PN-ABD-558
C5-038

THE DEVELOPMENT OF A DROUGHT RESISTANT WHEAT GERMPLASM

Annual Report for 1987/88 submitted to CDR-AID

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Rec'd in SCI MAY 1 1988

Work in this first year concentrated on several topics:
Preliminary testing of various breeding germplasm for yield and phenology under water stress as compared with non-stress conditions.
A preliminary comparative study of the performance of wheat and triticale under conditions of water stress,
A comparative study of stability in yield of advanced breeding materials tested under conditions of variable moisture regimes.
All materials tested were also planted in a nursery at Bet Dagan where their reactions to stripe rust (infected), stem rust (infected), leaf rust (natural) and septoria (natural) was scored.
These studies should allow to reveal potentially drought resistant materials at several levels of the breeding program in terms of stages of selection. Such materials would be advanced into further testing in the next year of work.

TESTS OF BREEDING GERMPLASM.

One hundred and forty six selections were planted in two tests. One test was planted at Bet Dagan under optimal growing conditions with adequate rainfall (653 mm). The other test was planted at Gilat, situated about 100 km south of Bet Dagan at a similar altitude. Rainfall at Gilat was short of requirement (307 mm), resulting in reduced yields. Both tests were optimally managed with respect to fertilization, weed control etc'. Both tests emerged within the the third week of November 1987.

Of all selection tested, 72 were not harvested for grain yield determination because of serious deficiencies observed in their phenology, disease reactions (at Bet Dagan) or general agronomic type. The remaining 74 selections were considered as agronomically suitable and they warranted harvesting.
Grain yields of the various harvested selections under optimum conditions at Bet Dagan ranged within about 450 to 850 gr m^{-2}. The respective grain yields under stress at Gilat were within about 300 to 450 gr m^{-2} (Fig.1). No association was seen in grain yield across selections between the two locations.

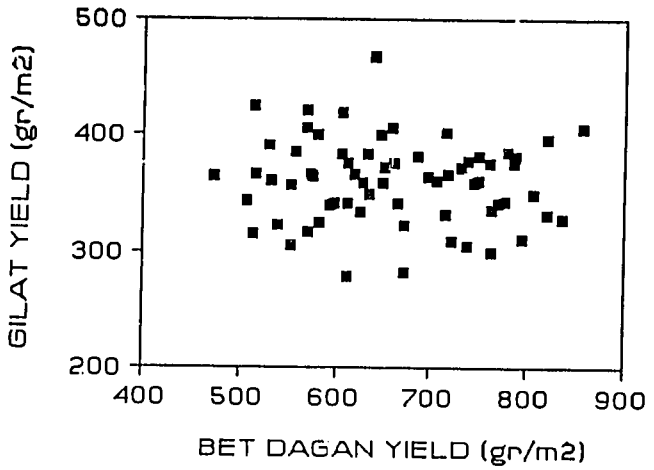

Figure 1: The relations between yield at Bet Dagan (non-stress) and yield at Gilat.

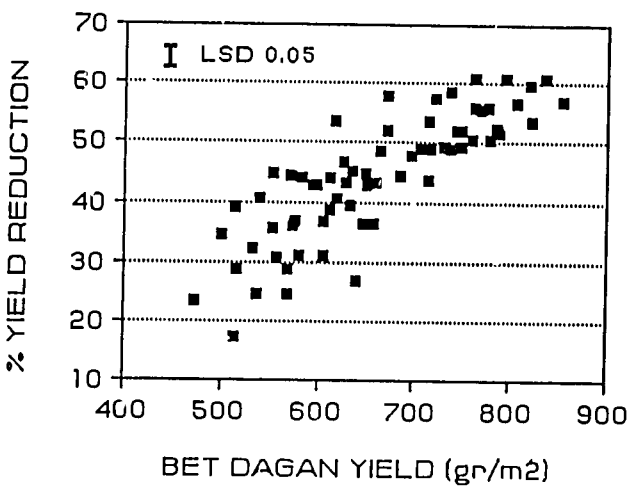

Figure 2: The rate of yield reduction (percent) in grain yield of various selections in Gilat, as compared with Bet Dagan (potential conditions). (LSD between selections in yield at Gilat).

