary Observation Nursery, 10th Regional Crossing Block, and 7th International Barley Observation Nursery, were planted in replicated hill plots and inoculated with Montana isolates of *Rhynchosporium secalis* (causal organism of scald) and *Pyrenophora teres* (causal organism of net blotch). A summary of the results is shown in Table 6. Also, these entries were planted in greenhouse seedling tests and inoculated with a mixture of *R. secalis* and *P. teres* isolates from Montana, North Africa, and the Middle East. A summary of these results is shown in Table 7.

3. Leaf Rust of Barley

Since leaf rust of barley, *Puccinia hordei*, is considered to be a major yield reducing factor in North Africa and the Middle East more emphasis has been placed on this disease during the last year.

In order to determine the virulence pool in the target area, leaf rust isolates were collected from many locations in different countries. Isolates from the U.S. were also included in the studies. Among the 12 isolates tested, 11 different virulence types could be detected using 12 barley cultivars/lines representing the genes Pa-Pa_9 as differentials (Table 8). The two isolates from the Moroccan locations - Khemis Zemar and Marrakech - were found to be identical. Among the known Pa genes the Pa_3 and Pa_7 gene proved to be the most effective resistance sources. However virulence to Pa_3 has been reported from Great Britain and strains of the pathogen virulent on Pa_7 were found near the alternate host, Star of Bethlehem (*Ornithogalum umbelluatum*). Initially 130 barley varieties which reportedly expressed a certain degree of resistance at some time or place were inoculated as seedlings with the 12 different isolates. Several good sources of resistance not identical with the already known Pa genes could be detected (Table 9). These varieties/lines will be or have already been incorporated into the leaf rust RSP's. In order to determine the genetic background of the unknown resistance sources, all of them have been crossed with susceptible varieties as well as with varieties carrying defined Pa genes.

During the last year more isolates of leaf rust have been collected from the Mediterranean area as well as from the U.S. Intensive literature survey and personal contacts with barley workers increased the number of potential resistance sources to about 170 varieties.

In 1969 only 32 of 7,000 entries at Sakha, Egypt expressed some degree of resistance to P. hordei under very heavy infection pressure. Most of the material had to be increased and seed is now available for further screening with different isolates. Among the five lines already entered in the previous tests, 3 outstanding resistance sources (386-16-2, CCIM-13, Ford 1203) were detected.

In many parts of the Mediterranean area the alternate host Ornithogalum umbelluatum is present and recombination of the pathogen might result in new virulence types. One isolate (Tel Aviv), originated from the alternate host, has already been included in our studies. Presently, work is underway to evaluate the effectiveness of such genes as Pa_3, Pa_7 and other unknown resistant sources to strains isolated from Ornithogalum umbelluatum. In order to obtain rare virulence sources the isolations are carried out on highly resistant barley varieties.

During the winter 80-81 leaf rust nurseries will be grown at two locations in Texas (San Antonio, Raymondville). Both locations suffer heavy leaf rust epidemics every growing season. Several leaf rust assessments will be carried out to discover slow rusting varieties/lines which usually express a susceptible reaction in the seedling stage but rust at a slower rate as mature plants.

4. Virus Diseases of Barley

Barley yellow dwarf virus (BYDV).

a. Developed the experimental capability of field testing barley and wheat at Bozeman with BYDV, using laboratory - reared aphids which were viruliferous.

b. Evaluated composite crosses XXXIIIA and B, developed by Mr. Rex Thompson, Mesa, Arizona, for tolerance to BYDV. Both barley crosses were grown at Bozeman, Montana, and Pullman, Washington. Inoculation was accomplished artificially with a given strain of the virus and a known aphid vector species. At Pullman, 40-50%, and at Bozeman, 10-20% of the plants in each cross exhibited symptoms of barley yellow dwarf. All symptomatic plants were rogued. Seed derived from these tests was bulked by cross and sent to Ecuador, Mexico, Morocco, and Syria for further evaluation to prevalent strains of BYDV. These composite cross populations, in addition to having the yd_2 gene for tolerance to BYDV, contain components for short stiff straw and rapid early growth. They also contain male sterile genes msg 1 and msg 2.

c. Increased seed of the following lines of barley tolerant to BYDV:

Source of yd_1 gene

Rojo

Source of yd_2 gene

Benton	UC 566
CM 67	Sutter
CM 72	CI 3208-2
Coracle	CI 3208-4
Abate	CI 2906-1

Seed will be available to interested parties

d. Identified three strains of BYDV from Montana via aphid transmission experiments.

e. Conducted a field test of spring barley, spring wheat, and winter wheat to determine what effect BYDV infection had on plant growth and grain yield. During the 1979-80 growing season, cultivars of winter wheat, spring wheat, and spring barley (Table 10) were planted and subsequently infected with a highly virulent, vector non-specific strain of barley yellow dwarf virus (BYDV). The BYDV tolerant spring barley cultivar, Sutter (CI 15475), and the BYDV tolerant spring wheat cultivar, Anza (CI 15284), were included to determine the effectiveness of these sources of resistance against the Montana isolate of BYDV.

Plants in the treatment plots were inoculated with the virus during the 3-5 leaf stage of development. Inoculation was accomplished by spreading viruliferous, oat bird cherry aphids, Rhopalosiphum padi L., along the rows and allowing a field inoculation feeding period of approximately 5 days. A spray of Malathion was applied to eliminate the virus vectors thus minimizing the possible spread of the virus into the healthy control plots. The inoculative aphids were reared in mass on Klages barley, (CI 15478), previously infected with the Montana vector non-specific strain (PAV) of BYDV. Uniform spreading of the inoculative aphids was facilitated by sprinkling the aphids with talcum powder, prior to field dissemination.

A similar field inoculation procedure was used in a 1979 study of barley cultivar response to late infection by BYDV. During years when natural infection levels are low, the mass rearing and field dissemination of viruliferous aphids is a reliable and simple method to provide close to a 100% infection level in inoculated plots and near 0% or at least minimal infection levels in the comparison control plots.

Disease symptoms and general growth effects for each cultivar were evaluated throughout the growing season. At an optimum stage of disease expression, fifteen plants/row/cultivar, showing typical and uniform BYD symptoms, were tagged for later identification and collection. At maturity, the fifteen tagged plants/row/cultivar were harvested individually and a corresponding fifteen plants from the healthy control plots also harvested individually. The remaining plants from the center six feet of each ten foot cultivar row, for both infected and healthy plots, were bulk harvested.

The data from this study will be used to evaluate the yield response of the cultivar entries to infection by BYDV. An analysis of the yield components and total yield parameters in comparison to disease ratings for each cultivar entry will be conducted as outlined in Table II.

Barley stripe mosaic virus (BSMV).

a. Developed barley germ plasm resistant to the seed transmission of three Montana strains of BSMV.

b. Furnished materials and information to scientists in Tunisia and Lebanon for the serodiagnosis of BSMV in seeds and plants.

c. Evaluated nurseries from ICARDA, (Tables 12, 13 and 14) relative to the presence of BSMV in individual barley entries:

5. Bacterial Diseases of Barley

Bacterial leaf streak, caused by Xanthomonas translucens, after twenty years of minor importance, is on the increase. The most likely explanation for this resurgence is that effective seed treatments are no longer available and that it may have spread from breeding programs into commercial lines. It is considered a "breeders problem" for this reason.

Our work in the past year:

a. Demonstrated seed infection 0-70% of seed from various fields.

b. Demonstrated seed transmission. 0-5% of infected seed will transmit the disease.

c. Demonstrated ineffectiveness of commonly used fungicidal seed treatments.

d. Demonstrated that bactericidal seed treatments effectively reduce transmission rates.

e. Determined that one infected seedling can infect 200 square meters, using marked strains.

f. Demonstrated that this pathogen is capable of active ice nucleation at -2^{o}C.

g. Inoculation has shown that few varieties are resistant. These have been crossed for genetic analysis.

h. Have developed rapid methods of field inoculation, permitting large scale inoculations.

i. Have found some resistance in a recurrent selection population grown at three separate locations in Montana, and at an additional location in Izmir, Turkey.

