Selection of Sweet Potato Plants with Internal Cork Virus that Produce Symptomless Roots

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ABSTRACT

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A stock of susceptible Porto Rico sweet potato infected with the internal cork virus (ICV) was propagated 10 yr and evaluated annually for internal necrosis (cork) in roots cured and stored at 25 C for 6 mo. The percentage of roots with symptoms declined from 93 to 50% in the 10 yr. Plants from this stock consistently produced fewer roots that developed internal necrosis than did plants from roots with symptoms. Plants propagated from symptomless roots had internal necrosis in 20% or less of the harvested roots. Scions from symptomless roots graft-inoculated to virus-free Porto Rico plants transmitted internal cork virus to the new crop of roots. The symptomless-carrier reaction of infected Porto Rico is assumed to have arisen from mutation.

Additional key words: *Ipomoea batatas*

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In the North Carolina sweet potato (*Ipomoea batatas* L.) improvement program, promising hybrids were evaluated for resistance to internal cork virus (ICV) (9). To provide a constant source of inoculum for possible vector transmission during the growing season, the hybrid selections were planted between rows of ICV-infected plants of the susceptible cultivar Porto Rico. Roots for this ICV-infected stock were initially selected in the spring of 1958 from roots of the preceding crop that had been stored at about 25 C to induce internal necrosis (6). Only roots with the internal necrosis symptom were used to produce the initial infected plants. From each subsequent crop, sufficient roots of the infected stock were harvested to provide plants for the next year. In addition, a sample of the roots was stored at 25 C to allow comparison of the development of cork symptoms in Porto Rico roots and in roots of other selections also stored at 25 C.

Internal necrosis developed in 93% of the roots from the first crop of ICV-infected stock. The percentage of roots with symptoms fluctuated from year to year but generally declined as the years passed. After 10 reproduction cycles, about 50% of the roots in warm storage had symptoms.

This decline in roots with symptoms from the ICV-infected stock suggested that some change in either the cultivar or the virus altered symptom expression in Porto Rico roots stored at 25 C. Tests were initiated to see if the plants from the ICV stock selected in 1958 consistently produced more symptomless roots than plants from roots with the internal necrosis symptom and if, by propagating and reselecting from symptomless roots, a stock of Porto Rico could be selected that did not develop the objectionable internal necrosis.

MATERIALS AND METHODS

The ICV-infected Porto Rico stock selected in 1958 was maintained for future propagation and monitoring internal necrosis development after storage at 25 C. All roots were cured at 25 C in high relative humidity for 1 wk; those for propagation were then transferred to 13 C for storage. Those for monitoring internal necrosis development remained at 25 C. The warm storage period was from September or October to March or April, when the roots were examined for internal necrosis. The propagating roots were bedded in early April in field soil treated with methyl bromide.

Plants from roots with and without symptoms were collected as the roots for monitoring internal necrosis were examined for symptoms. During warm storage, etiolated plants develop on most roots. As each root was examined, the plants were removed before the root was machine-sliced (about 2 mm thick) and the slices were examined for internal necrosis (cork). Plants from roots with internal necrosis were planted in wooden flats in a 2:1:1 soil, sand, and peat mixture and grown in the greenhouse until transplanted to the field. Plants from symptomless roots were similarly grown until transplanted in the field or graft-inoculated.

The ICV stock selected in 1958 was compared with plants from roots with symptoms. These ICV-infected plants were planted in alternate rows with sweet potato selections being evaluated for ICV resistance. At harvest, 4 bu of roots from each infected plant source were cured and stored at 25 C and the relative development of roots with symptoms was compared after storage. The test was performed over a 4-yr period.

In a second 4-yr test, plants from symptomless roots were compared with plants from roots with symptoms for the relative production of roots that developed internal necrosis in 25 C storage. In addition, plants from symptomless roots were graft-inoculated with scions from roots with ICV symptoms to see if the proportion of roots with symptoms would increase; virus-free plants derived from cultured meristem tips (7) were similarly inoculated with ICV-infected scions to check on virus transmission to the susceptible cultivar. In each of the four treatments, 100 plants were planted as 25-plant replications in a Latin square plot design. All harvested roots were cured and stored at about 25 C before examination for internal necrosis.

As the study progressed, plants from roots of the initial symptomless stock were reselected annually for this character to see if the proportion of symptomless roots could be increased to obtain a symptomless stock of the suceptible cultivar. In the concluding test, plants from roots reselected two and three times for the symptomless character were compared with plants selected once for the production of roots that developed no internal necrosis. Plants from the third reselection also served as scions to graft-inoculate 100 virus-free plants to see if they contained the virus.

