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Cytogenetics

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In Cytogenetics and Plant breeding, the conventional methods of collection, introduction, selection and hybridisation have been in use in this department since its inception. These methods are the most certain and are the basic ones for obtaining the desired plant selections. In the investigation of the fundamentals of genetics, much ground has been covered in the several crop plants, some systematic and others as and when the occasion arose. The storehouse of all desired characters has been in the wild plants from which the cultivated ones have been later selected. We have often to go back to nature to incorporate certain required characters into the cultivated type and also to invigorate it, make it resistant towards pests, diseases and adverse conditions. The scientist also watches for suitable mutations to occur in the homozygous materials. These occur at very low rates. Attempts have been made to increase the rate of incidence of such mutations by the application of agencies which cause changes in the heritable material. The conception of the gene or the heritable unit is still nebulous, though something is known about their location, arrangement and constitution. The gene cannot be newly created but an existing gene can be made to change by readjustment of its molecular structure. In taking recourse to hybridisation whether it be intervarietal, interspecific or intergeneric, only gene recombinations are produced.

In the following are stressed some of the lines of investigations which deserve a systematic trial so that the crop plants in general may be thoroughly understood and useful recombinations could be obtained with greater certainty. Experiments in the production of autopolyploids have been done in most crop plants in a satisfactorily systematic manner and a fairly wide ground has been covered.

In recent years considerable work has been done not only to produce artificially mutations but also to accelerate their production by the use of external agencies like x-rays, radium emanations, heat and chemical reagents. Interest in this kind of work was greatly stimulated by the discovery of Muller in 1928 that x-rays induced mutations in *Drosophila* similar to those occurring in nature but with a considerably greater frequency. Stadler (1928) working on the genetic effects of x-rays on barley and wheat, demonstrated the possibility of experimental

modification of heredity in plants by subjecting them to penetrating radiations. Since then several plant species, *Datura*, tobacco, cotton, maize, rice, millets, onion, tomato, flax etc. have been subjected to the action of several external agencies for production of variations and a considerable body of data has been accumulated. Although most of these induced mutations are recessive, and at first abnormalities and uneconomic ones are noted, numerous economic mutations appear in later generations. Horlacher and Killough (1931) studying the genetic effects of x-rays on cotton have put forth strong evidence for the occurrence of dominant progressive mutations also as a result of irradiation. With the improvements in technic systematic work with x-rays has shown that a good number of useful variations could be produced. Gustaffson (1947) discusses at length mutations in agricultural plants. Intensive and systematic work is being carried on in Sweden, England and America. Work on barley in Sweden has produced mutations for earliness, lateness, winterhardiness, straw characters, malting qualities and higher yield. In rape and mustard, strains with higher yield and oil content have been induced. The rate of mutations is some plants has been estimated at 300 times over the control. The usefulness of the x-rays in vegetatively multiplied plants is practically unlimited. There is yet another source of obtaining variations which has not been sufficiently exploited and that is vegetative buds. Vegetative variations known as "bud sports" have no doubt arisen from time to time in plants, but attempts have not so far been made, as a regular method of plant improvement to produce them artificially and increase the material for selection. The application of this method in encouraging the growth of dormant buds which may carry latent variations and which in normal agricultural practice are not given an opportunity to develop into shoots, and by causing injury aud mutilations to them by cutting and grafting to sexually propagated plants have not been intensively investigated and that is presumably due to the lack of necessity for vegetative propagation in such plants which readily set seed.

Recently the United States Department of Agriculture has set up a programme of research with the co-operation of the Atomic Energy Commission, in which the influence of radioactive materials on the growth of crops is to be studied. The programme includes researches (i) to measure the effects of additions of radioactive materials to soil fertiliser on the growth, maturity, yield and composition of various representative crops, (2) to determine the influence of low activities of alpha, beta and gamma radiations on the germination of seed and the growth and vigour of seedlings, and (3) to ascertain the influence of the radioactive materials on the number and activity of the bacterial and other soil micro-organisms. Usually plant hybridisation work is laborious and time-consuming. Several methods have been adopted for artificial emasculation of hermaphrodite flowers such as hot-water treatment etc.

It would help in producing a large number of hybrids if methods are available in which the anthers are rendered sterile without the stigma being affected. Chemicals like 2, 4-dichlorophenoxy acetic acid Maleic hydrazide, = Tri-iodo-benzoic acids and Naphthalene aceti acide have been reported to produce such male sterility (Rhen 1952). An interesting applications of genetic knowledge to plant breeding is the utilisation of male sterility in the production of hybrid seeds. Cytoplasmic male sterility was utilised for hybrid seed production in onion, maize etc. A preliminary experiment with 2, 4-D done in tenai, gave indications of positive results.

Somatic reduction has been recorded in a number of plants (Coffee, Cotton, *Oryza* etc.) and also been artificially induced. Huskin (1948 and 1949) has reviewed the literature on this subject. Sodium ribose-nucleate, and sodium nucleate were found by him to induce somatic meiosis in root tips of *Allium cepa* and other plants. This method of reducing the chromosome numbers from the diploid to the haploid level, as also that of higher polyploids to the diploid level has rendered the analysis of chromosome complements, and genomic analysis easy. This would give the breeder a useful tool to obtain completely homozygous plants. In many crop plants investigations on the relationship of the genomes between the cultivated races and the wild are being carried on in greater detail to know the degree of homology and the possible recombination effects, when hybridisations are made. A systematic study on this line of work is also called for.

The determination of linkage groups is of great importance in economic breeding as knowledge is obtained with regard to the genes that are combined together, the recombination possibilities, and the particular genes that could be made use of as marker genes for a particular linkage group. None of the crop plants grown in this State has been completely and systematically worked on this aspect.

The search for ancestral forms and through them the basic genome has been a very important item in the breeding programme of all crop plants. In seeking new genes, special attention should be paid to the centres of origin of the ancient forms, for it is in these centres that plants with great genetical diversity may be found. The transformation that has been effected in potato, maize, wheat, rye, cotton etc. as a result of the incorporation of wild genes collected through extensive expeditions is now a matter of history. The immense value of expeditions to these centres and collection of wild relatives of cultivated plants is emphasized. The study of the genetics of the wild plants related to the cultivated ones is also stressed.

In the field of plant improvement, cytogenetical work has to be intensified and more economic plants have to be brought within its

scope. More fundamental work untrammelled by considerations of immediate application will also have to be undertaken. This will help in the formulation of general principles and new and improved techniques which are vital to the progress of applied research. As science is primarily a mental discipline which is so variable with individuals, it is worthwhile to have a number of men working at the same problems and aspects to secure successful results. It is only by team work that substantial progress can be made.

Summary: The following investigations are suggested for inclusion in the future programme of cytogenetical research in this State: Systematic studies of (1) irradiation effects on crop and fruit plants with a view to production of new mutations, (2) Action of chemicals in the production of mutations as also male sterility for use in hybridisation and production of hybrid seeds, (3) Study of the relationships of the wild with the cultivated species and production of homozygous plants through induced haploids, (4) Systematic study of linkage groups and chromosome mapping as a help in the production of desired recombinations with greater certainty and (5) Collection and study of the wild plants with regard to their behaviour, genetics etc. and the selection of suitable races to be hybridised with the cultivated ones for crop improvement.

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