

THE JOURNAL  
OF  
The Department of Agriculture and Labor  
OF  
PORTO RICO

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VOL. III

JANUARY, 1919

No. 1

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**CROSS-POLLINATION OF SUGAR CANE.**

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Sugar cane has been propagated from seed and the seedlings selected for the purpose of originating new varieties since 1887. This was begun in Java and in Barbados at about the same time, and it has since been taken up in nearly all the cane-producing countries of the world. Originally no record was made of the parentage of the seedlings, and in many cases not even the name of the seed parent was kept. Some very good varieties were originated by this method.

For commercial purposes cane is propagated asexually by cuttings. When it is propagated from seed the variation in the resulting generation, even from a single parent variety, is considerable. It is presumed that some, if not all, of the varieties are more or less heterozygous. It seems nevertheless desirable, in many cases, to make controlled crosses in order to combine such characters as vigor and disease resistance of certain varieties with the good qualities of other kinds.

METHOD OF CROSSING.

It would, of course, be desirable to eliminate all possibility of self-pollination. Attempts to emasculate the florets have been made, and a few seedlings have been produced in Barbados in that way, though, according to Bovell, the number of seedlings produced in any single season has been small. The work is very tedious, for the reason that the florets are small and the panicle is brittle. The latter is also produced at 10 to 15 feet from the ground, so that it is necessary to do the hybridizing on a scaffold and sometimes the wind makes the work very difficult.

Kobus (4),<sup>1</sup> in Java, planted a pollen-sterile variety on the lee-

Another method reported by Bovell (1) to be employed in Barbados is to plant two varieties which flower at the same time in alternate stools, called "checkerboard system," for the purpose of facilitating natural cross-pollination. It is, of course, impossible to form any conclusion as to the extent to which crossing takes place with the method, unless the type of seedlings produced by each variety when growing separately is known.

Two additional methods are described by Wilbrink and Ledebøer (6). By the first method the tassels of the variety to be used as the male parent are cut off and tied in position with the one to be used as seed parent. For protection against undesired pollen a screen is provided, having an opening on the leeward side for the entrance of the tassels. By the second method the pollen of the desired variety is collected and carried to the one to be used as the female parent. This latter method is also one which was suggested by D'Albuquerque (3). It is reported that the pollen adheres in masses, and also soon deteriorates, so that no very satisfactory results were obtained.

#### METHODS EMPLOYED AT THE INSULAR EXPERIMENT STATION.

Crossing has been practiced at the Insular Experiment Station of Porto Rico for four years. The method here described was found to be more suitable, for the reason that with its use a fairly large number of seedlings can be produced. The work has not yet progressed far enough to report results of the crossing, in respect to the quality of varieties produced. It has been possible, however, to study to some extent the populations of seedlings originating from different parentages, as to inheritance of characters in first-generation seedlings.

Bags made of cheese-cloth are held extended by heavy wire rings sewed into them. The bags when completed are 48 inches long and 18 inches in diameter. The rings are placed one at the top and the other 16 inches from the bottom, so that a skirt of 16 inches is left to be drawn in and tied around the stems of the panicles.

The bags are supported over the panicles by means of bamboo poles set in the ground. The poles have a crossbar at the top which is fastened to them by being wedged into notches cut into the second internode from the top, and the bags are tied to this crossbar. The poles are set on the windward side of the stools just before the

<sup>1</sup> Figures in parentheses refer to "Literature cited."

panicles "shoot;" when this occurs, a bag is immediately suspended over each panicle and tied around its stem, so that it is protected from all undesired pollen before any of the florets open.

The cane blossom is hermaphrodite, but it has been found that certain varieties are almost completely pollen-sterile, or at least self-sterile. This makes it possible to pollinate them with another variety, with the assurance that nearly all the seedlings will be offspring of two known varieties, a few usually also being produced as the result of the self-pollination of the mother parent.

