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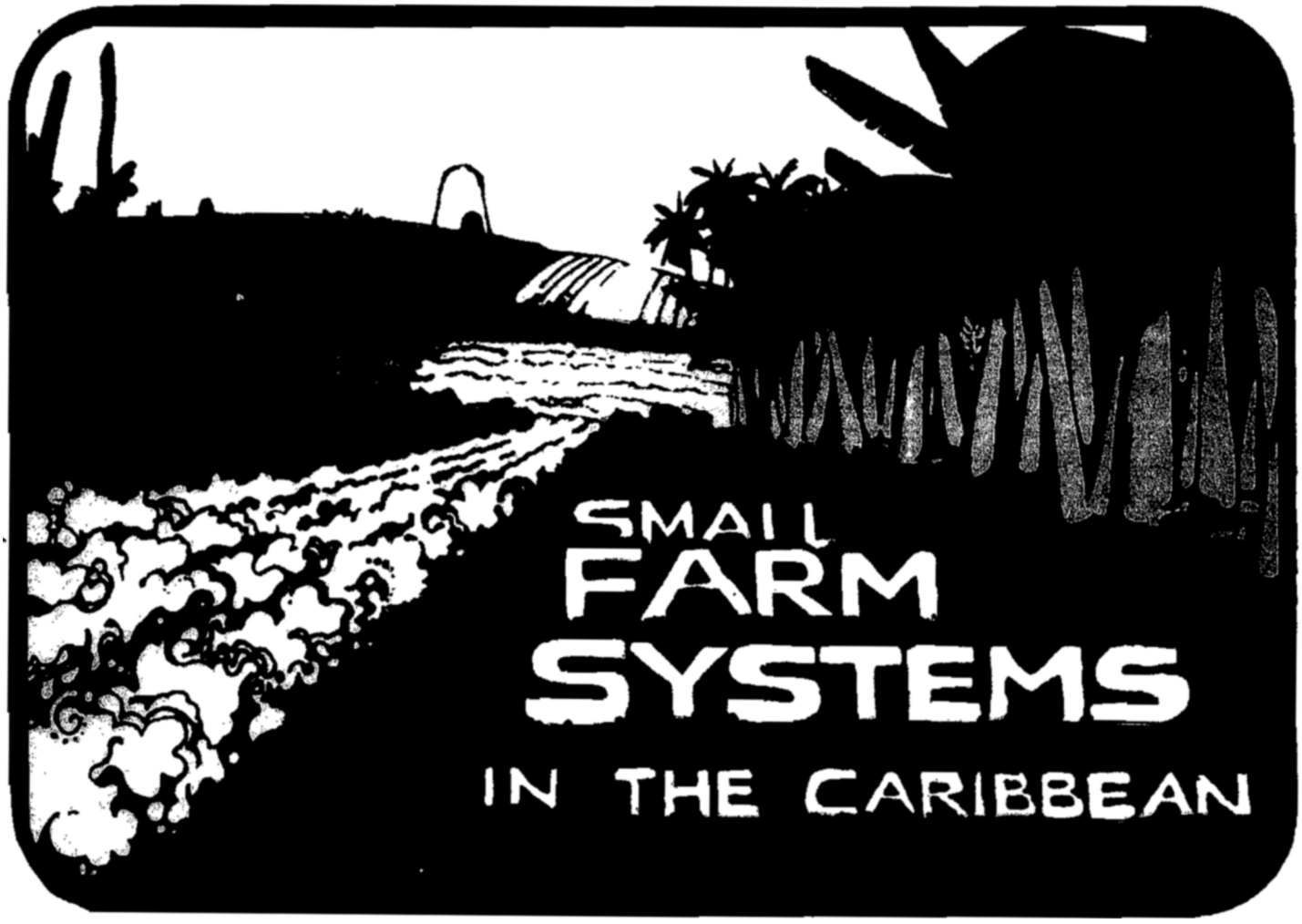

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Development and Characteristics of Twining Sweet Potatoes

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Sweet potatoes do not generally twine, but twining can be induced by shade. Twining sweet potatoes were produced by selection and polycrossing. Frequency of climbing sweet potatoes increased in four successive populations from 0.7 to 33, 56, and 48%. Twining sweet potatoes produce normal storage roots, and can be selected for other characteristics. The foliage is modified. Most twiners have entire leaves, long, thin vines with long internodes, thin basal vines and underdeveloped crowns. Vine tops tend to grow vertically and twine in a counter-clockwise direction. Propagation of twiners under optimum conditions is restricted by the ease with which the thin stems wilt, and by reduced rooting. Most twiners are susceptible to "virus" disease. The clone, whether propagated from stems or from sprouts, is less vigorous than the seedling generation. Principal symptoms are small, rugose leaves and slow growth. After one or two generations it becomes impractical to continue. Twiners are still vigorous under test on supports and in relay with corn. Stable twining varieties should be useful in multiple cropping.

