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Breeding Potatoes for disease resistance

All new potato varieties and a large number of advanced generation experimental lines from many sources have been tested for disease resistance and adaptability to California growing conditions. A true breeding program with the production and evaluation of large numbers of F_1—first generation hybrid —seedlings was initiated in the spring of 1958.

The objectives of the program are to develop varieties similar in appearance to those being grown in California, but with higher quality and resistance to disease—particularly to common scab and Verticillium wilt, and resistance to a predisposition to black spot.

Desirable materials to be used as parental lines in the various crosses are collected from many sources. Crosses must be made in the winter and early spring, when air temperatures do not exceed 70°F. Since potatoes require long days to initiate flowering, the natural daylight must be supplemented by artificial light during this time of the year. This is usually accomplished by a three-hour night time period of illumination with ordinary incandescent light.

At the time the crosses are made the plants used as females are cut from the roots and immersed in bottles of weak nutrient solution, where they remain for five weeks until the seed matures. If this procedure is not followed, many or all of the seed balls may drop from the plant.

The seeds are germinated in flats, and the small seedlings are transplanted to 4″ pots so that the small tubers from each plant may be kept separate at harvest. One year after the original crosses are made, the small tubers from the pots are planted in the field for evaluation and selection. Most of the seedlings are discarded for one reason or another. The small percentage selected is saved for further testing.

Inheritance is very complex in the potato. This necessitates the growing of large populations. For example, to obtain certain expected ratios in such plants as peas or corn, a population of at least 64 plants would be necessary. To obtain the same expected ratio in the potato, a population of 46,656 plants would be required.

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identical conditions. However, results from previous work do come close to being comparable with the test results of the last two years.

Tests were made in 1955 with two electric wind machines mounted 42′ above the ground in a large almond orchard near Chico. Before foliage development and with a 5°F inversion, the 280-pound thrust machine could not produce a 1°F temperature rise anywhere in the orchard. With a 4.5°F inversion the 340-pound thrust machine produced a 1°F rise over 1.8 acres. Although those tests were in an almond orchard, cling peach trees are similar in shape and the thrust of the electric tower machines was about the same as the under-tree wind machine. As the almond leaves increased in size, the response from the tower machines decreased. By the middle of March, 1955, it was difficult to follow the air jet—twig and leaf movement in the tree tops—beyond 150′ from the machine, and the jet was not reaching the ground anywhere. In contrast, in March 1959 and in April 1960, the under-tree wind machine had a detectable effect on the leaves to 240′ from the machine.

The tower machines generate turbulent air mixing, in the path of their air jets above the trees, which does not necessarily extend into the tree zone except where the jet itself strikes the tree tops. Here the air jet velocity is relatively high and the energy loss from forcing the air jet through the leaf and twig canopy at an oblique angle is great. In contrast, the under-tree wind machine works in the relatively open space under the tree canopy. Cover crops, tree trunks, and foliage offer some frictional resistance, but the jet does not have to penetrate a tree canopy at high speed. As the jet rotates under the trees, it sends out a slowly expanding wall of air which sweeps the cold air ahead of it. The warm air is drawn down from above, behind the slowly expanding wall of air. Occasionally the wall of air breaks through the tree canopy to be caught in the overhead wind and mixed with that warmer air over the orchard.

The under-tree wind machine generates air turbulence in the tree zone, which is then linked to the overhead wind and strengthened. The tower wind machines generate turbulence above the trees, which is then carried along by the wind except where the air jet is able to penetrate the tree canopy.

The combination of an under-tree wind machine with border heating gave fairly uniform temperature rises over a 10-acre area, which probably is about the maximum sized area for any under-tree wind machine. A larger thrust machine would require a larger propeller, and a 6′ diameter propeller seems to be about the maximum practical size. To increase the thrust of the air jet by speeding up the machine would cause wind damage to the trees.

In orchards of more than 10 acres, requiring more than one wind machine, the machines should be spaced close enough together so that heating is not necessary between them. The whole area to be protected should be outlined with a border row of heaters with a second row of heaters several tree rows inside. Under these conditions, the number of heaters per acre should be less than necessary with a single wind machine.

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