

Naturally Occurring Hybrids Between Sugarbeet and *Beta macrocarpa* in the Imperial Valley of California

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Introduction

Wild beets occur in most of the older beet-growing areas of California. In 1928, Carsner (1)² reported wild beets in Imperial, Santa Clara, Ventura, San Bernadino, Los Angeles, and Orange Counties. He speculated that these wild beets were either *Beta maritima* L. or hybrids that arose from natural crosses between this species and the cultivated beet. Sugarbeets were not grown commercially in the Imperial Valley in 1928, and Carsner thought that this was the only locality in which the original wild beet occurred. He was of the opinion that the wild beet had been introduced into California as a contaminant in some kind of seed.

Dahlberg and Brewbaker (3) theorized that wild beets found in Santa Clara County were either the descendants of cultivated sugarbeets introduced into the area about 1856 or beets of various types introduced by the Franciscan Fathers between 1770 and 1780. Johnson and Burch (4) observed that the biennial sugarbeet could, in a few generations, evolve into a wild annual beet that persisted as weeds along highway rights-of-way and other noncrop land areas. Many of our present wild beets probably arose in this manner.

Description and Taxonomy of the Imperial Valley Wild Beet

Wild beets continue to be widely distributed in the Imperial Valley. The plants tend to grow in clumps or colonies along irrigation ditches or in areas where waste water accumulates, and are frequently found in soils with a high salt content. Seed typically germinate in the fall. The plants have a prostrate growth habit and often spread in a mat-like fashion (Fig. 1). The first leaves resemble those of the cultivated beet, but the stem leaves are poorly developed and resemble bracts. They are lanceolate, medium green, and thick. At maturity, the bract-like leaves turn light red and are brittle. Plants typically have 5 to 10 stems. Seed stalks 1 to 2 feet in length form early, and the plants flower in January. Seed are mature by mid-March. The fruits are large with three to five germs, have large long sepals, and frequently display a cup-like depression on top of the fruit. The taproot is rarely more

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²Numbers in parentheses refer to literature cited.



Figure 1.—*Beta maritima* (left), Imperial Valley wild beet (right).

than $\frac{1}{2}$ inch in diameter and usually has small lateral roots. Stems, roots, and fruits are strongly colored with anthocyanin.

Comparisons were made in the field and greenhouse at Salinas, California, between the Imperial Valley wild beet and collections of *B. maritima* and *B. macrocarpa* Guss. species. The plant and root characteristics of the Imperial Valley wild beet were almost identical to those of *B. macrocarpa* collected in the Canary Islands by G. H. Coons. Both lots were characterized by a strong annual character and by large seed. The plants of *B. maritima* species more nearly resembled the cultivated beet (Fig. 1). The leaf rosette was semierect, and the leaves were dark green with long petioles and large blades. The plants were annuals, but were just starting to bolt when the seed of the Imperial wild beet was mature. The taproots were 1 inch or more in diameter and had many branch roots.

Botanists have differed in their classification of the section *Vulgares* of the genus *Beta*. Transhel (6), Ulbrich (7), and Coons (2) considered *B. macrocarpa* a separate species. Zosimovitch (8) placed *B. macrocarpa* and other closely related wild forms into the species *B. vulgaris* L. Krasochkin (5) classified *B. macrocarpa* as a variety of *B. maritima*. The wild beet found in the Imperial Valley differs

significantly from the typical *B. maritima* and from other wild beets found in California. The classification proposed by Transhel, Ulbrich, and Coons for *B. macrocarpa* has been followed, and the Imperial wild beet is assigned to this species.

B. macrocarpa occurs along the Mediterranean coastline and on the Canary Islands. Introduction to the Imperial Valley occurred prior to 1928 and probably as a contaminant in either feed grain or agricultural seeds. The species has not been reported from other parts of the United States.

Hybrids Between *B. macrocarpa* and Sugarbeet

Commercial sugarbeet production started in the Imperial Valley in 1937-38. The beets were grown as a winter crop and were planted in September and October for harvest between April and July. Varieties available in 1937 had only moderate bolting resistance, and most fields contained a low percentage of bolters. Many of these bolting plants produced mature seed prior to harvest. The sugarbeet crosses readily with *B. macrocarpa*, and the possibility of natural hybridization existed. One plant with a growth habit intermediate between sugarbeet and *B. macrocarpa* was observed in a fence row south of Brawley in 1958. Plants arising from the seed of this plant resembled the progeny of a known hybrid between these two species.

