Does our Lack of Knowledge on Genotype-Environmental Relations Hinder Wheat Improvement?

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As many know, our group does not have much respect for variety X location interactions. Such interactions do exist and can be measured, but we feel that varieties can also be developed that are consistent in their performance.

Such an opinion is not based on a few academic studies, but on experience from moving large numbers of breeding lines between countries as well as from results of the international spring wheat yield trials. There are now data from 10 sets of international yield trials. Of these, 4 trials were carried out in the Americas and 3 in the Near East. More recently these were combined into a world-wide test of which some data are available for three consecutive years. These trials combined represent over 150 yield tests in both hemispheres ranging from 35°S to 61° N., long day and short day conditions, fertilized and unfertilized and irrigated as well as dryland conditions. This undoubtedly represents the largest systematic yield testing of genotypes that has been attempted in any crop.

Varieties have been found that tend to do well throughout the spring wheat regions of the world. Sites in which they do not perform well can usually be explained on the basis of disease susceptibility rather than lack of adaptation. Pitic 62 has been the outstanding example of such varieties, but several other Mexican dwarfs show the same pattern. Pitic 62 not only has had the highest yield average over many sites and years, but is also among the highest yielders at the majority of sites. The consistent high yields of these varieties is further substantiated by the fact that between 12 and 13 million acres of them are being grown on the other side of the world from where they were bred.

Thatcher, Selkirk and other U.S.-Canadian wheats have also been consistent in their yield - they are almost invariably the lowest yielders. Such performance might be expected under short day, irrigated conditions, but these yields have generally been disappointing in even those areas where these varieties are of commercial importance.

It is becoming increasingly clear that varieties that have been bred for optimum conditions - particularly as regards fertilizer use - also tend to be superior under sub-optimum conditions. That is, varieties that do well with heavy

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fertilization tend to do at least as well as other varieties without fertilizers. Such performance is not unique to the group of spring wheats included in the international yield trials, but seems to be a widespread and often misunderstood plant breeding principle that applies to many crops. Examples in other crops would be the new dwarf rice varieties and new high yielding sorghum hybrids that are vastly superior with heavy fertilization and also yield as well as older types without fertilizer. Even in corn improvement where variety X location interactions have received so much attention, new prolific hybrids that were bred for dense populations and intensive management are proving to be superior under a wide range of conditions.

In summary, broadly adapted, high-yielding varieties can, and have been produced in wheat. The consistently high performance over a broad area increases the usefulness of varieties and facilitates the exchange of germplasm between crop breeders. It also indicates that greater efficiency will be achieved with strong cooperative regional and international programs in contrast to local, uncoordinated efforts.