

## Incidence of Severe Crown Gall Disease on Tetraploid Cultivars of Grape in Korea

Kwang-Hoon Park, Kyu-Sik Jeong and Jae-Soon Cha\*

Department of Agricultural Biology, Chungbuk National University, Chungbuk 361-763, Korea

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**The main grape producing regions in Korea were surveyed for the occurrence and relative incidence of crown gall disease on grapevine. The results of the survey showed that the disease tended to affect tetraploid cultivars, which produce a large and sweet fruit but are very weak to cold weather. Incidence of crown gall disease was high on the tetraploid cultivars, Kyoho (Gerbong), Daebong, and Black Olympia while it was low on the diploid cultivars, Cambell Early and Sheridan. The disease incidence was very high on Anseong, Cheonan, and Chincheon, where the major growing areas of tetraploid cultivars and grapevines were buried in the winter to protect from freeze injury, whereas it was low in Yungdong, Kimcheon, and Nonsan. Crown gall disease did not increase with grapevine age on both Cambell Early and Kyoho. It remained low in Cambell Early, but high for all ages on Kyoho. Galls were found on the crown region and mid part of the trunk, but more galls were on small branches and canes on Kyoho grapevines. More than one third of Kyoho grapevines inspected had galls on multiple locations on grapevines. On Kyoho, 56.3% of the galls covered more than 50% of the circumference of grapevines, which indicates that the crown gall disease affects severely on the cultivar.**

**Keywords :** crown gall disease, tetraploid cultivars, Kyoho, Korea, *Agrobacterium vitis*.

Crown gall is a serious disease plaguing grape crops in many grape-producing regions of the world. This disease reduces the yield and vigor of grapevine, especially on *V. vinifera* and interspecific hybrids where climatic conditions favor freeze injury (Schroth et al., 1988; Burr et al., 1998). The predominant pathogen causing the disease is *Agrobacterium vitis*, formerly known as *A. tumefaciens* biovar 3. It is well known that *A. vitis* can infect grapevines through root decay and stay dormant in grapevines without showing any symptoms until the grapevine is injured mechanically or by freezing, conditions which induce to form galls (Burr et al. 1998). Galls are formed not only on roots but also

more seriously on the aerial parts, often girdling the trunk and killing cold-sensitive cultivars (Burr et al., 1987; Bazzi et al., 1991; Chung & Shim, 1996).

Grape is the 4th common fruit crop in Korea, next to apple, tangerine, and persimmon in aspect of the cultivation area. The cultivation area of tetraploid cultivars, Kyoho (Geobong) and Black Olympia, has been increased in recent years because these tetraploid cultivars bear large and sweet fruits although Cambell Early is still the most widely growing cultivar of grapevine in Korea. The tetraploid cultivars are well known for susceptible to many diseases (Lee et al., 1996; Song & Ko, 1999). Although the rising incidence of crown gall disease on Kyoho grapevines have been recently recognized, detailed data concerning the crown gall disease of grapevine is still lacking. In this study, the occurrence and relative incidence of crown gall disease were surveyed in main areas of grapevine cultivation in Korea.

The aerial parts of individual grapevines on the vineyards of major grape production areas such as Anseong, Cheonan, Kimcheon, Nonsan, Okcheon, Yongdong, Chincheon, and Boeun, were inspected. Knowledge of the cultivar, vine age, and cultural practice were obtained by consulting the owner of the vineyard. Location of galls on grapevine and level of coverage by galls were checked in the selected Kyoho vineyards.

The disease incidence of crown gall was high on tetraploid cultivars while it was low on diploid cultivars (Table 1). The crown gall incidence of Kyoho (Gerbong), a major tetraploid cultivar in Korea, was 93.4% and those of Daebong and Black Olympia, other tetraploid cultivars, were 36.8% and 25.1% respectively. However, only 0.2% of Cambell Early and 0.3% of Sheridan, which are major diploid cultivars in Korea, had galls on vine. These results indicate that almost all of Kyoho grapevines were diseased with crown gall. A high disease incidence observed in Kyoho is believed to be closely related to cultivation practice. Kyoho is cultivated mostly on Anseong, Cheonan, and Chincheon where the vines were buried during the winter to protect from freeze injury. Burial of vines causes harmful injury to vines and subsequent injuries allow *A. vitis* to form galls. A previous study showed that tying and burial of vines in soil

\*Corresponding author.

