

Interspecific Hybrids in the Genus *Beta*

R. K. OLDEMEYER AND H. E. BREWBAKER¹

Vulgares x Patellares Hybrids

The species in the section *Patellares* Transch. of the genus *Beta* L. have many characters—nematode immunity, leaf-spot (*Cercospora*) and curly top resistance, and monogerm seed—which if transferred to sugar beets, would be of great economic importance. Initially the block preventing the transfer of these characters was the inviability of the F_1 hybrids, with one exception; Stewart grew an F_1 hybrid which produced additional generations but eventually all succumbed (3)². Sterility of the F_1 hybrids blocked transfer after hybrids were grown to maturity following grafting (1) and the use of bridge hybrids (2) (4).

A search for a race or species in the section *Vulgares* Transch., which would allow the production of many viable F_1 hybrids with *Patellares* species, was begun by the Great Western Sugar Company in 1951. Viable but sterile bridge hybrids were obtained in some crosses (4).

Crosses involving the Detroit Dark-Red variety of table beet with *Beta procumbens* Chr. Sm. and *B. Webbiana* Moq. were made in 1953. Most of the F_1 hybrids were viable with a growth habit similar to the hybrids with Swiss chard reported by Gaskill (2). The heavy anthocyanin pigmentation from the table beet carried over to the hybrids, however. Fifteen hybrid plants flowered profusely, but on exposure to sugar beet pollen, only one seed was set. No sound pollen was found when squashed anthers were stained with acetocarmine. The one seed has produced a weak plant which will probably die before it flowers (Photo 1).

Another cross involving an annual wild beet, *Beta maritima* L. with *B. procumbens* and *B. Webbiana* resulted in viable hybrids. Two hybrid plants (*B. maritima* x *B. procumbens*), morphologically identical and quite similar in growth habit to the *B. macrocarpa* x *B. Webbiana* hybrid reported by Oldemeyer (4) in 1954, flowered in 1955. One was completely sterile; about 4 percent of the flowers of the other produced seeds. Four other F_1 plants from the same crosses will flower in 1956.

About 1,000 seeds were harvested from the semi-fertile hybrid following pollination with sugar beet pollen. When the embryo cavity was exposed after the pericarp had been trimmed with a razor blade in scarification, many seeds contained only empty brown embryo sacs indicative of embryo abortion. Many seeds contained fully developed embryos, and about 400 seeds were saved. A progeny of 56 backcross plants is being grown. For the seeds saved, a yield of about 45 plants per 100 seeds was obtained. Many additional progeny will be obtained in the future; the original plant is thriving, and it is also being vegetatively propagated by clones.

The oldest backcross progeny are thriving, and the leaf rosettes resemble sugar beets closely (Photo 1). The petiole veins are deeply pigmented

¹ Plant Breeder and Director, respectively, Agricultural Experiment Station, The Great Western Sugar Company, Longmont, Colorado.

² Numbers in parentheses refer to references.



Figure 1.—Three thrifty progenies, background, of a *Beta maritima* x *B. procumbens* hybrid resulting from pollination with sugar beets. A weak progeny, foreground, of a red table beet x *B. procumbens* hybrid, resulting from pollination with sugar beets.

which could have been transmitted from either parent of the original hybrid. Under cold temperature, 50° to 55° F., and short day length, the plants show no signs of bolting.

The success of this particular cross was probably dependent on the *B. maritima* source, PEI 206411, an introduction from Turkey. Other *B. maritima* crosses have proven unsuccessful, and there have been no observed differences in crosses where various races of the *Patellares* species have been used (4).

It is hoped that sufficient interspecific chromosomal pairing and crossing-over will take place in the hybrid plant, and that some of the backcross progeny will carry germ plasm for the desirable traits present in the *Patellares* parent. If some of the desirable germ plasm is passed on to the progeny it may be possible to recover it in plants cross compatible with sugar beets. It would then be only a matter of backcrossing to incorporate the traits into sugar beet varieties.

This hybrid is most encouraging. No polyploid barrier exists, as would be the case if fertility were restored by chromosome doubling. With the possibility of producing a multitude of backcross progeny, the chance of recovering nematode resistance, disease resistance, and monogermness, in a useable form may be within reach.

Vulgares x Corollinae Hybrids

The species *Beta lomatogona* F. et M., *B. intermedia*. Bunge, *B. macrorrhiza* Stew. and *B. trigyna* W. et K. in the section *Corollinae* Transh. probably do not contain as spectacular germ plasm as the species in the section *Patellares*. However, they are extremely interesting for the cold-resistance germ plasm they contain. All are long-lived perennials, and at Longmont, Colorado, many are 14 years old and still alive. It may also be possible that these species carry cytoplasm for male-sterility in sugar beets which is not presently available.

