Genes for Resistance to Powdery Mildew in Cucumis Melo

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CANTALOUPE powdery mildew (*Erysiphe cichoracearum* DC.) first attracted attention in the Imperial Valley of California in 1925. During succeeding years it was often present in epiphytotic proportions and in several seasons about one-half of the crop was a total loss. From 1926 to 1931 control by various fungicidal treatments and cultural practices was attempted but none proved adequate or economically feasible. Concurrently with these attempts at prevention, a cooperative breeding program involving the development of mildew-resistant varieties was initiated by the University of California and the United States Department of Agriculture.

Obviously the first step in a successful approach to the problem of breeding disease resistant varieties was the collection of material which would represent the entire range of variation of the species. Among several lots of seed imported from India in 1927 for this purpose, there appeared a number of plants which were immune or at least highly resistant to infection by the fungus. Through a series of crosses and backcrosses to commercial varieties, the gene for resistance was incorporated into a genotype with desirable horticultural and market qualities (1). The variety that was produced as a result of this work, Powdery Mildew Resistant Cantaloupe No. 45, seemed to be homozygous for resistance since continued inbreeding did not produce susceptible individuals. However, it is stated by Jagger and Scott (1) that when grown in the coastal districts of California the vines usually show some powdery mildew late in the growing season.

In 1938, powdery mildew symptoms appeared on vines in fields planted with the No. 45 variety in the Imperial Valley. Studies were immediately initiated to determine the nature of this "new" mildew. These studies produced convincing evidence of a new biologic race of the powdery mildew organism (2).

The appearance of a second biologic race of *Erysiphe cichoracearum* DC. made it necessary to reinvestigate our accumulated stocks of *Cucumis melo* L. for the purpose of detecting genes for resistance to race 2, if such were present. Employing a technique, described in another publication (3), considerable progress has been made with this work. We have evidence that genes for resistance to biologic race 2 are available from several sources.

The purpose of the present report is to point out one of the original sources of these genes and to suggest possible improvements in plant breeding techniques arising from this experience.

Jagger and Scott (1) indicate that a single dominant gene is responsible for the powdery mildew resistance of the No. 45 variety, although no figures are given to support this statement. Examination of the pedigree shows quite clearly that the gene for resistance originated with the material imported from India in 1927.

In a routine test for powdery mildew resistance, we have discovered a strain of cantaloupe highly resistant to both races 1 and 2 which stems from the same source as the No. 45 variety. Thus we have a rather unique situation, in that, in the development of the No. 45 variety, apparently only the gene for resistance to one race of mildew fungus was carried forward from the original source; but when a new race of the fungus became prevalent, this gene was not effective, and the No. 45 variety was definitely susceptible. In the sister line a full complement of genes for resistance to both races of the fungus was brought forward from the original source. This condition of course would not have been uncovered except for the advent of a second form of the pathogen.

If the above statements represent a true explanation of the observed phenomena, a determination of the comparative resistance of the original seed to race 2 of powdery mildew would be a critical test of the hypothesis. Unfortunately, it has been our experience that germination of cantaloupe seed 10 years old or over is very poor. Of the remaining original Indian material from which No. 45 was derived three seeds germinated, and only one survived to be tested. This plant was rated as susceptible to race 2 when the mildew readings were made 16 days after inoculation. The original seed from which our resistant cantaloupe was derived did not germinate. This left no alternative except to test for resistance at a higher level in the pedigree. For purposes of this test we chose a selection made in 1935. Field notes made at the time, indicate that of the five plants in the field trial all were free of mildew. In 1942, 32 plants of this selection were tested. All were rated as immune except for some slight necrosis on the leaves of a few plants.

These tests seem to substantiate the theory that in the development of the No. 45 variety only one gene for resistance was carried in the germplasm, while in the sister line, genes for resistance to both races of the pathogen must have been inherited from the original source.

We are not prepared at the present time to advance a full factorial explanation for resistance to powdery mildew (race 2) in cantaloupes. Preliminary data indicate that not less than two or three genes are involved. Complete dominance of susceptibility or immunity is lacking. The F_1 generation on our scale of rating susceptibility is approximately midway between the homozygous susceptible and immune plants.

The evidence from this experience seems to warrant mention of the following points:

1. The practice of carrying forward a number of lines from the original material is justified on the grounds that a few will contain a full complement of resistant genes. This is an important consideration and it appears to be one means of insuring the most efficient use of resistant material.

2. It would seem advisable to make collections of the pathogen from a wide range of localities in order to determine the reaction of desirable material to as many biotypes of the parasite as possible.

3. It demonstrates the practical importance of obtaining and main-

taining collections of material from areas in which the host species is endemic. Vavilov (4) has developed the theoretical background for this practice, and the evidence from our experience with *Cucumis melo* adds support to his theory.

4. The importance of rigorous testing of the material both in the greenhouse and in the field cannot be over emphasized. The plant breeder seeking to develop disease-resistant varieties of crop plants is faced with the problem of variation in two organisms, the host and parasite. This adds tremendous complications to the task, and unless adequate techniques are available for testing resistance, progress is slow and uncertain.

Literature Cited

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