Phone) +82-43-261-2554, FAX) +82-43-271-4414

E-mail) jscha@chungbuk.ac.kr

**Table 1.** Disease incidence of crown gall on major cultivars of grapevine

	Tetraploid cultivars			Diploid cultivars	
	Kyoho	Black Olympia	Daebong	Cambell Early	Sheridan
Grapevines inspected <sup>a</sup>	13316	410	1144	16129	5110
Grapevines diseased <sup>b</sup>	12432	103	421	38	13
Disease incidence (%)	93.4	25.1	36.8	0.2	0.3

<sup>a</sup>The number of grapevines inspected<sup>b</sup>The number of grapevines having gall**Table 2.** Disease incidence of crown gall in main areas of grapevine cultivation

Areas	Anseong	Cheonan	Kimcheon	Nonsan	Okcheon	Yungdong	Chincheon	Boeun
Grapevines inspected <sup>a</sup>	7945	5426	4817	1692	1085	13816	1089	239
Grapevines diseased <sup>b</sup>	6835	5120	16	2	116	10	898	10
Disease incidence (%)	86.1	93.9	0.3	0.1	10.7	0.1	82.5	4.2

<sup>a</sup>The number of grapevines inspected<sup>b</sup>The number of grapevines having gall

during the winter induced the highest rate of crown gall incidence among heat conservation treatments (Nam et al., 1998).

The disease incidence of Black Olympia suggests that tetraploid cultivars are far more susceptible to diploid cultivars for crown gall disease. The vineyard of Black Olympia investigated in this study was on Okcheon where the vines were not buried during the winter. Twenty-five percent of Black Olympia had galls on vines while only 0.2% of Campbell Early had galls (Table 1).

The disease severity was high in Anseong, Cheonan, Chincheon while it was low in Kimcheon, Nonsan, Yungdong (Table 2). We speculate two reasons for the high disease incidence in the Anseong, Cheonan, and Chincheon area. One, they are major cultivation areas for tetraploid cultivars and the other reason is that vines were buried during the winter to protect from freeze injury in those areas.

The disease incidence did not vary greatly relative to grapevine age on both Cambell Early and Kyoho (Table 3, 4). It remained low in Cambell Early, but was high in Kyoho for all ages. Eight three percent of four-year-old Kyoho already had galls on vines. Such a high disease incidence on young grapevines suggests that a pathogen was carried over inside of new seedlings and physical injuries

**Table 3.** Disease incidence of crown gall on Cambell Early

Grapevine age (yr)	4	5	6	8	10	12
Grapevines inspected <sup>a</sup>	3163	2907	7742	1042	490	785
Grapevines diseased <sup>b</sup>	0	15	7	0	5	11
Disease incidence (%)	0	0.5	0.1	0	1.0	1.4

<sup>a</sup>The number of grapevines inspected<sup>b</sup>The number of grapevines having gall**Table 4.** Disease incidence of crown gall on Kyoho

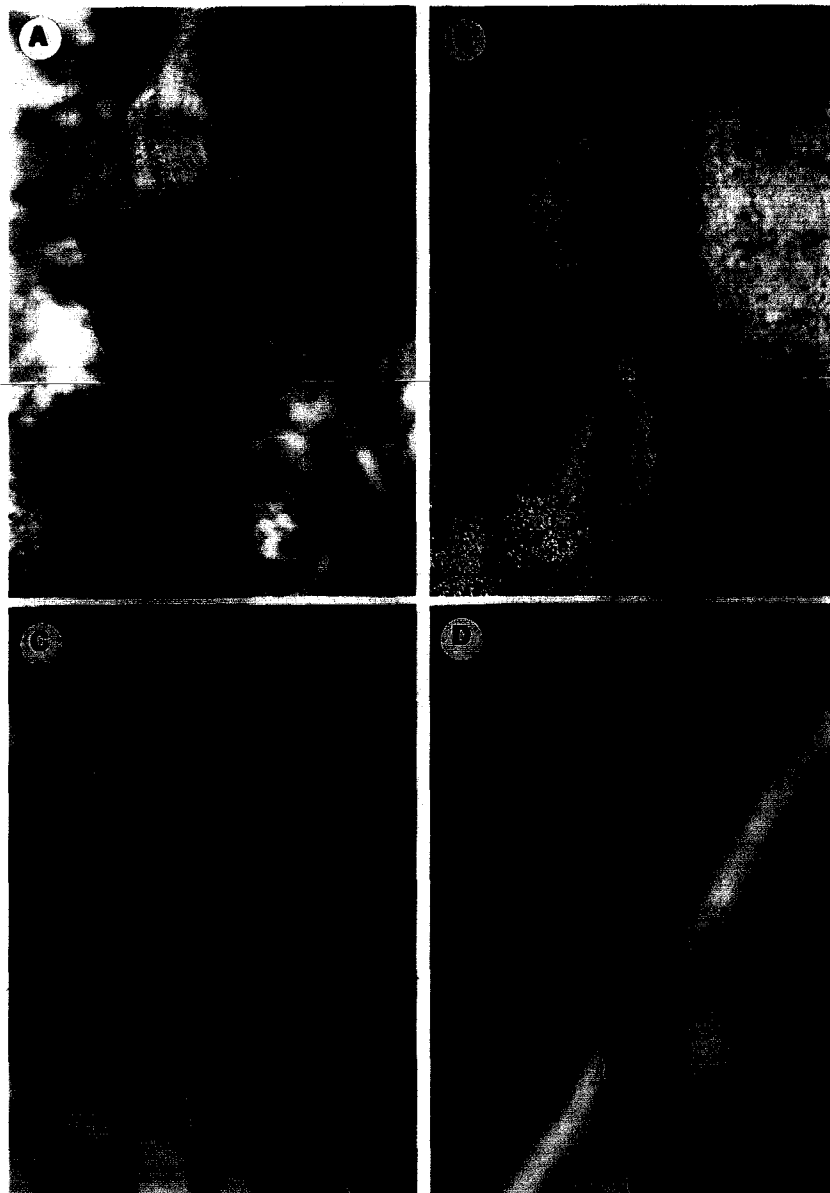
Grapevine age (yr)	4	5	6	7	8	10	12
Grapevines inspected <sup>a</sup>	1142	4228	4515	970	2039	190	232
Grapevines diseased <sup>b</sup>	954	3972	4275	858	1964	173	206
Disease incidence (%)	83.5	94.0	94.7	93.3	96.3	91.1	88.8