Five *B. vulgaris* (sugar beet) x *B. intermedia* hybrid plants were obtained in 1939. These plants grown in 1940 were transplanted to a permanent garden location in 1941 where one F₁ root survived 12 winters without protection (Photo 2).

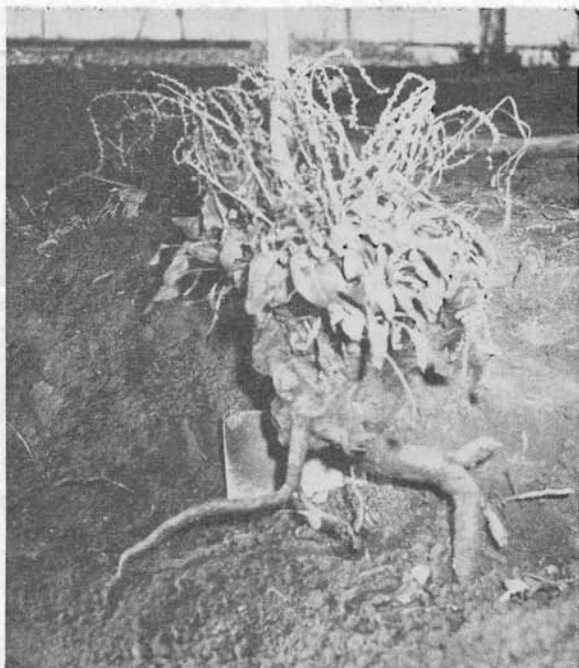


Figure 2.—A sugar beet x *Beta intermedia* hybrid with exposed roots after growing for 12 years.

Morphologically the hybrid plant was nearer its *B. intermedia* parent than sugar beet, although such characters as leaf smoothness and flower bracts showed the *B. vulgaris* parentage. The plant was highly sterile, but a total of nine offspring have been obtained following pollination by *Corollinae* plants of the species *B. lomatogona*, *B. intermedia*, and *B. trigyna*, and by sugar beet plants. Three of the offspring resembled sugar beets, had none of the *Corollinae* characteristics, and were fully fertile. Three were highly sterile and similar in growth habit to the F₁ hybrid, and three had all the characteristics of the *Corollinae* parent and were fully fertile. The viable gametes evidently contained either a full set of *Vulgares* or

Corollinae chromosomes to produce such progeny, indicating the chromosomes of the two species are non-homologous. It may be quite difficult, if not impossible, to transfer *Corollinae* germ plasma to sugar beets.

To determine the extent to which the *Corollinae* will hybridize with sugar beets, a group of cytoplasmic male-sterile sugar beets were planted in the perennial nursery in 1952, at Longmont, Colorado, which contained plants of *B. lomatosogona*, *B. intermedia*, and *B. trigyna*. The chromosome number of some of the sugar beet plants had been doubled by colchicine. A great number of hybrid seedlings were produced which were easily identifiable by their slow growth and intermediate growth habit. All were highly sterile and only a few seeds were produced. Characteristic growth types were present, clearly indicating the three *Corollinae* species had participated in pollination.

Two changes in technique would be desirable in future hybridization. The use of "Mendelian" male-sterile sugar beet parents to produce large numbers of hybrids rather than cytoplasmic male-steriles would eliminate male-sterility problems in later generations. If the *Corollinae* species were used as the female parent, cytoplasm which would cause male-sterility in sugar beets could express itself in advanced generations, if present.

Summary

Hybrids of Detroit Dark-Red table beet with *B. procumbens* and *B. Webbiana* are quite viable but highly sterile. Two hybrids of *B. maritima* x *B. procumbens* flowered. One was highly sterile, the other produced a number of seeds when exposed to sugar beet pollen. Others of the same type of hybrids, one involving *B. Webbiana*, will flower in 1956. The offspring resulting from pollination of the semi-fertile hybrid with sugar beets are quite thrifty, and there is hope that the desirable traits of the *Patellares* species can be transferred to sugar beet. The success of the cross is attributed to the *B. maritima* parent (PEI 206411).

A long-lived hybrid between sugar beets and *B. intermedia* is reported. Its progeny indicates there is little homology between the chromosomes of the two species. Hybrids of sugar beets with *B. lomatosogona*, *B. intermedia*, and *B. trigyna* are also reported.

References

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