THE HYPERSENSITIVE REACTION OF CERTAIN POTATO VARIETIES TO INFECTION WITH VIRUS X[1]

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Introduction

A new Canadian potato variety which is field-immune to infection with potato virus X has been introduced. This variety, called Hunter, is a product of the National Potato Breeding Project of the Canada Department of Agriculture at Fredericton, N.B. Although Hunter is the first new variety to be'introduced into North America with resistance of this kind to potato virus X, this so-called 'field-immunity' is common in many European varieties.

Immunity to all strains of potato virus X was obtained for the first time in the U.S.D.A. Seedling 41956 (6), and the factor for this immunity was shown to be transmissible to hybrid progeny (7). Although immunity to other Important potato viruses has not yet been found, Cockerham (2) has shown that some varieties and seedlings have a marked resistance to systemic infections with viruses A and X under field conditions. This resistance is due to an extreme sensitivity and consequent rapid death of tissue around the infection points of inoculated leaves. The elimination of these two viruses from potato stocks is now being made possible by the production of new varieties possessing these genetic factors. Hunter is such a variety.

Field Immunity

Fundamental differences between Old World potato varieties may be observed in the way varieties react when infected with any one of the potato viruses X, A, B or C (2). Some develop local necrotic lesions whilst others produce non-necrotic symptoms. These reactions distinguish varieties and are based upon simple genetic differences (1). The necrotic reactions indicate that there will be virtual immunity to these viruses under natural conditions of infection, Two varieties named King Edward VII and Epicure, that have been outstandingly popular with growers and consumers in Britain for the past 50 years have this field immunity to viruses X and A, Experience with varieties of this kind has shown that the expression "field-immune" Is apt.

When leaflets of a potato plant are inoculated with the virus to which that variety is field-immune, they develop necrotic local lesions (Fig, I). This is usually the only result of inoculation, but occasionally the infection does not remain localized and the virus moves throughout the plant causing a systemic necrotic disease. When this happens, necroses develop most rapidly and most readily at or near to the growing points of the plant (Fig. 2.) Because of this unvarying tendency for growing points to be rapidly invaded when a field-immune plant is systemically infected, the reaction is known as top-necrosis.

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Experience has shown that most plants with this characteristic react with local lesions to natural or rubbed inoculations on occasional leaves, and to top-necrosis following a graft with an infected scion or to natural or rubbed inoculations to many leaves.

Occasional plants of the variety Hunter that have reacted with top-necrosis have been found in the field when sources of virus X have been brought into the growing crop by roguers or cultivation equipment. Tubers set by such plants may show obvious necrotic lesions or areas (Fig. 3). Eyes may become necrotic and fail to spout; those that do sprout give rise either to healthy plants or to plants that become necrotic and die before tubers are formed.

Hypersensitivity

The general term hypersensitivity is commonly applied to a necrotic reaction that follows a plant cell-virus interaction. Potato plants with field-immunity, or those which give a similar but less valuable reaction described as lethal necrosis, are called hypersensitive plants in their relations with a specific virus. The two reactions are superficially similar enough to be confused. Lethal necrosis is caused by the rugose mosaic virus Y in certain varieties by specific strains. Field-immunity is caused irrespective of strain by any one of the viruses X, A, B or C, to which the variety is field-immune.

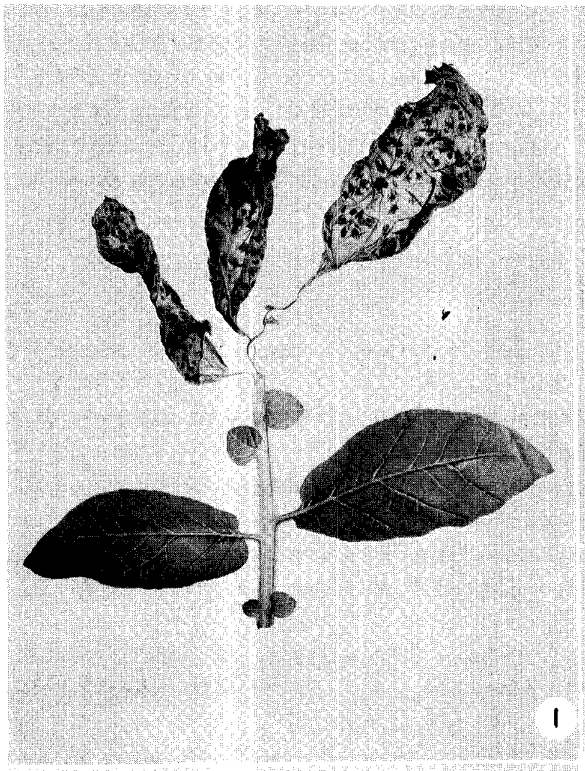
A visible difference between these two kinds of hypersensitive reaction is indicated by the type of cells which show initial necrotic symptoms in the stems of systemically infected plants, In the lethal-necrosis reaction necrosis begins in the collenchyma, continues into the rest of the cortex and eventually the phloem tissue. Finally most cells from the epidermis to the pith are necrotic (4, 5). In the case of field-immune plants the cells primarily affected are in the vascular tissues.

