VIRGIN ISLANDS AGRICULTURAL EXPERIMENT STATION
ST. CROIX, VIRGIN ISLANDS, U. S. A.
Under the supervision of the
UNITED STATES DEPARTMENT OF AGRICULTURE

BULLETIN No. 5

PRODUCTION OF SWEET-POTATO SEEDLINGS AT THE VIRGIN ISLANDS EXPERIMENT STATION

BY

JOHN B. THOMPSON, Director

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VIRGIN ISLANDS AGRICULTURAL EXPERIMENT STATION

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[Under the supervision of the Office of Experiment Stations, United States Department of Agriculture]

E. W. ALLEN, *Chief, Office of Experiment Stations*
WALTER H. EVANS, *Chief, Division of Insular Stations, Office of Experiment Stations*

STATION STAFF

JOHN B. THOMPSON, *Director*
W. M. PERRY, *Horticulturist*
M. S. BAKER, *Agronomist*
AUG. BISSERUP, *Clerk*

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SEED PRODUCTION ELSEWHERE

Very little interest has been taken by plant breeders in problems dealing with the development of improved varieties of sweet potato until within the last four or five years. Just why this particular branch of plant-breeding work should have been so long neglected is hard to understand, more especially when one considers the importance of the sweet potato as a staple food crop.

The earliest record of production of sweet potatoes from seed of which the writer knows is a report of work done at the St. Helena penal colony in Queensland, Australia,[1] in 1901, in which a few seedlings were originated. Since that time, similar work on a small scale has been done at some of the experiment stations of the British West Indies, including those of Barbados, St. Vincent, Tobago, Montserrat, and Antigua. Over 10 years ago, the Florida experiment station started seedlings from seed which was obtained from the West Indies, but the work was discontinued before definite results were obtained. Interesting data have been collected by Stout,[2] showing that considerable interest in sweet-potato breeding has developed within the last four or five years, rather extensive trials being begun in several widely separated tropical countries. A

[1] Queensland Agr. Jour., vol. 14, pt. 2, p. 90. 1904.
[2] A. B. Stout. The flowers and seed of sweet potatoes. Jour. New York Bot. Gard., vol. 25, No. 294, pp. 153–168, illus. 1924.

thousand or more seedlings are said to have been started at the agricultural experiment station in Santiago de las Vegas, Cuba, by Calvino, 205 were grown by Mendiola in the Philippines, and 700 by Chung at the Hawaii experiment station. Similar work is being done at the insular agricultural experiment station at Rio Piedras, P. R., and by the Office of Horticultural and Pomological Investigations, United States Department of Agriculture.

WORK AT THE EXPERIMENT STATION

Breeding work with sweet potatoes was begun early in 1922 at the Virgin Islands Agricultural Experiment Station. Since that time over 1,800 seedlings have been germinated, 1,100 seedlings have reached maturity, and approximately 240 varieties have been grown through three consecutive years. This bulletin gives some of the results of the work.

FLOWERS AND SEED OF THE SWEET POTATO

The sweet potato is of tropical origin and bears flowers and seed resembling those of the common morning-glory, to which it is closely related. Usually, the flowers measure from three-fourths to 1½ inches in diameter, and the tube 1 to 1½ inches in length. The color varies somewhat in the different varieties and, except in rare instances, is a shade of red, turning darker in the throat of the blossom. In 1,100 seedlings examined there were two exceptions to this rule, seedling No. 224 and an unnumbered seedling bearing pure white flowers. Five stamens of varying lengths encircle the pistil and are attached to the inner surface of the corolla tube, near its base. The two longer ones either meet at or extend beyond the stigma, thus facilitating self-pollination. The pollen grain is spherical and bears many minute papillæ, which are symmetrically arranged upon its surface. The grain is 0.09 to 0.1 millimeter in diameter, and, under the microscope, bears a striking resemblance to a small golf ball. The seeds are borne in a seed pod which is similar to that of the morning-glory, and range from 1 to 4 in a pod. The seeds are black, flattened, more or less disk shaped, and angular in form, measuring about 3.3 millimeters in greatest diameter. (Pl. I, fig. 1.) After having been stored for a period of 5 months at the station, 2,000 seeds from 9 mixed varieties were found to weigh 39 grams, which is equivalent to 23,261 seeds to the avoirdupois pound.

SEEDING HABITS

Seed production is restricted rather closely to tropical regions. The plant frequently bears flowers in the South Atlantic and Gulf States of the mainland, and occasionally as far north as Washington, D. C., but it is only in exceptional cases that perfect seed matures in the United States. Flowering is common in most tropical countries, but seed often fails to set. A relatively dry tropical climate apparently is conducive to seed production, whereas the more humid areas are less favorable.

