BUD SPORTS OF SUGARCANE IN NATAL.

By A. McMARTIN.

The necessity for uniformity in a product of agriculture or industry is too well known to be stressed. In agriculture the development of varieties is nothing more or less than a means of ensuring that a particular crop will be a collection of individuals giving under certain conditions a uniform and satisfactory performance. Between the segregation and growing in pure culture of selected strains of food plants by primitive peoples and the elaborate and highly technical methods used by the plant breeders of to-day, a large gap exists, but the same underlying principle holds, viz., selection and standardisation.

The propagation of the selected individual or individuals in such a manner that the population arising therefrom will reproduce the characters of the parent being essential for continuity, and the nature of plant life being such that variation is continually occurring to produce new forms, artificial means have to be resorted to in securing the desired result.

To appreciate the methods used by man to attain the desired result, viz. a uniform population, it is necessary to have some understanding of the processes by which plants reproduce themselves in nature. These processes can be grouped into two—firstly, sexual reproduction, and, secondly, asexual or vegetative propagation.

Sexual reproduction involves the union of the male and female elements, and is followed by the formation of an embryo or new individual. Vegetative propagation involves no sexual union, but is merely an extension of part or parts of the parent plant in such a manner that these parts can lead a separate existence and become independent of the parent. A simple example familiar to all is the strawberry. When the flower of this plant has been pollinated, sexual union occurs and the seeds, containing the embryos, are formed. At the same time, as the plant grows, runners are sent out along the ground which form little tufts of leaves at intervals; these eventually take root and form new plants, which can exist separately from the parent plant.

If the seeds give rise to seedlings, these have thus been produced sexually, while the plants formed on the runners have been produced asexually, or vegetatively.

The fundamental difference between these two methods is that in the first case two parents may contribute to the constitution of the offspring, whereas in the second case only one parent is involved. The sexual method allows for the combining of characters of two individuals, and for the possibility of change in the offspring; the vegetative method being, as it were, simply the further extension into space of the parent and not involving the introduction of new elements into the new individual, perpetuates the hereditary constitution of the original.

Naturally occurring examples of the latter type of propagation, in addition to the above example, are bulbs of lilies, tubers of potatoes, etc.

The fact that portions of many plants when separated from the parent are able to establish themselves as new individuals by the production of new organs has enabled man to adopt artificial means of vegetative propagation, such as by cuttings, layering, budding, grafting, etc., each of which simply involves the removal of some part of the plant into conditions where it can exist independently.

It will be appreciated that by propagating plants in this manner one is not producing new individuals in the strictest sense of the word, but simply extending the original. To raise new individuals one must resort to seed. The type of population arising by this method, however, depends upon the genetic constitution of the parents. If the seed is of hybrid origin, or if the genetic constitution of the parent is not stable, the offspring do not necessarily closely resemble the parent, but may consist of a collection of individuals of different types. In popular language some plants do not "come true" from seed, whereas others do. If, now, a desirable type is found, and it does not come true to type when reproduced by seed, it will readily be understood that if propagated vegetatively, the characters defining the parent are maintained.

Such is the case with sugarcane varieties. If fertile seed of any of our varieties is sown, the resulting population is not that of the parent variety, but a heterogeneous collection of types, many, perhaps mostly, or all, of an undesirable type. When however, propagation is effected by cuttings, the original type is maintained. If one looks upon the vegetative propagation of a plant as simply the further extension of the original over a wider area, it will be seen that all the Co.281, for example, grown now is still the same plant that was originally produced in India, only now it covers many acres. Local differences may be impressed upon it by varying environmental conditions, but its hereditary constitution has not been altered; it is still genetically

the variety Co.281. (It might be pointed out here that the term "variety" as used commonly to denote such offspring as are derived by vegetative means is not strictly correct; this term is used when referring to a plant propagated by seed; when propagated vegetatively the term "clone" ought to be used—thus it is correct to speak of a "variety" of wheat and a "clone" of sugarcane.)

