UA Research Directed Toward Hybrid Barley

By Robert E. Dennis

Hybrid vigor has played an important role in the improvement of many crops. Corn and sorghum are excellent examples of crops which have been improved by the use of hybrid vigor. However, production of hybrids for crops that are usually self-pollinated, such as barley, has presented some difficult problems. Until now, hybrid barley could be produced only by hand pollination, a costly process.

Dr. R. T. Ramage, research geneticist for the U.S. Department of Agriculture and Professor of Agronomy at The University of Arizona, has developed a procedure to produce hybrid barley using balanced tertiary trisomics. The term trisomic refers to plants which have an extra chromosome in their cells. The cells of normal cultivated barley plants have 14 chromosomes. The trisomic barley plant has 15.

Carries Extra Chromosome

In tertiary trisomics the extra chromsomes number two and seven from a others. The extra chromosome of the tertiary trisomic developed by Dr. Ramage consists of parts of chromosomes number two and seven from a normal barley plant. When the extra chromosome of a tertiary trisomic carries a normal gene for fertility, and the two chromosomes that correspond to it carry genes corresponding to the normal that are defective, then the tertiary trisomic is called balanced.

Defective genes, like male steriles, can be maintained from generation to generation by balancing them with normal genes carried on the trisomic chromosome. Balanced tertiary trisomic plants produce two types of pollen, one with the extra chromosome and one without. Pollen grains with the extra chromosome seldom function in fertilization. Thus, most of the self fed offspring of a balanced tertiary trisomic carry the defective gene, in this instance the male sterile.

These male sterile plants serve as the female parent in commercial hybrid seed production. The self fed offspring of these trisomic plants are about 70 percent diploid, male sterile and normal height and about 30 percent are identical to the parent.

BELOW, MALE sterile head of barley.

PREPARING FLORET for pollination (above) is Louis Lehmann, graduate student working under direction of Dr. Ramage. In photo at right, note that progeny of trisomic plants are about 70 percent male sterile and normal height (at left) and (at right) about 30 percent fertile and identical to the parent.

Balanced tertiary trisomics have only one purpose in the development of hybrid barley and that is production of male sterile plants.

Dr. Ramage found that there were two basic problems to solve in using tertiary trisomics in production of commercial hybrid barley. The few tertiary trisomic seeds which he produced had to be increased to millions of identical seeds, and an economical way of producing the hybrid had to be found.

Increasing and maintaining the tertiary trisomic seed was the first problem. To do this efficiently it was desirable to eliminate male sterile plants. The second problem called for development of a scheme to use the male sterile plants for the cross that would make the hybrid.

Used Marker Genes

In the course of his work, Dr. Ramage introduced marker genes for leaf

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shape. Differences in leaf shape made it possible to identify and remove the unwanted male sterile plants when they were only 6 to 8″ high. After removal of the male steriles, only tertiary trisomics were left for harvest. Thus, the first problem was solved.

The actual production of hybrid seed occurred in the second phase. Seed of the tertiary trisomic and seed of the variety to be used as the male parent were planted in adjacent or nearby rows. In this planting, as in the previous one, about 70 percent of the plants produced by the tertiary were male sterile, diploid (14 chromosomes) and except for sterility, normal in appearance. The very short, almost nontillering tertiary trisomic plants (about 30 percent) in the hybrid barley producing seed field were poor competitors. From a practical standpoint, these plants could be disregarded, since they produced almost no seed above combine cutting height. A variety or line planted near the tertiary trisomic provided pollen and served as the male parent of the hybrid.

Many improvements probably will be devised in this plan for hybrid barley seed production. Dr. Ramage and his associates are trying to develop a method that will eliminate the need for hand pulling of male sterile plants in the trisomic seed increase. Ways to obtain a higher percentage of pollination of the male sterile plants in the hybrid seed field may be developed.