Sweet-potato seed in considerable quantities matured in St. Croix during 1922, 1923, 1924, and 1925. During the first three years of

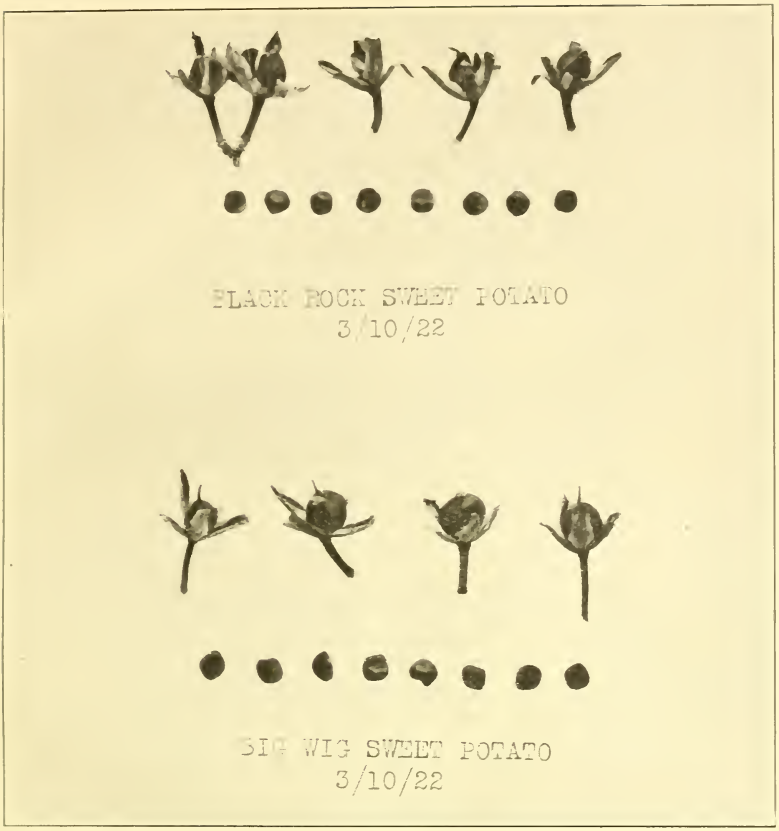


FIG. 1.—SEEDS AND SEED PODS OF THE SWEET POTATO

FIG. 2.—SWEET-POTATO SEEDLING WITH FOUR COTYLEDONS

this period the crop matured in February, March, and April, but in 1925 a large proportion of the seed ripened in January. The tendency to produce seeds and flowers in profusion varies with the variety, and also between individual plants of the same variety. Even with varieties of good seeding habit, the larger part of the plants often fail to produce seed. During the season of 1922 all seed from a planting of sweet potatoes containing 1,121 hills was collected and counted. The climatic conditions were nearly the average for St. Croix, but the yields were light, being 395 seeds for 271 hills of Bigwig, 230 seeds for 553 hills of Black Rock, and 60 for 297 hills of Key West Yam, or a total of 685 seeds from the 1,121 hills.

At least 405 of the seeds were collected from 65 plants, which would seem to indicate that a very large proportion of the other plants were nonproducers. A single plant of the Bigwig variety produced 173 seeds in 1924.

NATURAL CROSSING OF VARIETIES

Control of pollination by artificial means was not undertaken by the station until the spring of 1925, and the seed obtained as a result of these crosses has not been germinated. The wide variation in the progeny of adjacent varieties as compared with the similarity of the seedlings of a variety which was grown in isolation is evidence of the ease with which natural crossing may be effected. In 1922, some 300 seedlings were grown from the seed of three local standard varieties occupying adjacent plats. The result was the production of many seedling varieties showing a most remarkable variation in leaf design, habit of growth, and color of roots. Varieties with long running vines, cordate leaves, or white roots sprung from seed of the Bigwig variety, which is of bunching growth, with deeply cut leaves and red roots. Similar variation was observed in the progeny of other varieties. In 1923, a number of seedlings of the Wrenchy variety were grown, seed for the purpose being collected from an isolated planting where cross-pollination with other varieties could not well have occurred. This seeding resulted in the production of a series of varieties, some of which differed among themselves, but all bore marked resemblance to the parent. All the 11 seedlings of this series that were included in the variety tests of 1924 bore white roots like those of the parent. Judging from the results obtained in this work, and from other observations, it is thought that self-fertilization as well as cross-pollination is possible in some varieties of the sweet potato.

A number of hymenopterous insects, the most important of which is the honeybee, visit the flowers regularly, and undoubtedly play an important part in the cross-pollination of varieties. Three species of insects, identified by the Bureau of Entomology, United States Department of Agriculture, as *Campsomeris trifasciatus*, *Melissodes rufodentata*, and *M. foxii*, were taken from sweet-potato flowers in 1924. The collection was not exhaustive and it is probable that other insects visit the flowers. As a rule, the sweet-potato blossom opens only once. The bud opens during the night and remains open during the morning hours, then the corolla closes and withers. The time of closing of the blossom varies somewhat with the character of the day and the season. The flowers may remain

open all day during cool, cloudy weather, especially in January and February, but they ordinarily close about noon on bright, warm days during this season. Mature buds, which were collected for controlled pollination work in February, 1925, and placed in jars of water in the office, expanded during the night and frequently remained open throughout the following day. In the latter part of April, 1924, closing of the flowers in the field on clear, warm mornings was observed to take place between 9 and 10 o'clock. Usually, however, the flower is accessible to diurnal carriers of pollen for only a few hours.

SEED GERMINATION AND LONGEVITY

The outer covering of the sweet-potato seed is a tough, corneous integument which, by effectively excluding moisture, retards germination when the seed is planted, and aids in prolonging vitality when it is stored. Experience has shown that good, untreated seed, even when planted under the most favorable conditions, will germinate very irregularly. The first plants come up in two to four days, and others continue to come up for at least 100 days. This slow and irregular habit of sprouting is associated with imperfect germination and results in a low percentage of seedlings. The habit is not restricted to seeds of the sweet potato; it is also characteristic of various closely related or congeneric species that are grown for ornamental purposes.

House, in an article on Ipomoea,[3] says that "germination may be hastened and also made more certain by filing a small notch in each seed, or by soaking the seeds in warm water about two hours. The moonflower and the Japanese morning-glories particularly are likely to germinate poorly unless these precautions are taken."