The function of asexual propagation in providing a uniform population has been stressed; the object of this paper, however, is to draw attention to certain cases which are the exceptions to the general rule, in which for some reason or other the new plant severed from its parent does not reproduce in its entirety the characters of that parent.

Such a phenomenon, described as vegetative segregation, arises when some upset causes the production of a cell or group of cells, genetically dissimilar to those of the parent body. These cells, continuing growth as part of the plant, or being removed to start a new individual, differ genetically from the parent, and often do so in a manner which is readily discernible to the eye. In popular language, "freaks" are produced; such, for example, as a rosebush bearing one shoot with blooms of a different colour to the rest, or a citrus tree with a branch of a type differing from the rest of the tree.

Sugarcane is no exception to the rule, and during the past few years we have collected at the Experiment Station various types of freaks, or bud sports of common varieties.

Vegetative segregation in this crop plant has been known for a long time, and there is a considerable body of opinion that some, at any rate, of the older established varieties arose as bud sports from some other type.

Perhaps the commonest form of mutation is the production of a colour change in the stalk, e.g. a self-coloured cane which develops a form with longitudinal stripes of two colours on the joints, or, conversely, a striped coloured cane which produces a self-coloured form. One interesting case on record is that of the variety Mignonne, a striped cane introduced into Mauritius from New Caledonia in 1868 or 1869; a few years later a self-coloured cane was found in a stool of this striped cane, which was propagated separately by the finder, after whom the variety was known—Louisier. Some years later still, this variety produced a striped sport which was known after its finder, Horne.

Another well-known case is that of Striped Tanna, which in Mauritius produced two colour variants, Black Tanna and White Tanna. Though these are the only examples cited, sugarcane literature abounds with references to this phenomenon, which shows it to be fairly universal. Colour, moreover, is not the only variable attribute of the constitution of the sugarcane. The form of the leaf, the habit and other features are also liable to change. It has frequently been noted, also, that with colour variants a cycle occurs: the striped cane gives rise to the self-coloured, and this in turn gives another striped form. The question which was the original type in these old varieties is rather like that of the hen and the egg, but it is not unlikely that either form may have been the parent in different cases, as we have noted in seedling progenies that striped forms occur, as well as self-coloured types.

In Natal, a mutation of Uba was discovered several years ago, characterised by the presence of brownish-purple stripes, often commencing on the leaf sheaths, and running down the stems, where the stripes alternate with the original green. This striped Uba was quite extensively grown and became mixed with cultures of typical Uba, and is frequently still seen in the Mount Edgecombe district. In other respects it appears similar to the standard type. Several years later Mr. Gilbert, of Natal Estates, brought to the Experiment Station a specimen of a cane which he found growing in Uba; it was not striped, but appeared different in habit to Uba, though otherwise similar. This has been growing in our collection for some years, and it retains its different habit. The close similarity to Uba, and the fact that it was found in an area where striped Uba occurred, leads the writer to believe that it is a mutation from the striped form to a self-coloured form. It does not appear such a vigorous cane as Uba, of which it may be said to be a slightly degenerate type. Of the newer varieties the one in which most bud variation has been found is Co.281. Striped forms were noticed early to occur, and more than one type of striped cane has been collected. In one type the plant appears normal as far as growth and habit is concerned, but the stems are coloured with alternating green and purple stripes. In another, the stripes consist of dark purple and normal coloured, while in a third the colours are simply two different shades of the standard colour.

Other specimens have been found in which the striping has been accompanied by changes in other characteristics of the variety. For example, in one type the stems are thin, with a diameter about that of a pencil, and the leaves are narrow, giving the plant a reed-like appearance. Other types have been found which are visibly inferior in growth.

When propagating the green and purple striped type, it was noticed that occasionally canes were produced in which the lower joints had the two colours about equally distributed, but on proceeding up the stem the purple colour decreased at the expense of the green, while the top joints were of a

uniform self-coloured green. When now these joints were propagated separately, the top ones gave rise to self-coloured green canes, while the lower ones perpetuated the striped forms. This, then, is probably one manner in which green forms arise from self-coloured canes of another colour, through the production of striped forms as intermediates.

