PEACH ROOTSTOCKS RESISTANT TO ROOT KNOT NEMATODE (*)

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One of the limiting factors in the commercial production of peaches in the light sandy soils of the peach growing states of the southern half of the Unites States is the root knot nematode, *Heterodera marioni* (Cornu) Goodey. Although vigor, fruitfulness, affinity with comercial peach varieties, adaptation to various soil conditions and disease insect resistance must all be known before a peach stock can be recommended favorably for these areas. One of the first considerations is that it shall have a fairly high resistance to soil nematode. Nematologists have called attention to the difficulty of making an accurate test of such resistance due to the host preferences of each nematode population and other factors such as the vigor of the plant or type of soil of any given site, conclusions which are supported by the variations in resistance found on different sites. Horticulturists are not so much concerned with complete freedom from root knot infection as with the ability of the variety propagated on the particular rootstock to thrive in soil infested with this nematode.

Interest in finding root knot resistant rootstocks for peaches goes back over a period of twenty five years or more. McClintock (*6*) (*7*) working on this problem from 1922 to 1924 found considerable resistance in seedlings grown from seed obtained from an old peach tree in florida and showed that resistance was seed transmited. Shortly after this, Tufts (*9*) in an effort to find new rootstocks for trial in the nematode infested sandy soils of the inferior valleys of California tested out in 1928 seedlings of 133 named peach and nectarine varieties and found

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only one, the Bokhara peach, an introduction from Bokhara, Turkestan, U. S. S. R., which showed practically no infection at the end of the first year's growth in a nematode infested nursery soil. Additional varieties were tried out the following year and the Shalil peach (P. I. 63850 syn 36485), an introduction from Northwest India, appeared distinctly promising. During the next two or three years Tufts and Day (*10*) repeated these tests, with additional progenies. In tests of seedlings of 175 peach and 44 nectarine varieties carried out in a different section on soils apparently thoroughly infested with root knot nematode, those of the Bokhara and Shalil peaches and in addition, seedlings of three wild peaches from the mountains of Yunnan Province, China (P. I. 55885, 55886 and 55888) were free of infection. Seedlings of another selection of Shalil peach (P. I. 63851), Quetta and Traveller nectarines (the Quetta variety an introduction from Northwest India) were also highly resistant to root knot nematode. Seedlings of apricot, almond, plum and other fruits were also tested and considerable resistance to root knot nematode was noted in many, but other considerations make the peach the best stock for peaches.

During 1933 and 1934, seedlings of Shalil, Bokhara and Yunnan were planted in an orchard whose soil was heavily infested with root knot nematode and examination in the early fall of 1934 showed only a trace of infection on an occasional tree of Bokhara and Shalil. During the next six years Day and Tufts (*3*) put most of their efforts into testing seedlings of these three varieties. A total of 4500 trees on one or the other of these rootstocks were planted in 48 test plost representing areas in orchards where growers had failed to establish trees on common peach rootstocks. These tests were spread out over an area 500 miles long and afforded an apportunity to study the behavior of these rootstocks under various conditions of soil and climate, as well as their resistance to possible different strains of root knot nematode. The trees when examined by exposing a portion ow their root system, were from one to six years of age. The seedlings of Bokhara were 21 per cent; Shalil (P. I. 63850) 19.6 per cent and Yunnan (all three numbers combined) 17.6 per sent infected. A variance of from zero to as high as 24 per cent infection in Shalil seedlings was found between two nursery sites not over a mile apart and similar results were recorded for Yunnan and Bokhara. They conclude that differences in resistance between stocks were probably negligible and the choice between them depended on other factors. Continued experiments with seedlings of the Quetta nectarine indicated that they were probably as satisfactory as the others from the standpoint of nematode resistance. Day (*2*) points out that although it is impossible to evaluate the qualities of the tree until it reaches maturity, no trouble is anticipated with these peach stocks,

peach and almond varieties four and five years of age on Bokhara, Shalil and Yunnan roots having behaved normally and produced good crops.

