PROGRESS IN GENETICS — NEW METHODS IN PLANT BREEDING

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Ever since the rediscovery of Mendels law, there has been a reciprocal action between Genetics and Plant Breeding and without doubt to mutual benefit to both.

Plant breeding problems which should be of interest to the Genetic Section of this Society are:

1. Breeding For Resistance
2. Heterosis
3. Polyploidy

Considering the recently developed science of Applied Heredity, the foregoing are old problems, which in the light of newer advances made in their respective fields assume importance for future breeding methods.

Breeding for Resistance

Plant diseases affect agriculture adversely. This subject can be divided into two parts:

1. Diseases primarily of interest to the plant pathologist;

2. Diseases which cause large losses to agriculture. Notable examples of this latter class are rusts, leafspots, rots, smuts, and the like.

"Many of these diseases can be effectively controlled in various manner by the farmer, by such means as seed treatment, specific rotations, spraying, etc. Most of these methods are costly, however, and may not always be possible to accomplish. It appears reasonable therefore, that the most effective way to approach the problem is through disease resistant and disease tolerant varieties of crops. However even in this case the problems are beset with difficulties." At this point, the history of wheat breeding in this country and Canada was considered, pointing out how some varieties were apparently resistant for years to a certain physiologic form of wheat rust only to become susceptible later to new forms of the disease.

Breeding of beets resistant to Cercospora beticola was next considered. It was brought out that while we have sugar beet strains resistant to this disease, their behavior may be quite different when tested in countries other than those where they were developed. For example, Austrian varieties of Cercospora resistant beets were found susceptible in Canada, and Canadian varieties were found susceptible in Spain.

"To test this point the following study was made. Cercospora spores were gathered from five different countries. Six resistant strains of sugar beets each outstanding in the country where tested were used to test the infectivity of different strains of Cercospora spores. The seed was planted in sterilized soil in greenhouses where conditioned air, moisture and soil con-

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1/ Danish Sugar Beet Seed Company, Copenhagen, Denmark.
2/ Condensed by A. W. Skuderna.

ditions were kept favorable for the development of the disease. The study showed that four different strains of Cercospora were actually secured, the fifth being identical in infection to strain one as shown in Table I.

Table I. Infectivity of Cercospora Spores on Six Resistant Varieties of Sugar Beets.

Sugar Beet Varieties		A	B	C	D	E	F
Cercospora	1	+	X	+	X	+	X
Strains	2	X	X	X	+	+	+
	3	+	+	+	+	+	+
	4	X	X	+	X	X	X
	5	+	X	+	X	+	X

"We do all expect that sugar beet resistance is due to the presence or lack of genetic factors, but the experiment indicates in several cases convincingly, that a single genetic factor is effective only on one or a few contagious races of Cercospora. It must therefore be the task of the sugar beet breeder to introduce his breeding material resistant factors to as many contagious races of Cercospora as possible." (Dr. Siegumfeldt then added that we must be prepared for some disappointments when present varieties are tested under varying conditions of leafspot intensity. He concluded with the statement that fortunately in such cases the farmer has recourse to sprays, treatments, etc.).

Heterosis

The speaker then discussed heterosis in beets, pointing out that it took a varying number of generations of inbreeding and self pollination to insure purity of type. By crossing such inbred progenies it is possible to hybrid vigor markedly. As a rule about 80-85 percent true hybrids are obtained from such crosses, which for practical purposes he concluded was satisfactory. He added, that this type of beet breeding had its drawbacks, it being necessary to have material of diverse origin, a large number of pure lines and inbred lines to make the crosses, making possible thereby new combinations and eventual improvement of the beet by this controlled method of breeding. He stated, "In combining heterosis breeding with polyploidy, it should be possible to make great improvement, and this method I think will be of great importance for future sugar beet breeding."

Polyploidy

"This is the oldest method of breeding agricultural crops, such as wheat, oats and barley which must have originated from wild species. Increased vitality and vigor distinguish these plants with an increased number of chromosomes in their cells. It is only in the past ten years that the utilization of polyploidy in plant breeding has been recognized, and only in the past few years have reliable practical methods been available". Under this head come three methods:

1. The Callus Method
2. The Shock Method
3. The Colchicine Method

Callus Method

"This method is dependent upon the possibility that in vegetative parts of the plant close to the cambium layer, cells occur in which cells or cell groups have a double number of chromosomes in their nucleus. By making an incision close to such points, and continuously removing new buds from the incised wound, it is possible to force new growth of buds containing tetraploid cells from the callus on the wound surface".

The Shock Method

"The principle of this method is to disturb the first division of the embryo after fertilization takes place, so that no wall between the two nuclei is formed. Under controlled temperature and humidity conditions the length of the period between fertilization and this first division is ascertained," At the end of this period, the embryo is exposed to a shock (such as a rise in temperature, high electric current, Xray, etc.) for a period of 2 to 4 minutes. "By properly timing the shock, it is possible to prevent cell division, with the result that the two nuclei merge together immediately, or after the next division, thus forming a tetraploid nucleus, cells and embryo. By a cold shock, it is possible to release diploid pollen or eggcells. Tetraploid sugar beet plants have been obtained by using this method."

The Colchicine Method

"This method is very effective and simple to use either on seed or on the bud of the plant to be treated. It consists of one or several treatments a few hours at a time with an aqueous solution of Colchicine, which affects the nucleus dividing mechanism in the metaphase stage in such a way that only one tetraploid instead of two diploid nuclei are formed. As plant tissue is restrained in growth by this treatment, it is necessary to cut back surplus buds so as to secure the best possible growth condition for the wanted buds".

"The Colchicine Method was published in 1937, but had been used on many different plants with good results, and especially so when combined with the callus method. The practical significance of this method is in vitality, heavier growth, just what is apparently needed for heavier yields. Experience however has not shown this to be the case. In the case of the potato, the number of tubers and yield per hill decreased despite increase in size of tubers. With cabbage, the results have been very good. As a rule, tetraploid seed has a very low germination. With cereals, the tetraploid grain produce larger kernels and smaller yield than diploid seed".

"With sugar beet seed it has not been possible thus far to produce germinating tetraploid seed from tetraploid beets. Further, tetraploid plants as a rule are much more susceptible to diseases than diploid plants. However, this method must still be regarded as being in the experimental stage and should prove to be a valuable factor in the breeding program. Tetraploid plants tend to produce offspring with intensely disintegrating characters. Such plants can be crossed with other tetraploids, giving rise to new combinations which would be impossible to duplicate with diploids alone."