The pollinating is done by placing panicles of the desired variety into a bag, in such a position that their pollen will be shed or carried by the wind to the florets, of the other variety as they open. One or two panicles are used at a time, and they are allowed to remain in the bag two or three days, being renewed as often as necessary while the florets are opening. It has been found of advantage to cut the panicles with stems 4 to 6 feet long, and to place their lower ends in a joint of bamboo filled with water, by which they can be kept fresh two or three days.

#### RESULTS ACCOMPLISHED.

Up to the present time, results can only be expressed in terms of the number of seedlings produced and the extent to which the characters of the varieties are combined. The method above described was first tried in 1915-1916. Ten crosses were attempted, of a single combination, and all but two produced seedlings, a majority of which, when mature, showed characteristics of both parents. In all, about 1,600 seedlings were produced, one panicle alone giving over 1,000 seedlings. (2)

In the following winter 1916-1917, thirty crosses, comprising nine different combinations, were attempted, and nineteen of them, comprising six combinations, were successful. From one combination 1,309 seedlings were obtained, and in all 2,589 seedlings were produced. The work was all done by one man and a helper, including the making of the bags.

In 1917-1918 it was impossible to secure the services of a competent man to perform the crossing until late in the season, and the seed of all varieties was also much less viable than in the preceding year. Thirty crosses were attempted, comprising nine combinations. Fifteen of these were successful and 1,794 seedlings were produced, 157 of which were from one combination and 735 from another.

Judging from the small proportion of the seedlings out of the large

number propagated by the old method that are of sufficient value to become widely cultivated, it appears that a large number of first-generation seedlings is essential. Considered from the point of view of Mendelian inheritance, if many factors are involved, which is probably the case, the chance of getting a desired combination of characters is very remote when only a few seedlings are grown.

#### EFFECT OF THE CROSSING.

In 1915-1916 the variety used as a pollinator was a dark-colored cane, while the seed parent was medium light. This made it possible to trace the color of the male parent in the offspring. Some other characters could also be traced in the seedlings in the same way. In the following year this cross was again made, and the same general effects were observed, many of the same types being again recognized. (2)

In the year 1916-1917, some of the parent varieties of groups of seedlings showed fewer differences than was the case with the varieties combined the year before, consequently it was less easy to see the effect of the crossing in the seedlings. In all cases but one, however, some of the groups showed distinguishing characters of both parent varieties.

The disadvantage in this method, in not being able to eliminate all possibility of self-pollination, ought not to be overlooked. On account of the chance of some selfing, it has been the practice to estimate the value of a cross from the entire group of seedlings produced, always making allowance for probable self-pollination.

#### SELF-STERILITY.

At least two of the old standard varieties are nearly pollen-sterile here. We have never succeeded in producing more than five seedlings from single flats of several hundred seeds planted, while if these varieties are pollinated by any of several seedling varieties good germination follows. Lewton-Brain (5) in Barbados examined the florets of about fifty varieties and found that some bore pollen nearly all of which was large, well-shaped and full of dark granules, while with some the pollen was smaller, more or less irregular in form, and without granular matter. A third class of varieties had an intermediate amount of normal, well-developed pollen.

Wilbrink and Ledebøer (6) describe a method of testing the pollen with iodine, to determine its viability. If the pollen grain con-



tains starch it was believed to be normal. We have not, however, found this test to be absolutely reliable.

#### CONCLUSIONS.

From the work reviewed in the foregoing paper the following conclusions are possible:

1. Sugar cane can be cross-pollinated and protected from outside pollen, and by this process a considerable number of seedlings can be produced.

2. Characters of the parent varieties are combined in the seedling by this process.<sup>1</sup>

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<sup>1</sup> It should be expected that the desirable combinations could be perpetuated in hybrid condition because of the asexual method of propagation, a rather unusual advantage among our field-crop plants.—(Editorial note by L. H. SMITH.)