The rate of reduction in yield under stress conditions (Gilat) from non-stress (Bet Dagan) increased with the potential yield of the selection, as might have been expected (Fig.2). However, statistical analysis allowed to conclude that selections of similar yield potential at Bet Dagan may have differed in percent yield reduction at Gilat. It also appears from Fig.2 that there may be a tendency for greater variation among selections in yield reduction at Gilat especially for those selections that had medium to low yield potentials. This would conform with the theory that it should be easier to develop drought resistance in genotypes of moderate rather than of high yield potential.

Additional results from chemical desiccation tests after anthesis with these materials are being processed at this time.

THE COMPARATIVE PERFORMANCE OF WHEAT AND TRITICALE.

Nine wheat and nine triticale selections were tested. Each selection has already been selected for good agronomic type and good to high yield potential. All selections were planted in a randomized blocks design with four replicates at Bet Dagan and Gilat (conditions as described in section #1 above). Yield and yield components were determined for all selections in each location.

Under optimum conditions (Bet Dagan, "wet") the mean yield of all was higher than the mean yield of all wheats (Fig.3). Yields of the various wheat genotypes ranged from 449 to 772 gr m^2 while yields of the various triticale genotypes ranged from 654 to 1323 gr m^2. The yield advantage of the triticales under favorable conditions could not be ascribed only to growth duration, as the triticales were on the average only a few days later than the wheats.

