Longer-Lived Alfalfa

transference of resistance to bacterial wilt gives promise of greater productivity

This is the third article in a series of brief progress reports on the application of the science of genetics to commercial agriculture.

E. H. Stanford

Alfalfa resistant to the bacterial wilt disease, and adapted to California conditions is expected to be available within three years.

Genetics, the science which explains how characters are transferred from parent to offspring, has made it possible to conduct a breeding program for the development of a wilt resistant variety—with the results assured.

Serious diseases of alfalfa were unknown in California until twenty-five years ago. Fields seeded to alfalfa maintained good stands, and were productive for periods of 10 to 20 years.

In the last 20 years several diseases have become common, the most important of which is bacterial wilt. Today the average field of alfalfa is productive for a period of less than four years, largely as a result of the inroads of disease which destroy the stands.

The loss to growers caused by the necessity of reseeding more than a quarter million acres annually runs into the millions of dollars. There are extra expenses involved in releveling land, preparing a seed bed, and buying new seed, while re turns from the first year on a new seeding are about one-half those from an established field.

Three Part Program

The first step in the program for the development of an improved alfalfa was to obtain a variety which was resistant to wilt disease.

Certain importations from Turkistan were found to be highly resistant to wilt. They were unsuited for hay production in this state because they yielded little more than half as much as the California Common which is the variety usually grown.

Second Part

The second step in the program was to discover how the factor for resistance to bacterial disease was transmitted from parent to offspring.

Genetics studies have revealed that such plant characteristics as purple or white flower color, short or tall plant types—and many others—are transmitted from parent to offspring. The parental types reappear in the offspring in definite mathematical ratios. In like manner, resistance to many plant diseases is inherited according to a definite pattern.

The hereditary units which control plant characters are known as genes. They occur singly in the sex cells, and as pairs in the body cells of plants, one member of the pair being obtained from each parent.

In one Turkistan plant it was found that resistance to bacterial wilt was determined by a single pair of genes, which are designated by the letters *PP*. The susceptible varieties have a counterpart pair of genes which are designated as *pp*.

When the resistant plant is crossed with the susceptible plant, the offspring are Pp. When the Pp plants are selfed or crossed with other Pp plants, the offspring are of three types: *1*, the PP plants which are resistant and whose offspring will all be resistant; *2*, the Pp plants, part of which are partially resistant to the disease and which give both susceptible and resistant plants in their offspring; and *3*, pp plants which are susceptible, and which have only susceptible offspring. When the Pp plants are crossed with susceptible pp plants such as California Common then one half of their offspring are Pp, partially resistant, and one half are pp, completely susceptible.

Third Part

The third step of the breeding program involved combining the factor for wilt resistance in the Turkistan alfalfa with the many desirable factors found in California Common.

The resistant Turkistan plant had many undesirable factors which made it lower in yield and poorer in quality, due to less vigor and a tendency to become dormant early in the fall and to start growth late in the spring. It was necessary to replace these factors with those from the California Common.

The wilt resistant plant was crossed with California Common. The offspring of this cross, obtained one half their genes from Common, and one half from Turkistan. When crossed again to Common one half the remaining Turkistan genes were replaced by genes from Common. This process of replacing the Turkistan genes with genes from Common was carried on for five back-cross generations. By this time, only 1/32 of the original Turkistan genes were present and 31/32 were derived from Common.

It was necessary to be certain that the Turkistan gene for wilt resistance P was carried along in each generation. Therefore all plants were inoculated with the wilt disease, and those which showed resistance were saved as parents of the next generation.

After five such crosses the plants were tested for productivity. They were found to be equal in yield to the original Common. This indicated that all of the important genes from Common had replaced the undesirable genes from Turkistan.

These hybrid plants are heterozygous—not true breeding—for the factors of wilt resistance. They are Pp in the first generation and produce offspring in the following proportion: one quarter are PP; one half are Pp; and the fourth quarter are pp.

When the PP plants are selected, they breed true—are homozygous—that is, no completely susceptible plants appear in their offspring.

The PP plants are distinguished from the Pp plants by testing their offspring, and these are the plants which are saved for the final step of the program.

Alfalfa is normally a cross-fertilized crop—the pollen from one plant fertilizes a neighboring plant. If the plants are inbred, they rapidly lose their vigor. Therefore to maintain the vigor of the plants an average of about 200 plants were used as male parents and a like number as the female parents in making the crosses for each generation.

Program Continuing

The final step of the program will be to secure seed from all the plants which are found to breed true for wilt resistance and increase this seed as a new variety.

Since a large number of plants will be used, outcrossing, or mating of unrelated plants will be the rule, therefore vigor will be maintained.

While the final step of this program has not been completed, the results are assured because genetic studies have indicated—with mathematical certainty—just what may be expected in each generation of plants.

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ALFALFA

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Tests have shown that the wilt resistance has been maintained, and the desirable characteristics of California Common have been combined with it.

