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THE UNIFORMITY OF PIMA COTTON.

THOMAS H. KEARNEY

Physiologist in Charge

Office of Alkali and Drought Resistant Plant Investigations

Bureau of Plant Industry



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This circular describes methods which are used in the Salt River Valley of Arizona in providing pure planting seed of Pima long-staple cotton and in conserving the uniformity of the variety. It is believed that an account of this successful application of the one-variety community system of cotton production will interest growers and persons engaged in buying or manufacturing cotton in other parts of the country who are not concerned with the particular variety grown in Arizona.

The Pima variety, which belongs to the Egyptian type of cotton and produces fiber of an average length of $1\frac{9}{16}$ to $1\frac{11}{16}$ inches, has been found to be adapted only to the hot irrigated valleys of Arizona and southern California and is not adapted to other cotton-growing regions in the United States. Numerous trials have shown it to be unsuited to conditions in the main Cotton Belt. There is ample evidence that efforts to grow this variety in Texas or States farther east will be fruitless and will result merely in financial loss and in contamination of the local seed supplies, for Pima crosses readily with cottons of the Upland type, and the resulting hybrids are worthless agriculturally and commercially. This caution is necessary in view of the repeated attempts to grow cotton of the Egyptian type in the Southeastern States, all of which have resulted in failure.

DO COTTON VARIETIES RUN OUT?

It is widely believed that varieties of cotton deteriorate spontaneously, the reason for this belief being that many carefully bred varieties which showed a high degree of uniformity when first introduced have deteriorated after a few years so as to become almost worth-

less commercially. This has been noticed particularly in regard to long-staple cottons, the value of which for manufacturing purposes depends very largely upon the evenness of the fiber in length and other properties. Under ordinary conditions it is doubtful whether the average life of a variety of long-staple cotton exceeds 10 years.

In taking it for granted that deterioration and loss of uniformity are unavoidable, the fact is overlooked that cotton is seldom grown with adequate precautions to keep the varieties from becoming mongrelized. Different kinds are often grown in adjacent fields and the product is ginned at the same establishment, so that cross-pollination in the field and mixture of seed at the gin inevitably result. These are the real causes of the deterioration of varieties, there being no satisfactory evidence that a variety, if uniform at the outset, will degenerate so long as it is properly isolated.

Consideration of these facts led O. F. Cook, of the Bureau of Plant Industry, to formulate the principle of community production of a single variety of cotton¹ as the only sure method of preventing crossing and mixture of the seed. This was in line with the practice of former growers of the choice "crop lot" Sea Island cotton along the coast of South Carolina and Georgia. Efforts were made to exclude other kinds of cotton from the islands, and some of the planters maintained careful selection of their best plants as a means of securing uniform and high-grade planting seed. In recent years the production of Pima cotton in the Salt River Valley of Arizona has afforded an example of successful application of the community system based upon production of a single variety.

ORIGIN AND DEVELOPMENT OF THE PIMA VARIETY.

The Pima variety originated with a single plant discovered in a field of the Yuma variety at the cooperative testing garden at Sacaton, Ariz., in 1910. Successive progenies from this plant were grown at Sacaton during the five years following, and a high degree of uniformity was attained by selection. When it was decided that the new variety was suitable for commercial production, seed sufficient to plant a few hundred acres was supplied to farmers in the Salt River Valley in 1916. All of the seed was planted on neighboring farms in a district well isolated from other cotton, and the product was ginned with the greatest care to avoid mixture with other seed. This was effected by cooperation between the United States Department of Agriculture and the Tempe Cotton Exchange, an association of cotton growers in the vicinity of Tempe, Ariz. The same association, in cooperation with the department, has functioned ever since as the agency which handles the supply of pure planting seed for the Salt River Valley.

METHODS FOR PROVIDING GOOD PLANTING SEED.

There are three recognized methods for handling supplies of planting seed so as to insure a greater or less degree of purity.

(1) Line breeding is the method whereby the greatest possible degree of purity can be attained. This method is based upon the selection of an individual plant and the increase of its progeny under conditions of isolation, thus giving rise to a strain descended from a

¹ Department Bulletin No. 1111, One-variety cotton communities.

single individual. It is used by plant breeders, whether the purpose be to develop a new variety or to produce a uniform and otherwise desirable strain of an existing variety. In developing Pima at Sacaton the method was used for both purposes, the first selection, that of the original Pima plant, having resulted in segregating a new variety from the old Yuma stock and the subsequent selection having been directed to securing the greatest attainable uniformity and productiveness without departure from the Pima type. Selection along the latter line is being continued at Sacaton with the object of maintaining a stock of very pure seed to be drawn upon in the event of accident to the main supply in the Salt River Valley. Line breeding is not applicable when the object is to provide as quickly as possible planting seed for a large commercial acreage. It was, however, practiced with excellent results by individual growers of choice Sea Island cotton, the increase from a single plant having sufficed in a very few years to seed the entire acreage on a plantation.

