

Exocortis Transmission Tests

effect of Eureka lemon budwood in transmission of exocortis to trifoliolate orange and hybrids studied

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The problematical nature of the exocortis disease of trifoliolate orange—whether it is of a virus nature transmitted to the trifoliolate stock by an infected scion which in itself may show no symptoms, whether it is transmitted by an insect vector or whether it is genetic and an inherent character of the rootstock—is under further study in an experimental planting at Riverside.

The trifoliolate orange, Morton citrange, and Troyer citrange were selected as the test rootstock varieties. Uniform seedlings of each of these varieties in the nursery in the spring of 1950 were budded from various scion sources and planted in 1951.

In Treatment *A*, seedlings of all three rootstocks were budded to, and top formed from, Frost Nucellar Eureka. The budwood source was a 17-year-old tree, and the nucellar source was 35 years from seed.

In Treatment *B*, the seedlings were budded to, and top formed from, Frost Nucellar Eureka, but at the same time were also budded two to four inches below the top bud with a bud from a Eureka lemon—on Morton citrange stock—severely affected by exocortis. This inoculation bud was permitted to take but not allowed to grow thereafter.

In Treatment *C*, the seedlings were

budded to, and top formed from, Frost old line Eureka lemon.

In Treatment *D*, the seedlings were budded to, and top formed from, the Eureka lemon used as inoculation source in *B*.

The seedlings in Treatment *E* were inoculated by being budded to Eureka lemon as in *D*. The lemon buds were permitted to take but not to grow.

Seedlings not budded in any manner were planted as uninoculated checks: Treatment *F*.

Growth of Test Seedlings

In the nursery, trees budded to old line Eureka—*C* and *D*—grew much slower than trees budded to Nucellar Eureka—*A* and *B*. A marked difference of growth in the nursery has not been readily apparent between nucellar and old line lemons on stocks other than trifoliolate orange and some of its hybrids.

Trees from all six treatments were balled in the usual manner in the spring of 1951. Each treatment was planted as five single tree replicates per rootstock. The entire block received a uniform cultural practice.

In 1952, differences in tree growth between treatments were quite evident. The lemon tops budded from *C* and *D*—old

line Eureka—were growing markedly slower than tops budded from *A* and *B*—nucellar tops—on all three rootstocks. There was little initial difference between top growth of *A* and *B* or between that of *C* and *D*.

Differences in growth between *A* and *B* became evident soon after planting. Seedling trees in *E* were noticeably smaller than the check seedling trees in *F*.

By the fall of 1952—two years after inoculation and one year after orchard planting—it was quite evident that some bark disorders were appearing on certain combinations. This was characterized by mild cracking of the bark and a reddish brown discoloration of the ruptured tissue. The stunting of the top, the decrease in vigor, and the extent of bark symptoms increased in severity in 1953.

Observations

The trees in all treatments were thoroughly examined for bark symptoms in September 1953 and the trunks and stocks calipered.

The largest and healthiest appearing trees were of the *A* combination. The trees were well foliated and with healthy, dark green leaves. Bud unions were normal, with the stocks calipered larger than the scions. None of the rootstocks

Treatment A. Nucellar Eureka on trifoliolate orange, 3 years from budding. Budwood from 17-year-old tree.

Treatment B. Nucellar Eureka on trifoliolate orange, 3 years from budding—3 years from inoculation. Note small leaves.

Trifoliolate orange stock in Treatment A. Note size of stock and scion and no evidence of bark cracking.

Trifoliolate orange stock in Treatment B. Note the extensive cracking and splitting of the trifoliolate bark.



in this combination showed any indication of exocortis bark symptoms.

Trees of the *B* combination were next in vigor to the uninoculated nucellars. The trees on trifoliolate orange stocks were about 11% smaller than trees in *A*, and those on Morton citrange and Troyer citrange stock were about 4% smaller. However, tree appearance was a better indication of the effect of the inoculation than tree size. In addition to the stunting, these trees were lacking in growth flushes, the leaves were more yellow and the trees were open and sparsely foliated. Bark symptoms of exocortis were evident in four out of five trees on trifoliolate orange stock, one out of five on Morton citrange stock, and none on the Troyer citrange stock.

Trees in *C* were markedly stunted in all combinations, but it is difficult to attribute how much of the stunting is due to the presence of exocortis, or how much is due to the lack of vigor in an old line Eureka lemon. These trees were more chlorotic than *A*, had no new flushes of growth and were very open and sparsely foliated. Four of five trifoliolate orange stocks showed visible evidence of exocortis, one out of four with Morton citrange, and none on Troyer citrange.

