

IMPROVEMENT OF CANE BY SELECTION.

By R. R. STAPLES.

The Congress resumed at 2.30 p.m.

Owing to the unavoidable absence of Mr. R. R. Staples, B.A., Botanist, Cedara School of Agriculture, his paper on "IMPROVEMENT OF CANE (Selection)" was read by Mr. H. H. Dodds, as follows:—

In choosing the subject "Improvement of Cane by Selection," I merely wish to put before you certain scientific facts in connection with this subject, together with some suggestions for profitable lines of investigation on cane culture. Although some of these facts may not be of direct practical benefit to the planter, I trust he will find them of a certain degree of interest, especially in view of the establishing of a Sugar Experiment Station, whose duty it should be to pursue more fully the problem of Cane Improvement.

Selection Within the Variety.

There is no doubt of the great benefits to agriculture, that results from continuous selection along the right lines, in many crops. Amongst excellent instances that could be brought forward in support of this statement, that of the beet industry need only be mentioned.

Vilmorin, in Germany, three-quarters of a century ago, began work on the selection of beet plants, containing a high percentage of sugar. He developed a method of determining the percentage of sugar in any individual plant without injury to it, and then used the seed only from the plants with the highest sucrose content. By these methods the sucrose content of this crop has been raised from an average of 9% to an average of 16%. Selection of seed from the heaviest plants also materially increased yields in this crop.

To revert back to our subject, we in South Africa are confined to the growth of one variety of cane, Uba, and it is not unlikely that we will be confined to this variety indefinitely. Hence the importance of any improvement possible in it. We know that the Uba cane is by no means as high in sucrose content or in yielding ability as we would like it to be. It also has some undesirable milling qualities. Now if we made analyses of the juice from different stools or stems we would find (as in the case of beet) that there is quite appreciable variation in the sucrose content. The same would be

found in yielding abilities and in milling qualities. So the question arises to what extent can these desirable qualities be increased by the practice of selection in a similar method to that which proved so successful in beet. Although much work along these lines has been done, notably by Kobus in Java, and others, the consensus of opinion appears to be that there is no hope of raising the sucrose content, yielding abilities, etc., in any pure varieties in this way. The reason for this is that there is a fundamental difference in the propagation of the two crops, which makes this method of improvement unlikely. With beet, the crop is grown from cross-fertilized seed, whereas in sugar cane the usual method of propagation is vegetatively, and it is a scientific fact that where vegetative propagation is practised it is but rarely that heritable changes take place. Such changes are known as Bud variations. The same stability applies to all pure strains of self-pollinated plants. We will deal with Bud variations as a possible method of improvement later.

So the position is, that providing Uba is a pure variety, there is no likelihood of it being permanently improved in sucrose content, yielding ability or milling qualities by simple selection.

The only advantage selection will give is the temporary elimination of diseases such as Mosaic and Streak.

That the elimination of such diseases does materially increase the yield has been amply proved. I wish to lay emphasis on this point.

So much for simple selection. We will now examine other possible methods of cane improvement.

Bud Variation.

It has long been a known fact that plants tend to produce abnormal buds at rare intervals. Such buds, if propagated, usually reproduce their abnormalities. Greatly improved varieties of plants have been obtained by the propagation of desirable bud variations—mention need only be made of the Navel Orange. The possibility of propagating improved strains by obtaining suitable bud variations has been pursued for some time by an investigator, Shamel, in Hawaii, and the latest report by Barber in the International Sugar Journal is that the results so far have been both promising and disappointing. However, there appears to be little doubt that this is a possible line of improvement which under our condition should not be neglected.

Seedling Selection.

Another line of improvement which has been followed with very great practical benefits is the selection of cane seedlings. In different portions of the cane growing world, notably Coimbatore, in India, thousands of crossbred and inbred seedlings have been produced, a number of which have proved their superiority over older varieties. In crossbred seedlings, a reshuffling of the heritable characters takes place and it is possible to obtain a more desirable combination of qualities, than were present in either of the parent plants. The technique of crossing and the resultant testing and selecting of the most desirable seedlings, is difficult and can only be carried out successfully by a properly equipped experiment station.

The value of such work may be incalculable. Unfortunately, the Uba variety, although known to arrow fairly freely some seasons, has never been found to produce seed. It is not impossible, however that it could be forced to produce seed, or be at least the female parent, if grown under suitable hothouse conditions.

The method of forcing has been successfully carried out in the States.

The Possibility of the Production of More Vigorous Seed Cane.

An important practise long in, vogue with the potato grower is the use of seed from special areas known to produce vigorous and productive seed.

The English grower, every third or fourth season, imports Scottish seed. The use of such imported seed is all-important in the successful growing of the crop, as differences of three and four hundred per cent often result.

The exact cause of the inferiority of the home grown seed in such cases, is as yet, not clearly understood.