The Porto Rico selection NC198, released for commercial production in 1965 (10), was developed in 15 yr through annual hill selections within various Porto Rico clonal lines. During the period of selection and evaluation, roots from the plants selected annually were cured and stored at a warm temperature suitable to develop ICV symptoms (6). At bedding time each spring, one-half of the roots from each plant were examined for internal necrosis. If symptoms were present, the remaining roots from that plant were discarded. If the sample roots were symptomless, the remaining roots were used for propagation. Plants from symptomless roots of NC198 were compared with plants from similar roots of the ICV-infected stock on the production of symptomless roots.

As the treatments increased in successive tests, they were completely randomized in four replications. The percentages of roots with internal necrosis after storage at 25 C were tested for significance by analysis of variance.

Table 1. Relative production (%) of roots with internal necrosis

Source of ICV-infected[a] plants	Test no. 1	2	3	4
1958-ICV stock	54	47	42	50
Roots with symptoms	70	58	88	86
LSD, 1958 vs. roots with symptoms ($P = 0.05$)		8.4		

[a] ICV = internal cork virus.

Table 2. Necrosis in roots of plants from internal cork virus stock

Source of plants	Percent of roots with internal necrosis in test 1	2	3	4
Symptomless roots	13.3	6.4	7.9	21.6
Symptomless roots, inoculated[a]	23.1	14.4	10.9	24.9
Roots with symptoms	53.5	88.4	20.5	81.9
Virus-free roots, inoculated[a]	66.2	52.4	31.3	47.3
LSD ($P = 0.05$)	25.3	11.2	11.4	16.3

[a] Inoculated by grafting with scions infected with internal cork virus.

RESULTS

Plants from the 1958-ICV stock consistently produced fewer roots with internal necrosis in the four tests than did plants from roots with symptoms (Table 1). About 50% of the roots from the ICV stock developed symptoms. In each test, more sweet potatoes produced by plants from roots with symptoms developed internal necrosis, and the percentage of roots with symptoms in two crops was similar to that observed for the ICV stock selected originally. These results support the observation that fewer roots of the 1958-ICV stock produced internal necrosis.

Propagating from symptomless roots of the 1958-ICV stock reduced the percentage of roots that formed internal necrosis in warm storage (Table 2). Graft inoculation of plants from symptomless roots with scions from roots with symptoms tended to increase the percentage of roots with internal necrosis, but the differences were not significant for the tests or for the results of the four tests combined. In contrast, plants from roots with symptoms and inoculated virus-free plants produced more sweet potatoes that developed internal necrosis.

Other treatments in test 4 (not listed in Table 2) were plants from symptomless roots reselected 2 and 3 yr, virus-free plants inoculated with scions from symptomless plants reselected 3 yr, and plants from symptomless roots of NC198. The LSD value for test 4 is applicable for testing the significance of the data from these treatments. Symptoms developed on 10.4, 12.8, and 21.6% of roots after 3, 2, and 1 yr of selection, respectively, and the differences were not significant. Internal necrosis developed in 41.3% of the roots from virus-free plants inoculated with scions from symptomless stock reselected three times. This value is not different from that for inoculated virus-free plants (Table 2). Internal necrosis developed in 20.7% of the sweet potatoes from plants of symptomless NC198 roots, which is the same proportion as for plants from roots selected 1 yr from the 1958-ICV stock. The changes in symptom expression observed in the 1958-ICV stock apparently also occurred in the Porto Rico clonal lines from which NC198 was selected.

DISCUSSION

Presumably, the gradual increase in the production of symptomless roots by the ICV-infected Porto Rico stock resulted

from a somatic mutation in meristematic host tissue. Sweet potatoes mutate frequently, but cultivars differ in the frequency and nature of mutations (2,3). Mutations have affected the periderm and internal flesh color of roots (2,11), vine morphology (1), root sugar and starch content (5), and productivity (1,5,10,11). Mutants have been selected and propagated to maintain and improve the cultivar Porto Rico (1,5,10), but none of the mutations apparently has altered disease symptom expression or reaction to known diseases.

The mutation for symptomless roots in Porto Rico infected with ICV must occur with some regularity because the strain NC198 developed over a 15-yr period appears to have symtpomless roots in the same proportion as the infected stock investigated. The clonal lines from which NC198 was selected probably were infected with ICV because Porto Rico was the only commercially grown cultivar at the time selection was started, and most Porto Rico stocks in commercially producing areas of North Carolina were infected by 1951 (8).

Recurrent selection for the symptomless root character from the 1958-ICV stock for 3 yr indicated that a strain of Porto Rico might be obtained that produced few if any roots that developed internal necrosis in warm storage. If the roots were stored at the recommended temperature of 13 C, the objectionable internal necrosis would rarely develop in them (6). This symptomless-carrier reaction is similar to that of resistant cultivars developed since the advent of ICV (4).

Graft inoculation of plants from symptomless roots with scions from roots with symptoms consistently resulted in a small but nonsignificant increase in the proportion of roots with symptoms produced by the inoculated plants (Table 2). This suggests that strains of ICV more capable of eliciting the internal necrosis reaction were not present in the sweet potatoes studied.

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