<sup>a</sup>The number of grapevines inspected<sup>b</sup>The number of grapevines having gall

during the burial of grapevines induced the formation of galls. It is well known that *A. vitis* can endophytically colonize the plant xylem without showing any visible disease symptoms and injuries inside the vascular system or outside of the trunk allow this pathogen to induce galls on vines (Burr et al., 1987, 1998; Bazzi et al., 1991). Additionally, it was frequently observed that many galls were initially formed inside of twisted vine and were pushed to the outside (Figure 1C, D). Galls were often found on the pruning ends of cane as well.

Various sizes and shapes of galls were observed on different parts of the grapevine on Kyoho (Figure 1). Galls were not only on the crown region of the trunk but additional galls were also found on small branches and canes (Table 5). Thirty four percent of inspected grapevine of Kyoho had galls on 2 or 3 locations.

The assessment of the level of damage caused by crown gall on grapevines often vary since a single small gall is not believed to significantly weaken the grapevine and even some growers practice cutting around the trunk for early maturation and to increase sweetness of the fruit. However, Schroth et al. (1988) concluded based on 3 years study that galls covering more than 50% of the circumference of the grapevine weaken the trunk or branch having the galls and



**Fig. 1.** Galls were on different parts of the Kyoho grapevines: on the crown region of the trunk (A), on the mid part of the trunk (B), and on small branches and canes (C, D).

result in great economic loss of grapevines. On average, 56.3% of galls observed on Kyoho cover more than 50% of the circumference of the vine, which indicates crown gall disease is a serious problem on the cultivar.

Results of this study indicate that crown gall disease is very severe on tetraploid cultivars, especially on Kyoho in Anseong, Cheonan, and Chincheon, where are the major cultivation areas for tetraploid cultivars. Although the disease caused serious damage, control measures were not practiced in the areas. Growers usually changed diseased grapevines with new seedlings that were produced without paying particular attention to possible contamination of

pathogens inside the seedlings. We believe that replacement of the diseased grapevines with new seedlings increases the incidence of crown gall disease and disease severity of crown gall continue to raise every year.

It is well known that crown gall disease of grapevines is a difficult disease to control (Burr et al., 1988). Furthermore, the severeness of the disease on tetraploid cultivars found in Anseong, Cheonan, and Chincheon urge the regular use of control measures of the disease, such as the use of pathogen-free seedlings, the practice of proper heat conservation rather than burial of vines in the winter, and the application of chemicals inhibiting gall formation to vine. The breeding

**Table 5.** Locations and percentage of galls covering more than a 50% circumference of Kyoho grapevines

	Locations			
	Crown region of trunk	Mid part of trunk	Small branch	Multiple locations <sup>c</sup>
Number of grapevines having gall <sup>a</sup>	417	400	553	364
Disease incidence (%) <sup>b</sup>	39.2	37.6	51.9	34.2
Rate (%) of galls covering more than 50% of circumference	67.8	51.6	49.6	—

<sup>a</sup> The number of grapevines having gall among 1065 grapevines inspected

<sup>b</sup> Percentage of grapevines having gall on the location

<sup>c</sup> Grapevines having galls on 2 or 3 locations

of tetraploid cultivars resistant against crown gall disease is believed to be the best method in preventing the disease.

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