

Resistance of some *Citrus* species and hybrids to Mal secco (*Phoma tracheiphila* KANC. et GHIK.) disease.

Ö. TUZCU, A. ÇINAR,
M. KAPLANKIRAN, A. ERKILIÇ and T. YEŞİLOĞLU*

RESISTANCE OF SOME CITRUS SPECIES AND HYBRIDS TO MAL SECCO (*PHOMA TRACHEIPHILA* KANC. ET GHIK.) DISEASE.

Ö. TUZCU, A. ÇINAR, M. KAPLANKIRAN, A. ERKILIÇ and T. YEŞİLOĞLU.

Fruits, Mar. 1989, vol. 44, n° 3, p. 139-148.

ABSTRACT - In this study, 22 oranges [*Citrus sinensis* (L.) OSBECK] 35 lemons (*Citrus limon* BURM.F.), 10 mandarins (*Citrus reticulata* BLANCO), 4 grapefruits (*Citrus paradisi* MACF.), 29 sour oranges selected from the East Mediterranean region (Tuzcu clones) and 27 foreign and local originated sour oranges all together 56 sour oranges, (*Citrus aurantium*), 12 Poncirus varieties and hybrids, and 33 different species and varieties have been used. Inoculation of Mal Secco (*Phoma tracheiphila* KANC. et GHIK.) fungus have been made 20 cm. above the grafting point of 1 year age plants during the dates 27-29. 10.1985. In 24.6.1985 observations have been made and the resistance of species and varieties have been determined with a partly modified ranking scale of SOLEL and SPIEGEL-ROY (1978). From the varieties and species studied, Satsuma mandarin, Finike common, Tarocco, Salustiana oranges; Zagara Bianca, Aklimon and Sweet lemons, Yuzu and Australian sour orange have been found resistant, Cleopatra mandarin and Santa Teresa lemon have been found medium resistant. The other species and varieties have been found susceptible.

INTRODUCTION

Mal secco disease, caused by *Phoma tracheiphila* (PE-TRI) KANCHAVELI and GHIKASHVILI is an important fungal disease of *Citrus*. It is prevalent in Italy, Spain, France, Greece, Turkey, Tunisia, Algeria, Cyprus and east Black Sea cost area of USSR (CUTULI *et al.*, 1984). Although the disease was seen in these countries, it is mainly a problem in East-Mediterranean where it causes heavy losses

RESISTANCE DE QUELQUES ESPECES ET HYBRIDES D'AGRUMES AU MAL SECCO (*PHOMA TRACHEIPHILA* KANC. ET GHIK.).

Ö. TUZCU, A. ÇINAR, M. KAPLANKIRAN, A. ERKILIÇ et T. YEŞİLOĞLU.

Fruits, Mar. 1989, vol. 44, n° 3, p. 139-148.

RESUME - L'étude a porté sur 22 orangers, 10 mandariniers, 35 citronniers, 4 pomelos, 56 bigaradiers d'origines diverses, 12 Poncirus et des hybrides et 33 espèces et variétés différentes. L'inoculation du champignon du Mal Secco (*Phoma tracheiphila*) a été faite, en octobre 1985, à 20 cm au-dessus du point de greffe sur des plants d'un an. En juin 1985 des observations avaient été réalisées pour situer la résistance des espèces et variétés observées en s'appuyant sur l'échelle de SOLEL et SPIEGEL-ROY modifiée. Le mandarinier Satsuma, les orangers Commune Finike, Tarocco, Salustiana; les citronniers Aklimon, Zagara Bianca et le Sweet, et bigaradiers Yuzu et Australian, ont été trouvés résistants; le mandarinier Cléopâtre et le citronnier Santa Teresa étaient moyennement résistants; les autres espèces et variétés se sont révélées sensibles.

and threatens the lemon cultures (CUTULI *et al.*, 1984). CUTULI (1982) reported that complete control of the disease would double the lemon production in Italy which is 700.000 tons today. Same assumption could easily be made for other lemon growing countries, especially for Turkey. Mal secco was only seen in small local areas in 1933 (AKTEKE and KARACA, 1977) but has spread rapidly since 1940 with the expansion of lemon groves in Turkey.

Studies with systemic fungicides and other chemical compounds did not give expected control but resulted some resistance development (SALERNO and SOMMA, 1971; SOMMA and SAMMARCO, 1981; SOMMA and SALERNO 1973; PERROTTA *et al.*, 1974; SALERNO and PERROTTA, 1978; GIMENEZ VERDU and LUISI, 1978; SOMMA and LAVIOLA, 1982; DİNÇ *et al.*, 1982; CUTULI, 1984).

In order to protect the lemon trees from infestation of

* - TUZCU - Professor, Department of Horticulture, University of Çukurova.

ÇINAR - Professor, Department of Plant Protection, University of Çukurova.

KAPLANKIRAN - Teaching Assistant, Department of Horticulture, University of Çukurova.

ERKILIÇ - Assistant, Department of Plant Protection, University of Çukurova.

YEŞİLOĞLU - Assistant, Department of Horticulture, University of Çukurova, Adana, Turkey

the pathogen, cultural measures, the elimination of the inoculum sources and the use of resistant rootstocks and scions are recommended. Sour orange is a main rootstocks in Turkey and in many other Mediterranean countries. Since lemon cultivars as scion are susceptible for tip infection, and sour orange as rootstocks for root infection of the pathogen, the disease has spread rapidly in countries where above mentioned rootstock-scion combinations were commonly used.

To bring a sound solution to the problem there have been many efforts in confounded countries to obtain resistant scions and rootstocks against the pathogen. However the genera of *Poncirus*, *Fortunella* and *Severinia* and their intragenus and intergenera hybrids, and most of the species of the *Citrus* genus were found susceptible to *P. tracheiphila*, only few species and cultivars were given promising results (CUTULI *et al.*, 1984).