Pseudomonas syringae on barley.

The bacterial leaf blight disease, (Pseudomonas syringae) of minor importance in the arid regions, was found in all the countries visited by Dr. Sands and Dr. Sharp in the middle East, i.e. Morocco, Tunisia, Egypt, Syria and Turkey. The bacteria found in the middle East were identical to isolates from the United States, and most fell in a group of pseudomonads limited to hosts in the Gramineace. Studies showed seed transmission, systemic infection, and ice nucleation by most isolates.

A Taste Repellent for Pesticide Treated Seed.

A serious problem with seed treatments is the non-target exposure. This is especially true in areas where treated seed may be inadvertently fed to animals or humans. We have developed a seed treatment compound that:

a. Has a very high threshold of bitterness (i.e. >1:200,000).

b. Is non-phytotoxic.

c. Is repellent in animal feeding trials.

d. Is F.D.A. approved.

This compound added to pesticides may act as a safeguard against inadvertant human exposure.

6. Other Diseases of Barley

a. Root Rots of Barley

The primary purpose of our study was to develop a screening technique for common root and crown rot of barley. Literature surveys and isolations from diseased tissue from Montana and the Middle East countries implicated both Helminthosporium sativum and cultivars of Fusarium roseum as causal agents in decay of the crown and root tissues of barley. In our tests, F. roseum 'acuminatum', 'graminearum; and 'culmorum' plus one isolate of H. sativum were used as inoculum sources. Sixteen spring barley varieties were inoculated with each of these fungi. The varieties were selected for their agronomic adaptability and as a representative sampling of the four barley backgrounds, ie Hannchen, Manchuria, Smyrna, and Coast types. One known susceptible variety to common root rot, Melvin, was also included. Varieties tested included Piroline, Hector, Klages, Shabet, Betzes, Glenn, Larker, Unitan, Hypana, Melvin, Compana, Wapana, Wanupana, Washanupana, Lewis, and Clark.

Four techniques, two seeding dates, one cultivar each of F. roseum, and one isolate of H. sativum were evaluated. The greatest reduction in seedling emergence resulted from F. roseum 'graminearum' with a technique of treating the seed with a liquid suspension of conidia. With H. sativum, seedling emergence was not different from the controls but yield was reduced by sowing seed with infested oat kernels. Fusarium inoculum for 1980 was prepared with a shake culture grown using the methods of Booth. His medium is of minimal nutrition and contains carboxy methyl cellulose for viscosity and as a sticker. Mycelial plugs from single spore cultures of each isolate were grown for 60 hours on a rotary shaker. The liquid culture was poured on the seed, allowed to sit for two hours, excess liquid poured off, and the seed fan dried for 12-15 hours, at which time the seed was packaged for planting. The control treatment involved the growth medium but without a Fusarium isolate. Spore concentrations used were: F. culmorum - 5.16×10^5 conidia/ml; and F. graminearum - 2.82×10^5 condidia/ml; and F. acuminatum - 80.60×10^5 conidia per ml. H. sativum inoculum was prepared by placing a mycelial plug in a cooled, sterile quart mason jar containing 250 ml by volume of oat kernels and 90 ml of distilled water. A sterile filter paper and a mason lid kept the medium contaminant free while allowing air and moisture to circulate. The cultures were grown for 9 days, air dried, mixed at a concentration of 3:1 (infested:sterile) kernels, and packaged with 10 g of inoculum per packet. Autoclaved oat kernels were used as the control.

The 1980 field plot design consisted of four replications in a split plot with varieties as main plots and treatments as subplots. Four rows 10 feet long were planted for each treatment with the center two for yield and the two border rows for sampling. Seed was air blown and sieved for uniformity of size. Total yield and yield components will be collected for F. acuminatum and H. sativum but are not available as of this writing. Seedling emergence was so drastically reduced by F. culmorum and F. graminearum that yield data would be meaningless due to excessive tillering and later maturity, ie the plants were essentially "space-planted" rather than being in crowded rows.

A disease reaction score for *H. sativum* was recorded and is based upon the degree of discoloration of the sub-crown internode. A border row was up-rooted at the soft dough stage, washed, and placed in one of four disease categories. The disease reaction score is a single numerical value computed on a weighted average with the plants in severe categories given greater consideration. A second location in Glasgow, Montana was chosen with a previous history of common root rot for evaluation of the 16 barley varieties under natural inoculum pressure.

Concentration of conidia necessary for seedling blight and establishment of Fusarium in the crowns of surviving plants was studied in an experiment planted near the end of May. This test utilized Hector and Washanupana varieties. *F. culmorum* and *F. graminearum* were grown as described above. Concentrations of 10^5, 10^4, 10^3, 10^2, 10^1, and 0 condia/ml were used. A seventh treatment consisted of one month old inoculated seed from the test planted earlier in the spring. Plot design consisted of four replications in a split plot with the main plot as variety and the sub-plot as the 14 treatments. Forty g of seed were treated with 40 ml of conidal suspension with 150 kernels planted in each 10 ft row.

Preliminary results indicate that to screen for crown rot and seedling vigor, either *F. culmorum* of *F. graminearum* are equally effective, whereas *F. acuminatum* establishes itself in the plant, but it is much less destructive. Early planting with cool soil temperatures and a condidial concentration of 10^5/ml will result in a drastic seedling blight. Elimination of susceptible germplasm or of less vigorous seedlings in a recurrent selection population or in early generation material could be varied by using different concentrations of conidia. Selections from surviving plants may increase the level of tolerance to root and crown rot.

Inoculated seed that was stored for up to one month prior to seeding did exhibit severe blight and infection of crown tissue. Prior inoculation of seed would facilitate uniform coverage of all seed at one laboratory and still allow time for individual packaging for field planting.

Selection for resistance to *H. sativum* appears to be most effective with the use of natural inoculum. At least the techniques employed in this study were not substantially better in varietal differentiation than what one might expect to find with good site location for natural common root rot inoculum.

The natural inoculum location at Glasgow, Montana had significant replication differences indicating the variability of inoculum in the soil and/or the non-uniformity of a commercial grower's field. On the University Research Farm, artificially inoculated rows did produce higher disease scores than the rows to which no inoculum was added. The exceptionally wet growing season in Bozeman was ideal for high yields, thereby negating the pathogenic effects H. sativum may have on root and crown tissues. Artificial inoculation to insure uniform infection, coupled with a dryland growing situation, should be recommended for screening varieties for resistance to common root rot.

b. Seed Treatments for Control of Pyrenophora graminea (Helminthosporium gramineum).

Objectives were to determine the efficacy of five fungicides in controlling a natural infestation of P. graminea in Summit barley as compared to an untreated check and a Ceresan mercury control and to evaluate the effect of planting date on disease development.

A 1979 Summit barley seed lot with >90% infection as determined by a half-seed laboratory assay was treated with five fungicides - Trivax, Vitavax 200, Evershield RTU 1050, Nusan 30, and Sisthane. These fungicides were applied at the recommended rate and double the recommended rate. After being diluted to 5 mls with distilled water, the fungicide was atomized onto the seed. Treatments were tumbled for 3 minutes in a Gustafson bench top treater to ensure adequate coverage. A complete randomized block design with 4 replications was used. The 2nd planting date was 3 weeks later than the first.

Measurements were taken on emergence, % infected plants, yield, and thousand kernel weight. We found in the 1st planting date that Ceresan and Vitavax 200 - 2X increased % emergence (2/3 total emergence) more than the rest of the treatments and that Sisthane - 2X was phytotoxic. Only 1/3 of the check plot emerged. These differences were not so evident in the 2nd planting date, however only 2/3 of the check emerged and Sisthane - 2X was still phytotoxic.