It is perhaps most generally attributed to the disastrous effect certain diseases of the virus type have on the plant grown under rather adverse environmental conditions. Rigorous selection of healthy plants, although useful, will not prevent the decrease in yield. For example, in an experiment carried out in the States, the yields of a particular variety for 1914, 1915, and 1916 respectively were

196, 169 and 22 bushels per acre. Now, if such run-out seed be planted again under favourable conditions it is rejuvenated. For instance, in the above experiment, some of the 1916 tubers were planted in an area which normally produced good seed, and gave a yield of 170 bushels per acre in 1917 and in 1918, 300 bushels per acre, a good average yield.

Whether a badly diseased variety can be rejuvenated by planting tubers from diseased plants under favourable conditions is as yet an unanswered question. So much for vigorous seed tubers in potato growing.

It should be borne in mind that not only is cane propagated in the same manner as potatoes, but that cane is also being grown under a variety of conditions, some more favourable for its growth than others, and the question arises to what extent can yields be increased by growing cane from a different area.

It seems to me, gentlemen, a point worthy of investigation, which I hope will be accomplished in the near future.

To Summarize:-

(1) There is apparently no possibility of permanently improving a pure variety, (such as Uba), by simple selection for seed cane of stools, or stems, with the most desirable qualities, except from Bud variations

Selection, however, may temporarily eliminate certain diseases and in this way will result in markedly increased yields.

(2) Desirable bud variations do occur at rare intervals in plants and thus there is the possibility of obtaining an improved variation in Uba. It is wished to point out, however, that no improved variety of cane has been definitely known to have originated in this way.

(3) Improved varieties have been obtained from seedlings. The possibility of using Uba for the production of seedlings should be investigated.

(4) Climatic conditions are all-important in the production of vigorous seed potatoes. It seems possible that it should have a similar effect on seed cane.

DISCUSSION ON THE IMPROVEMENT OF CANE BY SELECTION.

Mr. Dent asked if Mr. Dodds would explain what was meant by the first portion of the summary, with reference to bud variation.

Mr. Dodds replied: Bud variation, or sporting, is the name given to certain definite and permanent differences which may rarely occur for some unknown reason in certain shoots of a plant propagated vegetatively, such as sugar cane. Unfortunately I am not a botanist, so cannot go very deeply into the theoretical part of it, which is, I believe, still very obscure, but it is generally understood that any plant which is propagated vegetatively, that is by cuttings, does not offer the same possibilities of permanent variation as you get in the case of seeds. In the one case you are just planting the same plant over and over again, so to speak, whereas in the other it is a new generation. But there does appear to be a possible exception to that in the case of the variation known as bud variation, by which it is believed that permanent heritable change may be brought about.

Mr. Dodds cited as an example of bud variation in sugar cane the occurrence of self coloured canes in fields of a striped variety, also possibly the isolation of strains resistant or tolerant to Mosaic disease, within a susceptible variety, as had been claimed at the Louisiana Sugar Experiment Station.

Mr. Storey said he doubted the validity or rather the interpretation which had been published of the latter instance, while freely admitting the first case mentioned, i.e., change of colour in canes, as an excellent example of bud variation.

Chairman: What I would like to have made clear is this: Is sugar cane capable of being improved in regard to its sugar content, if properly selected and planted out?

Mr. Dodds: At the Louisiana experiment station this question was studied over a period of a number of years after it was found that the standard varieties of cane grown there showed different chemical compositions in different parts of the stem; whether the upper, lower, or middle part was analysed it showed corresponding difference in the sucrose content and chemical composition generally. For years field experiments were carried out of planting tops from tops, middles from middles, and butts from butts systematically, but after a great many successive crops there was no appreciable difference in the composition of the cane produced. Only in one case was there a slight difference in the character of the impurities or the non-sugars which might have a small bearing on manufacture, but the all important question of sucrose content and general purity of the juice was not appreciably affected. Whether this course of experiments which went on, I believe, for ten years or more, was sufficiently prolonged to bring about any permanent improvement in that way, is a matter of doubt. At all events the experiments

had a negative result within that period. It seems to me, that by the careful selection of the best material for planting, you give the new plant a healthy and vigorous start, which, as we have seen in a good many respects, is a most important factor in ultimate growth, but that you don't really cause any material difference in the nature of the plant itself.

Mr. J. H. Armstrong asked if it was not possible to influence the sugar content by the chemical fertilisers used in the soil.

Mr. Dodds replied: It is claimed sometimes that fertiliser has an effect on the chemical composition of the juices, but I think such results are usually in the nature of secondary effects. For example a fertiliser may have the property of accelerating or delaying maturity in the cane, in which case you would have differences in chemical composition with canes compared over the same period of growth but not of the same degree of maturity. It is often found in Louisiana where they have a very brief growing period which is never sufficient for the proper maturing of the crop—the time available for growing is 9 or 10 months at most and only a few varieties will even approach maturity in that time, it is found that the application of nitrogenous fertilisers beyond a certain limit may result in increase of cane yields, but delays maturity so much that there is no increase or may be even a loss in sucrose. I consider fertilisers may act indirectly in that way but I doubt whether they really affect the composition of the cane very directly.

