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Ten Years Examination in the Primary Screening Test in a Project for Selecting Japanese Cedar Resistant to *Semanotus japonicus* (Coleoptera: Cerambycidae) conducted in Kanto Breeding Region

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Summary: A primary screening test was conducted for ten years on 200 *Cryptomeria japonica* clones that were selected from the Kanto Breeding Region by the pin pricking test as candidates for resistance to the bark borer, *Semanotus japonicus*. The mean height and diameter at breast height of trees tested each year varied greatly among years. Significant correlation was observed between these values and the mean number of larvae entering the bark and entering the wood and the number of emerging adults per tree each year, confirming the previous finding that female adults prefer to lay eggs on large trees. However, there was no correlation between the dimensional values of tested trees and larval survivorships, either from entering bark to entering wood or from entering bark to adult emergence. Fourteen clones showed 0% larval survivorship from entering bark to entering wood and 32 clones showed 0% larval survivorship from entering bark to adult emergence. Since the result of the primary screening test seems to be reliable for identifying resistant *C. japonica* trees to *S. japonicus*, it is expected that there exist resistant clones among the candidates collected in the Kanto Breeding region.

1 Introduction

Since the 1960s, *Semanotus japonicus* Lacordaire has been recognized as one of the most serious wood-boring insect pests of Japanese cedar (*Cryptomeria japonica* D. Don) plantations in Japan (Kobayashi 1985). Many researchers noticed considerable variation in the proportion of S. *japonicus* damage among C. *japonica* cultivars (Kishi et al. 1973; Kawarai and Kitazawa 1974). These observations strongly suggest that there exist in the field C. *japonica* trees that are highly resistant to *S. japonicus*.

Under the leadership of the Forestry Agency Japan, a project to select *C. japonica* resistant to *S. japonicus* began in 1985. Forest Tree Breeding Center, the Regional Forest Offices, and ca. 80% of the prefectures on Honshu and Shikoku Islands participated in the project. The selection procedure consisted of four steps (Ueki 1999). In the first step, trees that had suffered no injures from *S. japonicus* were selected from heavily infested stands. In the second step, these trees were checked their responsiveness to mechanical wounds by pricking with a pin. Rapid formation of traumatic resin ducts and secretion of resin were the screening criterion because resin exuded by *S. japonicus* was important as a host resistance to larval feeding by *S. japonicus* (Kobayashi 1982; Shibata 1987). As the third step, a primary screening test was conducted in cages in

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which trees were transplanted and *S. japonicus* adults were released. Low larval survivorship of *S. japonicus* was the screening criterion because the larvae caused no economic damage when they died before entering wood. The last step was a secondary screening test, in which newly hatched larvae were inoculated on the outer bark of each tree.

From the second step of the above procedure, a total of 222 individual trees were selected as candidates in Kanto Breeding Region. For 200 of these trees, the primary screening test was conducted from 1991 through 2000. Here, we report the summary of the primary screening test (i.e., performance of trees in cages) and compare the results with other breeding region.

2 Materials and methods

2.1 Study area

The primary screening test was carried out at Mito city, Ibaraki Prefecture, Japan (30 m above sea level; 36°20' N, 140°27' E) from 1991 to 1995 and at Juo town, Ibaraki Prefecture, Japan (50 m above sea level; 36°41' N, 140°44' E) from 1996 to 2000. Annual mean temperature and mean precipitation from 1991 to 1995 at Mito were 13.8℃ and 1,184 mm from 1996 to 2000 at Juo were 14.0℃ and 1,404 mm.

2.2 Insect phenology

S. japonicus adults emerge in spring and mate on the surface of the trunk soon thereafter; and the females lay their eggs in bark crevices. Newly hatched larvae enter the bark and feed in the cambial region, primarily on inner bark (Kobayashi 1985). The larvae molt three times. Full-grown larvae enter the wood in late summer, pupate in cells in autumn, and overwinter as adults.