(2) Mass selection consists in picking out a number of plants regarded as typical of the variety, the seed from which is planted together for increase. This method does not insure the high degree of purity attainable by line breeding, but provides a much larger initial supply of seed. Mass selection is extensively practiced by corn growers and is sometimes used in the case of stocks of cotton which have become mixed, when rapid increase of the type is desired.

(3) Roguing is a method for providing a large stock of planting seed of a variety which already has attained a high degree of uniformity as a result of line breeding. This method involves the removal from a field of such plants as are recognized as being off type or otherwise inferior, the seed produced by all the remaining plants being used for increase. The object of roguing is to eliminate any accidental hybrids or degenerate "sports" which, if allowed to remain in the fields supplying the planting seed, would impair the uniformity and general quality of the stock. It is to be regarded as a means of preventing loss of uniformity rather than as a method for improving a variety. When definite improvement is sought, line breeding must be resorted to, but with this method seed increase is too slow to provide a sufficient supply for planting a commercial acreage each year.

THE PIMA SEED SUPPLY IN SALT RIVER VALLEY.

A supply of pure seed for planting the annual crop of Pima cotton in the Salt River Valley is provided by roguing a limited acreage and by increasing during the following year the seed from the rogued field under such conditions as to prevent contamination. The products of both the rogued field and the increase fields are ginned with every precaution to avoid mixture with other cotton seed.

Every year a field located in the heart of the Tempe pure-seed district is rogued under the supervision of an agent of the U. S. Department of Agriculture. Representatives of the College of Agriculture of the University of Arizona also cooperated in this work in 1920, 1921, and 1922. The field selected for this purpose is located in the midst of an area planted with seed from the rogued field of the

year preceding and comprises usually about 80 acres. Every plant in this acreage is examined soon after blossoming has begun, and all plants which seem to be off type or otherwise undesirable are removed.

The seed cotton from the rogued field is ginned by the Tempe exchange, the gins being given a thorough cleaning before the product of the rogued field is handled. The resulting seed is carefully sacked and labeled and is used the following year to plant a compact acreage in the center of a district in which only Pima of known purity is grown. The seed cotton from these "increase" fields also is ginned separately, and the sacks of seed are labeled "certified" by the pure-seed committee of the Maricopa County Farm Bureau. The certified seed is sold to cotton growers throughout the valley for planting. Comparison of the quantities of seed distributed with the acreages planted from year to year shows that the great bulk of the Pima acreage has been grown from certified seed.

The Pima pure-seed district may be viewed as two concentric circles, of which the center is the field that is rogued. The inner circle, comprising on the average about 2,000 acres, contains the increase fields planted with seed from the rogued field of the preceding year, and the outer circle is planted with certified seed produced by the increase fields of the preceding year.

RESULTS OF ROGUING OPERATIONS SHOW NO LOSS OF UNIFORMITY.

The average numbers of plants per 10,000 removed in roguing the Pima seed fields² have been as follows: 1916, 21; 1917, 42; 1919, 20; 1920, 20; 1921, 6; 1922, 6. Expressed as percentages of the total numbers of plants in the rogued fields, the figures indicate that in different years from less than one-tenth of 1 per cent to about four-tenths of 1 per cent of the total number of plants in the field have been removed as off type or otherwise undesirable. A high degree of uniformity is shown by these results, especially as most of the rogued plants are merely sterile or abnormal rather than distinctly off type. Rogues of this character are likely to be thrown by any variety, no matter how uniform and highly bred it may be. During the last four years of roguing no plants have been found whose characters indicated recent crossing with another type of cotton.

Comparison of the proportions of plants removed in different years does not indicate that Pima cotton is degenerating. On the contrary, the unusually small numbers removed in 1921 and 1922 might be taken as evidence that the roguing has resulted in increasing the uniformity of the variety, but the probable explanation is that the fields rogued in the last two years were located on exceptionally uniform soil.

EXPERIMENTAL EVIDENCE THAT UNIFORMITY IS BEING MAINTAINED.