In reference to the first planting date 72% of the emerged plants in the check were infected. This was significantly higher than any other treatment. Sisthane and Vitavax 200 - 2X significantly reduced infection to 0 and 12% respectively. The infection levels (as a % of the emerged plants) in the 2nd date were not as high, check = 42% but the same trends in efficacy prevailed.

To date only the 1st date of seeding has been harvested.

Yields ranged from 33 bu/A check to 110.9 bu/Acre Sisthane - IX. Eleven treatments significantly increased 1000 kernel weight over the check at p.01.

Trade name	Common Name	Company	Rate
Trivax	methfuroxam	Uniroyal	.5 oz ai/cwt
Vitavax 200	thiram + carboxin	Uniroyal	4 oz for /cwt
Evershield RTU 1050	"	Cargill	4.36 oz for/cwt
Nusan 30	TCMTB	Wilbur Ellis	3/4 oz for/bu
Sisthane	Fenapanil	Rohm & Hass	1 oz ai/cwt

More efficaceous but low mammalian-toxic seed treatments will be sought, efforts will continue to develop a more efficient screening technique for resistance, virulence types from various parts of the world will be determined and effective sources of resistance, once determined will be advanced for variety development.

c. Powdery Mildew (PM).

Barley composite cross populations, synthesized as early as 1929, have been allowed to reproduce in Davis, California, Moccasin and Bozeman, Montana, without conscious selection. These CC populations can provide an effective method of broadening genetic variability. Growing and maintaining the populations at different locations will give information on the response to selection pressure by powdery mildew in the given environment.

Genes for PM resistance, carried by the parental material of these populations, can be identified through the use of specific races of *E. graminis f. sp. hordei* and their frequencies can be monitored from generation to generation in each population.

Several mildew isolates will be used to evaluate representatives of early, mid- and late generation of each populations:

These generations were chosen on the basis of their availability of seed and germination ability.

Until now two isolates have been tested on the representative samples of the populations to monitor the frequencies of specific resistance genes through the generations.

The first isolate (Montana isolate I) not reported as a specific race in the literature, but resembling very much race CR 3 - was super virulent and most of the test plants were very susceptible to it. Differences in level of susceptibility or in the severity of attack between the various populations and generations will have to be found later on, by computer analysis.

The second race, 59.11, was obtained from Dr. R. A. Kilpatrick Beltsville, MD, and gave more differential reactions on the test materials. The next step is to find out where and when race 59.11 has been reported, and to detect significant differences between the different generations of each population and between the populations themselves, grown at different locations.

Work is underway to detect other races or isolates showing different levels of virulence and differential reactions on the parental material as well as on the differential varieties for PM races. Attempts are currently being made to purify and identify 4 isolates recently received from California and 1 other originated from Rabat, Morocco.

7. Agronomic Improvement

Very little research has been done to develop techniques of selecting effectively in RSP's for adaptation and high yield in the small grains. Pending the development of disease resistant RSPs we have been investigating techniques of selecting drought resistant lines and attempting to verify the utility of these selection techniques. Major problems are involved with utilizing highly technical physiological stress indicators such as measured leaf water potentials, stomatal densities, growth rates or wilting indices as modes of drought selection. These methods are very valuable for detailed description of a few varieties, and as such have been used extensively here to classify 50 varieties according to drought tolerance. However, due to the time involved, these techniques can not be used to screen the large numbers of plant samples required to develop drought resistant populations. Consequently, the major impetus of our research has been to identify specific plant characters directly altered by stress, and which lend themselves to easy, quick and efficient screening of large numbers of plants.

One tool utilized extensively is the use of isogenic lines of barley varying in heading dates. Early heading varieties have long been recognized as drought escaping, and for this reason should be used in semi-arid regions. Also, a series of barleys heading in two to three day increments over a two week period allows the establishment of a constant stress gradient when planted in drought conditions. An isogenic heading date series of Titan barley was planted in 15 environments and plant responses revealed that each isolate was exposed to a different degree of time related moisture stress. Analysis of the responses revealed that plant heights, kernel weights, and kernels per spike are excellent indices of plant stress when interpreted as a ratio of the maximum obtainable expression of this trait. It appears that a given cultivar has a genetic maximum size for these traits, established primarily by genetically controlled growth rates and durations. Given optimum fertility, moisture, and temperature this maximum size can be estimated. The failure of a cultivar to attain this maximum size serves as an indicator of stress from whatever source. The degree to which it fails, indicates the severity of stress, and serves as an indicator of stress to be used in selecting drought tolerant lines.

In addition, a solution to a major controversy (Grafius, 1978) of which yield component to select for yield improvement was partially resolved by this study. It appears that kernels per spike are much more environmentally stable than tillers per unit area, so selection for increased kernels per spike in early heading cultivars, while maintaining adequate tillering should lead to increased yielding cultivars for semi-arid regions. Selection for high kernel number per spike can be easily performed on populations by any practiced agronomist.

Kernel weights were found to depend more upon late season stresses and upon the interactions of heading dates, tillering, and kernels per spike responses. Consequently, it was postulated that selection of plump kernels, by sieving, would serve as a massive pre-screening technique to be used on newer populations grown in arid environments. This would serve to cull out the majority of plants which are not tolerant to drought during the latter part of the life cycle. It also allows an agronomist to sample large numbers of environments without having to spend hours or days at plant by plant selection, in the early generations of RSP development.

The isogenic studies from which these findings were summarized dealt with six row adapted barleys. To verify these findings in a 2-row adapted barley (Shabet), a series of heading date isogenics differing in 2 day increments covering a twenty day (Shabet minus 10 days to Shabet plus 10 days) heading date interval have been developed ty diethyl-sulfate mutagenesis of Shabet, and subsequent plant selection for the appropriate heading date. The selected lines were backcrossed to Shabet to purify the genotypic background. Final selection of the isotypes will occur in August, 1981. These lines will then be grown in semi-arid conditions to further delineate the effects different heading dates have on the adaptation, yield response, and morphological responses by varying the degree of stress to which plants are exposed. This analysis should also reveal more plant characters correlated to stress responses.

From the Titan isogenic study, it was found that kernels per spike seem to express a feed back control on tillering. This phenomenon had been ignored by many U.S. authors but has been implied to exist by Aspinall (1961, 1963) and Kirby and Jones (1977). A verification of this control was found by growing 3 isogenic series of barley having 2 and 6-row genes combined with early and late heading dates. These three studies revealed that a genetically controlled number of kernels per spike response (2 versus 6 row) expressed a strong effect on the tillering response of these isolines. This, and other data, implies that the tillering response is the interactive component of a cultivar to the environment and hence expresses little heritability, given exposure to different degrees of stress. Consequently, selection for optimum tillering under irrigation and high fertility regimes, as proposed by some plant breeders, will probably not lead to advances in Yields on dryland sites, since tillering responses are so variable. These isogenic studies also reveal that varieties which yield optimally on irrigated plots usually do not yield optimally on dry land sites. It is therefore a strong conclusion from these studies that a variety should be selected for the environment in which it will be grown.

Rooting patterns were also postulated to be crucial to drought tolerance, consequently, twenty-six heading date isotypes in 2- and 6-row barley varieties and 33 isolines varying in plant height in 5 varieties were grown at 3 dryland environments and soil moisture data was collected on a plot basis in 30 cm increments to a depth of 180 cm. The soil moisture used as an estimate of physiological root activity at a given soil depth, was related to heading dates, heights, yield, yield components and quality components. It was found that those components established early in the life cycle were correlated to root activity in the upper profile and those established later tended to be associated with the deeper rooting patterns. Although studying rooting patterns enabled us to further delineate stress responses, and resupported the use of kernel weights, kernels per spike and plant heights as specific stress indicators, the complexity of this root assay prevents it from being useful in a large scale selection program.