2.3 Investigation method

In each study area, six nylon net cages (6.3 m long × 4.0 m broad × 5.0 m height) were established in the field. Five- to ten-year old *C. japonica* trees propagated from cuttings or graftings were transplanted to the cages at least one year prior to the test (i.e., in autumn two years before or in spring one year before the test). Fourteen to 30 clones were tested each year (Table 1); three sample trees per clone were planted although some died before the test for unknown reasons. Seven of the 200 candidate clones were tested two years, while other clones were tested only one year. Each year, only three of the cages were used while the other three were planted with new clones. In addition to the candidate trees, native cultivars such as *Bokasugi* (known to be highly resistant to *S. japonicus*) or *Kumotoshi* were also planted in the cage as controls. Planting methods followed 'The first guidelines for resistant tree

Table 1. Number of sample trees planted, number of clones tested, mean tree height (m) and mean diameter at breast height (DBH) (cm) in each year for the primary screening test

Year	Number of sample trees	Number of clones	Tree height (mean ±SD)	DBH (mean ±SD)
1991	41	14(11)	4.21±0.84	5.27±1.13
1992	87	29(26)	2.47±0.57	2.17±1.09
1993	60	20(18)	3.15±0.57	3.51±0.76
1994	60	20(18)	3.28±0.33	3.46±0.61
1995	59	20(18)	3.61±0.46	3.78±0.56
1996	90	30(29)	3.43±0.42	3.96±0.98
1997	90	30(28)	4.06±0.53	5.17±0.96
1998	75	25(19)	3.58±0.52	4.85±1.05
1999	69	25(23)	3.91±0.55	5.28±1.15
2000	63	21(19)	3.53±0.67	4.92±1.14

( ): Number of candidate clones

breeding to *S. japonicus*' (Forestry Agency 1988).

S. japonicus adults used for the release were collected from Omi seed orchard located 60 km southwest from Juo town using the band trapping method (Shibata 1983). In mid- or late April of each year, *S. japonicus* adults that had already mated were released in the cages at the rate of one pair of adults per two trees. Each October, when *S. japonicus* had almost grown to the adult stage, all sample trees were cut down and their height and diameter at breast height (DBH) were measured. The number of larvae entering the bark and entering the wood, and the number of emerging adults in each sample tree was counted by peeling the bark with a knife.

2.4 Larval survivorship

Larval survivorship from entering bark to entering wood was calculated by dividing the number of larvae entering wood by the number of larvae entering bark in each tree or in each clone. Larval survivorship from entering bark to adult emergence was also calculated by dividing the number of emerging adults by the number of larvae entering bark in each tree or in each clone. Statistical analyses for all survivorship data were made after the original data were arcsine-transformed. Clones for which no larvae entered bark were excluded from later analysis because larval survivorship could not be calculated.

3 Results

The number of sample trees and tested clones per year ranged from 41 to 90 and 14 to 30, respectively (Table 1). In the test of 2000, seven trees died in summer because of heavy damage by *S. japonicus*. Those trees were also excluded from data because it was impossible to count the number of larvae entering bark. The mean tree height and DBH varied greatly among the years, ranging from 2.47 to 4.21 m and 2.17 to 5.28 cm, respectively (ANOVA; $F= 55.43$ and 57.58; df= 9; $P< 0.001$).

The mean number of larvae entering the bark and entering the wood and the number of emerging adults per tree each year also varied greatly, ranging from 2.5 to 14.6, 0.9 to 7.2 and 0.3 to 6.1, respectively (ANOVA; $F= 17.45$, 12.02 and 10.42; df= 9; $P< 0.001$) (Table 2). Significant correlations were observed among the years between all the three values and the mean tree height and DBH in each year ($r = 0.67$ and 0.81, 0.79 and 0.84, and 0.71 and 0.80, $P< 0.05$). In all, there were six clones for which no larvae entered bark (three clones in 1992, one clone in 1993, and two clones in 1994).

