Occurrence of Concave Gum on Hyuganatsu (*Citrus tamurana*) in Japan

Hiroyuki Ieki and Takao Ito

ABSTRACT. Studies were conducted to determine the nature of the concave gum-like symptoms on Hyuganatsu (*Citrus tamurana*) in Kouchi and Shizuoka Prefectures, Japan. Based on field symptoms and indexing of affected trees by graft-transmission to Dweet tangor plants, the occurrence of concave gum disease was confirmed on Hyuganatsu.

Concave gum disease has been reported in sweet orange, mandarins and other citrus species in several citrus-producing countries (2, 3). The causal agent has not been isolated, but it is easily transmitted by grafting and topworking (3).

In Japan, symptoms resembling concave gum disease were first observed on Hyuganatsu (*Citrus tamurana*) in Kouchi, Miyazaki and Shizuoka Prefectures. These symptoms had already been reported in Kouchi Prefecture about 20 years ago and farmers designated the disease as "Baumkuchen" or brown annual ring-like disorder. The symptoms consist of gum exudation from the cross-section of twigs (Fig. 1-A) and the presence of concentric gum rings in cross-sections of large branches and subtrunks (Fig. 1-A and 1-B), gum exudation from bark cracking of trunks (Fig. 1-C), reduction of tree vigor, alternate bearing and finally tree death. These symptoms were particularly severe on 4-5 yr-old trees planted in plastic greenhouses (Fig. 1-D) and many trees died within 10 years. In Italy, D'Onghia, A.M. et al. (1) have also reported the occurrence of severe concave gum on Navelina orange.

Indexing for the causal agent. Hyuganatsu nursery plants, which harbored CTV but were healthy-appearing, were graft inoculated with tissue from Dweet tangor trees showing oak-leaf pattern (OLP) and interveinal leaf flecking (IVF) symptoms. Dweet tangor (Kouchi No. 1 and 2) was used as the indicator for concave gum. OLP and IVF symptoms (Fig. 1-E) were severely expressed on young developing leaves of Dweet tangor inoculated with the tissues of Hyuganatsu tree number 1 and 2 in Kouchi showing severe symptoms of concave gum disease. However, only the IVF symptom was observed by inoculation with the scions of seven other affected Hyuganatsu trees (Table 1). ELISA tests for citrus tristeza virus (CTV) and Satsuma dwarf virus (SDV) showed the presence of both in trees 1 and 2, but only CTV was detected in the other trees (Table 1).

Symptoms on Dweet tangor caused by SDV and CTV. Dweet tangor seedlings and Dweet tangor grafted on rough lemon seedlings were inoculated with SDV, CTV, or SDV and CTV together. Two isolates of SDV were used. One, SDV-KCG 2, originated from Kouchi tree No. 2, and the other, SDV-58, was isolated from a Satsuma mandarin showing typical Satsuma dwarf symptoms. CTV (KS3A), which was isolated from Satsuma mandarin (variety Kusumoto wase), was a severe seedling yellows strain. Symptoms similar to IVF appeared on young developing leaves inoculated with SDV, CTV, or SDV and CTV, respectively, while OLP symptoms did not appear. Therefore, the presence of IVF alone should not be considered a definite test for concave gum disease by indexing with Dweet tangor only.