In addition to the agronomic plant stress indicators mentioned above, a screening technique for Proline amino acid concentrations in the seed was developed. Many authors have postulated an association between plant internal water stress and free Proline accumulation in many crops. Others claim that since the water balance must drop to severe growth inhibiting levels (-20 bars) prior to any accumulation, it is not a practical stress selection assay (Hanson et al., 1978). However, the genetic material developed by these authors seemed to be limited. It was postulated that any barley grown in semi-arid or arid conditions will be exposed to stresses of this level and therefore, those cultivars producing the least amount of free proline will be the most tolerant. The free proline produced in the leaves should be translocated and concentrated in the kernels, magnifying the response. Consequently, an auxotrophic Leuconostoc mesenteroides bacterial assay was developed for use on only 1 gram of ground barley kernels.

The 50 varieties previously classified according to drought tolerance were grown in 4 separate environments and the kernels of each were assayed for proline concentrations as well as the previously described stress indices. The sensitivity of the new assay was sufficient to delineate significant varietal and environmental differences in proline. Proline accumulations were significantly correlated to the plant stress indicators, as well as to a drought tolerance regression slope developed for each of the 50 varieties, and to root volumes determined in non-stressed pot cultures. However, possibly due to low stress levels in these environments these correlations, although significant, were not as strong as expected. The technique is both rapid (200 samples per day) and accurate, and only requires a minimal 1 gram sample of seed. Therefore, it is ideally suited as a drought stress assay for RSP's. However, additional research is needed to both refine the technique, and to further clarify the controversy in the literature.

Besides stress resistance, there are several other plant characters crucial to survival in a given environment. One of these characters is the photoperiod sensitivity of a cultivar. Highly photoperiod sensitive plants can greatly alter their heading and maturation rates relative to other less sensitive cultivars, given varying photoperiods. In general northern latitude spring planted cultivars require moderate photoperiod sensitivities to adjust to different planting dates and allow maximum stooling for maximum yields. Southern latitude cultivars, typically fall planted, have usually established tiller primordia during the winter before warmer temperatures and long days allow rapid growth and maturation. These cultivars do not need, and typically do not have large degrees of photosensitivity. Caution must be taken when developing broad-based RSP's such as the disease resistant RSP's that an appropriate range of daylength sensitivities be maintained allowing agronomists to select cultivars with appropriate daylength sensitivities. Many researchers have attempted to develop assays for photoperiod sensitivity, but due to the large interaction with temperature these assays have not proved accurate.

An assay was postulated which by utilizing the mean heading date response of a nursery removes the temperature interaction and isolates the actual photoperiod response. 112 cultivars and isogenic heading date pairs were grown at 2 locations, each with an early (April) and a late (July) planting date. The ratio of each entries heading date to the mean nursery heading date was calculated. The change in a cultivar's ratio between planting dates served as the numerical daylength sensitivity index. The isogenic lines proved to have consistant indices showing that the technique works with limited accuracy. Each of the varieties and isogenic parents was then classified according to a photoperiod sensitivity rating. These cultivars can be planted at two dates next to any RSP and used as an indice of daylength sensitivity. If the agronomists selects plants flowering at the same time as these known checks, at both planting dates, he should be selecting lines with similar and appropriate daylength sensitivity. More research in this area is suggested for detailed descriptions of cultivars' daylength responses, and to improve and verify the accuracy of this assay.

F_1 seed from 30 of the very earliest cultivars available were crossed to 5 sources of male sterile to establish a very early heading, broadly based population with a large range of daylength sensitivity. This population is in its second recycling-intercrossing phase. It will serve as a tool to test this proposed selection technique for different daylength sensitivities, and to test the effect of this character on yield and morphological traits.

Each of the studies described above have given us valuable indices for plant selection which can be used easily on a large scale. The goal of defining a single 100% accurate selection indice for drought resistance is, in our opinion, impractical. The use of easily measured multiple/correlated indices such as those described above will lead to a better description of complicated interactive plant responses and therefore to more accurate selections. We have been selecting in existing RSP's using these indices to test this theory, and selection has commenced on the most advanced R. Secalis RSP. As other disease RSP's become available they will also be placed under agronomic improvement selection as well, utilizing the following proposed schedule. It is a continuing project, but the energy efficient RSP techniques should be analyzed carefully if it is to be used universally.

D. Outreach Program

Central to our outreach program and dissemination of results on decreasing losses from barley diseases are the annual trips to the Middle East to evaluate the various RSP nurseries and discuss problems and progress with scientific personnel in the various countries. In April - May of this year, Scharen and Langhans made this trip and the report is included in the appendix. We cooperate closely with CIMMYT and ICARDA not only in sending out our RSP nurseries to them but in also evaluating their crossing blocks and elite lines to barley diseases (see Tables). Additionally, members of our department are often involved with CIMMYT and ICARDA in International meetings and workshops. (See Visits and Presentations Section). An agenda is currently being developed for a Barley Workshop to be held in Rabat, Morocco April 12-16, 1981. This workshop will be jointly sponsored by Montana - USAID, CIMMYT, ICARDA and INRA of Morocco. Stress will be placed on the major diseases of barley and associated breeding methods. We are planning on a total group of about 45 people including 1 or 2 representatives from 14 LDC's and resource scientists from Montana State, CIMMYT, ICARDA, California, Minnesota and the Netherlands.

One of our graduates in Plant Pathology, Michael Bjarko, has just returned from 1½ year position with ICARDA at Aleppo, Syria. While there he was instrumental in developing a plant pathology laboratory and worked closely with the barley breeder in evaluations for disease resistance.

E. Training Program

Under the training portion of this program 3 graduate research assistants (GRA's) and 5 trainees from the LDC's were accommodated this past year. The GRA's and trainees participating this last year were as follows:

<u>GRA's from LDC's</u>

Guy De Smet------------------------------Morocco

Hee Kyu Kim------------------------------S. Korea

Moncef Harrabi [a/]------------------------Tunisia

<u>Trainees</u>

Elias Elias------------------------------Syria

Cahit Konak------------------------------Turkey

Moon Sup Chin----------------------------S. Korea

Amar Tahiri [b/]---------------------------Morocco (see Appendix)

Mohamed Khouya-Ali [b/]--------------------Morocco (see Appendix)

The GRA's were assigned thesis problems with barley diseases and were otherwise subject to the same rules and regulations as resident GRA's. The trainees were generally here for a 3 month period from June 15 to September 15. This time sequence covered disease development on barley in the field. The trainees had opportunity to work with all the major diseases of barley from a laboratory and field standpoint. This included diseases caused by fungi, bacteria and virus with some supplemental instruction on nematodes. They were given mini courses in each of these subject areas, followed by a written examination. The main emphasis, of course, was with a "hands-on" approach in field work. The training included isolation and identification of pathogens, inoculation of artificial medium and host plants (including mass field scale), evaluation of various diseases and selection of the best appearing resistant plants. Additionally, they became familiar with use of RSP's and the associated recombination through use of male sterility. All trainees prior to departure received a certificate verifying participation in a training period on barley diseases and associated plant breeding.

Two former trainees under the program, Cahit Konak (Turkey) and Elias Elias (Syria) have now been accepted into the graduate school and will be candidates for an MS degree in Plant Pathology commencing autumn quarter of 1980. Additionally, two other foreign students have expressed

[a/] funded directly by AID - Tunisia

[b/] funded directly by FAO

a desire to do graduate work in the Department of Plant Pathology with research on barley diseases. C. B. Karki is from Nepal, has had training in the wheat program at CIMMYT and is presently working with Dr. Stubbs on yellow rust of barley at Wageningen, Netherlands. Amor Yahyaoui has received a M.S. degree in Plant Breeding at Oregon State University. He has also spent 6 months in the Cimmyt training program in Mexico. He has returned to Tunisia for a 6 month period but would like to come here following this 6 month period. He is highly recommended by personnel at both Oregon State and CIMMYT, Mexico. Amor is presently developing a proposal on barley disease research. Some of the research may be conducted in Tunisia. The acceptance of these students is naturally contingent upon renewal of our barley AID contract.