Table 2. Mean number of larvae entering bark and entering wood and number of emerging adults per tree in each year

Year	Number of larvae entering or emerging adults (mean±SD)		
	Entering bark	Entering wood	Emerging
1991	7.1±8.3	4.4±5.0	2.7±4.4
1992	2.9±3.7	0.9±1.4	0.3±0.7
1993	2.5±2.5	1.1±2.2	0.9±1.6
1994	2.7±2.9	2.1±3.0	1.9±2.9
1995	6.8±5.8	1.8±2.2	0.8±1.4
1996	6.5±4.1	3.7±2.5	2.8±2.5
1997	10.6±8.1	7.2±6.4	6.1±6.2
1998	11.8±10.3	3.4±3.9	2.6±3.5
1999	14.6±8.2	6.2±6.1	4.2±5.2
2000	8.6±8.3	4.0±6.5	3.6±6.5

Mean larval survivorships from entering bark to entering wood and to adult emergence per tree in each year also varied greatly, ranging from 21.6 to 67.9% and 8.2 to 53.8%, respectively (Table 3)

Table 3. Mean larval survivorship from entering bark to entering wood or to adult emergence

Year	Larval survivorship ((%)±SD)	
	Entering wood	Adult emergence
1991	66.7±31.8	40.4±38.3
1992	37.7±35.1	11.9±23.1
1993	45.8±44.8	35.6±40.1
1994	57.6±48.0	48.6±47.9
1995	21.6±25.3	8.2±12.4
1996	59.1±32.2	40.9±36.0
1997	67.9±33.0	53.8±34.9
1998	36.9±30.5	27.4±27.6
1999	40.7±22.5	25.9±21.5
2000	36.3±32.9	32.6±32.4

(ANOVA; F= 12.56 and 12.33; df= 581; P< 0.001). The correlation of the two survivorships was significant for each year (r = 0.88, P < 0.01), suggesting that some years were better for larvae than others. However, neither of the mean larval survivorships was correlated with the mean tree height, DBH, number of larvae entering bark, entering wood and number of emerging adults per tree for each year (r = 0.39 and 0.31, 0.48 and 0.47, -0.04 and 0.07, 0.49 and 0.53 and 0.49 and 0.61, P> 0.05).

Figure 1 shows the frequency distribution in the number of clones per year that hosted the mean larval survivorship from entering bark to entering wood, grouped into 6 classes. The frequency distribution showed heap shape except for the years 1994 and 1997. Clones showing 0% survivorship appeared on seven of the ten years, totaling 19 of 234 clones (8.1%). Among candidate clones, 14 of 200 clones (7.0%) showed 0% survivorship.

Figure 2 shows the frequency distribution in the number of clones per year that hosted the mean larval survivorship from entering bark to adult emergence, grouped into 6 classes. As with Fig. 1, the frequency distribution showed a heap shape except for the years 1992, 1994, and 1997. Clones showing 0% survivorship increased two times compared with the survivorship in Fig. 1, totaling 39 of 234 clones (16.7%). Among candidate clones, 32 of 200 clones (16.0%) showed 0% survivorship.

4 Discussion

It has been reported that *S. japonicus* female adults tend to attack logs with larger diameters (Ito 1985; Shibata et al. 1994). A similar result was obtained in this study; fewer number of *S. japonicus* entered bark in the years with low average tree height and DBH (Tables 1 and 2). However, neither of the two mean larval survivorships was correlated with the mean tree height and DBH of the same year (Table 3); thus, there existed clones that showed 0% survivorship (7 and 16%, respectively) irrespective of tree size (Figs. 1 and 2). Shibata et al. (1994) also reported that there was no correlation between tree size and larval survivorship.