Root knot nematode infection had long been a serious problem to the peach growers in the southeastern states, particularly Georgia, and Hutchins (4) started test planting at Fort Valley, Georgia in 1928. Two hundred trees of Elberta, one half on Shalil (P. I. 63850) and the remainder on P. I. 61302 (Bolivian Cling X Quetta Nectarine) obtained from the United States Plant Introduction Garden, Chico, California, were planted; trees of the same variety on seedlings of the naturalized peach of the southeastern mountain areas and of other peaches as well as apricot, almond and plum were included in this tests. At the end of the third year no root knot could be found on the Shalil or P. I. 61302 stocks, while those of the "naturals" and other peaches were heavily infected. The apricot and plum stocks used were resistant, the almond only fairly so, but all made rather unsatisfactory stocks for the peach.

Additional tests of P. I. 61302 were made by grafting the Early Hiley peach variety on piece roots of this number and planting the grafts in a soil heavily infested with root knot nematode. When dug after one season's growth the roots were free of nematode infection. At the end of the third season's growth some 4000 trees of Early Hiley propagated on piece roots of this stock and planted in commercial orchards at Fort Valley, Georgia, were making a vigorous growth, producing heavy crops for their age and the understocks were free of root knot infection. As tested in the nursery in California, its resistence was comparable with Shalil (P. I. 63850) in the same test, 23,3 per cent of 236 seedlings becoming infected (3).

Weinberger, Marth and Scott (11) found a high degree of resistance to root knot nematode in seedlings of nine of 151 varieties of peaches tested at Fort Valley. Bokhara, Shalil (P. I. 63850 and 63852), Yunnan (P. I. 55885, 55886 and 55888) and P. I. 61302 were resistant. Yunnan (P. I. 55775 and 55776), tested for the first time, were found highly resistant. Three of seven Mao (Hairy peach, P. I. 107838) seedlings (used as a rootstock for peaches in China) were found free of root knot nematode in two separate trials under severe test conditions. Moderate infection was found under orchard conditions three years later. Subsequently the progenies of two of these seedlings were found to be, respectively, free and 16 per cent infected. Progenies of other trees grown from seed imported under the same number and of three earlier introductions of various localities in China tested at Chico, California, were all found to be heavily infected (5). Apparently the Mao peach is not a pure line. Root knot nematode resistance appears, according to these workers, to be dominant in the Yunnan type as well as in

Shalil and may be transmitted through parent functioning either as female or male.

Experience with these resistant stocks has revealed certain good traits as well as some shortcoming. Seeds of Shalil germinate less readily, at least in certain years, than those of Yunnan; however, improved methods of handling may solve this difficulty. Quetta nectarine seeds germinate poorly and contain many apparently aborted embryos (*3*). There is general agreement that Shalil and Yunnan seedlings are more vigorous than seedlings commonly used as rootstocks by nurserymen. Shalil seedlings make so much growth some seasons that their size at budding time creates a problem. The unusual vigor of Shalil seedlings when used as interplants has been noted (*10*) and the ability of Bokhara, Shalil and Yunnan seedling to make good growth in spite of toxic conditions adverse to the growth of seedlings commonly used for rootstocks has been reported by Proebsting and Gilmore (*8*). Shalil seedlings have a low chilling requirement to break the rest period and their early blossoming habit makes them susceptible to spring frosts. Yunnan seedlings on the other hand are hardier than Shalil and their chilling requirement is similar to that of Elberta, and have been more regular in bearing in Georgia (*11*). One Maryland nurseryman prefers seedlings of Yunnan to those of Shalil, finding the latter susceptible to cold injury between the first and second year in the nursery while carrying dormant buds. Blake (*1*) reports the Yunnan peach (P. I. 55776) as very hardy in wood and bud as grown in New Jersey; also that P. I. 55885 and 55886 have done well there. Bokhara is relatively a shy bearer and its seedlings do not grow as vigorously as those of Yunnan and Shalil (*10*). The Mao peach trees (P. I. 1078838) grown in Georgia have shown no superiority that would make them preferable to Yunnan as a peach rootstock (*11*) and of 510 two -year-old seedlings grown at the U. S. Plant Introduction Garden, Chico, California, from the remainder of the Mao seed, introduced under P. I. 107838,200 made a very vigorous, 180 fair and 130 very poor growth. Over one half of the seedlings gave evidence of suckering and all were more susceptible to peach leaf curl than any other peach variety.

