

Safflower germplasm: domesticated and wild

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In the first half of this century safflower (*Carthamus tinctorius*) was grown for oil over a wide area of south central India and, to a limited extent, in western Turkey and Upper Egypt. It was grown on a very small scale for the flowers which served as a source of dye to color foods (the poor man's saffron) over a much wider area of the Middle East. Culture for the flowers was disappearing and, under U.S. assistance programs, introduced safflower germplasm was, in some cases, replacing local types. Fortunately collections of local types began in 1958, before it was too late. There are now about 1,500 entries in the safflower collection of the U.S. Department of Agriculture.

Research begun at Davis in 1947 and enhanced by the germplasm collection, played an important role in establishing safflower as an oilseed crop in California. Commercial production began in 1950, and grew rapidly to a high of 341,000 acres in 1966. The annual average for 1965 to 1974 was 229,000 acres, producing a crop with an average annual farm value of approximately \$25.7 million. Safflower has been a particularly successful alternate crop for rice and cotton.

All safflower collections are routed through the Plant Inspection Station in Washington, D.C., where seeds are examined and treated to prevent the introduction of pests and diseases. H.L. Hyland of the Germplasm Resources Laboratory in Beltsville, Maryland has received, accessioned, and catalogued all introductions of safflower. The first year of introduction, samples are grown by the U.S.D.A. at the Plant Introduction Station at Pullman, Washington, distant from commercial acreages of safflower. A.M. Davis evaluates, maintains, and distributes seed stocks of all collections.

Value of the world safflower collection

The world collection found many uses:

■ An introduction from India was the source of a gene providing an oleic type safflower oil, chemically like olive oil (*California Agriculture*, December,

1965), and low in linoleic acid. A corn-oil type found in Iran can be used if there is a demand for it.

■ The world collection provided species resistant to Fusarium wilt which appeared on safflower in California. A wild species from southern Iran, closely related to the species cultivated in California, provided the highest level of resistance to rust. Currently, selections from the world collection are being evaluated for resistance to *Phytophthora* root rot.

■ A research station in northwestern Mexico produced a very early type of safflower from seed grown from the world collection. In breeding programs in the United States, it is used as a parent for earliness.

The world collection is a valuable international resource. Seed from the collection is used by most stations conducting safflower research in the U.S., and also in many other countries. The most comprehensive evaluation of the collection was made by Amram Ashri at the Hebrew University, Rehovot, Israel. Evaluations are now under way at the Punjab Agricultural Research Institute



Crossing safflower pollen in controlled breeding takes

at Lyallpur, Pakistan, and at the Nimbkar Agricultural Research Institute in India. One especially valuable benefit of this international cooperation to the United States is advance information on sources of resistance to pests and diseases not yet introduced here.

Wild species

The University of California has assumed leadership in studying species relationships in safflower. Five chromosome categories were found. Safflower species have either 10, 11, 12, 22, or 32 pairs of chromosomes. The cultivated species and at least three wild species have 12 pairs of chromosomes and are closely related, permitting an easy transfer of useful genes from the wild to the domesticated species. The wild species, as successful weeds in the Middle East and North Africa, have accumulated genes for vigor, and for disease and insect resistance. These wild species may well prove to be the most important source of valuable germplasm.

Although care has been taken to prevent the escape of weedy types into

California agriculture, two (*C. lanatus* and *C. baeticus*) have probably been here for 75 or more years (*California Agriculture*, April, 1958), and a third (*C. leucocaulos*), presumably from Australia, is a recent arrival.

The future

Some directions germplasm studies of safflower should take are:

- Collections should be obtained from additional areas, such as mainland China and southeast Asia.

- The area of adaptation of safflower should be expanded. Winter hardy types identified by N. Ghanavati in Iran have recently been introduced to the United States. Even greater winter hardiness is being transferred from a wild species to cultivated safflower by L.H. Zimmerman, U.S.D.A., at the University of Arizona. Safflower might be grown in coastal areas of California or humid areas of the Great Plains if resistance to diseases favored by high humidities could be found or developed.

- Cytoplasmic male sterile types should be developed for producing hybrids. Transfer of the nuclei of the domesticated species into the cytoplasm of a wild species may result in cytoplasmic male sterility as it did in wheat.

- Safflower potential at higher chromosome levels (polyploidy) should be explored. Examples of successful polyploid crop plants are: bread and durum wheats, the recently developed triticales, cotton, strawberries, and alfalfa. Similarly, could the cultivated species of safflower having 12 pairs of chromosomes be successfully combined with species having 10 and 11 pairs?

- Changes in the mating system should be explored. Although safflower is self-pollinated, its most successful weedy relatives are cross-pollinated. If there is some benefit from cross-pollination, it could be transferred to the cultivated type.

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care and patience.