F. Trip Reports

April 8 - May 7, 1980
A. L. Scharen & Victor Langhans

Purpose of trip:

Evaluate barley disease nurseries in Morocco, Tunisia and Egypt.

Obtain isolates of various barley disease organisms in the above countries to facilitate incorporation of resistance to diseases in the target areas.

Renew contacts and extend cooperation with participating countries.

Organizations & persons contacted:

Morocco:

Marion "Tex" Ford - AID Agricultural Officer, Rabat

Lynn Gallagher - Agronomist with Minnesota-AID program, Rabat

Robb Peters - FAO

Amara Tahiri - Trainee, Barley-AID program June-Sept. 1980.

Mohamed Khouya-Ali - Trainee, Barley-AID program June-Sept. 1980.

Tunisia:

M. Kettata - INRAT

A. Ghodbane - INRAT

John Fligginger - AID Agricultural Officer, Tunis

Mr. Touati - Technical Director, Office of Cereals

Mr. Mouffak - Deputy Director, Office of Cereals

Egypt:

Dr. Harvey - AID cereals program

Dr. Ev Everson - AID, Director, cereals program

Dr. Rashad Abdo - Barley breeder and head of the barley research station.

Dr. Gobrial - Agricultural Research Center, Giza.

Mr. James Ross - Agricultural Attache, American embassy.

Due to cancellation of some air flights in Turkey, no visits were made in that country and the unsettled conditions at Allepo, Syria precluded visits there.

Accomplishments and Impressions

Morocco:

We arrived in Rabat on 9 April and visited the field plots with L. Gallagher the next day. The main diseases noted were powdery mildew and leaf rust with minor amounts of scald and net blotch. Other barley areas visited in Morocco included Side - Kacem where leaf rust and net blotch were the main diseases. The net blotch RSP at this station showed a number of good types although disease incidence was too low for reliable readings. Powdery mildew had also been present earlier in the season and Helminthosporium gramineaum was present in some barley lines. At Benquirir the plots were very dry with barley only 12-14" high but the predominant disease was leaf rust with minor amounts of net blotch. The barley variety Asse was outstanding for leaf rust resistance. A barley field south of Beni-Mallal where precipitation was about 230 mm had a relatively high amount of net blotch and at an irrigated station (Tadla) net blotch was the main disease of barley with scattered plants infected with H. gramineum causing the barley stripe disease. At the Merchouch station there was very little disease and the barley looked very good.

Tunisia:

We arrived in Tunis at 1700 and were met by Kettata and Ghodbane. The next day after visiting briefly with Mr. Fliggenger (AID Agricultural Officer) we visited the Office of Cereals then went to the plots at Mateur. There were a number of barley diseases including scald, Helminthosporum stripe and net blotch but none were severe. Barley yellow dwarf virus was also suspected but not confirmed. At El Kef the road to the Dyr farm where the barley RSP's were planted was impassable due to excessive rainfall. Local nurseries showed a lot of powdery mildew and some scald.

On April 17 we surveyed the cereal trials at Pont du Fahs. Barley varieties included Beecher, Gem and Aurora-Esperance. There was a great deal of loose smut and Helminthosporium stripe. Powdery mildew, scald and yellow rust were also prevalent.

On April 18 we presented seminars at the Office of Cereals. The director and staff were particularly interested in the barley program and the short term training aspects.

Egypt:

On April 21 we went to the CIMMYT office, Cairo, Egypt where we met Dr. Ev Everson and Dr. Harvey who are with the AID major cereals program. Later we went to Giza, met with the staff of Research Center and presented seminars pertaining to barley projects at MSU. We then visited the plots. The main diseases present were powdery mildew and Helminthosporium stripe.

On April 22 the Sakha Station was visited where there are about 75 acres of wheat and barley plots. Powdery mildew and leaf rust were the main diseases of barley followed by yellow dwarf virus and net blotch. In the vicinity of Alexandria, we travelled through very dry areas with an average precipitation of 150-200 mm. The plants were well advanced in maturity but showed evidence of quite heavy earlier infections with leaf rust and powdery mildew. There was also some loose smut, covered smut, *H. gramineum* and root diseases.

May 22 - June 14, 1980
E. L. Sharp & M. Reinhold

Purpose of Trip

Check local facilities and local support on a proposed barley workshop scheduled for April 1981 in Rabat, Morocco.

Participate in the 5th European and Mediterranean Rust Conference in Bari, Italy.

Meet barley workers and visit barley growing areas in Germany.

Obtain isolates of Puccinia hordei to incorporate in our virulence pool.

Organizations & persons contacted:

Morocco

Marion 'Tex' Ford	- AID Agricultural Offices, Rabat
James Burleigh	- Pathologist with Minnesota-AID program, Rabat
J. Srivastava	- Director, Cereal Section, Aleppo ICARDA
E. Saari	- CIMMYT pathologist, Cairo
H. Faraz	- Director, National Institute of Agricultural Research (I.N.R.A.), Rabat

Germany

G. Fischbeck	- Department Head, Department of Plant Breeding, University of Munich
E. Schwarzbach	- Plant Pathologist, Department of Plant Pathology, University of Munich
G. Röbbelen	- Department Head, Department of Plant Breeding, University of Göttingen
R. Heitefuss	- Department Head, Department of Plant Protection and Plant Pathology. University of Gottingen
A. A. Hafez	- Director, Department of Agronomy, Tanta University, Egypt.

Accomplishments and Impressions

Morocco

We arrived in Rabat in the afternoon of May 24. The next morning James Burleigh (Plant Pathologist with Minnesota AID-program) was contacted. The same evening we met with Marion Ford (AID-agricultural officer, Rabat) and Jit Srivastava (Director, Cereal Section, Icarda) at Burleigh's home. Problems regarding the planned barley workshop in 1981 were discussed. It was agreed that Rabat would be an excellent location however due to shortage of money and personal support from the local AID - office the site appeared questionable. A second meeting was scheduled for the next morning at the AID-building. In the meantime hotel prices and meeting facilities were investigated. Eugene Saari (Cimmyt Pathologist, Cairo) joined the discussion the next morning. It was agreed that Moroccan officials should be contacted to obtain the necessary local support. M. Ford arranged a meeting with H. Faraz (Director, National Institute of Agricultural Research, I.N.R.A.). H. Faraz seemed to be very enthused about having the barley workshop in Rabat and offered all possible help - in particular to furnish a meeting room and an office at the I.N.R.A. headquarters in Rabat, to provide adequate refreshments during the breaks, transportation to and from the hotel (probably Tour Hassan) as well as furnishing a bus for a field trip to the experimental station at Merchouch. In addition he volunteered one of his subordinates (A. Quesson) to take care of the local arrangements. In an evening meeting with Dr. Saari and Dr. Srivastava tentative topics and speakers for the barley workshop were discussed. On May 27 we left Rabat for Bari via Casablanca, Madrid, Rome.

Italy

We arrived in Bari on May 28 and participated in the 5th European and Mediterranean Rust Conference from May 28 to June 4. A paper "Some virulence types of Puccinia hordei from semi-arid environments" was presented. In connection with the Conference several tours were scheduled. We used the opportunity to collect isolates of Puccinia hordei from two widely separated locations in southern Italy. These samples will be added to our virulence pool of Puccinia hordei from the Mediterranean area.