Although some lemon cultivars: Monachello, Interdonato, Santa Teresa, Continella and Zagara Bianca (Fior d'Arancio), were reported as resistant, they were not very useful in practice as expected (GRANATA *et al.*, 1977; SPINA and CUTULI, 1983). GRANATA *et al.* (1977) found that Monachello was resistant and Santa Teresa, Comune, Continella, Incapucciato and Fior d'Arancio were tolerant to Mal secco. In addition, some investigators reported that young plants and nucellar clones appeared more susceptible than old clones. SALERNO *et al.* (1967) observed significant differences while comparing susceptibility of *Citrus volkameriana* with that of sour orange, the former being more susceptible than the latter.

It was reported that some lemon cultivars like Adamopoulou and Messara in Greece, Molla Mehmet and Antalya Round in Turkey, Meyer and Dioskuoria in USSR, Santa Teresa in Israel and France were relatively resistant to Mal secco, but not as much as Monachello and Interdonato (AKTEKE and KARACA, 1977; PIONNAT, 1982; CUTULI *et al.*, 1984).

Some citron, Willow leaf mandarin and Cleopatra mandarin, kumquat and some orange cultivars were reported resistant; and Rough lemon, Rangpur lime, Macrophylla, Yuzu, sour orange, Taiwanica, trifoliata orange and its hybrids citrumelo and citrange were reported susceptible. But there were contrasting reports on resistance levels of Volkameriana, Sweet lemon, mandarin, grapefruit, Calamondin and Chinese sour orange to *P. tracheiphila* (CATARRA *et al.*, 1976; GRASSO and PERROTTA, 1978; SOLEL and SPIEGEL-ROY, 1978; LUISI *et al.*, 1979; CUTULI *et al.*, 1984).

Although the resistance of *Citrus* species and cultivars to Mal secco have been under investigation for many years in several countries, especially in Italy, desirable results have not been obtained yet, since the disease has not show constant epidemics, and different ecological factors and cultural measures affect the response of the hosts. Plus, cultivars and clones also exhibit degree of variability. In addition, artificial and natural infections may show different results, with artificial inoculation. The disease develops more rapidly and resulting damage is more severe compared to natural one.

According to several studies, the strains of the pathogen

were not found different from infectivity view point (LUI-SI, 1979; SPINA and CUTULI, 1983; CUTULI *et al.*, 1984). This paper reports a study of the relative resistance of various *Citrus*, *Poncirus*, *Fortunella* and *Severinia* cultivars and rootstocks to Mal secco.

MATERIAL AND METHODS

Twenty-two oranges [*Citrus sinensis* (L.) OSBECK], 35 lemons (*Citrus limon* BURM. F.), 10 mandarins (*Citrus reticulata* BLANCO), 4 grapefruits (*Citrus paradisi* MACF.), 56 sour oranges (*Citrus aurantium* L.) of which 29 were selected from eastern mediterranean (Tuzcu clones) and 27 had local and foreign origins, 12 trifoliata (*Poncirus* sp.) cultivars and hybrids and 33 other cultivars and species used in this study.

Young trees were obtained by fall budding on one-year-old sour orange rootstocks in 1983. The isolate, BK-10 of *Phoma tracheiphila* isolated from Kütdiken lemon trees in Davultepe village of İçel province were used as an inoculum source.

A piece of bark, 4 mm in diameter, was removed without harming the wood tissue at 20 cm height above the bud union by using a cork borer from one year old seedlings. A pathogen disk growing on PDA with same diameter was placed into a hole and removed bark placed over it. To provide necessary moisture for infection, infection sites were covered with steril water embedded cotton and wrapped with aluminium foil and polyethylene sheets and tied with raffia. Inoculations were made within the period of October 27-29, 1985. Wrappings were removed after one month from the infection.

First symptoms were observed by a start of new growth in spring, but complete symptom measurements were taken on June 24, 1985.

The symptoms were evaluated by modifying the SOLEL and SPIEGEL-ROY (1978) ranking scale (Table 1).

TABLE 1 - Symptom ranking scales for Mal secco (*P. tracheiphila*).

| Scale ranking | Symptoms |
|---------------|--|
| 0 | no symptoms |
| 1 | shoot tip (15 cm) is died |
| 2 | side branches and twigs are died |
| 3 | whole crown down to infection site is died |
| 4 | whole crown down to bud union is died |
| 5 | whole tree including rootstock is died |

Scale ranking was made for each tree individually and then averaged for each genus, species, and cultivars. The resistance of the trees is classified as follows:

| Mean scale rating | Groups |
|-------------------|--------------------|
| 0.00-0.99 | resistant |
| 1.00-1.99 | medium resistant |
| 2.00-3.99 | susceptible |
| 4.00-5.00 | highly susceptible |

After symptom evaluation, shoot samples were taken from each tree, and *P. tracheiphila* was reisolated. The study was carried at Alata Horticultural Research and Training Center in İçel.

RESULTS AND DISCUSSION

Resistance of some important *Citrus* species to Mal secco disease were given in Table 2. Table is prepared by using the average values of the cultivars used in the experiment. When Table 2 was examined, Yuzu and Sweet lemon were found resistant, Cleopatra mandarin was medium resistant and the others were susceptible.

Cleopatra mandarin and citron were medium resistant ; orange, lemon, Volkameriana, Rough lemon, Rangpur lime, sour orange, trifoliolate orange, Taiwanica, bergamot, Macrophylla, grapefruit and Chinese sour orange were susceptible, and these results were in concordance with other reported studies (CATARA and CUTULI, 1972 ; CRESCIMANNO *et al.*, 1973 ; RUSSO, 1977 ; CUTULI *et al.*, 1984). In this study Yuzu was the most resistant species compared to others which is shared up by CRESCIMANNO *et al.* (1973). CATARA and CUTULI (1972) and RUSSO (1977) mentioned that Yuzu was very susceptible to Mal secco disease. Again, Sweet lemon was determined susceptible by all three researchers, but in this study it was

in resistant group. The opposite of this is true for kumquat and calamondin. These contrasting results from Yuzu, Sweet lemon, kumquat and calamondin were probably due to the differences in genetic structures of the plants and experimental conditions. However mentioned authors believe that these experiments should be done with different aspects and at different places to get more precise results.

