

# Use of an Annual Tester for the Monogerm Conversion of Inbred Lines of Sugar Beets

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The use of monogerm sugar beet varieties by farmers for reduction of spring labor makes it imperative that all varieties, hybrid or otherwise, be monogerm. The breeding program of The Great Western Sugar Company is directed toward the eventual introduction of a male-sterile hybrid of inbred lines. If the hybrid is a 4-way cross, two of the parental inbred lines will have to be monogerm and "O" type (a genotype which in male-sterile cytoplasm causes male sterility).

The inbred lines presently in the stock of Great Western from which combining ability data has been obtained and which are considered uniform enough for hybrid production are all multigerm. Only in the last two or three years has monogerm material of proven value been available for initiating inbred lines.

In anticipating hybrid variety production, all inbred lines that have high general combining ability are indexed for "O" type. A monogerm conversion is initiated of the lines which are "O" type or are segregating "O" type. A few years saved in converting lines to monogerm will result in substantial profit to the grower.

F. V. Owen (2)<sup>2</sup> suggested using an annual cytoplasmic male-sterile tester to speed identifying "O" type plants. The annual which Owen developed for this purpose is in general use by beet breeders.

The identification of plants heterozygous for the recessive monogerm character is practically impossible in the early backcross generations of inbred lines even though plants heterozygous for monogerm have a reduced locule number; much genetic variation in locule number exists because of modifier genes. If heterozygous plants could be identified, backcrossing to multigerm inbred lines could be continued without a segregating generation for the production of monogerm plants upon which to backcross. For identifying monogerm heterozygotes, an annual monogerm strain, segregating for genetic male sterility, was obtained from F. V. Owen, USDA, ARS, Logan, Utah.

In the diagram, a method is outlined for using the annual monogerm tester in the monogerm conversion of multigerm in-

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<sup>2</sup> Numbers in parentheses refer to literature cited.

bred lines. The method involves crossing plants of unknown genotypes of the first backcross generation ( $F_1B_1$ ) to a male-sterile annual monogerm plant. Each corresponding  $F_1B_1$  plant, which has red hypocotyl, is also bagged with a green hypocotyl parental plant or to a parental plant which has been male-sterilized with a selective gametocide, FW450 (1) or FW 676, if the inbred line is homozygous red hypocotyl (With all green hypocotyl and heterozygous hypocotyl color lines, the red hypocotyl gene is used as a cross marker).

The next backcross generation is planted and vernalization is initiated. At the same time the annual test-cross seed is planted and readings for monogerm plants in the progeny are made in about eight weeks without vernalization. Subsequent backcross generations are made involving plants of progenies from parental plants having the monogerm gene as identified by the tester cross; progenies from plants without the monogerm gene are discarded. To extract monogerm plants, a number of backcross plants are intercrossed; without selection and with simple recessive inheritance, one monogerm plant occurs in sixteen plants in the segregating generation.

The value of this method is time saved. Two generations are saved (6 vs. 8) in converting to the third backcross generation,  $F_1B_3$ , and four generations to the  $F_1B_5$ , 8 vs. 12. One year is saved to the  $F_1B_3$  and two years to the  $F_1B_5$  if two generations are produced per year.

In backcross generations beyond the  $F_1B_2$ , it has been possible to identify a high percentage of heterozygotes by phenotype. The number of crosses necessary to assure using heterozygous monogerm plants as parents after the  $F_1B_2$  can be reduced by roguing the highly multiple plants. With some lines, the test cross is not necessary for identifying heterozygotes in later generations if roguing for reduced locule number is carried out.

Backcrossing without extracting the monogerm character has been successful in the conversion of 17 of 18 lines. One line evidently contains a gene or genes of major effect which obscure the monogerm character when the primary monogerm gene is homozygous recessive. A more complicated technique of test crossing and backcrossing might allow continuous backcrossing of this line but the simpler, although slower technique, is the production of a segregating generation and the extraction of the monogerm character in each backcross generation.

The use of a tester line which is a cytoplasmic male sterile would allow control of "O" type during backcrossing. Progress is being made toward the development of such a strain.