No other natural hybrids were observed in the Imperial Valley until March 8, 1973, when numerous bolting plants were found in a sugarbeet field 2 miles west of Imperial, California. The bolters occurred in patches throughout one end of the field. The seed stalks were erect or semierect and usually had a distinct red pigmentation. Flowering had not occurred.

This field and others in the general area were visited again on April 25. Considerable variation was noted in growth habit, maturity, and root characteristics of the bolting plants (Figs. 2,3). Some plants were semiprostrate and had distinct red pigmentation in the seed stalks and leaves. Others were erect, grew 2 to 4 feet high, and typically had streaks of red pigmentation on the seed stalks. The number of seed stalks per plant varied from one to several. The fruits had from two to five germs. Some plants had mature seed, whereas others were still in flower. Root size and shape were variable. The taproots of some plants were less than $\frac{1}{2}$ inch in diameter, whereas others were 1 inch or more in diameter. Number and size of branch roots also varied. Root color ranged from white to pink.

Wild beets with the characteristics of segregates from hybrids between sugarbeet and *B. macrocarpa* were observed in scattered sugarbeet fields throughout a 10-to-12-square mile area west of Imperial. The number of bolters varied from field to field and from one part of a field to another. The bolters tended to occur in patches or colonies. One field contained an infested area of several acres with 25% bolters.



Figure 2.—Wild-beet hybrids in a sugarbeet field at Imperial, California (April 25, 1973).

Many of these plants produced mature seed prior to beet harvest. Frequently, plants of the *B. macrocarpa* species were also found in these fields.

The occurrence of natural hybridization between sugarbeet and *B. macrocarpa* is apparently limited to this one area west of Imperial. The *B. macrocarpa* species is widespread throughout the Valley and occurs as a weed in several fields. Natural crossing can occur only when the two species flower at the same time. Bolting-resistant sugarbeets are grown in the Imperial Valley, but usually a few bolters occur in most fields. In years favorable for the induction of bolting, the number may reach 1 to 3% in some fields. These bolters usually appear in April, and the plants do not flower until May or early June. The *B. macrocarpa* plants normally flower in January and February. This great spread in flowering date accounts for the infrequency of hybridization between the two species.

When *B. macrocarpa* occurs in cultivated fields, the date of seed germination is determined by the cropping schedule. As an example,

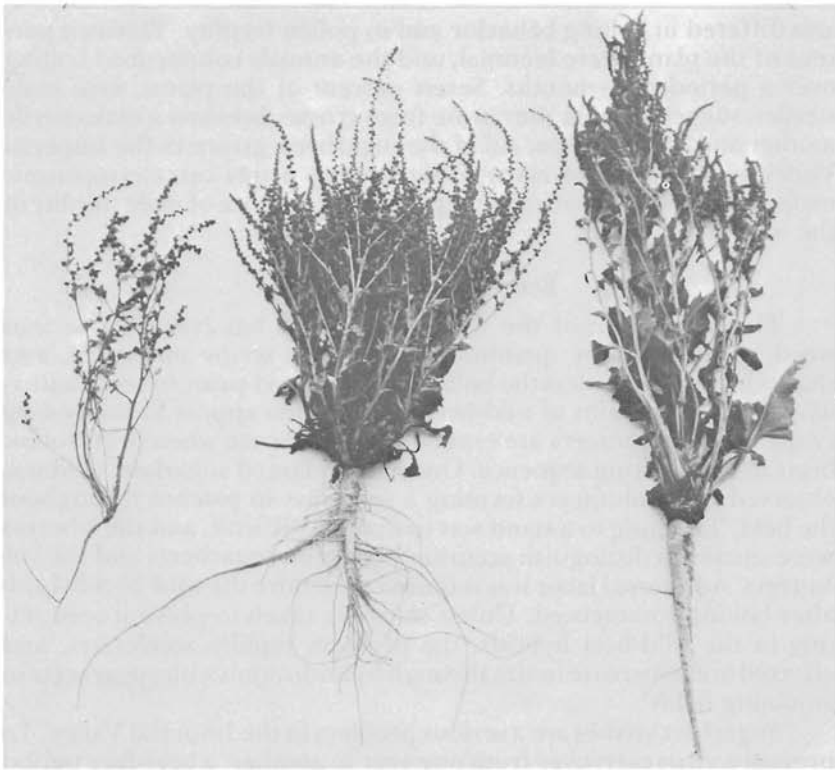


Figure 3.—*B. macrocarpa* (left) and segregates from a sugarbeet x *B. macrocarpa* cross.

grain fields are frequently sown in December or later and are maintained in a fallowed condition until the grain is sown. Usually rainfall is very low, and a portion of the *B. macrocarpa* seed does not germinate until the fields are irrigated. Plants from this late germinating seed do not flower until March or later. When sugarbeets are grown in an adjacent field, the flowering of an early-bolting sugarbeet plant occasionally matches that of a late-germinating *B. macrocarpa* plant. Hybrid seed produced on the sugarbeet plant shatters before the sugarbeets are harvested, and volunteer hybrid beets could grow the following year. Unless they were destroyed, the hybrids would interpollinate and form a colony of wild-beet weeds.

