

Preliminary Evaluation of the Tolerance of 18 Pummelo Cultivars to Stem-Pitting Tristeza

Zhao Xueyuan, Zhou Changyong, Tang Kezhi,
Jiang Yuanhui, Yang Fangyun, Huang Sen, Li Taisheng,
Liu Kehong, Liu Ying, and Chen Quanyou

ABSTRACT. The tolerance of 18 pummelo cultivars to stem-pitting strains of *Citrus tristeza virus* (SP-CTV) was tested. Budlings of each cultivar maintained in a screen-house were graft-inoculated with severe tristeza isolates collected from diseased pummelo trees. The plants were heavily pruned each spring, and the degree of SP was rated on several occasions. Four cultivars (Meng-lun-zao-you, Dian-jiang-bai-you, Man-sai-long-you and Chandler) showed high tolerance. Nine cultivars (Cui-xiang-tian-you, Tong-xian-you, Nan-kang-zao-you, Tai-bei-you, Feng-huang-you, Bai-shi-you, Wu-bu-you, Yu-huan-you and Guan-xi-mi-you) were susceptible, and most of these plants showed severe SP. The other five cultivars (Wan-bai-you, Long-an-you, Ling-nan-sha-tian-you, Chang-shou-sha-tian-you, and Liang-shan-you) were moderately susceptible. After preliminary tests showed that Chandler was tolerant to SP-CTV, it was grafted to 32 pummelo budlings or young trees with pummelo dwarf symptoms. After 2-3 yr, Chandler scions showed no stem-pitting or only a few pits. Budlings of Chandler, graft-inoculated with severe isolates collected from diseased pummelo trees from four different counties, also remained free of stem-pitting 3 yr post-inoculation.

Many new pummelo orchards have been developed in several provinces of China since the 1980s. Pummelo dwarf, caused by stem-pitting (SP) forms of *Citrus tristeza virus* (CTV) has become a serious problem in some counties since the 1990s, and is characterized by shortening of spring shoots, leaf curling, severe stem-pitting, fruit malformation and dwarfing.

Su (1) reported that pummelo dwarf in Taiwan was caused by pummelo dwarf isolates of CTV different from seedling yellows isolates. Zhou et al. (2) reported that pummelo dwarf was caused by SP-CTV.

Field observations indicate that many pummelo cultivars are susceptible to SP-CTV, but in 1992 we found several trees of the pummelo cultivar Tai-bei-you top-worked on another pummelo cultivar, Qian-niu-shan-you, in San-tai county, Sichuan Province. While the Tai-bei-you shoots showed severe symptoms of pummelo dwarf, the Qian-niu-shan-you shoots continued to grow well, suggesting that it is tolerant to SP-CTV.

Since 1994, 18 pummelo cultivars had been evaluated for tolerance to SP-CTV. The results

reported here confirm that pummelo cultivars vary in their reaction to SP-CTV, and that some are tolerant.

MATERIALS AND METHODS

Evaluation of tolerance by graft-inoculation. **Trial 1.** This was conducted in 1994-1998 in a screenhouse, using eight pummelo cultivars (Table 1). Four budlings of each cultivar were graft-inoculated with tissue from plants showing pummelo dwarf symptoms. One uninoculated budling of each cultivar was used as control.

Trial 2. This was conducted in 1996-2001 in a screen house, with six pummelo cultivars from trial 1 and 10 additional cultivars (Table 2). Six budlings of each cultivar were graft-inoculated as before, and three uninoculated budlings of each cultivar were used as controls.

In Trials 1 and 2, the test plants were heavily pruned before the spring flush each year. Stem-pitting intensity was recorded on a scale from 0 to 4 (0 = no pitting, 1 = slight pitting, 2 = 1/10 of the surface pitted, 3 = about 1/2 the surface pitted, and 4 = more than 2/3 of the surface

TABLE 1
CITRUS TRISTEZA VIRUS INDUCED STEM-PITTING INTENSITY IN EIGHT PUMMELLO CULTIVARS (TRIAL 1)

Cultivar	Stem-pitting intensity (scale 0-4)			
	Plant No.	1	2	3
Chandler		1	0	0
Wan-bai-you		1	1	2
Chang-shou-sha-tian-you		1	2	2
Tai-bei-you		3	3	0
Cui-xiang-tian-you		2	3	x ^z
Wu-bu-you		2	3	x
Feng-huang-you		3	3	3
Guan-xi-mi-you		3	3	4

^zPlant eliminated due to graft failure or damage.

pitted). During the test, none of the control plants showed SP; several inoculated plants were eliminated due to failure of the graft or damage by other causes.

Effect of SP-CTV on Chandler pummelo grafted on plants showing pummelo dwarf symptoms. Trial 3. This was conducted in 1998-1999. One Chandler bud was grafted to each of three potted pummelo plants that showed pummelo dwarf symptoms in March 1998.