Barker,[4] working with the morning-glory, noted that "some of the seeds have integuments so impervious to moisture that germination is very slow under natural conditions," and also that "it can be hastened by cutting a small hole through the seed coat to allow the water to enter."

Results of many tests at the Virgin Islands experiment station show that scarified sweet-potato seed will not only germinate more quickly and uniformly than that not so treated, but will produce more seedlings which will grow. In one of these tests, started in March, 1923, 100 seeds from a Bigwig seedling were divided into two lots that were as nearly equal and uniform as possible. In one lot a small part of the integument was shaved from the side of each seed to permit water to enter. The other lot remained untreated. On March 20, 1923, both lots were planted under as nearly the same conditions as possible. Three days later, 22 seedlings, representing 44 per cent of the scarified lot of seed, were coming up, while only 1 seed of the unscarified lot had germinated. Of the lot of unscarified seed, only 44 per cent had germinated at the end of 99 days, whereas of the scarified seed, 76 per cent germinated in 6 days.

Comparison of the germination of scarified seed with that of seed which had been submerged in water ranging in temperature from

[3] H. D. House. The Standard Cyclopedia of Horticulture, Vol. III, p. 1657. 1915.
[4] E. E. Barker. Heredity studies in the morning-glory (Ipomoea purpurea [L.] Roth). New York Cornell Agr. Expt. Sta. Bul. 392, p. 5. 1917.

65° to 95° C., for one and one-half to two and one-half hours, gave results uniformly favoring scarifying. From 646 seeds planted without scarifying in 1922, 265 seedlings, or 41 per cent, were grown. In five germination tests of scarified seed made in 1923 and 1924, approximately 1,771 seeds were planted, producing 1,438 seedlings, which was equivalent to a germination of 80.6 per cent.

Occasionally seed must be held from one season to another, or for longer or shorter periods before planting. Tests were therefore made to learn the influence of storing and age on the viability of the seed. In March, 1923, a limited quantity of seed was collected from a Black Rock seedling, and tested for germination at different ages. Table 1 gives the results of the test:

TABLE 1.—*Effect of age of sweet-potato seed on germination of seedlings*

Age of seed when planted	Number of seeds planted	Number of seeds germinating	Percentage of germinating seeds
One week	75	54	72.0
Three months	75	53	70.7
Fourteen months	50	41	82.0

After collection the seed was put in a common coin envelope and stored in the drawer of an office desk, and just before planting it was scarified. It will be observed that the seed showed actually a higher percentage of germination when it was 14 months old than when first collected. Fifty per cent of the older lot had germinated 48 hours after planting, and germination was complete at the end of four days. It seems safe to conclude, therefore, that seed can be stored in St. Croix for at least 14 months without deteriorating.

PROPAGATION METHODS AND THE DEVELOPMENT OF SEEDLINGS

Sweet-potato seeds were planted without scarifying during the season of 1922, when a relatively large number of the new varieties were being started, but the practice of scarifying was adopted in 1923, and since that time it has been consistently followed. When a large number of seedlings are being grown, the seeds are sown in flats which are so divided that the various lots can be kept separate and the identity of each resulting plant can be readily established. These flats are known as "pedigree boxes" for want of a better name, and answer the purpose for which they were made.

The sweet-potato seedling develops quickly and is easily grown. Under favorable conditions it should develop two or three true leaves within 10 days after germination. It can then be safely transferred to flowerpots, and about that time it should be labeled and given a number to retain permanently. Seedlings propagated in 1922 at the station were set in small tin cans 10 days after germination and transplanted to the seedling nursery three or four weeks later, at which time the most vigorous plants had begun to branch, and many showed a tendency to vine. The plants were set at distances of 6 feet in either direction and were arranged in

numerical order so that each one could readily be identified by its location in case the label got lost. As the plants developed, cuttings were taken from them and set in the clonal nursery, where a 50-foot row was set aside for each variety. The rows in the clonal nursery also were arranged systematically, the varieties being set in numerical order as they were numbered to facilitate identification in case the labels were lost or the records became obscure. (Pl. II.)