There is one opinion Mr. Staples has expressed here which I would like to enquire further into, if he were present. He states "We in South Africa are confined to the growth of one variety of cane, Uba, and it is not unlikely that we will be confined to this variety indefinitely." That is rather a disappointing outlook if it is true. Although Uba cane is very difficult cane to beat for most of our conditions yet in special situations, such as soils which are considerably above the average in quality, irrigated plantations, or alluvial plantations of Zululand, I think more suitable varieties than Uba could very easily be suggested, and it may be on the hillside plantations where Uba so far has proved supreme, that even there we may succeed in obtaining more successful varieties, but Mr. Staples evidently has little hope of it.

Chairman: In regard to one statement made by Mr. Staples in connection with tubers, that no result followed the breeding by selection in regard to the eradication of Mosaic disease, I happened to be overseas some eighteen months ago and I visited an Experiment Station run by the North of Scotland Agricultural Association and there they showed me

Mosaic tests over some five years. They showed by the process of selection that eventually the Mosaic disease was eliminated entirely from the potato, just by a process of selection, selecting the best plants every time and planting them out. That experiment seems to be quite in opposition to the idea expressed by Mr. Staples.

Mr. Dodds: I believe the old school of botanists used to maintain that any plant which was propagated vegetatively exclusively, that is from cuttings year after year, would eventually necessarily deteriorate, and the instance of potatoes is often cited as a classical example of this. But a more modern view, I believe, is that there is no inherent deterioration brought about in that way but that there may be, and generally is, an accumulation of some disease factor. Mr. Storey has informed me that in the case of potatoes, the deterioration of plants which are propagated from tubers lies in the eventual accumulative effects of disease, mostly of the Mosaic type. I would like Mr. Storey to explain that further to you as he could do so better than I can.

Chairman: And on the possibility of elimination of Streak disease in cane by selection.

Mr. Storey: That rather strikes into the paper I am going to give you. As Mr. Dodds has said this so-called deterioration is clearly due to the accumulated effect of a number of virus diseases of the Mosaic type. By the selection of healthy potatoes you may establish healthy stock just as by selection of Uba you may establish Streak free stocks of Uba cane. The case that Mr. Piccione has quoted is exactly similar to that which we have in Uba cane growing in some of these favourable localities where secondary infection is not severe. In the case of the potato the North of Scotland is a particular place where the secondary infection by potato virus disease is not severe, therefore, by selecting healthy tubers and planting them you stand a good chance of isolating a healthy strain, just exactly as you stand a chance of isolating healthy strains of canes in a good locality by selection.

The Chairman expressed the thanks of the members to Mr. Dodds for the manner in which he had dealt with this subject and to Mr. Staples for his paper.

THE CANE DISEASE SITUATION.

By H. H. STOREY, Government Mycologist.

Mr. Storey, Government Mycologist, then gave the following lecture on "THE CANE DISEASE SITUATION":—

A recent report from Hawaii includes the results of a careful series of experimental tests for the effect of Mosaic disease on the standard varieties of cane grown there. I would draw your attention to some of the results. Comparing the yield of cane from a planting of setts entirely healthy with that from setts entirely diseased, the experiments showed that with the variety Badila an average loss amounting to 78% of the gross yield was obtained. That is to say where a planting of healthy cane would give, shall we say, 30 tons to the acre, a planting of diseased cane on the same land and given entirely similar treatment would on the average yield just over 6½ tons per acre. With the variety D1135 the corresponding figures were a loss of 36%; that is to say where a healthy crop would give 30 tons a diseased crop gave slightly over 19 tons. In a similar way it was found with Lahaina—probably the variety known in this country as Louzier—gave instead of 30 tons only 15½ tons, and with H109—a Hawaiian seedling—instead of 30 tons it was only 19 tons. The varieties which I have mentioned are among the most valuable sugar producers in the world. They are the varieties which on special lands in Hawaii have given over 100 tons per acre and on the

estate scale have given an average return of sugar of nearly 8 tons per acre per annum.

In February 1923, there was introduced from Queensland by the management of Natal Estates, Ltd., a number of varieties of thick tropical canes which were considered to be suitable for South African conditions. Since that date the canes have been growing under my control and under frequent inspection by the Estates staff and myself. During 1923, these canes covered less than half an acre of ground. Their early growth was entirely healthy, but after a few months secondary infection of Mosaic disease began to appear. Immediately upon their discovery all diseased stools were dug out. Nevertheless each month ten to fifteen new cases of disease appeared; these canes representing a substantial proportion of the total amount of cane growing there.

At about this time Natal Estates on my recommendation decided on a policy of eradication of all existing Mosaic susceptible canes in their fields. This eradication policy has now been fully carried out and no Mosaic diseased cane is growing on those Estates to my knowledge, except for a few plants which up to the present, may have escaped eradication in the frequent inspections of the fields where the diseased canes originally grew. In effect the whole of the diseased, or practically the whole of the dis-