Resistance of some important orange cultivars were given in Table 3. Among orange cultivars used in this study, Finike common orange, Tarocco and Salustiana were the most resistant cultivars. Parson Brown cultivar should medium resistance ; Kozan common orange, Magnum Bonum, Pineapple , Valencia, Shamouti, Pepper Rind, and Trovita cultivars were very susceptible. SOLEL and OREN (1975) reported that Washington navel and Valencia oranges were susceptible, but Shamouti did not show any important symptoms. CATARA and CUTULI (1972) found that oranges were susceptible but did not show severe symptoms, and they reported low infection symptom on the cultivar Biondo, and a medium infection symptom on the cultivars Vaniglia and Ovale. These results were in agreement with results obtained in this study. But the response of Washington navel could be considered more resistant than Shamouti and Valencia.

Resistance of some lemon varieties were given in Table

TABLE 2 - Resistance of some *Citrus* species and hybrids to Mal secco (*Phoma tracheiphila*) disease.

| English name of the species | Latin names of the species | Damage ranking (weighted mean) | Resistance * to Mal secco |
|-----------------------------|---|--------------------------------|---------------------------|
| Yuzu | <i>Citrus junos</i> Sieb. ex. Tan. | 0.50 | ++ |
| Sweet lemon | <i>Citrus limettoides</i> Risso | 0.70 | ++ |
| Cleopatra mandarin | <i>Citrus reshni</i> Hort. ex. Tan. | 1.80 | + |
| Citrumelo | <i>C. paradisi</i> x <i>P. trifoliata</i> | 3.00 | - |
| Citron | <i>Citrus medica</i> L. | 3.07 | - |
| Orange | <i>Citrus sinensis</i> (L.) Osbeck | 3.17 | - |
| Mandarin | <i>Citrus reticulata</i> Blanco | 3.41 | - |
| Lemon | <i>Citrus limon</i> Burm. f. | 3.53 | - |
| Grapefruit | <i>Citrus paradisi</i> Macf. | 3.53 | - |
| Citrange | <i>C. sinensis</i> x <i>P. trifoliata</i> | 3.56 | - |
| Volkameriana | <i>C. volkameriana</i> Tan. and Pasq. | 3.60 | - |
| Rough lemon | <i>Citrus jambhiri</i> Lush. | 3.68 | - |
| Rangpur lime | <i>Citrus limonia</i> Osbeck | 3.80 | - |
| Sour orange | <i>Citrus aurantium</i> L. | 3.83 | - |
| Trifoliolate orange | <i>Poncirus trifoliata</i> (L.) Raf. | 3.92 | - |
| Taiwanica | <i>C. taiwanica</i> Tan. et Shim. | 4.00 | -- |
| Bergamot | <i>C. bergamia</i> Risso and Poit. | 4.00 | -- |
| Kumquat | <i>Fortunella margarita</i> Lour. | 4.00 | -- |
| Calamondin | <i>Citrus madurensis</i> Lour. | 4.00 | -- |
| Shaddock | <i>Citrus grandis</i> (L.) Osbeck | 4.00 | -- |
| Macrophylla | <i>Citrus macrophylla</i> Wester | 4.00 | -- |
| Chinotto | <i>Citrus myrtifolia</i> Raf. | 4.50 | -- |

* - Resistance level :

++ resistant + medium resistant - susceptible -- very susceptible

TABLE 3 - Resistance of some orange cultivars to Mal secco (*Phoma tracheiphila*) disease.

| Cultivar or clone | Origin * | Percent distribution of ranks | | | | | | Damage ranking (weighted mean) | Resistance ** to Mal secco |
|-------------------|----------|-------------------------------|-------|-------|-------|--------|-------|-----------------------------------|-------------------------------|
| | | 0 | 1 | 2 | 3 | 4 | 5 | | |
| Finike common | ATAE | 71.43 | 14.29 | | | 14.28 | | 0.71 | ++ |
| Tarocco | CRC | 80.00 | | | | 20.00 | | 0.80 | ++ |
| Salustiana | CRC | 66.67 | 16.67 | | | 16.66 | | 0.83 | ++ |
| Parson Brown | CRC | 60.00 | | | | 20.00 | 20.00 | 1.80 | + |
| Succary | ATAE | 16.67 | 33.34 | | | 16.67 | 33.32 | 2.67 | - |
| Dörtyol common | ATAE | 16.67 | | 33.33 | | 50.00 | | 2.67 | - |
| Madame Vinous | ATAE | 16.67 | | | | 83.33 | | 3.33 | - |
| Sanguino | ATAE | 16.67 | | | | 83.33 | | 3.33 | - |
| Washington navel | ÇÜZFBB | 20.00 | | | | 60.00 | 20.00 | 3.40 | - |
| Sanguinello | ATAE | 14.29 | | | | 85.71 | | 3.43 | - |
| Alanya Dilimli | ATAE | | 16.67 | | 16.67 | 49.99 | 16.67 | 3.50 | - |
| Moro Blood | CRC | | 11.11 | | | 88.89 | | 3.67 | - |
| Akçay Şekeri | ATAE | | | 16.67 | | 83.33 | | 3.67 | - |
| Barile | ATAE | | | 16.67 | | 83.33 | | 3.67 | - |
| Hamlin | CRC | | | | 33.33 | 50.00 | 16.67 | 3.83 | - |
| Kozan common | ATAE | | | | | 100.00 | | 4.00 | - |
| Magnum Bonum | ATAE | | | | | 100.00 | | 4.00 | - |
| Pineapple | ATAE | | | | | 100.00 | | 4.00 | - |
| Valencia | CRC | | | | | 100.00 | | 4.00 | - |
| Shamouti | ÇÜZFBB | | | | | 100.00 | | 4.00 | -- |
| Pepper Rind | ATAE | | 16.67 | | | 16.67 | 66.66 | 4.17 | -- |
| Trovita | ATAE | | | | | 80.00 | 20.00 | 4.20 | -- |

* ATAЕ - Citrus Research Institute, Antalya, Turkey.

CRC - Citrus Research Center, Riverside, California, USA.

ÇÜZFBB - Department of Horticulture, Faculty of Agriculture, University of Çukurova, Adana, Turkey.