Mr. C. B. Karki from Katmundu, Nepal, a participant of the Congress, indicated a strong interest in becoming a graduate student in plant pathology at Montana State University. He received a Masters degree from the University in Delhi, India and has had training at Cimmyt, Mexico. At present he is receiving additional training in Wageningen, Netherlands.

Germany

We arrived in Munich on the afternoon of June 5. In the evening, G. Fischbeck, Head of the Department of Plant Breeding at the University of Munich, was contacted. A visit with him and E. Schwarzbach (Plant Pathologist) was scheduled for the next day. He gave a detailed report on a cooperative project with the University of Tel Aviv on different types of resistance to powdery mildew in natural populations of Hordeum spontaneum. Resistance to Puccinia hordei was also detected in these populations. Later E. Schwarzbach gave us a short tour through the field nursery. Due to the cold and dry weather in April the disease incidence was not as heavy as expected. However some leaf rust samples of barley were collected. One of Schwarzbach's lines completely resistant to powdery mildew containing the gene ml-o (which is known for it's undesirable pleiotropic effects) reportedly has the yield level of Aramir - a recommended brewing barley variety for western Europe. As clearly shown in comparison with a foreign introduction line all german barley varieties had a considerable amount of resistance to stripe rust. The genotypes, however, are completely unknown. Most interesting Schwarzbach demonstrated his jet spore trap which, mounted on the roof of a car, enables him to carry out spore collections in a wide area and greatly facilitates the determination of the virulence pool. The spore trap is usable for mildew and rust spores but can possibly be used for several other airborne diseases. We also surveyed the barley and barley diseases in the Freising-Weihenstephan area.

The following weekend we drove north to Göttingen. On Monday, June 9, we visited with G. Röbbelen (Head of the Department of Plant Breeding at the University of Göttingen). Problems of breeding for "horizontal" resistance in cereals were discussed. In the afternoon we gave a seminar on the use of recurrent selection populations (RSP) in breeding for broad based resistance. We also described using P. hordei as an example of how the basic information about valuable resistance sources was obtained. The seminar was of considerable interest and was followed by an intensive two hour discussion. We also met A.G.I. Abdel-Hafez, a former student of G. Röbbelen who will be at the Department of Agronomy, Tanta University near Sakha, Egypt and probably would be an excellent cooperator on the AID project. We left Göttingen for Frankfurt June 10. On the way we collected several samples of P. hordei in the river valleys near Göttingen.

We returned to Bozeman, June 15, 1980.

G. Visits and presentations

E. L. Sharp:

Attended Cereal Coordination Meeting - Heraklion, Crete, 24-26 February 1980. Presented information on cereal pathology program, specialized training program in barley and discussed proposed barley workshop for 1981. (See schedule of topics for Crete meeting in Appendix). As an outgrowth of this meeting the 1981 Regional Workshop is to be confined to barley diseases and breeding and will be held the week of April 12 in Rabat, Morocco.

T. W. Carroll:

Invited to a special work shop on barley yellow dwarf funded and sponsored by CIMMYT at Mexico City, Mexico.

D. C. Sands:

Oklahoma State University, Sigma Xi lecture *Pseudomonas syringae* on wheat and barley Genetics and the nutritional value of microorganisms.

Christus Collegium Lecture, Bozeman, MT. World Food Problem and Microorganisms

Western Regional Integrated Pest Management Meeting, Denver, Colorado. Interactions of Pests in wheat and barley fields.

Western Regional Coordinating Committee (WRCC29). Diseases of small grains group. Reported our work on Xanthomonas.

H. Visitors

Mr. Guy Thiebaut, plant breeder with Claeys-Luck, S.A., Annouellin, France. Discussed barley breeding and the use of recurrent selection. Nov. 26, 1979.

Dr. Robert Allard, plant geneticist with Univ. of Calif., Davis. Presented seminar on barley composite crosses and held discussion sessions on barley breeding and genetics. March 6-10, 1980.

Mr. M. Boulif, graduate student at Univ. of Minn. from Morocco. Discussed AID barley project. July 1, 1980.

M. Khalifa and E. Gobrial, breeder and pathologist, Giza, Egypt. Discussed AID barley project. July 17, 1980.

Dr. Lynn Gallagher, breeder with Univ. of Minn. stationed in Rabat, Morocco. Discussed barley breeding. Aug. 14, 1980

I. Publications

Carroll, T. W. 1980. Barley stripe mosaic virus: its economic importance and control in Montana. Plant Dis. 64:136-140.

Carroll, T. W. 1980. Methods of detecting seedborne plant viruses. J. of Seed Technol. 4:82-95.

Bockelman, H. E., R. F. Eslick, and E. L. Sharp. 1980. Description of RSP-5A Rpg. Barley Newsletter 23:35.

Bockelman, H. E., R. F. Eslick, and E. L. Sharp. 1980. Description of RSP-5B Rpt. Barley Newsletter 23:36-7.

Bockelman, H. E., R. F. Eslick, and E. L. Sharp. 1980. Description of Composite Cross XXXVI. Barley Newsletter 23:38-9.

Bockelman, H. E., R. F. Eslick, and E. L. Sharp. 1980. Registration of Composite Cross XXXVI. Crop Sci. 20: (in press).

Reinhold, M. and E. L. Sharp. 1980. Some virulence types of leaf rust of barley *Puccinia hordei* in semi-arid areas. Proceedings of the 5th European and Mediterranean Cereal Rusts Conference. Bari, Italy. May 28 - June 5.

Sands, D. C., M. N. Schroth and D. C. Hildebrand. 1980. The genus *Pseudomonas* in Laboratory Guide for Identification of Plant Pathogenic Bacteria. ed. N. Schaad. A.P.S. St. Paul, Minn. 72 p.

Sands, D. C., A. L. Scharen and V. L. Langhans. A selective medium for fluorescent Pseudomonads. Phytopathology. Accepted for publication with revisions.

Yount, D. J. and T. W. Carroll. 1980. Identification of three distinct barley yellow dwarf virus strains in Montana by aphid transmission and enzyme immunosorbent assay. Phytopathology Abst. (In press).

J. Tables

Table 1. Locations of Disease Nurseries, 1979-80.

Bozeman, MT	Morocco
Fairfield, MT	Tunisia
Sidney, MT	Egypt
Woodland, CA	Syria
Georgia	Turkey
South Texas	Korea
France	Mexico

Table 2. Resistant Germplasm added to RSP-4 Rrs (2-row scald) in 1980.

C.I. 668
C.I. 936
C.I. 7323
C.I. 11579

Table 3. Resistant Germplasm added to RSP-5 Rpt (6-row net blotch) in 1980.

C.I..5404
C.I. 6475
C.I. 7744
C.I. 9648
C.I. 9831
C.I. 11631
C.I. 13727

Table 4. Resistant Germplasm added to RSP-4 Rpt (2-row net blotch) in 1980.

C.I. 1197	C.I. 8332
C.I. 5276	C.I. 9647
C.I. 5404	C.I. 9819
C.I. 6496	C.I. 11631
C.I. 7584	C.I. 12860

Table 5. Resistant Germplasm added to RSP-5 Rph (6-row leaf rust) in 1980.

Ford 1203
CCIM-13
386-16=2

Table 6. Disease Reactions of Entries in the International Barley Nurseries at Bozeman, 1980.

	scald no. of entries			net blotch no. of entries		
	R	I	S	R	I	S
9th PON	35	30	83	112	21	15
10th RCB	25	46	76	122	14	14
7th IBON	44	63	179	242	23	23

Table 7. Disease Reactions of Entries in the International Barley Nurseries in Greenhouse Seedling Tests.

	scald no. of entries			net blotch no. of entries		
	R	I	S	R	I	S
9th PON	34	41	73	8	77	63
10th RCB	22	41	87	12	85	51
7th IBON	70	86	127	60	94	134

Table 8. Reaction of differential varieties to isolates of *Puccinia hordei*.