While these canes were being studied, a stool of cane was observed by Mr. Colepeper, of the Experiment Station field staff, in the garden of an Indian, which did not appear like one of the released varieties; it was a green cane, and was grown by the Indian from tops he had collected at a railway siding. On being grown here, and compared with other canes, it was decided that it is a green sport of Co.281. It appeared a vigorous type, and was propagated to compare it with the standard Co.281. Though usually having a higher sucrose it falls short in tonnage, however, and does not compare with the standard in terms of sucrose per acre.

Other variants of Co.281 have been found which do not involve the production of striped canes.

A few years ago a stool of this variety was observed by the writer in which most of the plant was normal, but a few canes had drooping instead of erect leaves. These were collected and planted separately, and eventually a small plot was obtained of this drooping-leaved Co.281. It forms a good canopy, and from that point of view would probably be an improvement on the standard type. Unfortunately, however, in growth it appears weedy, and probably would not compete with the typical Co.281.

Another type is that in which the habit, instead of being erect, is recumbent; another one has semi-erect leaves; while yet another differs from the type in the production of a ligular process, the absence of which is a feature botanically describing Co.281. A type has also been found in which the leaf sheaths, instead of being of a lavender colour, are deepish purple.

An interesting case was noted some years ago, when for a special purpose we were asked to ascertain how stools of growing cane would stand the shock of transplanting. Accordingly stools of some varieties were transplanted into large tubs and tended. On attaining maturity it was noticed that in Co.281 and Co.290 many of the stems were greenish in colour; these were planted to see whether this was due to environment and not transferable, or whether a permanent change had been induced. The crop produced was almost entirely of striped forms, which being ratooned gave rise to striped, self-green, self-straw and normal coloured types.

Of other released varieties, P.O.J.2725 and P.O.J. 2714 have been found here with striped variants. Co.290 has a striped form, a green form, and a type with stiff erect leaves. Co.301 has a striped form, and an erect-leaved type has been seen.

A question which naturally arises is that of the economic importance of such phenomena. In considering this point, there should be borne in mind two points—firstly, such bud sports are the exception, not the rule; secondly, no form has been found, here, at any rate, in the cultivated varieties which could be said to be an improvement on the standard form; they are generally the reverse, often to such an extent as to be visibly so.

The problem might be different were the proportion of mutants higher, as is the case with some plants which produce what are known as "ever-sporting races," where sporting is the rule rather than the exception. In sugarcane, as long as the position remains as it is, however, vegetative propagation will ensure the continuity of the desired type, except in these exceptional cases referred to. The question arises, should one propagate from such types when they are found in the field? With the obviously inferior types, the answer is of course to avoid them. With types also, such as a striped form which appears normal otherwise, the fact that variation has begun and may continue further, leading eventually to the production of other, and perhaps inferior types, it would appear safer not to use them as seed material. As a matter of interest they might be propagated separately in a small plot for observation purposes, to see whether any further variation occurred, and if so of what nature.

One aspect of this problem which suggests itself is the possibility of the production of bud sports which exhibit some other desirable qualities apart from those apparent to the eye, such for example as one with a higher sucrose content, or with greater resistance to some disease. Such mutations would, of course, be very difficult to discover, as a variant for high sucrose, for example, could only be found by laboriously analysing separately all the stools in many acres of cane, if indeed one were found at all.

The occasional appearance of healthy stools of Uba in fields which have been highly infected with streak for years has suggested an increased resistance to this disease, but every case where such canes have been collected and propagated the results have been disappointing—infection has always occurred sooner or later.