** Resistance level : ++ resistant + medium resistant - susceptible -- very susceptible

4. In this study main local varieties grown in Turkey, the foreign originated varieties introduced in recent years and the promising Italian lemon varieties were used. Among these Zagara Bianca (Fior d'Arancio) variety showed full resistance to *Phoma tracheiphila* infections. Aklimon variety which is cultivated in very limited places in Antalya and Finike, and thought to be a hybrid of natural lemon x lime were also found to show very little symptoms.

In addition, Feminello Santa Teresa variety originated from Italy and one of clones of Aklimon were found medium resistant. Santa Teresa originated from California and Carrubaro originated from Sicily and some lemon cultivars brought from the different organizations in Turkey such as Cyprus, Maltese and Interdonato varieties were classified as susceptible. However, Maltese and Interdonato, were shown symptoms nearly to the very susceptible group. Among the 35 lemon varieties tested, Zagara Bianca showed similar results with other studies reported (CUTULI *et al.*, 1984). Although this variety was found resistant in Italy, it did not give expected results in practice. Because of that, trees which did not show any damage, from the varieties Zagara Bianca, Aklimon and Feminello Santa Teresa were taken to another plots for inoculation tests. The results will then be more precise after getting the results of reinoculation and the behaviour of the plants to natural infections are determined until they are fully developed.

In contrast, SOLEL and OREN (1975), GRANATA *et al.* (1977 and 1979), PERROTTA and TRIBULATO (1977), reported that Zagara Bianca belonged to susceptible group, and Monachello and Continella varieties were resistant. In our study, Continella, Italian and Turkish originated two Monachello clones were susceptible (Table 4). In fact, it is known that lemons, especially Feminello and Monachello sub-group lemon cultivars have a very heterogeneous genetic make up and the variability between the clones is very large and the response of the young plants to the infection is very strong (CATARA and CUTULI, 1972; GRANATA, 1977 and 1979; CUTULI *et al.*, 1984). Because of this it would be better to make decisions on the basis of clones. Santa Teresa showed persistent resistance (CATARA and CUTULI, 1972; PIONNAT, 1982; SPINA and CUTULI, 1983; CUTULI *et al.*, 1984). Cyprus, Antalya Round, Finike Round and Molla Mehmet cultivars which were given as a quite resistant by AKTEKE and KARACA (1977) were found susceptible. If the position of Monachello in the ranking is examined, the results might have been effected from the factors mentioned earlier as a result, experiments, especially on resistance of lemon varieties to Mal secco disease should be carried out in more details. The same ideas are shared by CATARA and CUTULI (1972) and CUTULI *et al.* (1984).

Results on the local and foreign originated sour orange

TABLE 4 - Resistance of some lemon cultivars to Mal secco (*Phoma tracheiphila*) disease.

| Cultivar or clone | Origin * | Percent distribution of ranks | | | | | | Damage ranking (weighted mean) | Resistance** to Mal secco |
|-----------------------------------|----------|-------------------------------|-------|-------|-------|--------|-------|-----------------------------------|------------------------------|
| | | 0 | 1 | 2 | 3 | 4 | 5 | | |
| Zagara Bianca (Fior d'Arancio) | ISA | 100.00 | | | | | | 0.00 | ++ |
| Aklimon (normal developing) | ATAE | 70.00 | 10.00 | | | 20.00 | | 0.90 | ++ |
| Feminello Santa Teresa | ISA | 25.00 | | 75.00 | | | | 1.50 | + |
| Aklimon (vigorous type) | ATAE | 50.00 | 25.00 | | | | 25.00 | 1.50 | + |
| Santa Teresa | CRC | | 20.00 | | 20.00 | 60.00 | | 3.20 | - |
| Carrubaro | ISA | | | 33.33 | | 66.67 | | 3.33 | - |
| Cyprus | ABAEM | | | 22.23 | | 77.78 | | 3.56 | - |
| Antalya Round | ABAEM | | 20.00 | | | 80.00 | | 3.60 | - |
| Maltese | ATAE | | | 12.50 | | 87.50 | | 3.75 | - |
| Interdonato | ABAEM | | | 10.00 | | 90.00 | | 3.80 | - |
| Finike Round | ABAEM | | | | | 100.00 | | 4.00 | -- |
| Messina | ÇAE | | | | | 100.00 | | 4.00 | -- |
| Sayfiye | ÇÜZFBB | | | | | 100.00 | | 4.00 | -- |
| Molla Mehmet | ABAEM | | | | | 100.00 | | 4.00 | -- |
| Monachello | ABAEM | | | | | 100.00 | | 4.00 | -- |
| Monachello | ISA | | | | | 100.00 | | 4.00 | -- |
| Lisbon | ATAE | | | | | 100.00 | | 4.00 | -- |
| Continella | ISA | | | | | 100.00 | | 4.00 | -- |
| Eureka | ATAE | | | | | 100.00 | | 4.00 | -- |
| Italyan Memeli | ABAEM | | | | | 100.00 | | 4.00 | -- |
| Kütdiken | ABAEM | | | | | 100.00 | | 4.00 | -- |
| Villafranca | ATAE | | | | | 100.00 | | 4.00 | -- |
| Di Spina | ATAE | | | | | 100.00 | | 4.00 | -- |
| Lamas | ATAE | | | | | 100.00 | | 4.00 | -- |
| Lunario | ATAE | | | | | 100.00 | | 4.00 | -- |
| Prior Lisbon | CRC | | | | | 100.00 | | 4.00 | -- |
| Frost Lisbon | CRC | | | | | 100.00 | | 4.00 | -- |
| Cook Eureka | CRC | | | | | 100.00 | | 4.00 | -- |
| Corona Foothill | CRC | | | | | 100.00 | | 4.00 | -- |
| Cascada Eureka | CRC | | | | | 100.00 | | 4.00 | -- |
| Frost Eureka | CRC | | | | | 100.00 | | 4.00 | -- |
| Allen Eureka | CRC | | | | | 100.00 | | 4.00 | -- |
| Limoneria 8 A Lisbon | CRC | | | | | 100.00 | | 4.00 | -- |
| Ponderosa | ATAE | | | | | 100.00 | | 4.00 | -- |
| Carves Lisbon | CRC | | | | | 66.67 | 33.33 | 4.33 | -- |

* ISA - Citrus Research Institute, Acireale, Italy.

ATAE - Citrus Research Institute, Antalya, Turkey.