Barley Varieties	Gene(s)	Isolates: San Antonio	Creston	Sidney	Rabat	Merchouch	Khemis Zemarar	Marrakech	Sakha	Tel Ayiy	Tel Hadia	Homs	Izmir
Batna	Pa_2+?	+[a]	+	+	+	+	+	+	-	-	+	-	+
Bolivia	Pa_2+?	+	+	+	-	-	+	+	+	+	-	+	-
Cebada Capa	Pa_7	+	+	+	+	+	+	+	+	+	+	+	+
Egypt	Pa_8	-	-	-	-	+	-	-	-	-	-	-	-
Estate	Pa_3	+	+	+	+	+	+	+	+	+	+	+	+
Gold	Pa_4	-	-	+	-	-	-	-	-	-	-	-	-
Quinn	Pa_2+Pa_5	+	-	-	-	+	-	-	-	+	-	-	+
Peruvian	Pa_2	+	-	-	-	+	+	+	-	+	+	-	-
Rekal	Pa_2+?	-	-	+	-	-	-	-	+	-	-	-	-
Ricardo	Pa_2+?	+	-	-	+	+	+	+	-	+	+	-	+
Sudan	Pa	+	-	+	+	+	+	+	-	+	-	+	-
CI 1243	Pa_9	+	+	+	+		+	+	+	-	+	-	

a/ + = Resistant - = Susceptible

Table 9. Promising sources of resistance to leaf rust of barley *Puccinia hordei*.

Resistant to 6 isolates out of 12	Asse, Juliaca. CI 4219 Menelik, Amber
Resistant to 7 isolates out of 12	Peruvian, Ricardo, Sudan CI 4974
Resistant to 8 isolates out of 12	Weider, CI 11577, Modjo San Carlos
Resistant to 9 isolates out of 12	Batna, Bolivia
Resistant to 10 isolates out of 12	Ariana, CCIM-13
Resistant to 11 isolates out of 12	Ford 1203
Resistant to all isolates	Aim, Cebada Capa, Estate, Forrajerra Klein x Reka, CI 11801, 386-16-2.

Table 10. Cultivars evaluated for growth response and yield when infected with a vector non-specific strain of BYDV.

Winter Wheat Cultivars	Spring Wheat Cultivars
Winalta CI 13670	Fortuna CI 13596
Winoka CI 14000	Lew CI 17429
Cheyenne CI 8885	Tioga CI 17286
Centurk CI 15075	Prodax CI 17407
Warrior CI 13190	Anza CI 15284
	Olaf CI 15930

Spring Barley Cultivars
Sutter CI 15475
Unitan CI 10421
Steptoe CI 15229
Hector CI 15514
Compana CI 5438
Klages CI 15478
Piroline CI 9558

Table 11. Cultivar evaluation parameters in response to BYDV.

General Characteristics
Disease reaction rating
Plant height
Yield / 15 plants
Yield / 6 ft. row

Yield Component Parameters
Tillers / plant
Seeds / head
Sterile florets / spike
1000 kernel weight

Table 12. International Barley Observation Nursery (IBON) BV-79.

Entry No. Infected with BSMV	Cultivar or cross
3	Centinela
4	CM 67
27	Api-CM67 x Apam - IB 65
50	Weeah - Strain 205
68	Api-CM 67 x 10876.1
80	Porvenir
103	Centinela
104	CM 67
133	Huizache "S" x Api-CM 67
138	CM 67 - Sask. 1800 x Pro - CM 67 Kelaya
140	Composite cross 89
202	Apizaco
203	Centinela
204	CM 67

Table 13. Ninth Preliminary Observation Nursery 1979-1980.

Entry No. Infected with BSMV	Cultivar or cross
P46	Tlaxcala
P49	Piri
P50	D 8738
P72	Composite 29 Kenya Feed Barley
P73	B^aI 16-Pro
P74	Heines standard
P79	Koher
P103	Martin-Hyproli, TC 73-68
P147	Gremleck (CI 1215)

Table 14. Tenth Regional Crossing Block 1979-1980.

Entry No. Infected with BSMV	Cultivar or cross
R40	Piri
R42	Mzq/DL71

K. Appendix

Suggested Schedule of Topics
Cereal Coordination Meeting
Heraklion, Crete, Greece 24-26 Feb.1980

24 Feb. Sunday:		
	Morning Session : Chairman	O. L. Brough
0800-1000	Institutional Developments	
	CIMMYT	R. G. Anderson/ D. L. Winkelman
	ICARDA	H.S. Darling
	ACSAD	L. R. Morsi
	The Ford Foundation (FF)	P. Bronzi
	The Rockefeller Foundation (RF)	C. K. Mann
	Others-Discussion	
1000-1030	Coffee/Tea	
1030-1145	Regional Development: Agronomy within the Region, the current goals, objectives and future plans.	
	ICARDA	W. Anderson
	CIMMYT	R. G. Anderson/A.R.Klatt
	ACSAD	L. R. Morsi
	Others-Discussion	
1145-1300	Cereal Pathology	
	CIMMYT	J. M. Prescott/ E. E. Saari
	ICARDA	A. H. Kamel
	Institute for Plant Protection (IPO)	R. W. Stubbs
	Montana State University (MSU)	E. L. Sharp
	Discussion	
1300-1400	Lunch	
1400-1800	Sight Seeing-E. E. Saari arrange transportation	
1900-2100	Happy Hour(s) Reception- J.P. Srivastava and E. E. Saari arrange.	
25 Feb. Monday:		
	Morning Session: Chairman	M. A. Nour
0800-1000	Training	
	In-Service	
	ICARDA	J. P. Srivastava
	ACSAD	L. R. Morsi
	CIMMYT	H. Vivar
	Discussion	
	Specialized Training	
	MSU	E. L. Sharp
	IPO	R. W. Stubbs
	RF	C. K. Mann
	FF	P. Bronzi
	Economics	D. L. Winkelman
	Others- Discussion	

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100-1030	Coffee-Tea	
1030-1200	Breeding within the Region: Current goals, objectives and results.	
	BARLEY- ICARDA	J. P. Srivastava
	CIMMYT	R. G. Anderson/A.Klatt
	ACSAD	L. R. Morsi
	Discussion	
1200-1230	Triticale Breeding	
	CIMMYT	R. G. Anderson/A.Klatt
	ICARDA	E. M. Matheson
1230-1330	Lunch	
	Working Lunch-ICARDA-CIMMYT	
	Staffing within the Region- J.P. Srivastava and E. E. Saari H.S. Darling, M. A. Nour, J.P. Srivastava A. H. Kamel, E. M. Matheson, R. G. Anderson, A. R. Klatt, J. M. Prescott, G. Varughese, D. L. Winkelman, E. E. Saari	
1330-1530	Chairman	A. R. Klatt
	Durum Wheat Breeding: Current goals, objectives and results	
	ICARDA	A. H. Kamel
	CIMMYT	R. G. Anderson/A. Klatt
	ACSAD	L. R. Morsi
	Discussion	
1930-2130	Germplasm: Nurseries and Plant Quaranteen	
	Evening Session: Open to interested participants	J. M. Prescott
26 Feb. Tuesday	Chairman	H. S. Darling
0800-1000	Regional Programs	
	East Africa	G. Kingma
	North-West Africa	G. Varughese
	Disease Surveillance	J.M. Prescott/E.E.Saari
	South-Southeast Asia	E.E. Saari/R. G. Anderson
	Regional Economics	D.L. Winkelman
	Discussion	
	High Elevation Winter Cereal Programs	
	ICARDA	E. M. Matheson
	CIMMYT	R. G. Anderson/A.R. Klatt
	Others- Discussion	
1000-1030	Coffee-Tea	
	National Programs	
	Algeria	P. Masson
	Egypt	E. E. Saari
	Jordan	D. Bray
	Kenya	G. Kingma

	Lebanon	O. L. Brough
	Pakistan	H. M. Hepworth
	Syria	J. P. Srivastava
	Turkey	J. M. Prescott
	Tunisia	C. Mock/C.K. Mann
1230-1330	Lunch	
1330-1530	Chairman	H. M. Hepworth
	Report: Germplasm nurseries and Plant Quaranteen Evening Session-Elect Reporter	
	Summer Nursery-Kenya	G. Kingma
	Travel Coordination	A. H. Kamel
	Workshops and Conferences	
	MSU	E. L. Sharp
	Regional Workshop 1981	J. P. Srivastava
	Future Coordination	E. E. Saari
	Discussion	
	Summary and Closing Remarks	M. A. Nour
1530-1600	Coffee-Tea	
1600-1730	ICARDA-CIMMYT Business	
1930	CIMMYT-In-house	R.G. Anderson/A. Klatt

INTERNATIONAL TRAINING

U.S. Department of Agriculture cooperating with the Food and Agriculture Organization of the UN, Universities, Colleges, and other organizations.