This exact breeding procedure has been tested thoroughly with such self-pollinated crops as wheat and barley. The results obtained with alfalfa to date show that the procedure is equally applicable to cross-fertilized crops.

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POULTRY

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upper beak is removed—according to general observations—it takes about six months to grow back. The rate of debeaking varies with operators and their experience. A crew of two men can debeak about 300 birds per hour.

Future Research

The most certain information on cannibalism is its uncertainty and complexity. This is not surprising since inheritance, management and nutrition may all be involved in its expression. Reports on studies of cannibalism are numerous, which is a measure of how little accurate and reliable information is available on the subject.

Until such a time as cannibalism can be produced at will, there will be little hope for a successful attack on the problem.

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The above progress report is based in part on Research Project No. 677D3.

CORN

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The selective action of 2,4-D is a relative matter depending on several factors: amount of 2,4-D used, weed species present, age of sweet corn, growth conditions such as temperature and rainfall previous to application, and rainfall and irrigation following application of 2,4-D. A disregard of these factors involved can bring about injury to the crop plants or a poor kill of the weeds, or both.

No pre-emergence spraying or cultivation was used in the plots of this experiment previous to the use of 2,4-D. The weeds were purposely allowed to attain considerable size and were therefore hard to kill.

Effect in Weeds

Water grass was not killed at all by the 2,4-D. Rough pigweed and tumbling pigweed required three pounds per acre of 2,4-D for a satisfactory kill. All the other weeds present were killed satisfactorily by the one- or two-pound applications.

It would seem as though a pre-emergence treatment with a fortified oil emulsion, or one early shallow cultivation, followed by a one pound per acre application of 2,4-D sprayed at the base of the plants when they are a foot high would be an effective procedure for weed control in sweet corn.

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NEW PUBLICATIONS

A copy of the publications listed here may be obtained without charge from the local office of the Farm Advisor or by addressing a request to Publications Office, College of Agriculture, University of California, Berkeley 4, California.

FERTILIZERS, SOIL ANALYSIS, AND PLANT NUTRITION, 1949, by D. R. Hoagland, Cir. 367, Revised April, 1949.

This circular explains in nontechnical terms how plants, soils, and fertilizers are related. It does not give specific recommendations for fertilizing a particular soil or crop; but gives farmers a basis for choosing their fertilizer program wisely. It lists the "plant foods" crops need and discusses certain soil conditions that sometimes make it difficult for plants to get some of them from the soil. It explains the limitations of soil analysis in solving fertilizer problems, and describes the use of plant analysis for studying what "plant foods" a crop lacks.

DONATIONS FOR AGRICULTURAL RESEARCH

Gifts to the University of California for research by the College of Agriculture accepted in April, 1949

BERKELEY

General Chemical Division, Allied Chemical & Dye Corporation
48 lbs. Geniton S-50, 48 lbs. Astr. Lead Arsenate
Division of Entomology & Parasitology

American Cyanamid Co. ..... 10 lbs. Parathion
Division of Entomology & Parasitology

Beet Sugar Development Foundation $1,500.00
Division of Plant Nutrition

California Olive Association $250.00
Division of Food Technology

California Spray Chemical Corp. ..... 1 drum Tanatox
Division of Entomology & Parasitology

Chipman Chemical Company ..... 1 gallon can Toxaphene 60% liquid
Division of Entomology & Parasitology

Corn Industries Research Foundation $7,000.00
Division of Plant Nutrition

E. I. DuPont de Nemours ..... 50 lbs. Copper A Compound
Division of Plant Pathology

Lederle Laboratories Division, American Cyanamid Co.
1000 micrograms of Vitamin B-12, 1 bottle 15 unit liver preparation
Division of Poultry Husbandry

Dr. D. F. Green, Merck & Co., Inc. ..... 2 10-gram ampules Neopyrithiamine hydrobrom
Division of Poultry Husbandry

Dr. L. I. Pechuman ..... 14 species—16 specimens of Talanidae for insect collection
Division of Entomology & Parasitology

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Division of Entomology & Parasitology

DAVIS

Anderson's Hatchery, Rio Linda ..... 150 Cockerels
Division of Poultry Husbandry

Mrs. Belle Benchley ..... A pair of ocellated turkeys
Division of Poultry Husbandry

E. I. DuPont de Nemours
250 grams D(–) Lysine Monohydrochloride, 250 grams L(+) Lysine Monohydrochloride
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Essick Manufacturing Co.
Model 530-S Essick Air-Power Sprayer with Mechanical Agitation, Serial #490159
Division of Botany

Julius Hyman & Co. $1,250.00
Division of Entomology

W. A. Stine and Jack Farnham ..... 1—Model 7 Webster—Chicago Wire recorder with foot control, 6 assorted spools of recording wire. 1—Worthington centrifugal pump for sprinkler irrigation
Division of Pomology

U. S. Rubber Company ..... 10 lbs. Spurgon Seed Protectant
Division of Agronomy

RIVERSIDE

California Fruit Growers Exchange $545.00
Division of Plant Physiology