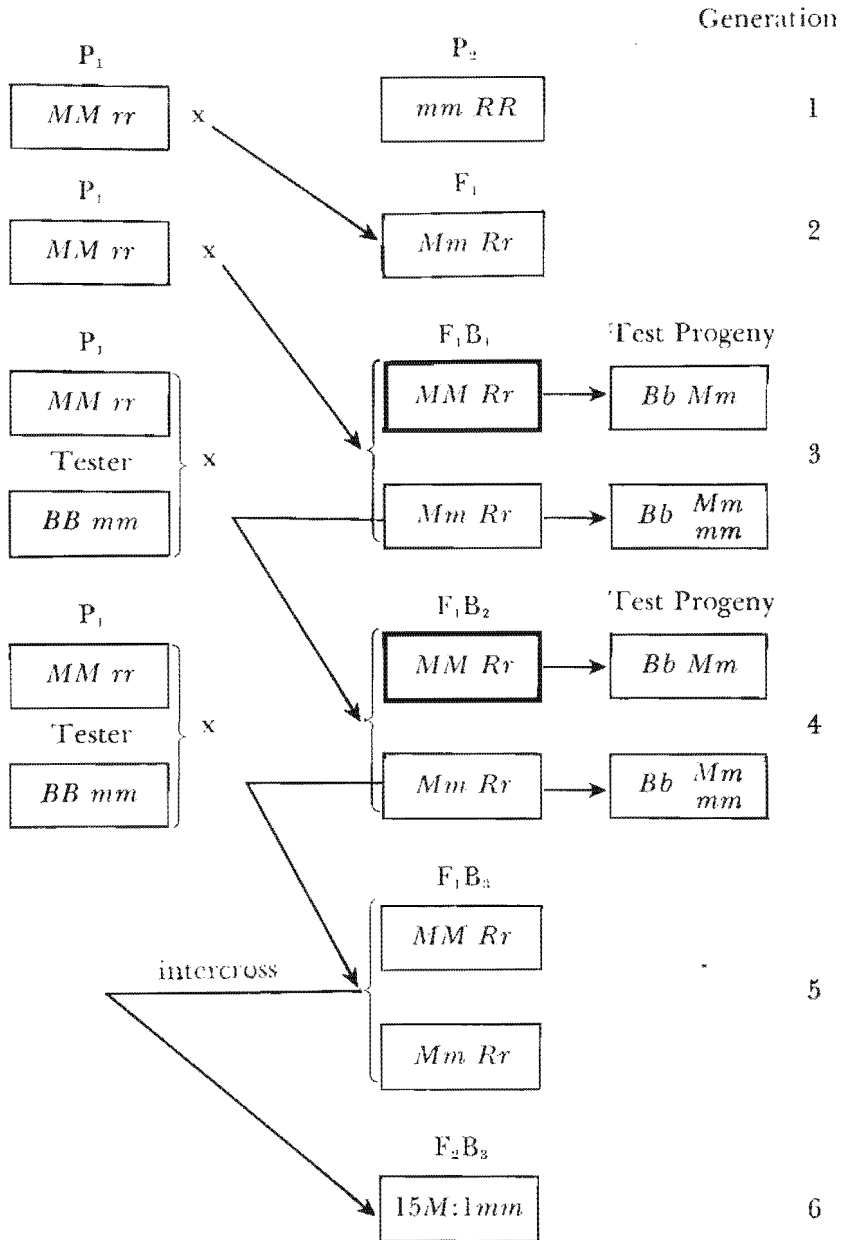


Fig. 1.—Diagram of monogerm backcross conversion of beets using an annual tester to identify the heterozygotes assuming simple recessive inheritance. *M* vs. *m*, multigerms and monogerm genes; *R* vs. *r*, red vs. green hypocotyl; *B* vs. *b*, annual vs. biennial. Encircling with   indicates discarding of all backcross progeny from plants not having the *m* gene.

Inbred lines of Great Western are for the most part self-incompatible, having been developed under environmental conditions conducive to selfing. The true nature of the incompatibility system in beets is questionable; as yet no particular trouble has been experienced in seed set by continuous backcrossing although many of the parental lines are probably homozygous for incompatibility alleles as judged from their sib-incompatibility. Perhaps additional evidence will be forthcoming as to the nature of self-incompatibility in beets as the result of continuous backcrossing.

In several instances in converting "O" type lines, most all backcross hybrid progenies have been male sterile when the non-recurrent parent was used as the female of the first cross and the backcross plant rather than the recurrent parent was the female in subsequent backcrosses. It is assumed that an "O" genotype was introduced into male-sterile cytoplasm which originally was not expressed because of the presence of a restorer genotype. It is, therefore, particularly important that either the recurrent parent be used as the female parent of the original cross or the non-recurrent parent be "O" type.

### Summary

A tester plant which is annual, monogerm and male sterile can be used to identify heterozygous monogerm plants so that continuous backcrossings can be made in monogerm conversion without losing the monogerm gene.

### Literature Cited

- (1) DUDLEY, JOHN W. 1960. Effects of sodium 2, 3 dichloroisobutyrate, a selective gametocide, on sugar beets. *J. Am. Soc. Sugar Beet Technol.* 11: 25-36.
  - (2) OWEN, F. V. 1950. The sugar beet breeder's problem of establishing male-sterile populations for hybridization purposes. *Proc. Am. Soc. Sugar Beet Technol.* 6: 191-194.
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