4-1-1979

Research notes: Selection of a maternally inherited male-sterile trait in soybeans

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1) Selection of a maternally inherited male-sterile trait in soybeans.

The induction of male sterility in soybeans with the use of ethidium bromide (EB) was reported in 1977 (Burton, 1977). Further investigations have provided evidence that the sterility of one of the plants recovered from mutagenesis is maternally inherited.

In 1976, large samples of 'Ransom', 'Jackson' and 'Lee 74' seeds were treated with EB and planted in the field (the M₁ generation). Twelve phenotypically male-sterile plants, 7 Ransom, 4 Jackson and 1 Lee 74, were selected from this population (Burton, 1977). The M₂ progeny from these plants were presumably hybrids, having a random fertile genotype as the male parent. These progeny were expected to be sterile if the induced M₁ sterility was due to cytoplasmic factors, provided a dominant fertility restorer gene had not been contributed by the male parent. The progeny were expected to be male-fertile or a mixture of sterile and fertile if the induced M₁ sterility was due to a single dominant nuclear gene or due to environmental factors.

Seed from the 12 plants selected in 1976 were planted in the field in 1977 (the M₂ generation). Eleven of the 12 had fertile progeny. The other, a selection from Ransom, had only five progeny which survived to maturity, and all had phenotypes characteristic of genetic male-sterile (ms₁ms₁) plants (reduced pod set, mostly one-seeded pods, and they remained green past the normal Ransom maturity). In addition, all of the plants had leaves with more than three leaflets. The seed from these plants were presumably hybrids with an unknown male parent. The plants were bordered on either side by male-fertile Ransom plants which should have increased the likelihood that Ransom was the male parent.

Three or four seeds from each plant were grown in the greenhouse during the 1977-78 winter (the M₃ generation). The multi-leaflet trait was not expressed in these plants. At maturity, 15 plants had pods and 3 plants had none. The plants with pods averaged 14 pods/plant and 1.3 seeds/pod.

References

In the summer of 1978, the remainder of the seed from the 1977 plants was grown in the field (M3 generation) along with the seed from the greenhouse plants (M4 generation). At maturity all of these plants, 96 with 1977-78 greenhouse parents and 64 with the 1977 field parents, had a male-sterile phenotype. In addition, some of the plants from the M3 families and some from the M4 families had the multi-leaflet trait. However, the expression of this trait was not as pronounced as it was in the M2 generation and the segregation pattern of the trait did not suggest single gene inheritance.

All plants in the M1, M2, M3 and M4 generations had male-sterile phenotypes in the field environment which is good evidence that the trait is maternally inherited. Pods with seeds are rarely produced on genetic male-sterile (ms1ms1) plants grown in the greenhouse, presumably due to a lack of insect pollen vectors. Therefore, the occurrence of full pods on 15 of 18 M3 plants grown in the greenhouse may have been the result of an environmental restoration of male fertility. Environmental influences on fertility restoration of cytoplasmic male-sterility has been reported for other plant species, notably Triticum (Wilson, 1968) and Nicotiana (E. A. Wernsman, personal communication). Because the progeny of these plants were phenotypically male-sterile in the field, any male-fertility restoration which occurred in the greenhouse must have been nonheritable.

Study of these male-sterile lines is continuing in order to further characterize the phenotype, as to flower morphology and pollen viability. Methods of restoring fertility will also be investigated. A cytoplasmic male-sterile soybean line should be quite useful to soybean geneticists if a genotype can be found which will restore fertility in hybrid combination with the sterile line.

References

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