With the exception of the trees on Morton citrange, the trees in *D* tended to be more stunted than any other lemon top combination. Since this lemon selection represents a different bud strain from *C*, it may be an inherently slower growing strain; or since the bud source combination was known to carry the exocortis factor—and *C* was not heretofore known to carry exocortis—*D* may possibly contain a more virulent strain of the disorder or other deleterious components. These trees were also somewhat

Influence of Eureka Lemon Bud Source on Size of Young Trees Planted in 1951, Measured Sept., 1953

Treatment	Rootstock					
	Trifoliolate orange		Morton citrange		Troyer citrange	
	Size ACS-CM ₂ *	Size %	Size ACS-CM ₂	Size %	Size ACS-CM ₂	Size %
Lemon Tops						
A	17.94	100.0	39.23	100.0	28.17	100.0
B	15.99	89.13	37.92	96.66	27.11	96.24
C	10.03	55.91	27.89	71.09	18.57	65.92
D	9.40	52.40	28.95	73.80	13.27	47.11
Seedlings						
E	4.65	74.76	6.76**	51.17	10.56	77.19
F	6.22	100.0	13.21	100.0	13.68	100.0

* ACS-CM₂ = Area cross section rootstock trunk; square centimeters.

** See explanation under *E* in text.

Influence of Eureka Lemon Bud Source on Presence of Exocortis Bark Symptoms on Several Rootstocks, Sept., 1953.

Treatment	Rootstock					
	Trifoliolate Orange		Morton Citrange		Troyer Citrange	
	No. of trees	No. showing exocortis	No. of trees	No. showing exocortis	No. of trees	No. showing exocortis
Lemon Tops						
A	5	0	5	0	5	0
B	5	4	5	1	5	0
C	5	4	4	1	5	0
D	4	3	7	3	4	0
Seedlings						
E	5	0	3	0	5	0
F	5	0	5	0	5	0

chlorotic, thinly foliated and lacking in growth flushes. Three out of four trees on trifoliolate orange showed bark symptoms, three out of seven on Morton

citrangle, and none on Troyer citrange.

Inoculated seedlings of all three rootstocks—*E*—were markedly stunted. It seems apparent that the stunting of these seedlings—as in the other inoculated combinations—is due to the presence of exocortis, but other factors could have been, and probably were, introduced with the inoculation material. The trees of trifoliolate orange and Troyer citrange were about 25% smaller than check seedlings, and those of Morton citrange were nearly 50% smaller. However, through an oversight in the nursery operations, the inoculation buds on the Morton citrange were permitted to grow and the Morton tops were cut off. As soon as the mistake was noticed, the lemon tops were cut back and the Morton citrange tops forced. This error and consequent time lapse in top growth may account for part but not all of the marked stunting on these particular seedlings. Two of these seedlings failed to satisfactorily

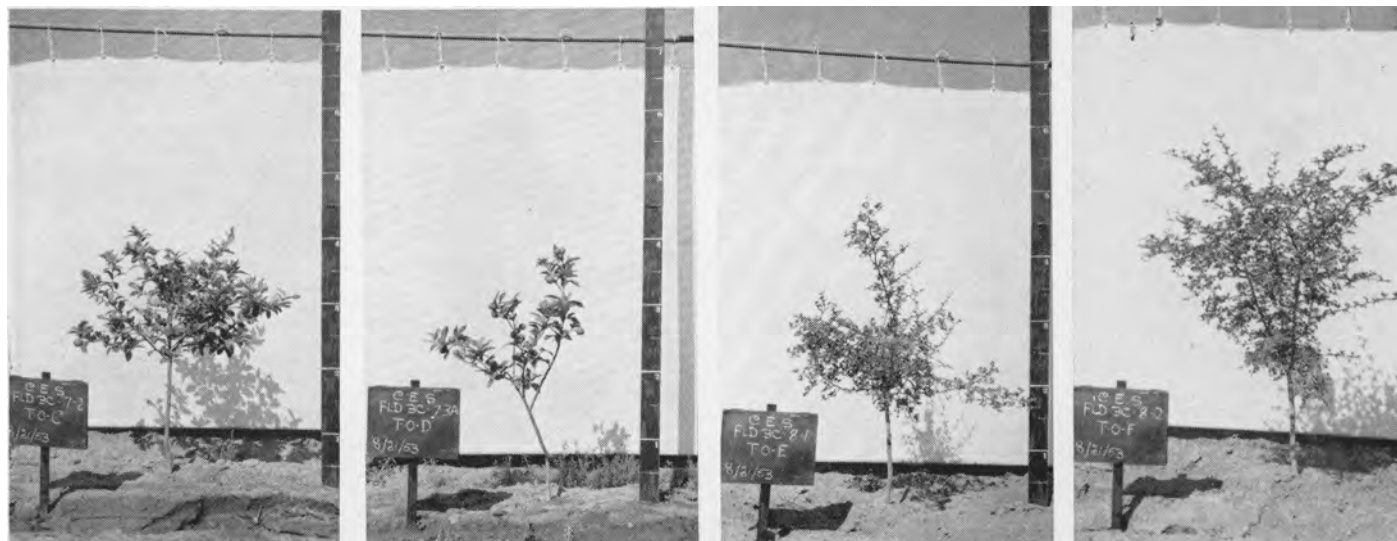
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Treatment C. Frost old line Eureka on trifoliolate orange, 3 years from budding. Note marked stunting.