SEEDLINGS WITH MORE THAN TWO COTYLEDONS

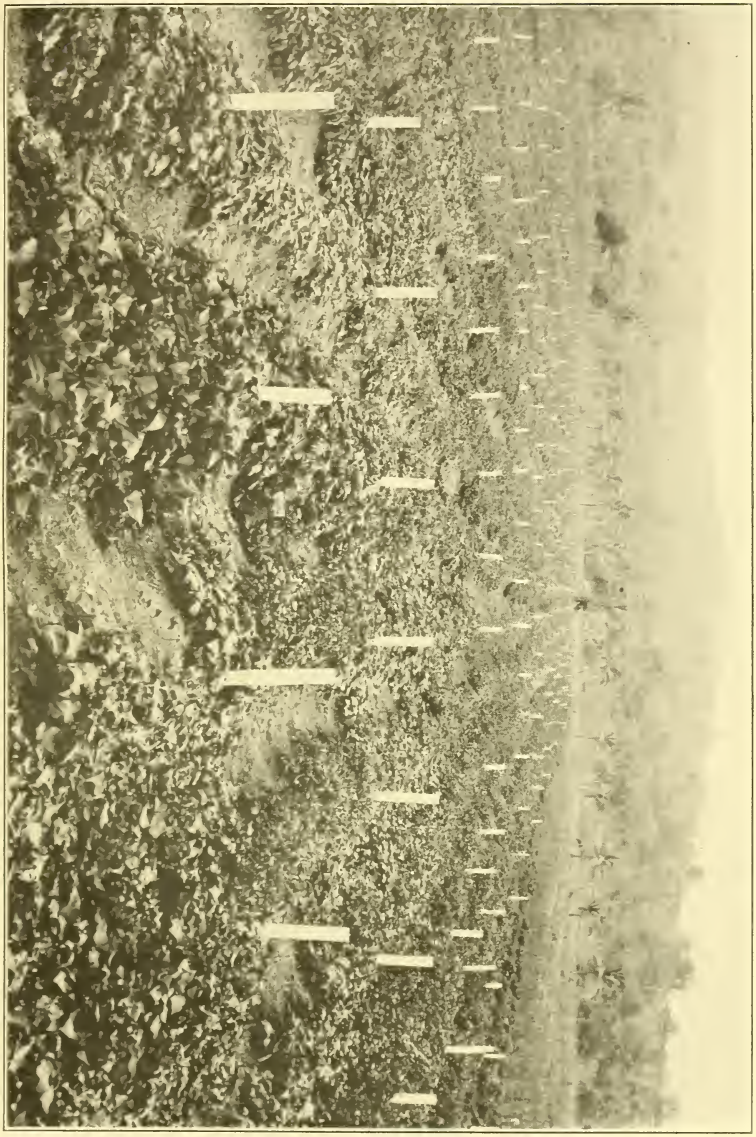
Seedlings with more than two cotyledons were frequently found at the station. In the majority of these cases there were three cotyledons to the plant, although plants with four cotyledons were also observed. Data on the frequency of this interesting phenomenon have been collected on three lots of plants. In one lot of 84 small seedlings, 5 had 3 cotyledons each, whereas in a second lot of 41 seedlings all were normal plants. In a third lot of 1,204 seedlings, consisting of progeny of 6 different varieties, 5 of 194 seedlings of the Payne variety had 3 cotyledons; 1 of 78 Field Champion seedlings had 3 cotyledons; none of 35 Wrenchy seedlings had more than 2 cotyledons; 3 of 205 Todd Vine seedlings had 3 cotyledons; and 5 of 257 Black Rock seedlings had 3 cotyledons; and of 435 Key West Yam progeny, 10 had 3 and 1 had 4 cotyledons. (Pl. I, fig. 2.) Taken en masse, these data indicate that 2.2 per cent of the 1,330 plants examined bore more than two cotyledons and that plants showing this character frequently appear among the progeny of many of the different varieties.

METHOD USED TO ELIMINATE UNPROMISING SEEDLINGS

At the close of the 1924 season it seemed desirable to reduce the number of seedlings on hand by eliminating those giving little promise of economic value. Although it was an easy matter to discard seedlings of manifestly inferior quality, it was considered advisable, at least for the greater part of the varieties on hand, to base selection upon productivity. Very poor crops were obtained during 1922 and 1923, owing to a severe, prolonged drought, but the crop of 1924 was very satisfactory, so far as growth and uniformity were concerned. It was impossible to replicate the plats, however, and each seedling was therefore compared with its parent growing in an adjacent plat.

A study of the records soon showed it to be unwise to depend solely upon a comparison in yield of seedlings and parent for determination of value of the seedlings. In some cases a seedling with a very good record of yield per acre averaged low when it was compared solely with the parent, due to an unusually high yield of the parent; in other cases, a seedling with a very light actual yield was rated high because the yield of the parent control plat was below average.

To determine productivity under the existing conditions more accurately, it was decided to adopt a standard comparing the yield of the seedling with the mean of the yield of the parent check and that of all the parent progeny. The following method was used for



SWEET-POTATO BREEDING WORK AT THE STATION, 1924

the purpose, the production of the seedlings being arbitrarily increased by 10 per cent to guard against the elimination of possibly valuable sorts: Let $A+\frac{10A}{100}-\frac{(B+C)}{2}=D$, where A represents the yield of the seedling, B the yield of the parent control, C the yield of all parent progeny, and D the determining factor of production. When the value of D is negative, the seedling is discarded; and, conversely, when the value of D is positive, the seedling is retained. For example, if the yield of seedling No. 127 (13,721 pounds per acre) equals A, the yield of Bigwig check plat (17,770 pounds per acre) equals B, and the average yield of Bigwig progeny (9,503 pounds per acre) equals C, D will be equal to 1,457 pounds. Thus, substituting the values of A, B, and C in the formula, we have:

$$13{,}721+\frac{13{,}721}{10}-\frac{(17{,}770+9{,}503)}{2}=1{,}457.$$

In this illustration seedling No. 127 is shown to have yielded at the rate of 4,218 pounds per acre above the average for all Bigwig progeny. The yield was also approximately 1,500 pounds per acre greater than was the average for all Bigwig checks; yet in the specific control plat with which the seedling was compared the parent produced the maximum yield, which was about 25 per cent higher than that of the seedling.