The sweet potato, *Ipomoea batatas* (L.) Lam. belongs to the Convolvulaceae family, which consists chiefly of twining herbs. The species of *Ipomoea* most closely related to sweet porato (section *batatas*) are twiners, including *I. trifida, I. leucantha,* and *I. littoralis*. They are very closely related in origin ro the sweet potato (Nishiyama, et al., 1975), *I. trichocarpa, I. ramoni, I. tileacea,* and *I. gracilis*. Nevertheless, the sweet potaro is nor usually a twining plant. In his survey of the variation of sweet potato in Ecuador, Peru, and Pacific Islands, Yen (1961) does not even mention twining behavior. The varieties of sweet potaro used as food throughout the tropics vary from running vines to compact bushes. According to Yen (1968), "One of the most striking variations in *I. batatas* is its growth habit, for it ranges from a compact bush plant, little more than two feet across at maturity, to a long sprawling vine in which individual stems have been measured at 15 feet."

Nevertheless, some sweet potatoes can climb by twining. Plant breeders, working with large numbers of seedlngs, observe twining individuals (Jones, 1967). Gollifer (1973), observing tendencies to twine in some varieites, provided stakes, and sponraneous twining occurred in the variety Faunalea. Staking this variety increased the yields of roots. Austin (1983), in searching for new variation in the sweet potaroes, reporrs that twining varieties are frequently found in home gardens in western South America. The author has heard accounts in various counrries of twining varieties produced in isolated parts of tropical America. Thus, it appears entirely feasible to develop twining varieties.

Twining varieties might have several advantages over non-twining in some situations. They might be able to climb and subdue some weeds. When planted with corn, they mighr be able ro climb the stalks and thus obtain more light. They might be able to obtain sunlight more effectively when posirioned on trellises and thus yield more.

This study was made in order to ascertain the feasibility of developing twining varieties of sweet potato and to determine the effects of twining on other characteristics.

MATERIALS AND METHODS

The initial materials for this study were 3,000 sweet potato seedlings from which the twiners were selected. Twiners were also selecred from three generations of progeny of crosses among twiners. In addition, 50 non-twining seedlings were propagated by stem currings and grown in pots in three environments, full sun, 20% shade, and 80% shade in order to study the effects of light on twining.

Twiners were identified by observing field-grown plants for twining tendency. A bamboo stake of one meter length was placed in the foliage of such plants. Plants that climbed these stakes were twiners.

The tuberous roots of twiners were harvested and evaluated at 5.5 months of age if started from seeds, or at 4.5 months of age if from cuttings. Normal, terminal cuttings, 30 cm long, were taken from the tips of the vines for transplanting and propagation trials. Three consecutive generarions of seedlings segregating for twining were produced in polycrosses. Twenty or more twiners were propagared from cuttings, permitted ro climb by twining, and cross-pollinated by honey bees in the polycross.

RESULTS

Fifty seedlings, selected at random, showed no twining tendency when grown in pots in full sun. When grown in 20% shade (saran cloth) six seedlings showed a tendency to twine and one twined up a bamboo pole. When grown in 80% shade (fiberglass roof), 33 of the seedlings showed a tendency to twine and eight twined up bamboo poles.

Polycrossing among twiners increased their frequency among seedlings (Table 1). Even one polycross increased the percentage of twiners by a factor of 47, and the percentage of twiners was increased to 57 by the second polycross. It is obvious that by polycrossing, large percentages of twiners are easily recovered.

Of 171 tip cuttings taken from 57 twiners from polycross I progeny, 161 (94.2%) rooted normally under optimum conditions. However, in subsequent trials the thin cuttings of twining

TABLE 1. Frequency of climbers among seedlings.

GENERATION	NUMBER OF SEEDLINGS	NUMBER OF CLIMBERS	FREQUENCY OF CLIMBERS (%)
PARENTS: UNSELECTED SEEDLINGS FROM VARIOUS SOURCES	3000	21	0.7
POLYCROSS I PROGENY	178	59	33.1
POLYCROSS II PROGENY	105	60	56.6
POLYCROSS III PROGENY	134	65	48.5

varieties often wilted readily. When nine selected twiners were propagated by resprouting tuberized roots, all showed virus symptoms. These were so severe that eight of the nine selections were effectively lost. We have seen virus symptoms when tuberous roots are resprouted and interpret this as an increase in titer of normally occurring viruses due to propagation technique. Some sweet potatoes do not outgrow these conditions. What is unusual is that such a large proportion of twiners displayed such behavior.

