RESEARCH PROGRESS IN HYBRID WHEAT

Norman E. Borlaug 1/

A great deal more is known today than a year ago about the factors which will ultimately determine the feasibility of hybrid wheat. Tests during the past year have shown a high magnitude of heterosis, when based on crosses between well adapted, high yielding varieties, and today something is also known of the distribution of heterosis among present day varieties.

During the past year we have conducted in Mexico studies of heterosis involving 25 crosses of related experimental hybrids among varieties within our own breeding program. Sometimes this has involved crosses between two dwarf wheats, but more frequently dwarfs have been crossed with some of the taller former commercial varieties which they have replaced in Mexico. We believed that, if we found usable levels of heterosis in crosses between well adapted wheats in our own program, the level of heterosis would be of even greater magnitude if a broader search was made, using wheats from many different breeding programs. Twenty-three of the twenty-five experimental hybrids tested showed high levels of increase in yield - heterosis - above that of the highest yielding parent. These heterotic responses generally ranged between 18 and 30 percent. The highest heterotic response measured was 43 percent above the highest yielding parent.

The twenty-five experimental hybrids tested were grown under irrigated conditions involving a low degree of experimental error. The yield results were very encouraging for irrigated wheat, where yield levels are generally high, heavy applications of fertilizer are used, and water can be controlled. Based on these results, we are now evaluating 35 experimental hybrids between Canadian spring, northern U. S. spring, Argentinian and Mexican spring wheats, to determine the extent of heterosis in this broader range of materials.

We have milled and baked all of the experimental hybrids from the first year tests, and have found the gluten strength of the hybrid to be about as expected, considering the parents used. When crossing strong by strong gluten type wheats, with one exception, we have obtained strong gluten types in the hybrid, or types more like the strong parent. Weak, soft wheats crossed with strong types have given intermediate types tending toward the soft. We have found that, when crossing Thatcher with certain other strong type wheats, the resulting population will be skewed over toward weaker gluten types than expected. The gluten characteristics of Thatcher appear to be due to several recessive genes, which are difficult to recover in conventional breeding except in long backcrossing programs.

1/ Director, International Wheat Improvement Project, The Rockefeller Foundation, Mexico City

Practically all the commercial wheat varieties now being grown under irrigation in Mexico are dwarfs, semi-dwarfs or double dwarfs. In crossing dwarf varieties with normal height wheats, we have found the F_1 hybrids to be very much like the taller parent in height, and we thus have experienced serious difficulty with lodging with such hybrids. This leads us to believe that it will be necessary to introduce the dwarf characteristic for our conditions into both parents, or use a triple dwarf as one parent in order to keep the hybrid at manageable height. Triple dwarfs have been too short for practical use in conventional breeding programs, so we have discarded them from our program. A dominant gene for dwarfing is urgently needed for hybrid programs. Thus the value of certain parental characteristics can change greatly as we move into a different type of breeding program.

One of the exciting prospects in hybrid wheat development is the opportunity to increase the disease resistance of a self-pollinated crop plant, such as wheat. We have pioneered the use of multilineal varieties developed by mechanically mixing backcrossed lines with different types of rust resistance. When seed of such lines is mechanically mixed, no single race of rust can increase and attack the entire population. This indicates the principle of multilineal varieties. Currently two multilineal varieties, developed for control of stripe rust in Colombia, are being grown successfully. If a good economic hybrid is produced, there is the opportunity to make every plant different in the population of a hybrid by the multilineal hybrid approach. This obviously won't be done with the earliest hybrids, but would be worth doing with an outstanding commercial hybrid. The result would be similar to an open pollinated crop with all of the variability in disease resistance which could give greater stability in efforts to control highly specific pathogens such as the cereal rusts.

Much has been said about the economic possibilities of hybrids by other speakers. My own feeling is that the magnitude of heterosis, which has been clearly demonstrated by many investigators during the past year, is sufficient to make hybrid wheat an economic reality on the irrigated portions of the world's wheat acreage. Admittedly this acreage is very small and unimportant compared to the total wheat acreage. How extensively these present levels of heterosis will permit hybrid wheat to be grown under dryland conditions is not known. However, it seems reasonable to assume that early hybrids will prove most economical in the heavier rainfall areas of dryland wheat production, where maximum amounts of fertilizer can be applied and higher yields harvested to offset the cost of hybrid seed.