Treatment D. CES old line Eureka on trifoliolate orange 3 years from budding. Note marked stunting, poor growth.

Treatment E. Trifoliolate orange seedling inoculated 3 years. Note marked stunting compared to Treatment F.

Treatment F. Trifoliolate orange seedling same age as Treatment E budded but uninoculated to serve as check.



MOTH

Continued from preceding page

indicate about 40, 45, 50 and 55% damage to seeds.

Where no treatment was given, the estimated damage was above 50%, and the damage appeared to be more severe in those heads that were open at the time the first treatment was given. The actual damage to seeds probably would have been less than the estimated damage by about 10%. It is believed that many commercial fields in 1952 suffered similar losses.

A single treatment of opened heads gave good control of the pest, DDT being most effective and lindane the least. A second treatment of such heads gave no consistent improvement in control.

Insecticides applied to heads in the bud stage gave very little control, except DDT which reduced the injury from 51% to 20%. The heads that were in bud at the time of the first treatment had opened for the second, and control of the larvae in such heads from the second application was similar to that achieved in open heads by one application.

It might be argued that insecticides should be applied after all the heads had opened. Two circumstances, however, make this an unwarranted recommendation. First: the larvae would accomplish much of their damage in early heads before the insecticide was applied, and they might be deep enough in the head to escape injury. Second: the heads tend to face downward shortly after they open, and dust or spray applications by air would fail to reach the face of the heads.

Growers have found that the use of insecticides on this pest has not given consistent results. More often than not DDT has not been too successful. Lack

of success is believed to have been due to late applications when the sunflower heads have been facing downward. One seed company has reported excellent control when the insecticide—40 pounds of 2% parathion and 5% DDT—was applied when the heads had just opened. The dust was flown on with a plane going in an east to west direction, because sunflower heads always face eastwards after they open.

Because these investigations were limited, no unconditional control recommendations can be made.

However, if the larvae are present in the head, and about 60% of the heads are in bloom, a mixture of 5% DDT and 2% parathion applied at 40 pounds per acre should be effective.

If two applications are intended, a 10% DDT dust at 40 pounds per acre can be used for both treatments, with the first applied when the heads are about 20% in bloom and the second applied about 10 days later.

Equivalent amounts of insecticides in liquid form may be used, although no comparative results with dusts seem available. After the florets have dropped from the heads and the seeds are exposed, parathion only should be used because DDT will contaminate the seeds.

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Normal seeds, left; and damaged by sunflower moth, right.

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establish the Morton top, and the lemon inoculation bud again took over. These two trees have been eliminated from *E* and included in *D* for the Morton citrange. There were no visible external symptoms of exocortis on any of these seedlings.

Seedlings of all three rootstock varieties—check *F*—appeared healthy in every respect. There were no visible external symptoms of exocortis.

Because the three rootstocks included in these trials did not show exocortis—when budded to nucellar Frost Eureka lemon tops—it suggests that the nucellar lemon is not carrying exocortis.

Apparently the old line Eureka lemon in *C* was carrying exocortis but it ap-

pears to have been filtered out in passing that particular strain of lemon through the nucellar seedling process.

The fact that the nucellar line *A* was apparently not carrying the virus at the time buds for this experiment were obtained—35 years of age from seed—might suggest that exocortis may not be readily transmissible to lemon by an insect vector. The parent trees of the nucellar line and old line are adjacent trees. The lemon strain in *D* also carried exocortis.

Because none of the check seedlings of trifoliate orange, Morton citrange, or Troyer citrange are showing exocortis—nor showing the disorder when budded to a nucellar Eureka—it suggests that exocortis is not an inherent character in these rootstocks.

The fact that the inoculated seedlings

of trifoliate orange, Morton citrange, and Troyer citrange are severely stunted but—in September 1953—were showing no visible symptoms of exocortis might indicate that a combination with a lemon top is a more favorable host for the virus than the inoculated seedlings. However, it is anticipated that these inoculated seedlings will show symptoms in time. The trifoliate orange appears to be more sensitive to the inoculation than the Morton citrange, and the Troyer citrange appears to be the least sensitive.

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