Washington, D.C. 20250

June 12, 1980

PROGRAM AND ITINERARY

Mr. Amar TAHIRI
Mr. Mohamed KHOUYA-ALI
FAO Fellows of Morocco

Barley and Barley Diseases

Duration: 3 Months
Arrival Date in USA: June 11, 1980
Departure Date from USA: September 17, 1980

NOTE: This program is under the sponsorship of the Food and Agriculture Organization of the United Nations. Bills for tuition and other authorized charges will be paid by FAO/Rome, but should be sent directly to: Mr. Earl Terwilliger, Program Leader, Agronomic and Engineering Branch, International Training Division, Office of International Cooperation and Development, United States Department of Agriculture, Room 3548-South Building, 14th Street and Independence Avenue, S. W., Washington, D.C. 20250

TAHIRI-Morocco
KHOUYA-ALI-Morocco

PROGRAM CONTENTS

TAHIRI-Morocco
KHOUYA-ALI-Morocco

BACKGROUND INFORMATION AND OBJECTIVES OF STUDY

1. Background Information

Barley is a very important crop in Morocco, and is used for both food and feed. Barley is grown on large units of land which are not suited for other creal grains. In Morocco, barley is fall planted, grows through the winter and spring, and then is harvested in late spring or early summer.

Foliar diseases in barley are widespread, and large losses do occur, especially in wetter years. There is a need for more trained manpower specializing in plant pathology for barley, and also for other cereals and legume crops.

2. Training Requested

The fellows should participate in a practical , field-oriented program dealing primarily with barley diseases. They should participate in all aspects of field and laboratory procedures used in the program. Special emphasis should be given to development and maintenance of horizontal resistance.

TAHIRI-Morocco
KHOUYA-ALI-Morocco

PERSONAL DATA

NAME:	Mohamed KHOUYA-ALI
ADDRESS:	Central Research Station for Autumn Cereals B.P. 415, Rabat, Morocco
MARITAL STATUS:	Single
EDUCATION:	Ingeneur Agronome, 1975 National School of Agriculture Meknes
PRESENT POSITION:	Agronomist at Central Research Station for Autumn Cereals. Resistance of barley to mildew and Septoria

* *

NAME:	Amar TAHIRI
ADDRESS:	Central Food Legume Station
MARITAL STATUS:	Single
EDUCATION:	Ingeneur Agronome, 1979 Hassan II Agriculture and Veterinary Institute
PRESENT POSITION:	Agronomist at Central Food Legume Station, Chick-pea and Bean Diseases

TAHIRI-Morocco
KHOUYA-ALI-Morocco

PROGRAM AND ITINERARY

June 11, 1980 — Arrive in Washington, D.C.

June 12-13 — WASHINGTON, D.C.

June 12 — FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

CONTACT: Mr. R. A. Nicolosi/Teresa Clark
Administrative Officer
Room 100

Telephone: Area Code 202/376-2226

Objectives or activities: Receive orientation on administrative and financial arrangements connected with the fellowship.

June 12 (2:00 p.m.) — UNITED STATES DEPARTMENT OF AGRICULTURE
14th and Independence Avenue, S. W.

CONTACT: Robert B. Bertram, Assistant Program Specialist
Agronomic and Engineering Branch
International Training Division
Office of International Cooperation and Development
Room 3548-South Building
Telephone: Area Code 202/447-5434

Objectives or activities:

1. Review the proposed program and discuss final planning of the training experience.

2. Orientation covering agriculture in the United States and recent technological changes, work and responsibilities of the Department of Agriculture, and introduction to the use of modern management as a tool in agricultural development.

June 14 — Travel to Bozeman, Montana

June 16, 1980- September 15, 1980 — MONTANA STATE UNIVERSITY
Bozeman, Montana 59717

CONTACT: Dr. E.L. Sharp
Dept. of Plant Pathology
Montana State University
Bozeman, Montana 59717

Telephone: Area Code 406/994-4832

TAHIRI-Morocco
KHOUYA-ALI-Morocco

Objectives or activities: Participate in a practical, field-oriented training program on barley and barley diseases, with special emphasis on horizontal resistance.

1. Identification of principle foliar diseases of barley, e.g. rusts, septoria, helminthosporia, mildew, etc.

2. Identification of sources of resistance, classification of type of resistance and degree of infection. Methods used in race identification.

3. Methodology involved in collection and storage of inoculum.

4. Inoculation techniques used in development of epidemics.

5. Selection of resistant or tolerant types.

6. Design and maintenance of disease nurseries, site location considerations, etc.

7. Use of resistance sources in a breeding program. Development of stocks, use of various techniques to incorporate disease resistance in agronomically desirable lines. Considerations in releasing a new variety, especially with regard to disease resistance.

8. Monitoring of disease resistance and development of virulent pathogen races.

9. Participate in all aspects of field activities involved in barley research, data collection, plot maintenance, harvest, etc.

10. Accompany research team on off-station trips, inspecting diseased fields, and various other extension-type activities.

September 16, 1980 — Travel to Washington, D.C.

September 17, 1980 — UNITED STATES DEPARTMENT OF AGRICULTURE
14th and Independence Avenue, S. W.

TAHIRI-Morocco
KHOUYA-ALI-Morocco

CONTACT: Robert B. Bertram, Assistant Program Specialist
Agronomic and Engineering Branch
International Training Division
Office of International Cooperation and Development
Room 3548-South Building

Telephone: Area Code 202/447-5434

Objectives or activities: Discuss terminal activities. This will include arrangement for clarifying technical subject matter questions, reports needed, appointments with officials in USDA and preparation for departure from the United States.

September 17, 1980 FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

CONTACT: Mr. R. A. Nicolosi/Teresa Clark
Administrative Officer
Room 100

Telephone: Area Code 202/376-2226

Objectives or activities: Clarify fiscal affairs and prepare to depart from the United States.

September 18, 1980 Depart from the United States for Morocco

REPORTS

The Fellow is expected to prepare reports for FAO and USDA. The following are expected:

All Technical Assistance and Other Fellows

Send originals of your narravitve report to your Program Manager, a carbon to FAO/Rome, and a carbon to your Program Specialist, USDA.

In the Event There Is No Project Manager

Send the original of your narrative report ot Irene Field, FAO/Rome, and a carbon to your Program Specialist, USDA.

TAHIRI-Morocco
KHOUYA-ALI-Morocco

THE FOLLOWING PROVIDED ASSISTANCE IN THE DEVELOPMENT OF THIS PROGRAM:
Institutions, organizations, and firms listed herin, and
Teresa Clark, Food and Agriculture Organization of the United Nations, Washington, D.C.
Irene Field, Food and Agriculture Organization of the United Nations, Rome
Dr. E. L. Sharp, Montana State University
Robert B. Bertram, Office of International Cooperation and Development, USDA (Coordinating Program Specialist)