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The Canker Damage on Yield of Pummelo (*Citrus maxima* (Burm.) Merr.) var. Tabtimsiam in Nakhon Si Thammarat Province, Thailand

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Canker is one the most severe disease of citrus all over the world. Pummelo (*Citrus maxima* (Burm.) Merr.) var. Tabtimsiam growing in Pak Panang, Nakhon Si Thammarat as well as all citrus was severe damaged by canker caused by *Xanthomonas axonopodis* pv *citri* especially on the fruits. This research was done to estimate severity and yield effecting from this disease by monitoring this disease on leaves and the mature fruits. The disease severity on leaves monitoring at orchard at 3-5 and 6-8-year age trees were significant different of 13.22 and 16.63 %but on fruits were not different of 18.92 and19.27 % respectively. While most of fruits appeared of canker symptom with incidence of both age trees were 78.58 and 86.29 % respectively. They were not significantly different between 3-5 and 6-8-year age trees. The disease severity of canker on fruit was non-effect on all fruit yield component included fruit weight, peeled weight, peel weight, peel thicken, diameter, solid sugar content and titratable acidity. However, the canker appearance reduced the domestic market price from 6.38 to 2.29 USD/fruit (63.88%) and they were not marketable quality accept for exporting.

Keywords: canker, yield component, severity, marketable

Introduction

Citrus canker was the seriously damage on citrus growing area all over the world. It originated in the area of Southeast Asia-India and spread to Japan, South and Central Africa, the Middle East, Bangladesh, the Pacific Islands, South and North America and Australia. Several citrus including Sweet oranges, Tangerines, Tangelos, Clementine, Orlando, Pummelo (*C. grandis*); Limes (*C.latifolia*) Tahiti lime, Palestine sweet lime; Trifoliate orange (*Poncirus trifoliata*);

Citranges/Citrumelos (*P.trifoliata* hybrids) were susceptible to canker disease (Gottwald *et al*, 2001; Brugnara *et al*, 2012). The pathogen,

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Xanthomonas. Axonopodis pv. *citri* favor warm weather and dispersed by splashed rain and wind. Even though several areas of the world have eradicated citrus canker, but the disease remains endemic in those areas. The rapid spread was high potential for damage, and impact on export sales and domestic trade, citrus canker is a significant threat to all citrus-growing regions (Gottwald *et al*, 2002; Spreen *et al*, 2003). Tabtimsiam Pummelo (*Citrus maxima* (Burm.) Merr.) growing in Pak Panang, Nakhon Si Thammarat is in the tropical monsoon with high precipitation of 2000-2500 mm/year and it had the rain every month. The Tabtimsiam pummelo growing in this area was seriously damaged by canker disease. The fruit was infected and symptom appeared due to highly decreasing marketing quality especially in appearance performance. This research objective was to study the effect of canker disease on yield component and marketing price.

Materials and methods

Canker disease severity on the Tabtimsiam pummel

Canker disease severity on leaves and mature fruits at Pak Panang, Nakhon Si Thammarat province was evaluated. The trees were category into 3-5 and 6-8-year age plant. Nine trees were sampled for each group to monitoring canker severity. Four main branches of each sampled plant from each direction (north, east, west, and south) of the canopy were evaluated severity. Disease severity score on leaf was modified based on Horsfall-Barratt (Bock *et al*, 2009) and James (1971) measurement scale for visual estimation. Disease severity was rated into 5 categories: 0, 5, 15, 25, and 50 % infection leaf area. Fruit canker severity on fruit was evaluated using visual estimation scale modified from Dom ńguez *et al* (2014). Fruit infection symptom was rated into 5 groups as well as leaf infected scale. Ten fruits from each sample plants were evaluated disease severity and percent of symptom appear fruit were counted for incidence calculation. Severity of canker between 3-5 and 6-8-year age plant compared analysis by Independent Two-Sample T-Test

Effect of canker disease on fruit component and marketing price

The highest severity infected fruits at the harvesting period (6.5 months) were taken to evaluate the effect to fruit yield component. Fruit weight, peeled weight, peel weight, peel thicken, fruit diameter, solid sugar content and titratable acidity. Damage of canker disease on marketing acceptance was

evaluated. Fruit yield component between symptom appear fruits and non-symptom appear fruits was compared by Independent Two-Sample T-Test. The harvesting period of Tabtimsiam pummelo was critically at 180-195 days after flowering. The fruits were weighting and/or sizing graded, and disease or insect damage appearance inspected, then price was evaluated. The pricing of different grades was collected from collectors to calculate and compare.

Results

Canker disease severity on the Tabtimsiam pummelo

Nine trees from 3-5 and 6-8-year age plant were sampled for each group to monitoring canker severity. The result showed that severity of canker on leaf of the older age plant was higher the young plant of 13.22 and 16.63 % respectively (Table 1). The severity on maturing fruit was not significantly different with disease severity on 3-5 and 6-8-year age plant of 18.92 and 19.27 % respectively. For the observation of fruit symptom appearance, it showed high disease incident high at 78.58 and 86.29 % respectively. It was not statistical significantly different.