The cause, or causes, of vegetative mutation under field conditions, at any rate, are rather a matter of speculation. It is not unlikely, however, that one factor which can cause an upset in the otherwise orderly behaviour of vegetatively propagated plants is that of damage or disturbance. One case observed by the writer was in a stem of two-years old Co.290,

in which the lower half was normal, but about halfway up the stem was damaged as if by some insect, and the remaining top portion was striped. The case mentioned before of the Co.281 with the drooping leaf was found originally in a stool on the edge of a field, and it appeared as if it had been damaged some time previously, perhaps by animals. In sugarcane, also, the manner in which the crop is harvested, i.e. by cutting followed by ratooning and further cutting, probably aids in the production of these occasional variations.

The artificial production of mutations has attracted the attention of some investigators recently; it has been discovered, for example, that such phenomenon can be produced by the irradiation of buds with X-rays, by treatment with certain drugs (the principal one at the moment being colchicine), by freezing, injury caused by pricking with a needle, and other mechanical methods. Though such methods seem to offer so far no hope of replacing the more laborious but perhaps more fruitful method of seedling raising, they are additional tools in the hands of the plant breeder.

Lastly, one aspect of these naturally occurring phenomena which has occurred to the writer, is what might be termed the legal status of such mutations in an agricultural industry such as that of sugarcane in Natal, where strict quarantine restrictions are imposed upon the cultivation of varieties. Here the only varieties allowed to be grown commercially are those approved by the responsible authorities. If, now, a bud sport arises and is of a dissimilar constitution to its parent, it is genetically speaking a different variety; what is its position within the meaning of the law? It is a subtle point, and would depend upon the legal definition of the term "variety," which if not expressed in wide enough terms would create the undesirable situation in which every cane planter, in whose estate bud sports are found growing, becomes an unwitting breaker of the law.

Summary.

Sugarcane is propagated by vegetative means to ensure the uniformity of population in the field. Occasionally, however, plants arise which do not exhibit the usually consistent behaviour of this crop plant, and produce vegetative mutations, or bud sports.

Thus mutations involve changes in the colour of the stem, habit of the leaf and other organs, and in vigour. The possibility of change in other, less readily recognised characters, is also discussed. The causes of such phenomena appear in some cases to be due to damage, mechanical or otherwise, and means are now known of artificially inducing such genetic changes. From the economic point of view, such bud sports as have been found in Natal so far, show no promise of being the forerunner of improved types; the method of seedling raising shows more promise of yielding results of value.

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The PRESIDENT, in opening the paper for discussion, pointed out that there were quite a number of bud sports at the Experiment Station, and those interested would have an opportunity the following day of inspecting them. The paper showed the necessity for careful observation of these new varieties.

Mr. DODDS found this paper of the greatest interest. He pointed out that he had discussed the legal aspect of growing bud sports with Dr. McClean, Government Mycologist, and he had given him the assurance that bud sports arising out of released varieties would not be regarded as new varieties by the Department of Agriculture. A good deal of work had been done in other countries, especially Hawaii, on bud sports, and also on "unseen"' bud sports having for example, no other distinction than a higher sucrose content than the original variety. Although not very successful here so far, the possibility of getting a sport of real economic value always remained.

Mr. BIJOUX congratulated Dr. McMartin on his paper, and pointed out that were sporting more frequent, errors in the classification of cane for differential payment might easily arise; and that Dr. McMartin was to be thanked for showing us the pitfalls of nature for the layman, and the danger of being too dogmatic in the classification of cane varieties on their physical appearance only.

Mr. P. MURRAY asked whether new varieties had been developed at the Experiment Station artificially.

Dr. McMARTIN replied that no X-ray experiments were conducted at the Experiment Station as the apparatus was not available. New varieties raised by this means in India were imported, but unfortunately had not grown here. Injections of colchicine into cane to produce mutations had, however, been done here, but without much result hitherto.

In reply to Mr. Moberly, Dr. McMartin pointed out that in unseen bud sports the chromosome constitution was changed, but it was very difficult to find unseen sports.

Mr. BOOTH wanted to know whether Dr. McMartin had been able to increase the sucrose content of cane by injecting colchicine.

Dr. McMARTIN replied in the negative. Changes produced so far were only temporary and also very localised.

Dr. McMartin was accorded a hearty vote of thanks for his instructive paper.