Regarding larval survivorship from entering bark to entering wood and to adult emergence, Kato (1997) reported from the results at Kansai Breeding Office that there were two (about 1%) and 24 candidate clones (13%) that showed 0%, respectively; these percentages are lower than those obtained in this study. On the other hand, Ueki et al. (2000) reported from the results at San-in and Shikoku Branches that 14 (5%) and 19 (22%) candidate clones showed 0%

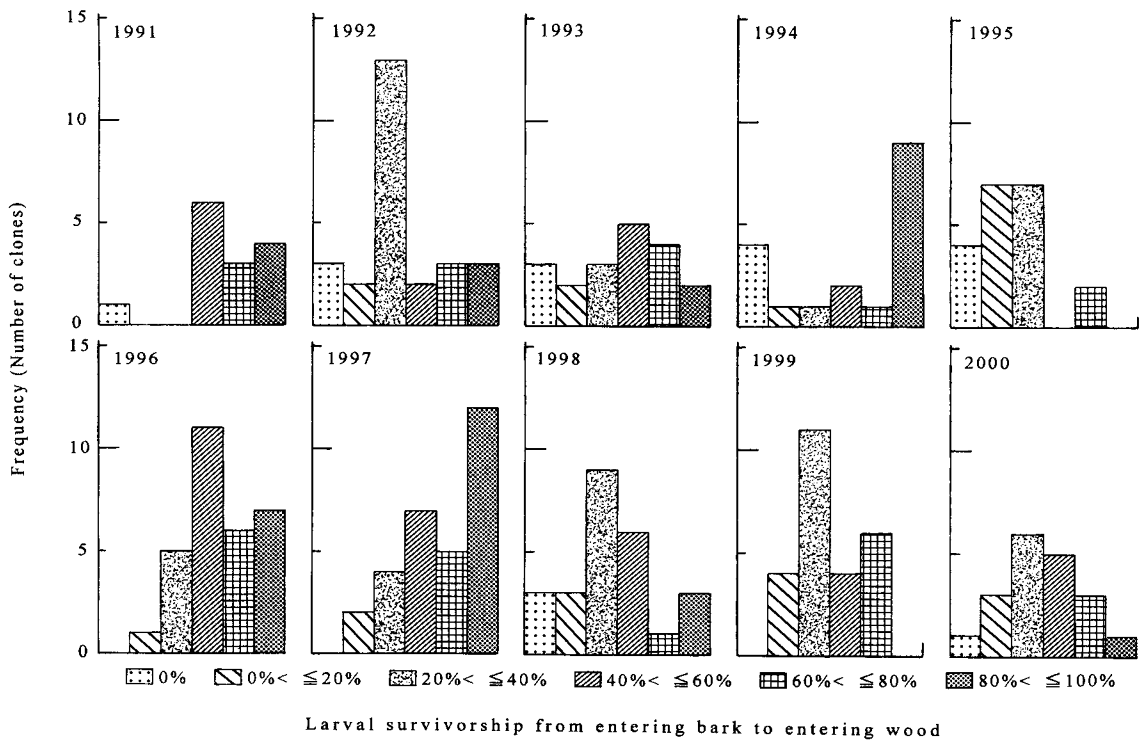

Fig. 1 Frequency distribution in the number of clones per year that hosts the mean larval survivorship from entering bark to entering wood, grouped into 6 classes.

