Graft Transmission from Kumquat of an Agent Inducing Budunion Crease in Parson's Special Mandarin Grafted on Volkamer Lemon Rootstock

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ABSTRACT. In 1976, an abnormal budunion was noticed in Corsica on Parson's special mandarin plants on Volkamer lemon graft-inoculated with bark tissue from two kumquat lines. These trees, nine years after planting in the field, show a severe budunion crease. Other kumquat lines did not induce budunion crease under the same conditions. These results indicate that the budunion disorder studied in these experiments is due to a transmissible agent present in certain kumquat lines and is different from those reported earlier.
Index words. Graft transmissible agent.

Several lines of kumquat have been introduced into Corsica (table 1). To check for the presence of the cachexia agent, bark from these lines was graft-inoculated in April 1976 on Parson's special mandarin budded on Volkamer lemon rootstock. Six months after inoculation, the indicator plants inoculated with bark from two of the six kumquat lines showed an abnormal budunion in the greenhouse. Some of the indicator plants were planted in the field to follow the evolution of the budunion abnormality. The results of these experiments are presented here.

MATERIALS AND METHODS

Indexing for the cachexia agent on Parson's Special mandarin was according to Roistacher *et al.* (5), except that Volkamer lemon was the rootstock. Four indicator plants were used for each of the six kumquat lines described in table 1. The plants were inoculated in April 1976 and were grown in the greenhouse at 25-30 C in 5-liter containers filled with alluvial soil.

RESULTS

In October 1976, the indicator plants inoculated with bark from kumquat lines K124 and K125 showed abnormally constricted budunions. All other plants were normal. In April 1977, bark was peeled from the four symptomatic plants inoculated with material from line K125. Typical budunion crease was revealed. These plants as well as all other plants inoculated with kumquat bark showed no cachexia symptoms. Similar indicator plants inoculated at the same time with bark carrying the cachexia agent (positive control) showed clear-cut cachexia syptoms.

In May 1977, the four symptomatic Parson's Special mandarin trees on Volkamer lemon inoculated with bark

TABLE 1
DESCRIPTION OF KUMQUAT LINES USED IN CORSICA

Kumquat line	Variety	Shape	Origin	Type of line
K123	Marumi	Round	Soueilah, Morocco	old
K124	Marumi	Round	Boufarik, Algeria	old
K154	Marumi	Round	Mecca, Calif.	nucellar
L125	Nagami	Oval	Boufarik, Algeria	old
K169	Nagami	Oval	Boufarik, Algeria	old
K153	Meiwa	Round[z]	Mecca, Calif.	nucellar

[z]Round, large size

of kumquat line K124 and the four normal trees inoculated with bark of kumquat line K169 were planted in the field. Two groups of four Parson's Special mandarin trees on Volkamer lemon inoculated in April 1976 with bark of Washington navel sweet orange carrying California strain 158-62 of the concave gum agent, and Orlando tangelo infected with the Tarocco strain of the cristacortis agent were also planted in the field at the same time. Four uninoculated trees were used as negative controls.

Nine years later (June 1986), the four trees inoculated with bark of kumquat line K124 were badly stunted and showed severe budunion crease with gum-impregnated bark penetrating deep into the stem at the union. The Volkamer lemon rootstock tended to overgrow the mandarin scion. All other trees had normal unions. The trees inoculated with the concave gum agent or the cristacortis agent showed the symptoms of these agents on the sensitive mandarin scion, but their budunions were normal.

Table 2 indicates the effect obtained when bark of kumquat line K124 was inoculated into two scion-rootstock combinations other than Parson's Special mandarin on Volkamer lemon, and when buds of kumquat line K125 were propagated on trifoliate orange and Troyer citrange. No symptoms were observed on the two additional scion-rootstock combinations inoculated with K124, but a severe effect was obtained when kumquat line K125 was propagated on Troyer citrange; the trees declined and died. The kumquat trees on trifoliate orange and Troyer citrange were part of a larger experiment initiated in 1972 in which five of the six kumquat lines of table 1 (K123, K124, K125, K169 and K153, but not K154 (2)) had been propagated on the two rootstocks. While the kumquat trees propagated on trifoliate orange did well, those on Troyer citrange declined and died within 4 years, except kumquat line K169 which grew normally (Table 3). The presence of citrus tristeza virus (CTV) was investigated and kumquat line K123 was found to be infected with an unusual strain of CTV (strain K) (1, 3).

Finally, Navarro *et al.* (4) have described an agent from kumquat line K153 (Meiwa and not Nagami as indicated in reference 4) that induces vein clearing on leaves of sweet orange. We have also observed this vein clearing induced by kumquat line K153, and we have found that none of the other five kumquat lines causes this vein clearing symptom.

DISCUSSION

These results show that kumquat lines K124 and K125 carry a distinct transmissible budunion crease agent. In the course of this work several agents have been encounted in various kumquat lines. They induce the following diseases (table 3): budunion crease of Parson's Special mandarin on Volkamer lemon (BCMV), decline of kumquat on Troyer citrange (DKTC), strain K tristeza (KT) and vein clearing of sweet orange (VCSO).

TABLE 2
INOCULATION OF TWO SCION-ROOTSTOCK COMBINATIONS WITH KUMQUAT LINE K124 AND PROPAGATION OF KUMQUAT LINE K125 ON TWO ROOTSTOCKS

Scion	Rootstock	Year of inoculation (i) or propagation (p) of kumquat lines	Effect observed
Clementine SRA 64	Troyer citange	1974 (i)	none
Parson's Special mandarin	Citrumelo 1452	1981 (i)	none
Kumquat K125	Trifoliate orange	1972 (p)	none
Kumquat K125	Troyer citrange	1972 (p)	decline and death

TABLE 3
SUMMARY OF AGENTS PRESENT IN KUMQUAT LINES IN CORSICA

Kumquat line	Budunion crease of Parson's Special mandarin on Volkamer lemon (BCMV)	Decline of kumquat on Troyer citrange (DKTC)	Strain K tristeza (KT)	Vein clearing of sweet orange (VCSO)
K123 Old, Marumi	no	yes	yes	no
K124 Old, Marumi	yes	yes	no	no
K154 Nuc., Marumi	no	nd[z]	no	no
K125 Old, Nagami	yes	yes	no	no
K169 Old, Nagami	no	no	no	no
K153 Nuc., Meiwa	no	yes	no	yes

[z]Not done

DKTC is not due to citrus tristeza virus strain K (CTV-K) since kumquat lines K124, K125 and K153 are free of CTV-K, yet they induce DKTC (table 3). VCSO and BCMV are not due to the DKTC agent since kumquat line K124 induces DKTC but not VCSO and BCMV. BCMV is not due to the combined action of the agents of DKTC and VCSO, since kumquat line K153 induces DKTC and VCSO but not BCMV.

Hence the agents of BCMV, DKTC, VCSO and KT (CTV-K) are apparently unrelated. BCMV, as described in this paper for the first time, seems to be a new graft transmissible disease. Parson's Special mandarin on Volkamer lemon is a good indicator plant for the BCMV agent, as the first symptoms appear 6 months after inoculation and cannot be confused with those of cachexia.

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