ABAEM - Alata Horticultural Research and Training Center, Erdemli, İçel, Turkey.

CRC - Citrus Research Center, Riverside, California, USA.

ÇAE - Tea Research Center, Rize, Turkey.

ÇÜZFBB - Dept. of Horticulture, Faculty of Agriculture, University of Çukurova, Adana, Turkey.

** - Resistance level : ++ resistant + medium resistant - susceptible -- very susceptible

cultivars were given in Table 5 and 6. When Table 5 is examined, among the 29 sour orange cultivars selected from the East Mediterranean region, Tuzcu 31-31 and Tuzcu 33-3 clones were found susceptible and the rest was very susceptible. Among the local and foreign originated sour orange cultivars Australian was found medium resistant, Bouquetier de Nice, Menton, Luisi, Florida, Daidai SEAB, Apépu Azaguié, Petit Pierre, Alibert 12,

Vallauris var. Fine, Genest and Cardosi were susceptible, and the rest was very susceptible. Australian showed relatively more resistance. Plants, from the varieties Bouquetier de Nice, Luisi, Daidai SEAB and SEAB, which showed no symptoms, were replanted to another plots for second inoculation.

Determination of resistant sour orange varieties to Mal

TABLE 5 - Resistance of Eastern Mediterranean sour oranges to Mal secco (*Phoma tracheiphila*) disease.

| Clone | Percent distribution of ranks | | | | | | Damage ranking (weighted mean) | Resistance * to Mal secco |
|-------------|-------------------------------|-------|---|---|--------|-------|-----------------------------------|------------------------------|
| | 0 | 1 | 2 | 3 | 4 | 5 | | |
| Tuzcu 31-31 | 16.67 | | | | 85.33 | | 3.33 | - |
| Tuzcu 33-3 | | 16.66 | | | 66.67 | 16.67 | 3.67 | - |
| Tuzcu 31-26 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 01-13 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 31-30 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 01-22 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 33-8 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 33-6 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 31-25 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 01-19 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 01-14 | | | | | 100.00 | | 4.00 | - |
| Tuzcu 33-7 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 01-24 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 01-17 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 33-9 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 31-27 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 01-23 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 01-18 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 33-10 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 33-12 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 01-21 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 33-2 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 31-1 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 31-29 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 01-20 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 01-16 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 01-15 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 33-4 | | | | | 100.00 | | 4.00 | -- |
| Tuzcu 33-5 | | | | | 66.67 | 53.33 | 4.33 | -- |

* Resistance level : - susceptible -- very susceptible

secco disease is especially important to prevent the root infections. Because of that, breeding of resistant rootstocks is as important as breeding of new cultivars. CRESCIMANNO *et al.* (1973), and CUTULI *et al.* (1984) mentioned that sour orange varieties were susceptible and there was not any clone which could be accepted as resistant. Results obtained in this study may provide important source for further studies.

Resistance of some mandarin cultivars to Mal secco disease were shown in Table 7. Satsuma mandarin was found to be resistant ; Willow leaf, Fairchild, Clementine, Fremont and Kinnow mandarins were susceptible (Table 7). CATARA and CUTULI (1972) reported that Willow leaf, King, Clementine and Wilking mandarins showed some resistance ; SOLEL and OREN (1975), found that Wilking and Clementine mandarins were susceptible and RUSSO (1977) reported that Wilking mandarin was very susceptible. These results are in agreement with the results obtained in this study, and inoculation results indicated that mandarin cultivars were peculiarly resistant.

Resistance of some grapefruit and shaddock cultivars were given in Table 8. Marsh Seedless grapefruit was susceptible ; Red Blush, Star Ruby grapefruits and Rienking shaddock were very susceptible. CATARA and CUTULI (1972) reported that symptom development in grapefruits to Mal secco was very slow and therefore different reports were given by in various studies. SOLEL and OREN (1975),

RUSSO (1977) and CUTULI *et al.* (1984) found that Marsh Seedless grapefruit showed resistance to natural inoculations our results depends on the response of young tree to artificial inoculation. This situation proves the idea mentioned by CATARA and CUTULI (1972).

Resistance of some *Citrus* rootstocks to Mal secco disease were given in Table 9. When Table 9 was examined, Yuzu and Sweet lemon were found resistant ; Cleopatra mandarin was medium resistant ; Citrumelo 1452, Tuzcu M-1, Troyer and Carrizo citranges, Benecke trifoliolate orange, UCLA and Milam rough lemons, Volkameriana and Rangpur lime were susceptible and the rest was very susceptible. CATARA and CUTULI (1972), mentioned that Volkameriana, Rangpur lime, Bergamot, Macrophylla, Yuzu and Troyer citrange were susceptible, CRESCIMANNO *et al.*, (1973) reported that Rough lemon and Yuzu were resistant, Macrophylla was medium resistant; Taiwanica and Carrizo and Troyer citranges were very susceptible. RUSSO (1977), mentioned that Cleopatra mandarin was resistant ; Volkameriana, Rangpur lime, Macrophylla, Yuzu, Trifoliolate orange, Carrizo and Troyer citranges and citrumelo were susceptible. The results obtained in this study agree with CRESCIMANNO (1973) on Yuzu ; SOLEL and OREN (1975) on Sweet lemon ; and RUSSO (1977) on Cleopatra mandarin. Our results supported the reports of CATARA and CUTULI (1972) and RUSSO (1977) on the susceptibility of Macrophylla.