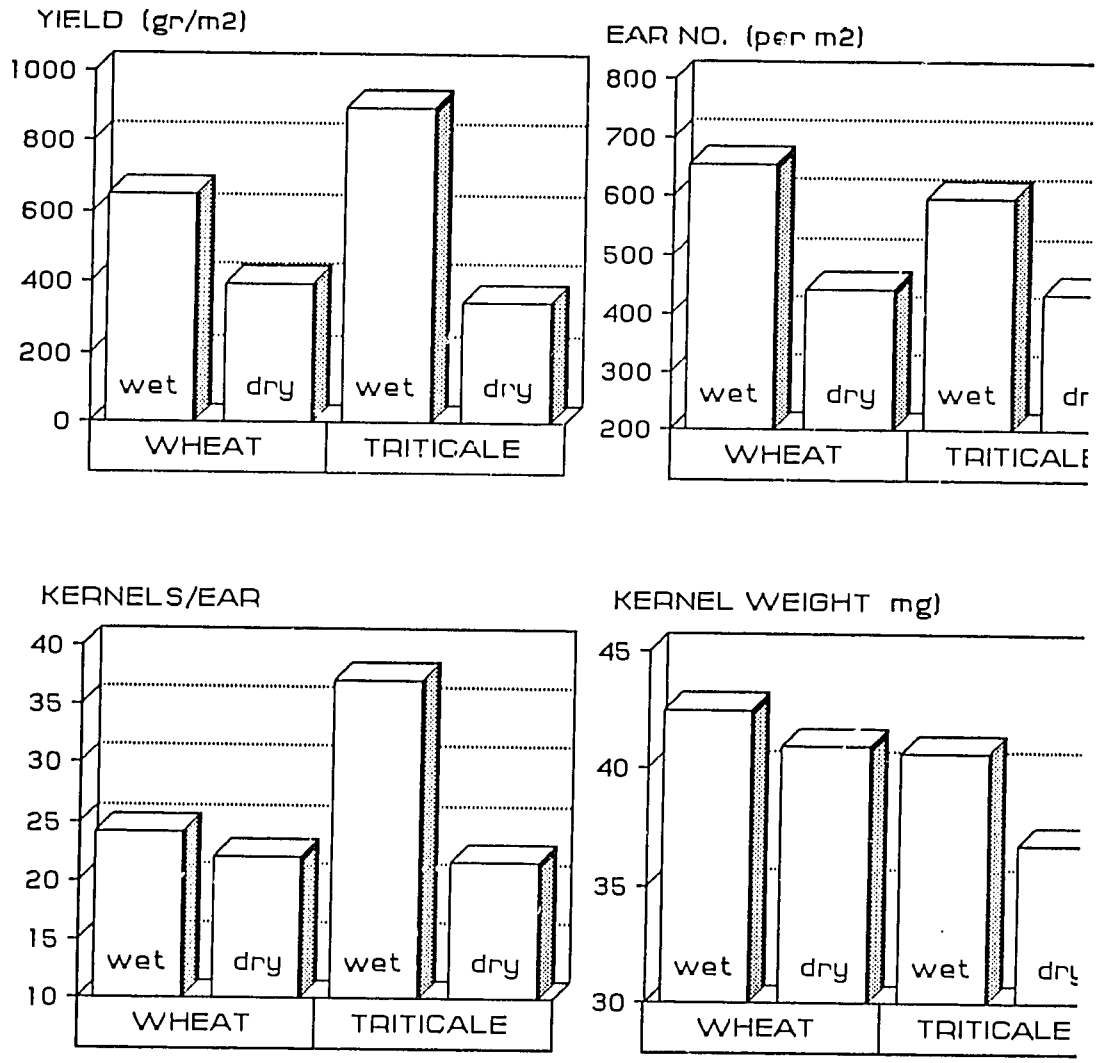

Figure 3: Mean yield and yield components of 9 wheats and 9 triticales tested under optimum conditions at Bet Dagan ("wet") under under water stress at Gilat ("dry").

The mean yield of triticale was relatively more reduced at Gilat ("dry"), as compared with the mean of wheat. The yield advantage of triticale under non-stress conditions was not sustained under stress conditions in Gilat. Yields of the various wheat genotypes in Gilat ranged from 326 to 464 gr m^2, while yields of the various triticale genotypes ranged from 249 to 409 gr m^2. Mean yield of triticale in Gilat was reduced largely because of reductions in ear per m^2, kernels per ear and kernel weight (fig.3). Mean yield of wheat in Gilat was reduced largely because of reductions in ears per m^2. Wheat in Gilat sustained relatively smaller reductions in kernels per ear and kernel weight, as compared with triticale. It can therefore be concluded that while triticales showed a prominent yield advantage over wheat under non-stress conditions, they were relatively more susceptible than wheat to water stress mainly in kernel number per ear and grain filling. These results warrant further investigation of the relative reactions of wheat and triticale to moisture stress.

YIELD STABILITY OF ADVANCED WHEAT BREEDING MATERIALS.

Thirteen varieties and advanced selections of Israeli origin were planted in randomized blocks design with 4 replicates in 11 locations. Data were collected on yield and yield components. Additional data collected (such as canopy temperatures), are not ready for reporting at this time. Yield data were analyzed for stability, as per Finlay and Wilkinson, by the joint linear regression of variety yield on the mean yields of locations. An example of the analysis for two representative varieties is presented in Fig.4.