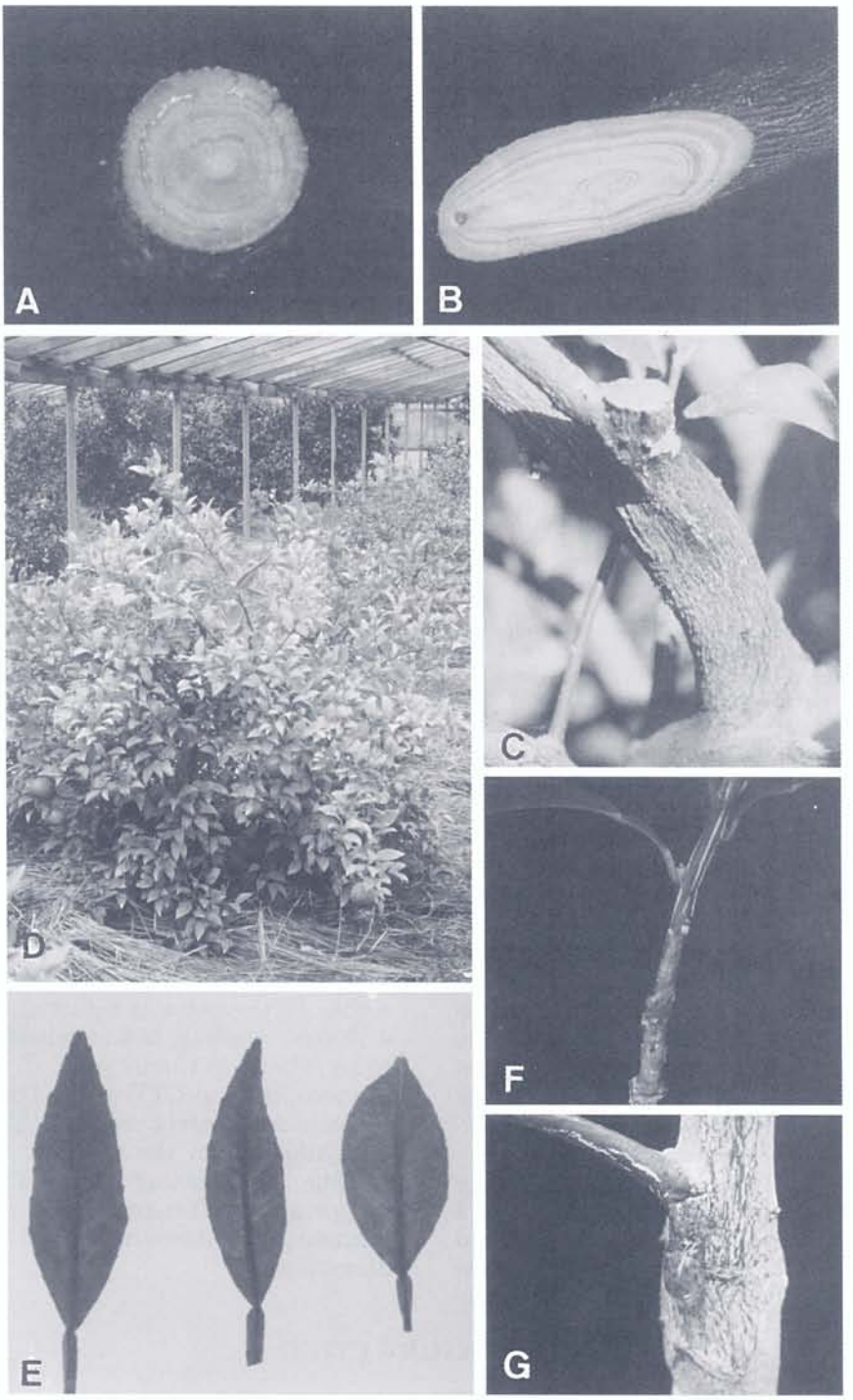

Fig. 1. Symptoms of Concave gum-like disease occurring on Hyuganatsu. A. Gum exudation from cross-section of twig. B. Concentric gum ring of sub-branch. C. Bark cracking of trunk. D. 4-5 yr-old trees damaged in plastic greenhouse. E. Oak-leaf pattern symptoms on Dweet tangor. F. Gum exudation on inoculated part of healthy Hyuganatsu 2-3 months after inoculation. G. Gum exudation on trunk of Hyuganatsu inoculated approximately 2 years previously.

TABLE 1
SYMPTOMS, INDEXING FOR SEVERAL VIRUSES AND GRAFT-TRANSMISSION ON HYUGANATSU (*CITRUS TAMURANA*) AFFECTED WITH CONCAVE GUM-LIKE DISEASE

Collection Site	Tree no.	Symptoms on Hyuganatsu in the field[z]	Indexing with Dweet tangor[y]	ELISA results		Gum exudation[x]	
				CTV	SDV	A	B
Kouchi	1	severe	OLP +++ IVF +++	+	+	+	+
Prefecture	2	very severe	OLP +++ IVF +++	+	+	+	+
	3	mild	IVF ++	+	-		+
	4	very mild	IVF +	+	-		-
	7	very severe	IVF +++	+	-		+
	8	severe	IVF ++	+	-		+
	9	moderate	IVF ++	+	-		+
	10	severe	IVF +++	+	-		+
	11	moderate	IVF +++	+	-		+
Shizuoka Prefecture	4	mild	IVF ++	+	-		+
Miyazaki Prefecture	2	mild	IVF ++	+	-		

[z]See the text.
[y]OLP = oak-leaf pattern. IVF = interveinal leaf flecking.
[x]A. Gum exudation on nursery plants of healthy Hyuganatsu inoculated with scion of Dweet tangor showing OLP and IVF symptoms. B. Gum exudation on nursery plants of healthy Hyuganatsu inoculated with the scion of Hyuganatsu affected with concave gum-like disease in the field.

Graft-transmission tests. Hyuganatsu nursery plants, which harbored CTV but were healthy-appearing, were graft-inoculated with tissue from Dweet tangor trees showing OLP and IVF symptoms (Kouchi No. 1 and 2) and kept at ca. 25°C in glasshouse, and 2~3 months after inoculation, gum exudation (Fig. 1-F) was observed on the inoculated part of healthy Hyuganatsu (Table 1, A). In another experiment (Table 1, B), nursery plants of healthy Hyuganatsu were also inoculated with scion tissue of Hyuganatsu showing severe symptoms in the field. After approximately 2 years, gum exudation was observed from bark cracking and the cross-section of branches far from the inoculum (Fig. 1-G). Therefore, it was confirmed that symptoms of gum exudation were graft-transmissible.

Concave gum disease in the field is manifested by three symptom types (3). However, one type, consisting of the presence of cavities in the trunk of sweet orange, mandarins or tangor, was not observed in Hyuganatsu. Hyuganatsu is referred to as a chance seedling, but is considered to be related to *Citrus yuzu*. *C. yuzu* is susceptible to CTV, while Hyuganatsu is moderately resistant. Based on symptoms in the field, and the results of indexing with Dweet tangor and graft-transmission tests, concave gum disease was eventually diagnosed.

LITERATURE CITED

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