TABLE 6 - Resistance of sour oranges to Mal secco (*Phoma tracheiphila*) disease.

| Cultivar or clones | Origin | Percent distribution of ranks | | | | | Damage ranking (weighted mean) | Résistance * to Mal secco | |
|------------------------|---------------|-------------------------------|-------|-------|---|--------|-----------------------------------|------------------------------|----|
| | | 0 | 1 | 2 | 3 | 4 | | | 5 |
| Australian | Australia | 75.00 | | | | 25.00 | 1.00 | + | |
| Bouquetier de Nice | France | 14.29 | 28.57 | 14.29 | | 28.57 | 14.29 | 2.43 | - |
| Menton | France | | | 50.00 | | 50.00 | | 3.00 | - |
| Luisi | Corsica | 12.50 | 12.50 | | | 75.00 | | 3.13 | - |
| Florida | Florida | | 25.00 | | | 75.00 | | 3.25 | - |
| Daidai SEAB | Algeria | 16.67 | | | | 83.33 | | 3.33 | - |
| SEAB | Algeria | 14.28 | | | | 85.72 | | 3.43 | - |
| Apépu Azaguié | Côte d'Ivoire | | | 28.57 | | 57.14 | | 3.59 | - |
| Petit Pierre | Tunisia | | 14.29 | | | 85.71 | | 3.63 | - |
| Alibert 12 | Tunisia | | | 25.00 | | 62.50 | 12.50 | 3.63 | - |
| Vallauris var. Fine | France | | | 16.67 | | 83.33 | | 3.67 | - |
| Granito | Corsica | | | 14.29 | | 85.71 | | 3.71 | - |
| Genest | Spain | | | 12.50 | | 87.50 | | 3.75 | - |
| Cardosi | Corsica | | | 16.67 | | 66.66 | 16.67 | 3.83 | - |
| Standard Sour | California | | | | | 100.00 | | 4.00 | -- |
| Ferando | Corsica | | | | | 100.00 | | 4.00 | -- |
| Brasil | Brazil | | | | | 100.00 | | 4.00 | -- |
| Adil Okan | Turkey | | | | | 100.00 | | 4.00 | -- |
| Ruche Foncière | Corsica | | | | | 100.00 | | 4.00 | -- |
| Daidai | Tunisia | | | | | 100.00 | | 4.00 | -- |
| Santucci | Corsica | | | | | 100.00 | | 4.00 | -- |
| Alibert | Algeria | | | | | 100.00 | | 4.00 | -- |
| Curaçao | Antilles | | | | | 87.50 | 12.50 | 4.13 | -- |
| Tulear | Algeria | | | | | 75.00 | 25.00 | 4.25 | -- |
| Kırmızı meyveli | Cyprus | | | | | 66.67 | 33.33 | 4.33 | -- |
| Sarı meyveli | Cyprus | | | | | 50.00 | 50.00 | 4.50 | -- |
| Çin turuncu | California | | | | | 50.00 | 50.00 | 4.50 | -- |

* Resistance level : + medium resistant - susceptible -- very susceptible

TABLE 7 - Resistance of some mandarin cultivars to Mal secco (*Phoma tracheiphila*) disease.

| Cultivar or clone | Origin * | Percent distribution of ranks | | | | | Damage ranking (weighted mean) | Resistance ** to Mal secco | |
|--|----------|-------------------------------|-------|-------|---|--------|-----------------------------------|-------------------------------|----|
| | | 0 | 1 | 2 | 3 | 4 | | | 5 |
| Satsuma | ÇÜZFBB | 100.00 | | | | | 0.00 | ++ | |
| Willow leaf | ATAE | | | 83.33 | | 16.67 | 2.22 | - | |
| Fairchild | CRC | | 50.00 | | | | 50.00 | 3.00 | - |
| Clementine | | | | | | | | | |
| (Algerian tangerin Ranch Selection) | CRC | | 20.00 | | | 40.00 | 40.00 | 3.80 | - |
| Fremont | CRC | | 16.67 | | | 50.00 | 33.33 | 3.82 | - |
| Kinnow | CRC | | | 14.29 | | 71.42 | 14.29 | 3.86 | - |
| King | ATAE | | | | | 10.00 | | 4.00 | -- |
| Kara | CRC | | | | | 100.00 | | 4.00 | -- |
| Fortune | CRC | | | | | 40.00 | 60.00 | 4.00 | -- |
| Wilking | CRC | | | | | 33.33 | 66.67 | 4.67 | -- |

* ÇÜZFBB - Department of Horticulture, Faculty of Agriculture, University of Çukurova, Adana, Turkey.

ATAE - Citrus Research Institute, Antalya, Turkey.

CRC - Citrus Research Center, Riverside, California, USA.

** Resistance level : ++ resistant - susceptible -- very susceptible

TABLE 8 - Resistance of some grapefruit and shaddock varieties to Mal secco (*Phoma tracheiphila*) disease.

| Variety | Origin * | Percent distribution of ranks | | | | | | Damage ranking (weighted mean) | Resistance ** to Mal secco |
|-------------------|----------|-------------------------------|-------|---|---|--------|---|-----------------------------------|-------------------------------|
| | | 0 | 1 | 2 | 3 | 4 | 5 | | |
| Marsh Seedless | CRC | 20.00 | 20.00 | | | 80.00 | | 2.60 | - |
| Red Blush | CRC | | | | | 100.00 | | 4.00 | -- |
| Star Ruby | Texas | | | | | 100.00 | | 4.00 | -- |
| Rienking Shaddock | CRC | | | | | 100.00 | | 4.00 | -- |

* CRC - Citrus Research Center, Riverside, California, USA.

Texas - A Citrus Plantation in Texas, USA.

** - Resistance level : - susceptible - - very susceptible.

TABLE 9 - Resistance of some rootstocks to Mal secco (*Phoma tracheiphila*) disease.