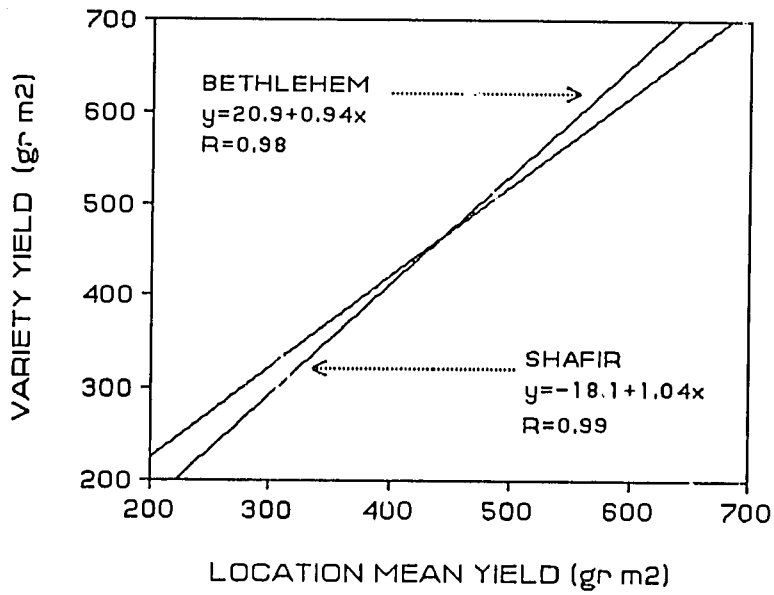

Figure 4: An example of stability analysis for grain yield of two varieties over 11 (n) locations.

'Bethlehem' represents genotypes of relatively superior performance under conditions of low yield (low location mean yields). 'Shafir' represents genotypes of relatively better yield when conditions favour high yields. 'Shafir' is however relatively inferior under low yielding conditions. It has already been established that in such regional wheat variety tests in Israel, the main factor causing variations between location mean yield is the water regime. This can be seen in Fig.5, where yield data of Fig.4 were regressed on total (rainfall and irrigation) in each location.

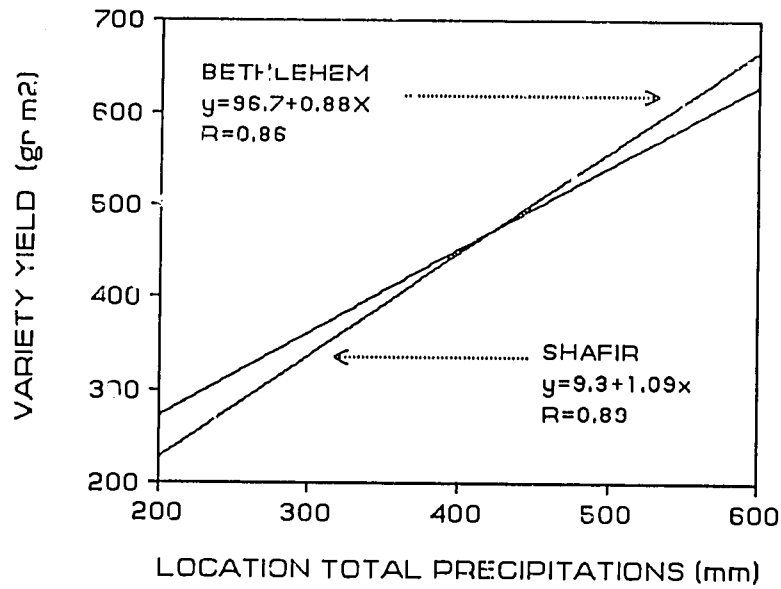

Figure 5: The regression of variety grain yields on total annual precipitations in 11 locations.

Variety 'Bethlehem' again was superior over 'Shafir' under conditions of low water supply (ca. <350 mm). 'Shafir' outyielded 'Bethlehem' when the water regime was optimized. Thus, the stability analysis (Fig.4) is valuable for identifying genotypic responses to variable moisture regimes, under the Israeli test conditions. The results for the stability analysis for all 13 genotypes is summarized in Fig.6.