Table 1. Comparison of canker disease severity and incidence on leaves and mature fruits at the harvesting period (6.5 months) between 3-5 and 6-8-year age plant

Canker disease severity and incidence	Age of tree	
	3-5- year (%)	6-8- year (%)
Leaf symptom	13.22[b]	16.63[a]
Fruit symptom	18.92	19.27
Fruit incidence	78.58	86.29

1/ = Severity significance difference analyzed by Independent Two-Sample T-Test at 0.05

Effect of canker disease on fruit yield component and marketing price

The effect of canker severity was evaluated from the highest severity infected fruits at the harvesting period (6.5 months). The result showed that all yield component of symptom appeared fruit and non-symptom appeared fruit was not significantly different. Yield component including fruit weight, peeled weight, peel weight, peel thicken, fruit diameter, circumference, solid sugar content and titratable acidity were 1,765.17 g, 1,348.73 g, 490.76 g, 1.53 cm, 17.70, 53.99 cm, 11.08 and 0.62 % respectively, while, non-symptom appeared

fruits were 1,837.55 g, 1,246.14 g, 591.41 g, 1.67 cm, 17.16, 53.18 cm, 11.11 (Brix) and 0.66 % respectively (Table 2).

Table 2. Fruit yield component: fruit weight, peeled weight, peel weight, peel thicken, fruit diameter, circumference, solid sugar content and titratable acidity.

Yield component 1/	**Symptom appear fruit**	**Non-symptom appear fruit**
Fruit weight (g)	1,765.17	1,837.55
Peeled weight (g)	1,348.73	1,246.14
Peel weight (g)	490.76	591.41
Peel thicken (cm)	1.53	1.67
Fruit diameter (cm)	17.70	17.16
Fruit circumference	53.99	53.18
Solid sugar content (Brix)	11.08	11.11
Titratable acidity (%)	0.62	0.66

1/ = All yield component significance difference analyzed by Independent Two-Sample T-Test at 0.05

Canker disease on fruit of Tabtimsia pummelo was affected both on exporting and domestic marketing. The fruit was category into three grades; Grade A (≥1,800g or≥42.75cm), Grade B (1600-1800g or 40.50-42.75cm), Grade C (1400-1600g or 38.25-40.5cm) (Table 3). The price of Grade A, B and C without canker symptom appearance was 7.14, 6.29 and 5.71 USD respectively (Table 3). At the same grade with canker symptom appearance was accept only in domestic market and the price of Grade A, B and C was reduced to 2.00, 1.71 and 1.71 USD respectively. It was reduced to 28.00, 27.27 and 30.00 %. While severity canker symptom fruit were not accepted for domestic consumer who bought whole fruit, but it was advantage for cut fruit marketing of the lowest price of 2.29 USD/fruit with 68.00, 63.64 and 60.00 % reducing price (Table 3).

Table 3 Effect of canker disease on price at the different grades of Tabtimsiam pummelo for both exporting and domestic market.

	Exporting market			Domestic market		
	Grade A	**Grade B**	**Grade C**	**Grade A**	**Grade B**	**Grade C**
Weight (g)	≥1,800	1600-1800	1400-1600	≥1,801	1600-1801	1400-1601
Fruit circumference	≥42.75	40.50-42.75	38.25-40.5	≥43.75	40.50-42.76	38.25-40.6
rice/fruit of non- canker symptom (USD)	7.14	6.29	5.71	7.14	6.29	5.71
Price/fruit of canker symptom (USD)	-	-	-	5.14	4.57	4.00
Reducing price/ fruit (USD)	-	-	-	2.00	1.71	1.71
Percentage reducing price/ fruit (%)	-	-	-	28.00	27.27	30.00
Server canker symptom price/fruit(USD)	-	-	-	2.29	2.29	2.29
Percentage reducing price/ fruit (%)	-	-	-	68.00	63.64	60.00

Discussion

Canker disease severity of canker monitoring on leaf and fruit from different age plant (3-5 and 6-8-year age plant) was high severity and incidence. One of involved factor was the seedling plant propagated by cutting / layering/ grafting from infected tree. Canker disease colonized and spreading since the one year age tree grow. We found that all trees appeared canker symptom. Pummelo is the susceptible plant as well as lime with high canker occurrence in Thailand. The secondary factor was high humidity from irrigation and monsoon. All farmers irrigated by sprinkle which gave high humidity and this area also received high humidity from monsoon. The precipitation was high at 2000-2500 mm a year with rainfall every month (Meteorological Department, 2003-2015). Bacterial *X. axonopodis* pv. *citri* causing agent of canker was favor by high temperature and humidity (Bock *et al*, 2005; Gottwald and Irey. 2007; Gottwald *et al*, 1997 and Pruvost *et al*, 2002). Citrus lefminer (*Phyllocnistis citrella*), serous insect pest of pummel also synergized canker severity was severe occurred in this area (Chagas *et al*, 2001). Canker disease symptom appear fruit was seriously dropping quality, since this cultivar, Tabtimsiam pummelo was premium product.The high price per fruit was reduced to 30.00 % in domestic market. While severity canker symptom fruit were not accepted for domestic consumer. It was bought for cut fruit with the lowest price of 2.29 USD/fruit with 68.00, 63.64 and 60.00 % reducing price

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