| Rootstock | Origin * | Percent distribution of ranks | | | | | | Damage ranking (weighted mean) | Resistance ** to Mal secco |
|--------------------------------|----------|-------------------------------|-------|-------|-------|--------|-------|-----------------------------------|-------------------------------|
| | | 0 | 1 | 2 | 3 | 4 | 5 | | |
| Yuzu | CRC | 50.00 | 50.00 | | | | | 0.50 | ++ |
| Sweet lemon | ATAE | 80.00 | | | 10.00 | 10.00 | | 0.70 | ++ |
| Cleopatra mandarin | ATAE | 40.00 | 20.00 | | | 40.00 | | 1.80 | + |
| Citrumelo 1452 | CRC | 50.00 | | | | 50.00 | | 2.00 | - |
| Tuzcu M-1 citrange | ÇÜZFBB | 20.00 | 20.00 | | | 60.00 | | 2.60 | - |
| Milam Rough lemon | ATAE | | | 66.67 | | 33.33 | | 2.67 | - |
| Benecke trifoliolate orange | CRC | | 20.00 | | 20.00 | 60.00 | | 3.20 | - |
| UCLA Rough lemon | CRC | 11.11 | 11.11 | | | 77.78 | | 3.22 | - |
| Troyer citrange | CRC | 16.67 | | 16.67 | | 33.33 | 33.33 | 3.33 | - |
| Carrizo citrange | CRC | | | 20.00 | 20.00 | 60.00 | | 3.40 | - |
| Volkameriana | CRC | | | | 40.00 | 60.00 | | 3.60 | - |
| Rangpur lime | CRC | | | | 20.00 | 80.00 | | 3.80 | - |
| Taiwanica | CRC | | | | | 100.00 | | 4.00 | -- |
| Macrophylla | CRC | | | | | 100.00 | | 4.00 | -- |
| Tuzcu M-2 citrange | ÇÜZFBB | | | | 20.00 | 60.00 | 20.00 | 4.00 | -- |
| Savage citrange | CRC | | | | | 100.00 | | 4.00 | -- |
| Cunningham citrange | SRA | | | | | 100.00 | | 4.00 | -- |
| Citrumelo Scaton | CRC | | | | | 100.00 | | 4.00 | -- |
| Pomeroy trifoliolate orange | SRA | | | | | 100.00 | | 4.00 | -- |
| Common trifoliolate orange | ÇÜZFBB | | | | | 100.00 | | 4.00 | -- |
| Florida Rough lemon | CRC | | | | 12.50 | 62.50 | 25.00 | 4.13 | -- |
| Flying Dragon trifoliolate or. | CRC | | | | | 50.00 | 50.00 | 4.50 | -- |

* CRC - Citrus Research Center, Riverside, California, USA.

ATAE - Citrus Research Institute, Antalya, Turkey.

ÇÜZFBB - Department of Horticulture, Faculty of Agriculture, University of Çukurova, Adana, Turkey.

SRA - Citrus Research Institute, Corsica, France.

** - Resistance level : ++ resistant + medium resistant - susceptible -- very susceptible

The results obtained for Rough lemon were in agreement with that of SOLEL and OREN (1975) and RUSSO (1977).

CONCLUSIONS

In this study, it was once more determined that Mal secco is an important fungal disease not only for lemons but also for other *Citrus* species and cultivars. In addition to branch and leaf infections, root infections are also very important for the spread of the disease and, causing dama-

ge to susceptible species and cultivars. Because of this, it is very important to determine the resistant varieties and the rootstocks for the infected regions. Further studies on host-disease interactions and resistance mechanisms are also needed. Within the framework of this study, Satsuma mandarin, Finike common orange, Tarocco, Salustiana oranges, Zagara Bianca, Aklimon and Sweet lemon, Yuzu and Australian sour orange can be said resistant; Cleopatra mandarin and Santa Teresa lemon can be said medium resistant. These varieties might contribute some information to further experiments.

LITERATURE CITED

- CUTULI (G.), LAVIOLA (C.), PERROTTA (G.), SALERNO (M.) et SPINA (P.). 1984.
Le Mal secco des agrumes.
Séminaire international AGRIMED 1984-1988, Capo d'Orlando, Messina, Italie, 131 p.
- CUTULI (G.). 1982.
Il limone in coltura sotto rete : effetti sul microclima e sullo stato fitosanitario delle piante con particolare riguardo al Mal secco.
Inf. Agr., 38, 21425-21429.
- AKTEKE (Ş.A.) and KARACA (I.). 1977.
Studies on the survey and biology of Mal secco disease [*Phoma tracheiphila* (Petri) Kanchaveli et Ghikashvili] of lemon trees.
J. Turkish Phytopath., 6, 91-102.
- SALERNO (M.) and SOMMA (V.). 1971.
Osservazioni sulla sistemicità del benomyl in semenzali di arancio amaro e risultati di lotta contro il Mal secco degli agrumi:
Phytopathologia Mediterranea, 10, 99-106.
- SOMMA (V.) and SAMMARCO (G.). 1971.
Inefficacia di due antibiotici contro il Mal secco degli agrumi e primi risultati sull'attività di due nuovi fungicidi sistemici.
Atti Giornate Fitopatologiche, 1971, 1, 241-245.
- SOMMA (V.) and SAMMARCO (G.). 1973.
L'influenza del Tween 20 sulla sistemicità e sull'efficacia del Benomyl contro il Mal secco degli agrumi.
Atti Giornate Fitopatologiche, 1973, 1, 425-428.
- PERROTTA (G.), TIRRO (A.) and GRANATA (G.). 1974.
Prove di lotta contro il Mal secco degli agrumi con fungicidi sistemici.
1. Assorbimento e persistenza dei fungicidi applicati per irrorazione alla chioma.
Tecnica Agricola, 26, 1001-1013.
- SALERNO (M.) and PERROTTA (G.). 1978.
Lo stato della lotta chimica contro il Mal secco degli agrumi.
Tecnica Agricola, 30, 307-316.
- GIMENEZ-VERDU (I.) and LUISI (N.). 1978.
Tolleranza al Benomyl del *Phoma tracheiphila*.
Atti Giornate Fitopatologiche, 1978, 1, 157-164.
- SOMMA (V.) and LAVIOLA (C.). 1982.
Un quadriennio di prove di campo sull'efficacia del Benomyl e del metiltiofanate contro il Mal secco degli agrumi.
Atti Giornate Fitopatologiche, 1982, 2, 197-204.
- DİNÇ (N.), TURAN (K.) and SALİH (H.). 1982.
Akdemiz bölgesi limonlarında görülen Uçkurutan hastalığı [*Deuterophoma tracheiphila* (Petri) Kanc. et Ghik.] nin savaş yöntemleri üzerine araştırmalar.
Bitki Koruma Bülteni, 21, 89-99.
- CUTULI (G.). 1972.
Il «Mal nero» : una particolare forma di Mal secco [*Phoma tracheiphila* (Petri) Kanc. et Ghik.] osservata su specie diverse di agrumi.
Annali Ist Sper. Agr., 5, 281-290.
- GRANATA (G.), PERROTTA (G.), TIRRO (A.) and GRASSO (S.). 1977.
Comportamento di selezioni clonali di limone nei confronti di infezioni naturali di *Phoma tracheiphila*.
Tecnica Agricola, 29, 337-344.
- SALERNO (M.) and CUTULI (G.). 1977.
Control of *Citrus* Mal secco in Italy today.
Proc. Int. Soc. Citriculture, 3, 1001-1003.
- SPINA (P.) and CUTULI (G.). 1983.
Orientations des recherches réalisées en Italie sur le Mal secco des agrumes.
Fruits, 38 (7-8), 541-544.
- PERROTTA (G.) and TRIBULATO (E.). 1977.
Observations on the susceptibility of nucellar lines of lemons to Mal secco disease in Sicily.
Proc. Int. Soc. Citriculture, 3, 1004-1005.
- PIONNAT (J.C.). 1982.
Le Mal sec [*Phoma tracheiphila* (Petri) Kanc. et Ghik.]. Perspectives sur la lutte chimique et les variétés résistantes.
Fruits, 37 (4), 237-248.
- CATARA (A.), PERROTTA (G.), CARTIA (G.) and GRANATA (G.). 1976.
Problemi fitopatologici connessi con l'impiego di portinesti dall'arancio amaro in Sicilia.
Incontro frutticolo sui portinesti degli alberi da frutto, p. 249-258. *Società Orticola Italiana, Frutticoltura, Pisa*.
- LUISI (N.), De COCCO (V.), CUTULI (G.) and SALERNO (M.). 1979.
Analisi della patogenicità di *Phoma tracheiphila* (Petri) Kanc. et Ghik. su alcune specie e cultivar di agrumi.
Phytopathologia Mediterranea, 28, 162-165.
- GRASSO (S.) and PERROTTA (G.). 1978.
Production of pycnidia in trees of the *Rutaceae* family affected by *Phoma tracheiphila*.
Riv. Pat. Veg., 14, 41-45.
- SOLEL (A.) and SPIEGEL-ROY (P.). 1978.
Methodology of selection of lemon clones for tolerance to Mal secco.
Phytoparasitica, 6, 129-134.
- CATARA (A.) and CUTULI (G.). 1972.
Osservazioni sulla suscettibilità di alcune *Rutaceae* alle infezioni epigee di *Phoma tracheiphila*.
Ann. Ist. Sper. Agr., 5, 29-49.
- CRESCIMANNO (F.G.), SOMMA (V.) and CALABRESE (F.). 1973.
Preliminary research on resistance of some rootstocks to Mal secco.
I. Congresso Mundial de Citricultura, 2, 119-120.
- RUSSO (F.). 1977.
Il miglioramento genetico per la resistenza al Mal secco del limone in Italia.
Ann. Ist. Sper. Agr., 9-10, 231-243.
- SOLEL (A.) and OREN (Y.). 1975.
Outbreak of Mal secco disease in Israel on normally tolerant *Citrus* cultivars.
Plant Disease Reporter, 59, 945-946.
- GRANATA (G.), TIRRO (A.) and PERROTTA (G.). 1979.
Comportamento di selezioni clonali di limone and confronti di infezioni naturali di *Phoma tracheiphila*.
Tecnica Agricola, 31, 103-109.