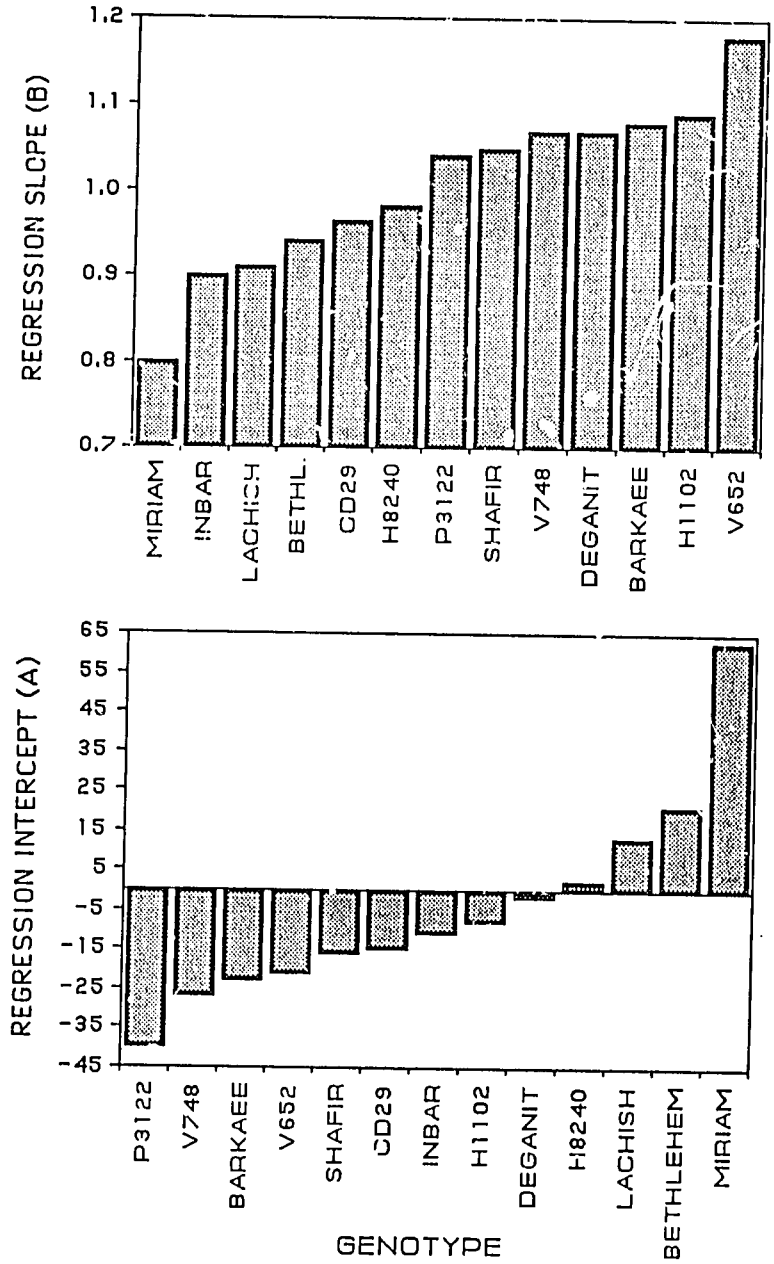

Figure 6: Summary of the stability analysis by the joint linear regression for 13 genotypes over 11 locations. Top: regression slope (b); bottom: regression intercept (a).

It is understood that there is a general negative association between a and b of the joint linear regression. However, within the framework of this association, some significant results can be seen. 'Miriam', 'Bethlehem' and 'Lachish' presented relatively larger slopes, indicating their relative adaptation to conditions of moisture stress. While 'Shafir' was taken above as an example of relatively poor stress adaptation (Fig. 4, 5), poorer varieties in this respect were seen, such as 'P3122'. It is important to note that while 'V652' had the largest slope (indicating excellent response to improved growing conditions), it did not present the lowest intercept among all genotypes.

WORK PLANS FOR THE SECOND YEAR

Work in the second year will concentrate on the following topics:

All data of the first year will be analyzed in time for planning of further experiments.

New breeding materials will be submitted to tests in Gilat and Bet Dagan. Materials tested in the first year will be selected for further testing at both locations. Data on canopy temperatures under stress and chemical desiccation after anthesis will be collected. The response of these materials to heat stress is now under evaluation.

Work on wheat and triticale will be expanded and more detailed tests will be performed under a shelter at Bet Dagan.

Regional testing of advanced selections and varieties will be continued in order to establish the stability analysis over a greater number of locations.