Hybrid barley seed will be more expensive than seed of existing varieties because of increased production costs. Since hybrid barley seed has not been produced commercially using this method, actual cost estimates are not available. Precision and timely planting will help to reduce the amount of seed required per acre and help to keep the cost of seed from being prohibitive.

Yields Should Grow

When there are no complicating problems, grower yields using hybrid barley are expected to be much improved. Most of the yield increases from hybrid barley will result from more tillers and, therefore, more heads per acre. The production of hybrid barley seed using the method described appears practical but many details concerning production practices remain to be worked out.

Dr. Dennis is an agronomist in the Agricultural Extension Service.

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For Two Elevations

2 New Cotton Varieties Are Released

Two new long staple cotton varieties are being released cooperatively by the U. S. Departmnt of Agriculture and the agricultural experiment stations of Arizona, New Mexico and Texas.

The two are Pima S-4 and Pima S-3. The S-4 line is especially adapted to low elevations, the S-3 best for higher elevations.

Pima S-4 is the fruit of research by Drs. Carl V. Feaster and E. L. Turcotte, USDA Agricultural Research Service scientists at The University of Arizona's Cotton Research Center at Phoenix. The S-4 selection is a cross of experimental strain P32 x S1 10-8 and Pima S-2. It has been tested throughout the southwestern cotton belt by federal and state cooperators.

S-4 Similar to S-2

S-4 has a type of plant similar to Pima S-2, the current commercial variety of long staple American-Egyptian cotton. It is well adapted to low elevations, where it gets an early start, begins fruiting relatively low on the plant, and continues fruiting throughout the growing season. It is less subject to lodging than S-2.

On higher elevations it is early and often fruits too low on the plant for efficient machine harvesting, excepting on exceptionally fertile soils.

Arizona preliminary tests in 1963 and regional tests 1964-65 show Pima S-4 with yields 17 percent more than Pima S-2 in six tests over a three year period at low elevations. At intermediate and high elevations S-4 did about the same as the older variety.

S-4 seems to have more tolerance than Pima S-2 to high night temperatures. Also, at low elevations, it is capable of setting more fruit than S-2 during July and August. The Pima S-4 has a slightly lower percentage of lint, longer fiber, similar fiber strength, similar to slightly finer fiber and similar spinning performance, when compared to S-2.

S-3 Has Many Parents

The other new long staple variety, Pima S-3, is a selection from Hybrid B, which was developed at the Far West Texas Research Station, El Paso. Background of Hybrid B was work of Dr. P. J. Lyerly and Dr. L. S. Stith, who mass-crossed Pima S-1, Pima experimental strain 1-71, Tanguis, Ashmouni, Giza 12, Pima 32, various Coastland strains and an Upland strain, C1. This mass-crossing was divided into three groups, one of which was Hybrid B. Dr. E. P. Spivey and, later, Dr. E. F. Young Jr., began making selections from which came the refined Hybrid B.

Pima S-3 begins fruiting higher on the plant, is later and taller than the present commercial variety, Pima S-2. It is adapted to higher elevations, where it begins fruiting at a desirable height on the plant, is less subject to lodging, and is reasonably early excepting where held back by conditions of extremely high fertility.

At lower elevations Pima S-3 is undesirable because it sets fruit late in the season, makes rank vegetative growth and is generally unproductive. At high elevations Pima S-3 is similar in yield to S-2, has a lower percentage of lint, longer and finer fiber, and similar fiber strength. It gives a slightly stronger yarn.

Breeder Seed Available

Regarding seed of the two new American-Egyptian cottons, small amounts of breeder seed of S-3 may be obtained by bona fide seed breeders who write the Far West Texas Research Station at El Paso. Supplies of foundation and certified seed will be distributed through the Texas and New Mexico Crop Improvement Associations, and through the Arizona Cotton Planting Seed Distributors at Phoenix.

Pima S-4 breeder seed in small amounts may be obtained by seed breeders who write the USDA, ARS, at The University of Arizona's Cotton Research Center, Phoenix, or from the Arizona Cotton Planting Seed Distributors, also at Phoenix.