**RESISTENZ EINIGER ZITRUSARTEN UND HYBRIDEN GEGEN
'MAL SECCO' (*PHOMA TRACHEIPHILA* KANG. UND GHK.).**

Ö. TUZCU, A. ÇINAR, M. KAPLANKIRAN,
A. ERKILIÇ und T. YEŞİLOĞLU.

Fruits, Mar. 1989, vol. 44, n° 3, p. 139-148.

KURZFASSUNG - Gegenstand der Untersuchung waren 22 Orangenbäume, 10 Mandarinenbäume, 35 Zitronenbäume, 4 Grapefruitbäume, 56 Pomeranzenbäume verschiedener Provenienz, 12 Poncirus bzw. Hybriden, sowie 33 andere Arten und Sorten. Die Impfung mit dem Mal-secco-Pilz (*Phoma tracheiphila*) geschah im Oktober 1985 an einjährigen Jungpflanzen 20 cm oberhalb der Propfstelle. Im Juni 1985 wurden die einzelnen Arten und Sorten auf ihre Resistenz nach Massgabe der modifizierten SOLEL-SPIEGEL-ROY-Skala beobachtet.

Als resistent bezeichnet werden konnten der Mandarinenbaum Satsuma, die Orangenbäume Commune Finike, Tarocco und Salustiana, die Zitronenbäume Aklimon, Zagara Bianca, und Sweet, sowie die Pomeranzenbäume Yuzu und Australian. Als mittelmässig resistent erwiesen sich der Mandarinenbaum Cléopâtre und der Zitronenbaum Santa Teresa; die übrigen Arten und Sorten waren anfällig gegen das Mal secco.

**RESISTENCIA DE ALGUNAS ESPECIES E HIBRIDOS DE
AGRIOS AL MAL SECCO (*PHOMA TRACHEIPHILA* KANG.
Y GHK.).**

Ö. TUZCU, A. ÇINAR, M. KAPLANKIRAN, E. ERKILIÇ
y T. YEŞİLOĞLU.

Fruits, Mar. 1989, vol. 44, n° 3, p. 139-148.

RESUMEN - El estudio ha tratado de 22 naranjos, 10 mandarinos, 35 limoneros, 4 pomelos, 56 naranjos amargos (bigaradiers) de orígenes diversos, 12 Poncirus e híbridos y 33 especies y variedades diferentes. La inoculación del hongo del Mal Secco (*Phoma tracheiphila*) se ha efectuado en octubre 1985, a 20 cm por encima del punto de injerto sobre plantas de un año. En junio de 1985 se habían realizado observaciones para situar la resistencia de las especies y variedades observadas apoyándose sobre la escala de SOLEL y SPIEGEL-ROY modificada.

Se ha encontrado que eran resistentes el mandarino Satsuma; los naranjos Commune Finike, Tarocco, Salustiana; los limoneros Aklimon, Zagara Bianca y el Sweet, y los bigaradiers Yuzu y Australian; el mandarino Cléopâtre y el limonero Santa Teresa eran medianamente resistentes; las otras especies y variedades se han revelado sensibles.