Trial 4. This was conducted in 1999-2001. One Chandler bud was grafted to each of nine potted pummelo plants that showed pummelo dwarf symptom in March 1999.

Trial 5. This was conducted in 1998-2001. Twenty 3-yr-old pummelo trees in the field showing pummelo dwarf symptoms were top-worked with Chandler in October 1998.

Effect on Chandler of SP-CTV from four different localities.

Trial 6. In October 1997 two Chandler buds were grafted to each of 12 healthy potted pummelo plants. Groups of three plants were then graft-inoculated with tissue from plants showing pummelo dwarf symptoms collected from localities San-tai, Da-chuan, Nan-bu and Bei-bei, respectively. Five pieces of shoot bark or stem from the diseased plants were grafted into each plant below the Chandler buds. The

plants were heavily pruned in March 1998 to facilitate the sprouting of Chandler.

RESULTS

Evaluation of the tolerance of 18 pummelo cultivars by graft-inoculation. The results of Trials 1 and 2 are given in Tables 1 and 2 respectively.

The results showed that tolerance to SP-CTV in the 18 pummelo cultivars could be classified into three groups:

- (1) Tolerant (Meng-lun-zao-you, Dian-jiang-bai-you, Man-sai-long-you and Chandler): No or mild SP.
- (2) Moderately susceptible (Wan-bai-you, Long-an-you, Ling-nan-sha-tian-you, Chang-shou-sha-tian-you and Liang-shan-you): No or mild SP with some severe SP.
- (3) Susceptible (Tong-xian-you, Nan-kang-zao-you, Tai-bei-you, Feng-huang-you, Bai-shi-you, Wu-bu-you, Yu-huan-you and Guan-xi-mi-you): Some mild but mostly severe SP.

Effect of SP-CTV on Chandler when grafted to plants showing pummelo dwarf symptoms. Shoots from Chandler buds grafted to 32 pummelo budlings with pummelo dwarf symptoms in Trials 3, 4 and 5 showed no or little SP after 2-

TABLE 2
CITRUS TRISTEZA VIRUS-INDUCED STEM-PITTING INTENSITY IN 16 PUMMELLO CULTIVARS (TRIAL 2)

Cultivar	Stem-pitting intensity (scale (0-4)					
	1	2	3	4	5	6
Meng-lun-zao-you	0	0	0	0	0	0
Dian-jiang-bai-you	0	0	0	0	x ^z	x
Man-sai-long-you	2	0	0	0	x	x
Chandler	1	2	0	0	0	0
Wan-bai-you	2	2	2	2	0	x
Long-an-you	1	1	1	2	3	x
Ling-nan-sha-tian-you	1	2	2	2	3	0
Chang-shou-sha-tian-you	2	2	2	2	3	3
Liang-shan-you	1	2	3	4	0	0
Tong-xian-you	2	2	3	3	4	4
Nan-kang-zao-you	3	4	4	4	4	0
Tai-bei-you	2	3	3	4	x	x
Feng-huang-you	2	3	4	4	x	x
Bai-shi-you	2	3	3	4	4	x
Wu-bu-you	3	3	3	4	4	4
Yu-huan-you	2	4	4	4	4	x

^zPlant eliminated due to graft failure or damage.

3 yr. This indicates that Chandler is highly tolerant.

Effect on Chandler of SP-CTV from four different localities. Trial 6, when rated in 2001 (4 yr elapsed), showed no or little SP on Chandler shoots, indicating that Chandler was tolerant to the SP-CTV collected from the four localities sampled.

DISCUSSION

Based on symptom expression, 18 pummelo cultivars could be tentatively classified as tolerant, moderately susceptible, and highly susceptible to SP-CTV. Trial 1, and performance in the field, show that Cui-xiang-tian-you should be classified as susceptible.

Since most Chinese pummelo cultivars are susceptible to SP in the

field, other control measures such as mild-strain cross-protection should be studied. To develop SP-CTV tolerant pummelo cultivars for the control of pummelo dwarf is also recommended.

Pummelo is commonly used as rootstock for pummelos in China, and SP-tolerant cultivars of pummelo for rootstock use should also be selected.

This study has shown that Chandler pummelo is highly tolerant to SP-CTV, therefore top-working diseased pummelos with Chandler buds might overcome the pummelo dwarf problem to some extent.

ACKNOWLEDGMENTS

This research was funded by the Chinese Academy of Agricultural Sciences and the Ministry of Agriculture, P.R.China.

LITERATURE CITED

1. Su, H. J.
1981. A tristeza virus strain causing dwarf of pomelo and grapefruit. Proc. Int. Soc Citricult. 1: 423-426
2. Zhou Chang-yong, Zhao Xue-yuan, Jiang Yuan-hui, and Tang Ke-zhi
1996. Characterization of citrus tristeza virus isolates infecting pummelo and sweet orange in Sichuan Province, China. In: Proc. 13th Conf. IOCV, 78-82. IOCV, Riverside, CA.