A total of 205 twiners were produced and evaluated over a three-year period. From these, 14 selections were made as tentative varieties. All seedling twiners were evaluated for foliage, kitchen, and physiological characteristics. Twiners tended to share the following characteristics as compared to non-twiners: long, thin vines with long internodes; long running vines that climb on encountering a support; thin basal vine (crown); tendency of the tips of the vines to grow vertically (in contrast to horizontally, as in the case of running vines); twining by a counter-clockwise movement, as seen from above; leaves usually cordate and seldom lobed; low to intermediate anthocyanin production in the leaves and stem; early and out of season (long day) flowering; and a tendency to exhibit virus symptoms (smaller, rugose, cuspid leaves, sometimes with a light mosaic appearance).

When climbers, without symptoms, as a group were compared to non-climbers, no differences were seen in root form, internal or external root color, root yield, or in quality characteristics, including texture, flavor, sweetness; and fiber of the cooked root.

Virus symptoms increased rapidly in the selections. Once the vines showed virus symptoms, vigor was lost, growth and climbing ability were reduced, nodes were shorter, propagation from stem tip cuttings became more difficult, and yields were drastically reduced. Some of the selections were lost due to their poor viability, and after one year, only one of nine vigorous and relatively disease-free selections was maintained. However, five more selections have since been made. Those remaining selections are under trial in several production systems.

There is a suggestion that mass selection for twining has also increased virus susceptibility. This could occur if the traits are genetically linked.

Twining is a specialized form of stem growth that leads to climbing. It is not necessary for stems to touch an object in order to twine, for in several species, twining tendency can be identified by the coiled growth of stems not touching any object. The causes of this phenomenon were subjects of concern for early plant physiologists (Pfeffer, 1905). Twining resembles tropisms in that it is due to a growth curvature of the stem. Such growth appears to be due to the unequal distribution of auxin in the elongating cells of the young stem (Schrank, 1950).

In common beans, *Phaseolus vulgaris* L., twining tendency has been shown to be controlled by the phytochrome pigment system (red, far-red light response) (Kretchmer, et al., 1977). A single gene controls the twining trait and determines whether the particular plant can climb or not (Kretchmer, et al., 1978). Nevertheless, minor genes and environment modify these effects. The system of control of twining in sweet potato is still far from elucidated, but rapid increase in this trait through selection and polycrossing suggests that relatively few genes are involved, and the influence of shade suggests a strong environmental component as well.

The effort to develop climbing sweet potatoes is still young. Nevertheless, results thus far show that while development of twining sweet potato is feasible, we have still to learn how to handle them.

References

1. Austin, D. 1983. Personal communication.
2. Gollifer, D.E. 1973. Staking trials with sweet potatoes. Tropical Agriculture 50:279-284.
3. Jones, A. 1967. Should Nishiyama's K123 (*Ipomoea trifida*) be designated *I. batatas*? Econ. Bot. 21:163-166.
4. Kretchmer, P.J., J.L. Ozhun, S.L. Kaplan, D.R. Laing, and D.W. Wallace. 1977. Red and far-red effects on climbing in *Phaseolus vulgaris* L. Crop Science 17:797-799.
5. Kretchmer, P.J., D.H. Wallace and D.R. Laing. 1978. Inheritance and morphological traits of a phytochrome controlled single gene in beans *Phaseolus vulgaris* L. Crop Science 18:334-339.
6. Nishiyama, I., T. Miyazaki, and S. Sakamoto. 1975. Evolutionary autoploidy in the sweet potato (*Ipomoea batatas* [L.] Lam.) and its progenitors. Euphytica 24:197-198.
7. Pfeffer, W. 1905. The physiology of plants. Clarendon Press, Oxford. 451 pp.
8. Schrank, A.R. 1950. Plant tropism. pp. 59-74. *In:* Arnon, D.I., and L.M. Machlis (Editors). Annual Review of Plant Physiology. Vol. 1. Annual Reviews, Stanford, CA. 364 pp.
9. Yen, D.E. 1961. Sweet potato variation and its relation to human migration in the Pacific. Tenth Pacific Science Congress. Bernice Pauahi Bishop Museum, Honolulu. pp. 93-117.
10. Yen, D.E. 1968. Natural and human selection in the Pacific Sweet Potato. Elleo T. Drake (Editor). Evolution and Environment. Yale University Press. New Haven, CT. pp. 387-412.