POLYPLOIDY INDUCED BY COLCHICINE AND ITS ECONOMIC POSSIBILITIES

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THE technique employed by plant breeders has undergone revolutionary changes since the first workers began the production of new and improved varieties. The methods of the selectionists, such as Luther Burbank, were certainly spectacular, but they were laborious, expensive and haphazard. Mendelism marked a great step forward, in that it was possible to work along preconceived lines in an orderly and economical manner with a fair idea of what was likely to materialize. There is no doubt, however, that Mendelian methods have taken us as far as they can, at least in respect of our commonest crop plants. We have exhausted all possible combinations of known characters and have reached a point where, as Salaman has declared, we are simply 'ringing the changes' on existing material. A point has been reached where the hybridizer can only wait for some new mutation to turn up.

Attempts have already been made to produce these mutations by the artificial production of polyploidy. Such practices as thermal treatment, centrifuging and decapitation of the apical shoots in the seedling have proved successful in a very small number of cases. They are, however, far too laborious to be considered worth while.

In view of the above facts, it is small wonder that the discovery by Blakeslee and Avery of the value of colchicine as an agent for the production of polyploidy has received a great welcome. The need for such a stimulus has probably accounted for the wave of optimism which seems to have swept through the ranks of plant breeders throughout the world. Results up to the moment, however, scarcely seem to justify the description of the new technique as being more than promising.

The drug colchicine, prepared from parts of *Colchicum autumnale*, has been known to physicians for many years, mainly as a specific for gout. Hope was expressed that it might also prove to have an inhibiting action on carcinomatous cells. It is only recently that its influence on mitosis has been discovered and put to practical application.

There have been several theories as to the exact manner by which it brings about somatic doubling. It has been suggested that nuclear division takes place at a greater rate than cell division, under the influence of colchicine, thus resulting in bi-nucleate cells with subsequent fusion of the pairs of nuclei. The investigations of Levan, supported to a certain extent by others, have practically established the fact that another mechanism is responsible. It appears that inactivation of the nuclear spindle prevents anaphase reduction, thus leading to a doubling of the chromosome number. Experiment has shown that meiosis is also affected, but this has no economic application as has the influence on mitosis.

The exact action of colchicine and the mechanism by which changes are effected has great interest for the cytologist. However real may be the achievement in this direction, the practical plant breeder is more concerned with the accomplished fact and its possibilities.

Literature on the subject has already assumed large dimensions and results pour in from all parts of the globe. The number of workers is now so great as to make a detailed account of their different activities impossible in a small space. A review of available publications leaves one with the impression that, in the main, reports are fragmentary and often unconvincing.

Easy and rapid methods for identifying the polyploid condition are certainly desirable; but it is doubtful whether they are, as yet, sufficiently trustworthy to be used in proof of claims made for the results of a new and revolutionary technique. One could wish that statements were supported by something more concrete than such criteria as pollen grain size, dimensions of the stoma guard cells and *gigas* characters. On the other hand, claims for the production of tetraploid plants of several species are made which are supported by chromosome counts. It must be conceded that the work is as yet in its infancy, and technique is by no means perfected.

The practical application of the treatment has taken different lines and there are several methods for the administration of the alkaloid. The soaking of the seed in dilute solutions varying in concentration from 0·05 to 1·0 per cent is the commonest practice. The influence upon the seedling depends upon such factors as the concentration of the solution, period of soaking, nature of the testa and the rapidity with which the seed germinates. In some cases it is suggested that the testa should be removed or that the seedling itself should be treated.

A large amount of routine work is necessary to determine the optimum concentrations for the seeds of different species. I have found that a 0·05 per cent solution has a profound influence on the seedlings of mustard after soaking the seed for four days. In the case of several gramineous species the seed of which had been treated in like manner, only a very small proportion of individuals was visibly affected. In the case of sweat peas, the seeds either failed to germinate or the distorted seedlings perished.

The main objection to seed treatment is that germination is either partially or completely checked, root development is restricted or absent for some considerable time and a great waste of material occurs. There is a characteristic swelling of the hypocotyl, more notable in some species than in others. Many odd distortions occur, each characteristic of a particular species.

The treatment of apical and axillary buds has produced tetraploid shoots. This is affected by painting on the solution, in combination with a wetting agent, by spraying or by immersion. A 0·4 per cent solution is recommended by American workers for the direct application method.

Spraying of the parts is the least desirable of methods from the operator's point of view. It is important to stress the fact that colchicine is a dangerous drug and that in the hands of irresponsible persons disastrous results may occur. The human mucous membranes are particularly sensitive and one reads of serious eye injuries.

I have employed the 'injection' method as elaborated, for other purposes, by the East Malling workers. A 0·05 per cent solution has been used, a vertical slit in the stem of the plant or a severed petiole being placed in a tube of the solution. Profound morphological changes take place, and, as the influence is localized, its intensity varies throughout the affected part of the plant. In the case of *Vicia Faba*, the flowers were swollen at the base and were all abortive except two. These gave rise to pods showing *gigas* characters with an erect habit of growth. In *Fragaria* species, distorted fruits have been produced. A large amount of material has been treated by this method, but it is as yet too early to determine whether polyploidy has resulted.

Colchicine is an expensive commodity and investigations are proceeding to explore the possibilities of acenaphthene as a cheaper substitute. Kostoff has shown that the disintegrating fragments of the corm of Colchicum can produce polyploidy in germinating seedlings in close proximity.

Reviewing the whole of the work on induced polyploidy in a dispassionate manner, one must admit the remarkable nature of the achievements from the cytological point of view. Whether there will be much material gain accruing to the plant breeder remains to be seen.

In the case of garden plants there are distinct possibilities. Abnormal or distorted varieties with unusually large flowers have an economic value with a public displaying an insatiable appetite for novelty. Food plants are in a different category. Tetraploids are of frequent occurrence, but are not always of special merit; in fact, the reverse quite often obtains. Increased size is not always of importance, for with most of our arable crops there are varieties capable of producing plants just as large as the soil will grow them.

We do not, of course, know how the new tetraploid types will react to disease infection, how their cooking qualities may be affected for better or worse, or how altered morphological characters may be of benefit to the cultivator. For the present the chief possibility appears to be the production of fresh material upon which to build.

OBITUARIES

Dr. A. Harker, F.R.S.

THE death of Dr. Alfred Harker, emeritus reader of petrology in the University of Cambridge, on July 28 at the age of eighty years has removed from our midst an outstanding figure in British geology—one whose brilliant contributions in his own field over half a century placed him in the forefront of living petrologists.

Born in Hull on February 19, 1859, Harker entered St. John's College, Cambridge, in 1878 and graduated eighth wrangler in the Mathematical Tripos of 1882. He was placed in the first class of both parts of the Natural Sciences Tripos with physics as his chief subject, and was elected to a fellowship in his college in 1885. Though not of the 'Bonney School', so much were his early geological interests strengthened at St. John's that he was eventually attracted to a demonstratorship under McKenny Hughes. He became University lecturer in 1904 and on the death of Hughes in 1917 was elected to a special readership in petrology.

Harker's earliest papers dealt with the cleavage structure of slates, an investigation for which his mathematical training peculiarly fitted him. These studies were based in part on his observations on the