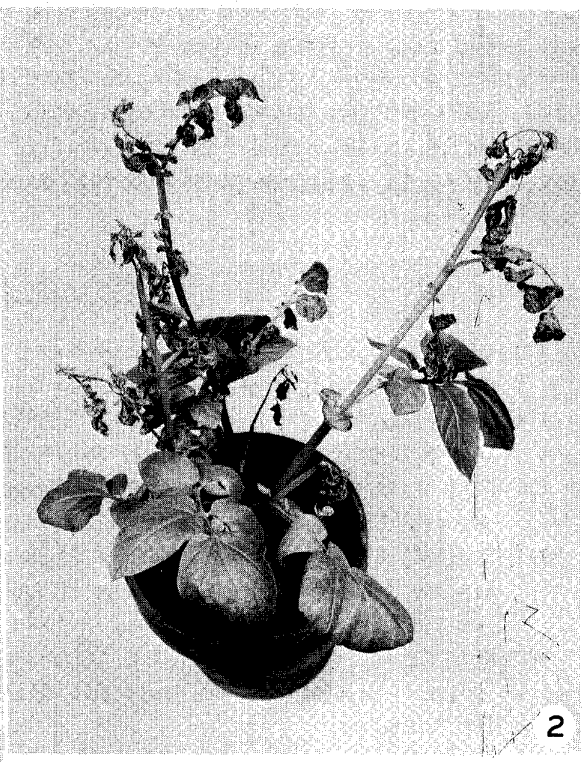
The reaction to virus infection by lethal necrosis is valuable in that although plants in a field crop may easily become infected, the infected plants are quickly killed and do not remain a focus of infection. If tubers are large enough to be harvested they will produce, in the following year, plants that will die rapidly from lethal necrosis when they are only a few inches high.

Field-immunity is a stage ahead of lethal-necrosis in that infection usually remains localized in a leaflet, and when as occasionally happens, a plant becomes systemically infected, the necrotic tubers are glaringly obvious.

Discussion

The advantages of breeding for hypersensitivity to virus X over that of breeding for immunity (3) is that there is a linkage between the genes responsible for hypersensitivity to virus A, the cause of mild mosaic, and those responsible for hypersensitivity to virus X. Seedlings that are top-necrotic to virus X are top-necrotic to virus A, but not vice-versa. Consequently Hunter is also field-immune to virus A, There is also a wide range of possible parents that are hypersensitive to potato virus X carrying many different combinations of other desirable qualities required in a potato. Breeding for the immunity to virus X obtained from U.S.D.A. Seedling 41956 is restricted to the use of that seedling and its derivations as one parent,





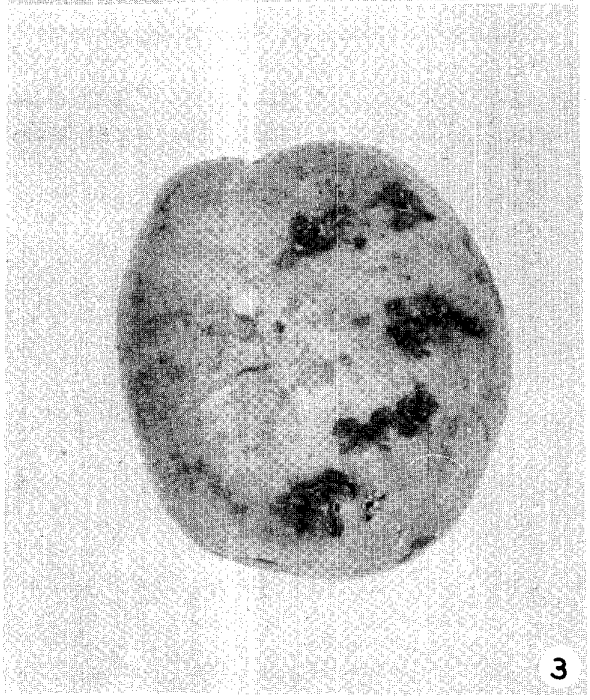


Figure 1. Terminal and first primary leaflets on a Hunter plant inoculated with a mixture of virus X strains.

Figure 2. Hunter plant with top-necrosis of each growing point caused by virus X infected scions.

Figure 3. Necrotic lesions on tuber progeny of virus X infected plant.

The main possible weakness in hypersensitive seedlings is that of being extremely susceptible to the virus. When lop-necrosis of a potato plant caused by virus X is seen in the field for the first time, there is usually doubt both as to its cause and to its relative importance. There should be no concern because the phenomenon is uncommon, it is self-eliminating, and it is abnormally conspicuous in relation to the actual number of such plants that **would** be in a growing crop.

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