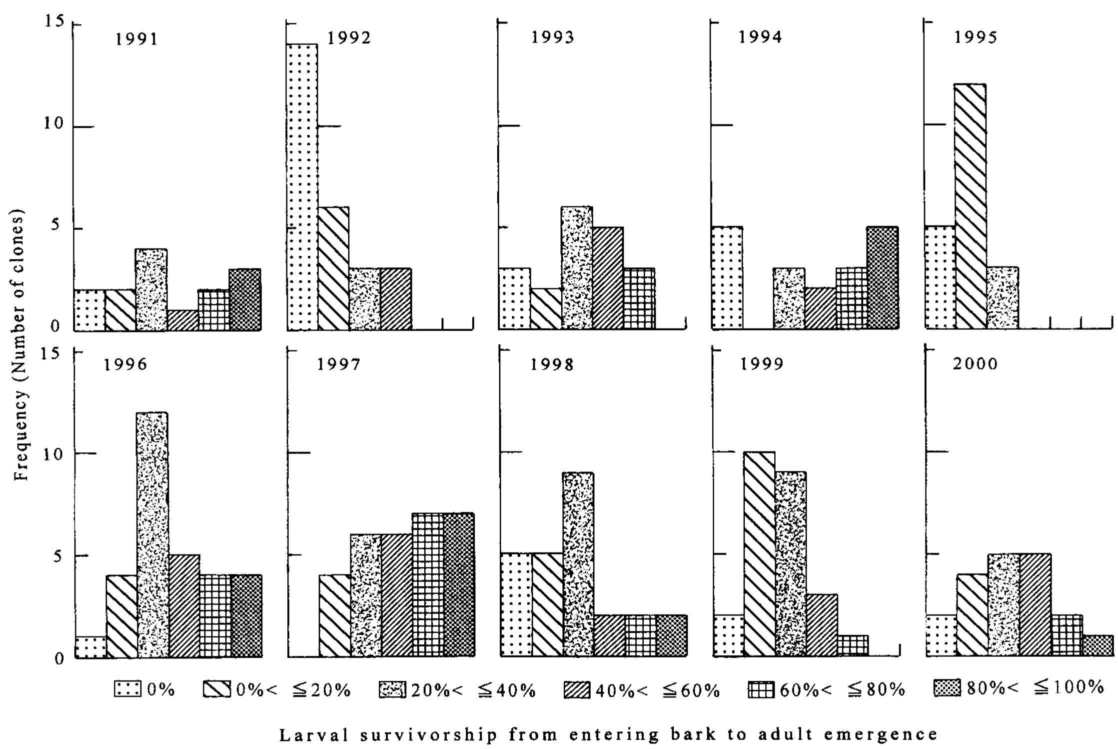

Fig. 2 Frequency distribution in the number of clones per year that hosts the mean larval survivorship from entering bark to adult emergence, grouped into 6 classes.

larval survivorship from entering bark to entering wood and that 85 (28%) and 19 (22%) showed 0% larval survivorship from entering bark to adult emergence; these percentages are higher than those obtained in this study. Overall, these results suggest that the larval survivorship varied greatly among the study sites.

S. japonicus larval survivorship is influenced by many abiotic and biotic factors; among abiotic factors, precipitation in spring and altitude are known to be important (Hagiwara and Ogawa 1970; Tokumoto 1972). The screening test sites above mentioned differed greatly in those conditions. For example, the altitude is 150 m at Kansai Regional Breeding Office and 400 m at Sanin Branch, while Shikoku Branch is the same altitude as our study site. Also, the precipitation from March to April was over 300 mm at Sanin and Shikoku Branch, whereas it was almost 200 mm at Kansai Regional Breeding Office and at this study site.

As a biotic factor, female adult size may be important, because larval survivorship from entering bark to adult emergence is greater for progeny of heavier parent females than for lighter parent females (Kato et al. 2000). Furthermore, it is also reported that tree vigor is an important factor (Kato and Kawamura 1993; Ito 1999). Since in the primary screening test the trees were densely planted (planting interval was 90- 180 cm) and the period from the planting of the trees in the cage to the release of *S. japonicus* adults was short (only one year), it is likely that the sample trees were more stressed than they would be in the field.

Therefore, many factors were likely to affect the difference in the larval survivorship among primary screening sites and years. This suggests that some of the clones that did not show 0% survivorship from entering bark to entering wood or to adult emergence may be highly resistant under more favorable conditions. On the other hand, Kato (1998) and Ueki and Kato (2000) reported that there was a significant correlation on the larval survivorship in each clone between the primary and secondary screening test (i.e., the third and fourth steps of screening). The result of the primary screening test, therefore, seems to be ultimately reliable for identifying resistant *C. japonica* trees to *S. japonicus*.