YIELD OF THE ORIGINAL SEEDLING AS A MEASURE OF PRODUCTIVITY FOR THE VARIETY

During the early stages of the work it became a question whether the yield of the original seedling could safely be taken as a measure of the productivity of the variety, and thus permit of early elimination of a large number of worthless forms without too great risk of discarding valuable ones. There were no available data showing whether the first two or three generations from seed might not run largely to vegetative growth, during which time even relative yields would carry little significance. When the seedlings were harvested in 1922, records were made of the number and weights of roots produced by each of the original seedlings. It might be well to explain at this point that the term "original seedling" is used to indicate the plant resulting from sexual propagation and representing the first plant of the variety. Yield records of the original plants were available for 177 varieties included in the comparative tests of 1924, and it is possible to determine the correlation between high or low yield of the first single plant and high or low yield of the corresponding variety grown under field conditions in 1924. The plant material used in these tests consisted of draws, taken from roots, produced by vine cuttings obtained from the original plants. Fifty-four seedlings of the 177 varieties yielded as original seedlings in 1922 more than the average and were classed as high producers, and 123 varieties produced less than the average yields as original seedlings in 1922 and were ranked as low producers. Table 2 shows to what extent the ratings as high or low producers, fixed by the yields of the original seedlings, were maintained in the field plantings of 1924:

TABLE 2.—*Numerical standing, with respect to yield, of varieties originating as high or low producing seedlings*

	Number of seedlings above average in 1924	Number of seedlings below average in 1924
54 varieties originating as high producers:		
Bigwig progeny	17	11
Black Rock progeny	13	8
Key West Yam progeny	3	2
Total	33	21
123 varieties originating as low producers:		
Bigwig progeny	36	41
Black Rock progeny	17	28
Key West Yam progeny		1
Total	53	70

It is seen that of the 54 varieties originating as high-producing seedlings, only 33 proved to be high yielders in 1924, whereas 21 were low in yield; and of the 123 varieties originating as low producers, only 70 were below the average in yield in 1924, whereas 53 showed high production. With these figures, and using Yule's method, which has been employed and clearly explained by East,[5] and again by Young,[6] the coefficient of correlation between high or low production in the original seedling and high or low production in later generations of the same varieties when grown from draws under field conditions is determined thus: r equals

$$\frac{(33\times70)-(21\times53)}{(33\times70)+(21\times53)}=0.349\pm0.0455.$$

In calculating correlations by Yule's formula, the results may vary between -1, which would represent an absolute negative correlation, and 1, showing absolute positive correlation; and, as East points out, the accuracy of the results will increase with the number of individuals considered. In this case there is a positive correlation between high yield of the original seedling plant and high yield in the corresponding variety after the lapse of several generations, but reliance solely upon yield of the former as a measure of productivity would have resulted in eliminating 53 high-producing varieties from the 1924 tests and retaining only 33. If, however, such data are to carry any great significance they must be collected from a larger number of varieties, and the final productive capacity of the variety with which the yield of the original seedling is compared should represent averages from many plantings. The trend of evidence, however, indicates that the yield of the first seedling can not be adopted as an accurate measure of production for any given variety. The record of yields of the original seedlings also shows that 36 numbers bore no fleshy roots at all, and that only 3 of these, or 1 in every 12, were valuable. It might perhaps be wise to discard all seedlings yielding no fleshy roots when unlimited quantities of seed are available and the work is being conducted on an extensive scale.

[5] E. M. East. Report of the agronomist. Connecticut State Agr. Expt. Sta. Rpt. 1907, p. 444.

[6] W. J. Young. Some phases of breeding work and seed production of Irish potatoes. South Carolina Agr. Expt. Sta. Bul. 210, p. 7. 1922.

CLASSIFICATION OF VARIETIES

The need of some simple method of classification to permit of a collective study of the large number of previously unknown varieties at the station, and at the same time facilitate quick comparisons without the necessity of searching through the voluminous mass of individual records for information, soon became apparent. A simple classification key, with groupings based upon color of root and midrib, length of vine, and leaf pattern, was therefore prepared. The key has been constructed to meet special needs rather than for use under general conditions. A class division which is based upon the length of vine, for instance, would hardly be found generally workable, because this character varies widely with soil, climatic, and other conditions. It is entirely practical for local purposes, however, where all varieties are grown under almost identical conditions. With perhaps some modification, the key may be useful as a guide to plant breeders who are doing work similar to that done by the station. A thorough knowledge of the key itself and a definite fixed mental standard for interpreting its various groupings should enable the breeder to classify varieties accurately and quickly. Groupings which are based on leaf pattern were intentionally made to conform with the normal varietal differences in leaf character of the three principal parent varieties used in the work of the station. Of these, the Bigwig variety has distinctly lobed leaves, Black Rock has entire leaves, and the Key West Yam has leaves that are marginally cut, but not distinctly lobed.