Some of the original stock of Pima seed furnished to the Tempe farmers in 1916, grown at Sacaton in 1915, had been held in reserve with the idea that occasion might arise to make a comparison with the original stock. It was deemed advisable to make this compari-

² A field was rogued in 1918 also, but owing to the limited personnel available under war conditions it was impracticable to keep a record of the number of plants removed.

son in 1921 as a check on the evidence, obtained in roguing, that the variety had suffered no deterioration during five years of commercial production in the Salt River Valley. Commercial certified seed of the crop of 1920 and some of the original 1915 stock were planted in cooperation with B. J. Showers on his farm near Scottsdale. Two blocks of four rows each of the two lots of seed were planted on a uniform piece of land, the blocks of 1916 seed in alternation with the blocks of 1920 seed. Each pair of rows in each block was harvested separately so as to furnish four large samples from each lot of seed. Comparison of the 1915 and 1920 seed stocks was made as to yield of seed cotton and of lint, lint percentage, lint index (weight of lint per 100 seeds), and amount of fuzz on the seeds. The averages of the four samples from each lot of seed did not differ significantly in regard to any of these values. Cotton classers of the Bureau of Agricultural Economics, chosen because of their familiarity with this type of cotton, compared the samples in respect to the length, strength, and uniformity of the fiber and found no consistent difference between the products of the two lots of seed.

Another experiment carried out in 1921 gave additional evidence that there has been no deterioration and no change of type in the stock of Pima cotton grown in the Salt River Valley since its introduction in 1916. In this experiment one of the selections which had been grown at Sacaton under carefully guarded conditions and known to be highly uniform was compared with the stock of commercial certified seed produced in 1920 and distributed to the cotton growers of the Salt River Valley in 1921. The planting was made in cooperation with W. H. Parker, on his farm near Phoenix. Four plats were planted with the commercial certified seed, in alternation with plats planted with the selected seed from Sacaton. Each plat was harvested separately in the fall, and the samples thus obtained were compared in regard to the yield of seed cotton and of lint, lint percentage, lint index, and amount of fuzz on the seeds. The averages for the plats representing each stock of seed did not differ in respect to any of these values, while examination of the resulting samples by the Bureau of Agricultural Economics showed no significant differences in the length, strength, and uniformity of the fiber. These results indicate that the system followed in regard to the commercial supply of planting seed in the Salt River Valley has for all practical purposes maintained the characteristics and the uniformity of the Pima variety as successfully as the method of line breeding used at Sacaton.

UNIFORMITY AFFECTED BY SOIL VARIATION.

The best evidence available indicates that the Pima variety is intrinsically very uniform and that its uniformity has been successfully maintained during the seven years of commercial production. A distinction should be made, however, between the purity of the stock and the uniformity of the product as it reaches the market. Complaints have been received from users of this cotton that some bales are of mixed quality, containing cotton that differs both in grade and staple. This is regrettable, but it does not indicate a lack of purity of the planting seed. As a result of the rapid expansion

of the Pima acreage in recent years, much of the cotton has been produced by farmers who had had little or no previous experience in growing this crop under irrigation. Consequently many of the fields have been badly leveled and have not been properly irrigated. Moreover, there is considerable diversity in the soil of the Salt River Valley and exactly the same seed may produce fiber of very different staple and quality, depending upon whether it is planted on good or on poor soil. Not only does the soil vary in different parts of the valley, but there are often noticeable variations in the same field, which are plainly reflected in the growth of the plants. In fields which have been poorly leveled or which contain spots of sandy or alkali soil or of soil infected with the root-rot disease, there is sure to be variation in the length and strength of the fiber produced. If the product of the poor spots is picked and ginned with the better grown cotton in the same field, the contents of the resulting bales necessarily will be mixed.

The associated cotton growers of the Salt River Valley have under consideration a plan to handle the cotton from spotted fields in such a way as to insure the separate picking, ginning, and baling of the product of the poor spots and prevent its being mixed with the well-grown cotton of superior length and quality. Plans are also under consideration for better control of the ginning so as to avoid the mixing of "ropy" cotton, or cotton containing clipped seeds in the same bale with fiber that has been properly ginned. If these measures are carried out, the potential uniformity of the variety, which has been attained by selection and by careful management of the planting seed, will be translated into actual commercial uniformity.

FUTURE MAINTENANCE OF THE PURITY OF PIMA COTTON.

Publicity has been given recently to the fact that Upland cotton has been planted in the Salt River Valley. Spinners of Pima cotton whose attention has been called to this situation may have wondered whether the future of the variety is in jeopardy. Fortunately, the associated growers of Pima cotton in the Salt River Valley are fully alive to the importance of protecting the supply of planting seed. Pima cotton alone is grown in the several square miles which comprise the Tempe pure-seed district, and no Upland cotton is handled at the Tempe gin. The purity of the certified planting seed will thus be protected and, if only certified seed be planted, the commercial value of the Pima cotton need not be impaired by the presence of Upland cotton in parts of the valley remote from the Pima pure-seed district.

Unquestionably, the occurrence of another type of cotton in the Salt River Valley makes it necessary to use all possible care in the future handling of the Pima seed supply. The uniformity of the variety can be maintained in spite of this peril, but only by keeping all other cotton out of the district which supplies the certified seed and by using none but certified seed for planting the crop. If these precautions are taken, there is no reason to fear that the value of the product will decline.