The crosses between sugarbeet and *B. macrocarpa* that gave rise to the colonies of wild beets apparently occurred several years ago and remained undetected until 1973. Great variability was observed among the plants in these wild-beet colonies, indicating that segregation and backcrossing to sugarbeet and possibly to *B. macrocarpa* had taken place. A seed composite from these wild beets was grown in the field at Salinas in 1974. The plants not only varied greatly in plant type, but

also differed in bolting behavior and in pollen fertility. Thirteen percent of the plants were biennial, and the annuals commenced bolting over a period of 3 months. Seven percent of the plants were male steriles, suggesting that they arose from crosses between a male-sterile mother and *B. macrocarpa*. All of the sugarbeets grown in the Imperial Valley are hybrid, and many of the bolting plants carry cytoplasmic male sterility. This inheritance explains the presence of male sterility in the wild-beet hybrids.

Economic Importance

The occurrence of the wild-beet hybrids has created a serious weed problem. Large quantities of seed are set by mid-April, and shattering occurs, unless the bolters are removed prior to seed maturity. Large populations of wild-beet hybrids then appear in succeeding crops. These volunteers are especially troublesome when beets follow beets in the planting sequence. One newly planted sugarbeet field was observed with volunteers forming a solid mat in patches throughout the field. Thinning to a stand was extremely difficult, and the laborers were unable to distinguish accurately between sugarbeets and the volunteers. Additional labor was required to remove the wild-beet hybrids after bolting commenced. Unless steps are taken to prevent seed setting in the wild-beet hybrids, the problem rapidly accelerates, and affected areas increase in size through hybridization with sugarbeets in adjoining fields.

Sugarbeet viruses are a serious problem in the Imperial Valley. To prevent a virus carryover from one year to another, a beet-free period is observed between sugarbeet crops. The effectiveness of the beet-free period is diminished when plants of virus susceptible wildbeet hybrids occur as weeds in crops other than sugarbeet. Likewise, these wild-beet hybrids are susceptible to the sugarbeet nematode, and population levels of the nematode increase in infested fields planted to either sugarbeet or other crops.

Control Measures

The best way to avoid the wild-beet hybrid problem is to prevent crossing between sugarbeet and *B. macrocarpa*. Precautions should be taken to remove any *B. macrocarpa* plants that occur along ditch banks, headlands, and other noncrop areas. If *B. macrocarpa* occurs as a weed in cultivated fields, care should be taken to avoid a cropping sequence permitting *B. macrocarpa* to flower at the same time as the sugarbeet. If danger of interpollination with sugarbeet exists, seed stalks should be removed from nearby sugarbeet fields prior to seed maturity.

Should control be neglected or the presence of hybrids go undetected, a high population of wild-beet hybrid seed may build up in the soil. When it does, sugarbeet production should be avoided for a few years. The heavily infested fields can be planted to grain or other crops that can be either treated with a selective herbicide or clean cultivated.

If these precautions are taken, little difficulty should be experienced with sugarbeet \times *B. macrocarpa* hybrids.

Summary

Wild beets identified as *B. macrocarpa* are widespread in the Imperial Valley of California. Seeds of this species are thought to have been introduced from the Mediterranean area prior to 1928. *B. macrocarpa* crosses readily with the cultivated sugarbeet, but crossing is normally prevented by a wide difference in flowering dates for the two species. Hybridization apparently occurred a few years ago in an area west of Imperial, California. Intercrossing has taken place, and wild-beet hybrids that vary greatly in plant and root characteristics occur in a 10-to-12-square mile area. These wild beets and wild-beet hybrids create a serious weed problem, especially in sugarbeet fields. Control can be obtained through removal of *B. macrocarpa* from noncrop areas and by prevention of hybridization with sugarbeet. When fields become badly infested with wild-beet hybrid seed, sugarbeets should not be grown until the infestation is brought under control.

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