Key used to classify seedling varieties of sweet potatoes in the field

GROUP I. Roots white, cream, or yellow.
A. Vine, trailing; stems, usually more than 3 feet long.
a. Leaves, distinctly lobed.
1. Midribs, wine to amber colored ..... CLASS 1.
2. Midribs, amber to green colored; seldom, if ever, wine-colored ..... CLASS 2.
aa. Leaves, entire with uncut margins.
1. Midribs, wine to amber colored ..... CLASS 3.
2. Midribs, amber to green colored; seldom, if ever, wine-colored ..... CLASS 4.
aaa. Leaves, more or less marginally cut, but not distinctly lobed.
1. Midribs, wine to amber colored ..... CLASS 5.
2. Midribs, amber to green colored; seldom, if ever, wine-colored ..... CLASS 6.
B. Vine, bunching; stems, usually less than 3 feet long.
b. Leaves, distinctly lobed.
1. Midribs, wine to amber colored ..... CLASS 7.
2. Midribs, amber to green colored; seldom, if ever, wine-colored ..... CLASS 8.
bb. Leaves, entire with uncut margins.
1. Midribs, wine to amber colored ..... CLASS 9.
2. Midribs, amber to green colored; seldon, if ever, wine-colored ..... CLASS 10.
bbb. Leaves, more or less marginally cut, but not distinctly lobed.
1. Midribs, wine to amber colored ..... CLASS 11.
2. Midribs, amber to green colored; seldom, if ever, wine-colored ..... CLASS 12.
GROUP II. Roots, various shades of red.
A. Vine, trailing; stems, usually more than 3 feet long.
a. Leaves, distinctly lobed.
1. Midribs, wine to amber colored ..... CLASS 13.
2. Midribs, amber to green colored; seldom, if ever, wine-colored ..... CLASS 14.
aa. Leaves, entire with uncut margins.
1. Midribs, wine to amber colored ..... CLASS 15.
2. Midribs, green to amber colored; seldom, if ever, wine-colored ..... CLASS 16.
aaa. Leaves, more or less marginally cut, but not distinctly lobed.
1. Midribs, wine to amber colored ..... CLASS 17.
2. Midribs, amber to green colored; seldom, if ever, wine-colored ..... CLASS 18.
B. Vine, bunching; stems, usually less than 3 feet long.
b. Leaves, distinctly lobed.
1. Midribs, wine to amber colored ..... CLASS 19.
2. Midribs, amber to green colored; seldom, if ever, wine-colored ..... CLASS 20.
bb. Leaves, entire with uncut margins.
1. Midribs, wine to amber colored ..... CLASS 21.
2. Midribs, amber to green colored; seldom, if ever, wine-colored ..... CLASS 22.
bbb. Leaves, more or less marginally cut, but not distinctly lobed.
1. Midribs, wine to amber colored ..... CLASS 23.
2. Midribs, amber to green colored; seldom, if ever, wine-colored ..... CLASS 24.

VARIATIONS IN PROGENY

Only one of the parents of the various seedlings thus far tested at the station is known. Under the circumstances character variations are not of special scientific interest, except that in the case of the sweet potato these data may help to shed light upon the little known mode of fecundation in this species. Evidence of the tendency of varieties to cross when planted in coadjacent plats is seen in the variations among the progeny of a common parent. The 1922 series of seedlings was grown from seed of Bigwig, Black Rock, and Key West Yam. When the seed crop used in propagating these seedlings was being produced the three parent varieties were growing in close proximity to one another, and under conditions affording every facility for crossing by means of natural agencies. Considering the area on which this seed crop was grown as a whole, Black Rock occupied 49.3 per cent of the hills, Key West Yam, 26.5 per cent, and Bigwig, 24.2 per cent. The different varieties had approximately similar flowering habits, but varied decidedly in tendency to set seed. Key West Yam especially was poor in seed production, but, nevertheless, it may have exerted a strong influence as a pollen parent in the general results. The different parent varieties are identified by the following general characteristics:

Bigwig: The exterior root is of peculiar frosty red color; the plant is of bunching habit, and the leaves are deeply lobed.

Black Rock: The root is of deep red color; the plant is of vining habit, and the leaves are cordate.

Key West Yam: Although the root occasionally shows a tinge of rose, which is so slight as to be hardly perceptible to the casual observer, it has been classified with the white or cream-rooted varieties. The plant is of vining habit, and the leaves are marginally cut, but not lobed.

In Table 3 the 1922 progeny of the parent varieties are classified with reference to color of root, habit of growth, and leaf pattern (figs. 1 and 2).

TABLE 3.—*Seedlings grouped according to parentage and classified with reference to characters*

Seedlings	Color of root		Habit		Leaves		
	Red	White	Bunch	Vine	Lobed	Entire	Marginally cut
Bigwig progeny	112	19	106	25	83	29	19
Black Rock progeny	67	8	50	25	30	28	17
Key West Yam progeny	4	4	5	3	3	3	2
Total	183	31	161	53	116	60	38

It will be observed that there was wide variation among seedlings of the same female line, and likewise distinct variability in seedlings which were grown from seed originating in the same seed pod. This was true of Bigwig seedlings Nos. 45 and 46, which came from the seed of one pod. In leaf characters and vine growth these varieties are very similar, but the roots of No. 45 are red, whereas those of No. 46 are white. In several instances where two or more varieties were grown from the seed of one common pod, and where the seed was produced under conditions facilitating natural cross-pollination, wide variations were noted.

The seedlings within a group also showed wide variation in yield of roots. Of 131 Bigwig seedlings, 36, or 27.4 per cent, made heavier yields in 1924 than did the parent, producing 10 to 98 pounds per 50-foot row. In the same test, 4 of 75 Black Rock seedlings, or 5.33 per cent, outyielded the parent, the yield ranging from 7½ to 78½ pounds per 50-foot row. In the case of the 8 Key West Yam seed-

