The tepary bean, Phaseolus acutifolius, is native to the southwestern United States and northwestern Mexico. It was domesticated in pre-Columbian times by indigenous Indians and is well adapted to hot, arid regions. This was well illustrated in field studies conducted at the University of California at Riverside during the hot, dry summer months of 1980 and 1981. Replicated plantings of 3 tepary and 3 common bean cultivars were furrow-irrigated for 48 hours at planting, but received no further irrigation or rain. Common bean cultivars failed to produce seed in either year under these stressful conditions, but in 1980 the teparies gave low yields of up to 440 kg/ha based on 11.25 sq. m. plots consisting of 100 plants. Data for 1981 are not yet available.

Teparies were also more disease resistant and tolerant of insect pests than common beans. In the 1980 planting, virtually all common beans showed symptoms of charcoal rot, Macrophomina phaseolina, which contributed to mortality. Only a few teparies showed disease symptoms and none died. In 1981, a heavy infestation of lesser cornstalk borer, Elasmopalpus lignosellus, caused almost 100% mortality in common beans. In tepary plantings, differing levels of tolerance were evident ranging from 72% mortality to 39% mortality in different cultivars. Many tepary plants showed damage, yet survived to produce seed, indicating tolerance rather than resistance to lesser cornstalk borer.

Also, preliminary data obtained at UCR indicates that teparies are tolerant to levels of boron in soil that cause toxicity symptoms in common beans.

The sum of these traits makes the tepary bean of interest as an under-exploited crop for dryland areas. However, work at UCR has focused on teparies as a source of genes for the improvement of common beans through interspecific hybridization. Some of the disease resistance and pest tolerance characters may be simply inherited and therefore relatively easy to transfer. Heat and drought tolerance almost certainly are complex characters with both physiological and morphological components. If all components are necessary to produce significant heat or drought tolerance, the chance for successful transfer of these characters is slim. On the other hand, if one or two components are much more important than others, it may be possible to transfer a useful degree of tolerance. Root length may be one important component contributing to drought tolerance in tepary beans. Using a neutron soil moisture probe, it was found that teparies grown at UCR were able to extract stored soil moisture from soil depths greater than 2 meters, while common bean roots did not penetrate below the top meter of soil (1). When planted in 1.5 meter tall pots and examined weekly during the first month of development, teparies were found in every case to have longer root systems than the common bean.

Problems arise both in the production of P. vulgaris x P. acutifolius F₁ hybrids and in overcoming the sterility of the F₁ plants. Most crosses were made using P. vulgaris as the female parent, since the larger flowers
were easier to emasculate. Common bean cultivars Light Red Kidney, Dark Red Kidney, Gloria Pink, Sutter Pink and Masterpiece yielded hybrid embryos with every cross-pollination, while Small White cultivars had a much lower success rate. The reciprocal cross was also successful, but less frequently.

Hybrid embryos began to abort 2 to 3 weeks after pollination, with the exception of crosses between a wild P. vulgaris line and a wild tepary. The latter produced some mature seeds and yielded F1 hybrids after difficult germination. All other crosses required embryo culture. Using a modification of the system devised by Mok et al. (2), plantlets developed fairly successfully, but most were lost in the transfer step from culture medium to potting mix. Ways to increase the success of this step are being tested, including use of liquid culture medium to reduce root damage in transfer, use of indole butyric acid to promote root development, incorporation of shredded sphagnum moss in the potting mix, and use of a growth chamber in which environmental conditions can be closely controlled following transfer.

Sterility in F1 hybrid plants was formidable. In most cases, only 5-10% of pollen was stainable with aceto-carmine. Hybrid plants produced small pods which contained neither developed ovules nor embryos. These form even when flowers are emasculated, and thus the pods seem to be parthenocarpic. Attempts to overcome F1 sterility by production of allotetraploids using colchicine have been unsuccessful.

In spite of F1 sterility, some F2 seed has been obtained (3). Fertility of F2 plants varied, but in most cases was sufficient to yield F3 seed spontaneously. Backcrosses to both parental species, using F1's as female parents, have also succeeded, resulting in progeny with improved fertility. Some segregating materials derived from backcrosses to P. vulgaris were planted in single rows ten feet in length in July 1981, together with common bean cultivars. Plants received an initial irrigation at planting and one additional irrigation at flowering. A combination of heat, drought and lesser cornstalk borer predation caused high mortality in the common bean cultivars. Some of the material derived from interspecific crosses survived the drought and pests and produced a small quantity of seed after daytime temperatures began to decline in the fall. This suggests that some drought and pest tolerance has been transferred, but not much heat tolerance. An experiment is now underway to determine how backcrossed and F4 materials grown under drought conditions compare with parental species with regard to root length.

References