There can be no question of the gain to peach growing in root knot nema-infested areas through the use of these resistant stocks. Nevertheless, it is still too early to tell whether the problem is entirely solved. The "ideal" stock must meet a long list of exacting requirements in addition to nematode resistance. It must yield seed heavily and regularly, the seed preferable freestone, must germinate readily and well; the seedlings must be vigorous, must take the bud well and must not sprout in the orchard. Since one nursery's trees may be sold over a wide area, the "ideal" peach stock should have wide adaptability to

soils of different types and at least average resistance to winter freezing and, in some areas, some resistance to alkali. If these traits could be combined with production of a fruit suitable for canning or drying, the cost of seed would be materially reduced. Whether all these virtues can be combined in one line, time will tell. In searching for this "ideal", or in compromising on stocks for certain regions, the greater the number of root knot nema-resistant stocks that are available, the better is the chance of finding some that are highly valuable horticulturally. For this reason further examination of progenies from peaches collected from various parts of the world and growing in the United States Plant Introduction Garden at Chico, California has appeared desirable.

During 1941 and 1942 somewhat over 10.000 trees, representing open and self pollinated progenies of 47 peach introductions, were tested for resistance to root knot nematode infection by growing them in a heavily infested light sandy soil, digging them at the end of each growing season and recording the per cent of each that were free of any visible root knot gall infection (5). Of the 47 peach progenies tested, other than Shalil, Yunnan (both already shown to be resistant) Lovell and Muir (both generally known to be susceptible) included for purposes of comparison, nine showed very high resistance to root knot infection during the first season of growth. All but one had less than three per cent infection on both the open and self pollinated seedlings and this exception (Chico Nº 18) had only 6.5 per sent. These showings are comparable to those of the Shalil and Yunnan progenies grown in these tests. Of the nine that were highly resistant, two (Chico Nos. 11 and 12) came from China, the home of the nema-resistant Yunnan and Mao types; five (Chico Nos. 13 to 17 inclusive) from India, the home of the Shalil peach and the Quetta nectarine and two (Chico Nos. 18 and 19) were introduced from Turkestan, U. S. S. R., the home of the Bokhara peach.

RESUMEN

A pesar de las condiciones especiales que para la fruticultura poseen los suelos livianos arenosos de los estados del sur de los Estados Unidos, en muchas regiones de ellos el ataque de la anguilula (*Heterodera marioni* (Cornu) Goodey) es un serio factor limitante para el cultivo del durazno.

En las investigaciones realizadas en ese país para encontrar un portainjerto resistente al nematodo, entre otros, por Hutchins en Georgia, Day y Tufts en California y Weinberger, Marth y Scott en Fort Valley, se ha observado que las variedades: Yunnan (P. I. 55776), pro-

cedente de la provincia china del mismo nombre; Shalil (P. I. 63850), procedente del noroeste de la India, y Bokhara procedente de Bokhara (Turkestan, U. R. S. S.) poseen una alta resistencia, unida a otras sobresalientes cualidades como vigor, precocidad, etc. Genéticamente el carácter de resistencia es dominante en las dos primeras variedades y pueden trasmitirlo ya sea actúen como progenitores masculinos o femeninos.

Una notable resistencia fué observada además, en progenies de polinización libre y autofecundadas de las variedades mencionadas e igualmente en la variedad PI 61302 (Cling Boliviano X nectarían Quetta) y en los nectarines Quetta (del Norte de India) y Travellar.

En los experimentos mencionados el ciruelo y el damasco revelaron alta resistencia y algo menor el almendro, pero sus condiciones como portainjertos son inferiores al durazno.

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