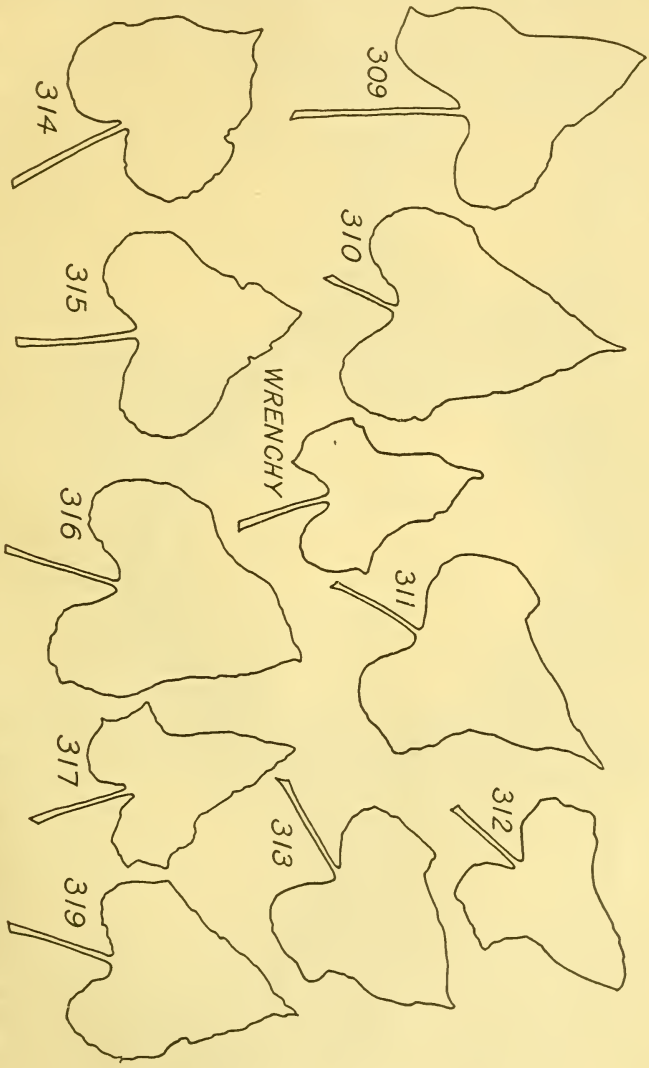


FIG. 1.—Showing the leaf pattern of the Wrenchy variety and 11 of its progeny. The seedlings are believed to have resulted from self-fertilizations. Note the general similarity of leaf design.

lings, 2, or 25 per cent, outyielded the parent, the yields varying from 24 to 73 pounds per 50-foot row. The Bigwig progeny averaged 9,503 pounds in yield, the Black Rock progeny, 8,850 pounds, and Key West Yam progeny, 9,297 pounds. Of the 1923 series of Wrenchy seedlings which are thought to have resulted from self-fertilization, 8 of the 11, or 72.7 per cent, yielded more than did the parent.

INTERNAL ROOT COLORING

The fleshy interior of the roots of many of the seedling varieties was found to be of a more or less red color. This varied from a mere trace of color in some roots to a uniform shade, involving all the interior flesh, in others. The color also varied from a light mauve to a dark magenta, and, in extreme cases, the root closely

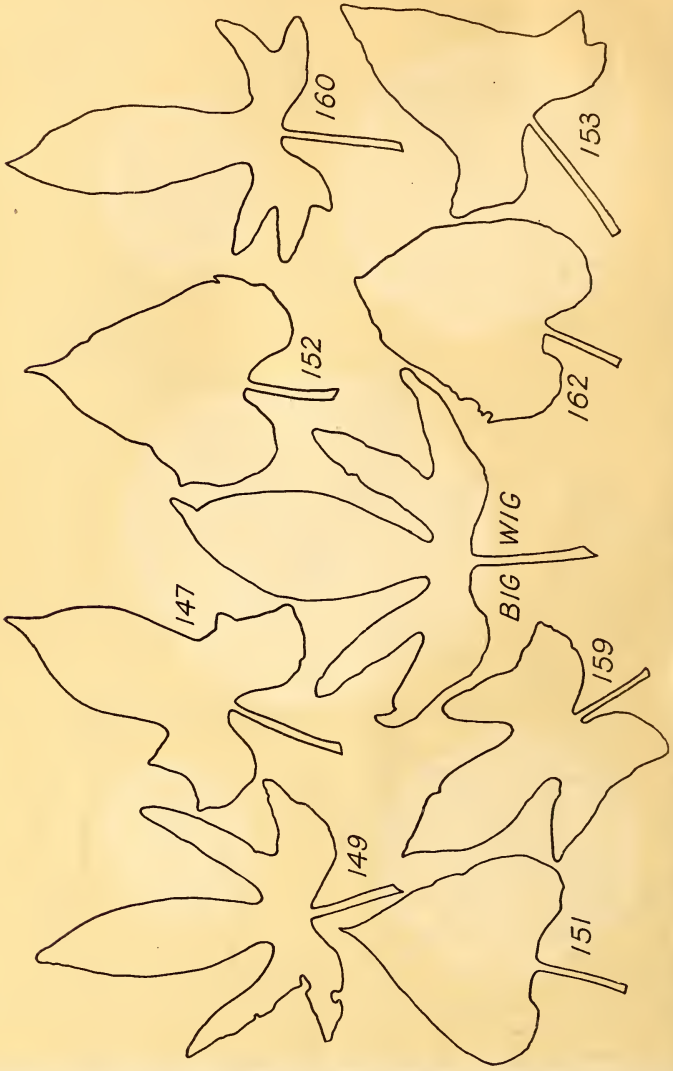


FIG. 2.—Showing leaf patterns of the Bigwig variety and a number of its seedlings resulting from cross-pollinations. The seedlings were grown from seed which was collected from a single plant. Note the wide variation in the shape of the leaves.

resembled a table beet in internal coloring. (Pl. III.) The different seedlings varied too, not only in the intensity of coloring, but also in the proportion of colored roots. Some varieties showed only 1 per cent of colored roots, whereas others had 100 per cent colored. In a special study of 228 seedling varieties, in which a total of 18,804 roots were examined, 141 varieties, or 61.8 per cent, were

ROOT OF SWEET-POTATO SEEDLING, SHOWING INTERNAL COLORING (NATURAL COLOR)

found colored in varying degrees of intensity. Unfortunately, not as many roots were available for the study as could have been desired. It is thought, therefore, that where 20 to 40 roots were examined and only 1 root of every hundred was found to be colored, failure to detect coloring was not conclusive evidence of the total absence of this character. Whenever sufficient roots were available, not less than 100 roots of a variety were examined. Table 4 shows the frequency of the occurrence of color in roots of seedlings from the different varieties.

TABLE 4.—*Frequency of color in the roots of some sweet potato seedlings* [1]

Parent	Number of seedlings examined	Number of seedlings colored	Number of seedlings uncolored	Proportion of seedlings colored
				Per cent
Bigwig	120	78	42	65.0
Black Rock	63	40	23	63.5
Key West Yam	8	4	4	50.0
Wrenchy [2]	11	4	7	36.3
Robert E. Lee	3	----------	3	----------
Nash	1	----------	1	----------
Unknown	22	15	7	68.1
Total	228	141	87	60.9

[1] The figures under the caption "Number of seedlings colored" have reference to the number of varieties showing some colored roots, but have no bearing on the percentage of colored roots within the variety. Those under the caption "Proportion of seedlings colored" also have to do with the proportion of varieties showing some color, and not to frequency of occurrence of colored roots within the variety.

[2] These seedlings are thought to have resulted from self-pollination; it is interesting to see that 4 of the 11 showed some color in some of their roots, when this character is wholly absent from the roots of the parent.

This character was found to be almost constant and of uniform intensity within the hill. A variety may be classed as 50 per cent colored, indicating that 50 roots of a lot of 100 were found to be colored, but examination of the variety on a hill basis usually shows that all the roots in a given hill are either colored or not colored and that coloring occurs in the various roots of the same hill in about equal intensity. The principle of total absence or complete occurrence of coloring among the roots of a hill was found to obtain in all but 4 hills of 97 which were examined, and in these mixed hills only faint traces of coloring were found. It is possible that in the exceptions noted red coloring may have been present in all the roots but of such low intensity as to escape notice.

Color in a sweet potato might be considered objectionable from a purely economic standpoint, but it is not believed to affect either the flavor or the food value. The variety Enterprise, a Black Rock seedling, with 100 per cent colored roots, was chosen in 1923 for experiment to determine the possibility of breeding a colorless form through selective planting. A large number of the roots were cut, and the few that showed only minute traces of coloring were used for growing draws in 1923. Of a lot of 50 hills of these draws, one hill with three roots proved uncolored in the 1924 crop. Draws were in turn grown from these roots and planted, and the crop harvested in 1925 was found to be entirely free from this coloring.

VOLUNTEER SEEDLINGS

The appearance of volunteer seedlings in the field is of interest because it helps to explain the occurrence of new forms in localities where seed matures. Young volunteer seedlings have frequently

been observed in the fields at the station. Some of these were dug and planted in pots in 1922, and later 22 were numbered and propagated. A few of the most promising were retained for further study.

SUMMARY

Notwithstanding the constant and growing demand for sweet potatoes, comparatively little interest has been shown until recently in the work of developing improved varieties from seed. Breeding work was begun at the Virgin Islands Agricultural Experiment Station in 1922, and since that time over 1,800 seedlings have been produced, of which nearly 1,100 have reached maturity. Approximately 240 varieties have been grown for two or more years.

In flower and seed, the sweet potato resembles the morning-glory, to which it is related. The plant occasionally blossoms as far north as Washington, D. C., but very seldom, if ever, sets true seed except in tropical regions. Seed in large quantities matured in St. Croix in 1922, 1923, 1924, and 1925. The production of flowers and seeds varies with the variety. Of 685 seeds, collected from 1,121 hills, 405 came from 65 plants, which would seem to indicate that most of the other plants were nonproducers of seed.

Natural crossing occurs readily. Some 300 seedlings, the progeny of three local standard varieties, when grown in adjacent plats, exhibited remarkable variation in leaf design, habit of growth, and color of root. In another planting, the seed for which was collected from an isolated plat where cross-pollination could not readily take place, a series of seedlings resulted, which differed among themselves, but all resembled the parent. Insects undoubtedly play a large part in cross-pollination.

Good untreated seed germinates very irregularly, even when it is sown under favorable climatic conditions. The first seeds germinate in 2 to 4 days after planting, and the others at any time within 100 days. Germination can be improved and hastened by scarifying the seed.

Tests of the influence of storage and age on seed, showed that sweet-potato seed can be stored under St. Croix conditions for at least 14 months without deteriorating.

Plants bearing more than two cotyledons were frequently found. As many as four cotyledons were observed in some cases.

To permit of accurate determination of the productivity of a seedling, a standard method was adopted which compares the yield of the seedling with the mean of the yield of the parent and that of the progeny. Experience has shown it inadvisable to attach very great importance to the yield of the original seedling. Of 54 varieties which originated as high-producing seedlings, only 33 were found to be high producers in 1924; whereas of 123 varieties originating as low producers, 53 gave a high yield in 1924.

A simple classification key, with groupings based upon color of root and midrib, length of vine, and pattern of leaf, was made to facilitate quick comparison of the seedling varieties.

The color of the fleshy interior of the roots of seedling varieties was found in many cases to be red, the shade varying from a light mauve to a dark magenta. Of 228 seedlings examined, 141 varieties possessed this character in variable degrees. This internal coloring appears to be uniform among the roots of the same hill, and the possibility of eliminating it through selective breeding has been shown.

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