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Appendix Mean tree height, mean diameter at breast height, mean number of larvae entering bark, mean number of larvae entering wood and mean number of emerging adults in each candidate clone

Clone	Year	Tree height (Mean)	Diameter at breast height	Number of larvae entering bark (Mean)	Number of larvae entering wood (Mean)	Number of emerging adults (Mean)
Bokasugi	1991	4.7	5.4	0.3	0	0
Minamitama 5	1991	1.3	0.3	0.5	0.5	0.5
Higashisirakawa 3	1991	4	4.3	1.3	0.6	0.3
Umeda 1	1991	3.6	3.8	2	2	2
Ibaraki 7	1991	4.5	5.1	4.3	2	2
ibaraki 14	1991	4.7	5.1	3	2.3	0
Ibaraki 12	1991	3.7	4.8	4	3.6	3.3
Ibi 1	1991	4.2	5.4	4.7	3.7	1.7
Otsuki 1	1991	3.6	4.2	8.7	5	3
Ishikawa-sho 2	1991	4.3	5.6	13.7	5.7	3.7
Kumotoshi	1991	4.8	5.5	8	6	5
Ibaraki 6	1991	4.7	5.2	13.7	6	1.3
Sanbusugi	1991	4.7	6.8	17.3	8	1.7
Minamishitara 1	1991	4.7	6.1	15.7	15	12
Ibaraki 22	1992	2.1	1.4	0	0	0
Ibaraki 24	1992	2.2	1.6	0	0	0
Chiba 19	1992	2.4	1.8	0	0	0
Honsugi	1992	1.8	0.9	0.7	0	0
Ibaraki 27	1992	1.8	1.2	1	0	0
Chiba 1	1992	2.4	2	2.3	0	0
Chiba 10	1992	2.4	2.2	1	0.3	0.3
Ibaraki 26	1992	2.7	2.2	2.3	0.3	0
Ibaraki 18	1992	2.2	1.7	0.7	0.7	0
Ibaraki 8	1992	2.5	1.9	0.7	0.7	0
Chiba 7	1992	2.8	2.9	0.7	0.7	0
Ibaraki 19	1992	1.9	1	1.7	0.6	0.3
Ibaraki 28	1992	1.9	1	1.7	0.7	0
Chiba 16	1992	2.5	2.3	1.7	0.7	0
Ibaraki 23	1992	1.7	3	2	0.6	0.3
Chiba 14	1992	2.3	1.6	2.3	0.7	0
Chiba 5	1992	1.9	1.5	1.3	1	0.7
Chiba 3	1992	3.1	2.9	1.7	1	1
Chiba 12	1992	2.6	2.5	3.3	1	0.3
Nukata 3	1992	2.1	1.3	3.7	1	1
Chiba 18	1992	3.1	3.2	6	1.3	0
Chiba 11	1992	2.3	1.8	2.3	1.7	1
Chiba 9	1992	3.2	3.4	10.7	1.7	0.7
Bokasugi	1992	3.1	2.9	3.3	1.7	0
Chiba 17	1992	2.4	2.3	5	2	0
Chiba 8	1992	3.2	3.4	7	2	0
Ibaraki 20	1992	2.4	1.3	3.3	2.4	0.7
Kumotoshi	1992	3.8	3.8	10.7	2.7	2.7
Chiba 13	1992	2.7	2.6	11.7	4.6	4.3
Ibaraki 38	1993	3.3	3.7	0	0	0
Ibaraki 2	1993	4.1	4.5	1	0	0
Ibaraki 33	1993	3.8	3.4	1.3	0	0
Bokasugi	1993	2	1.6	2.3	0	0
Ibaraki 3	1993	2.8	3.6	0.7	0.3	0.3
Chiba 6	1993	3.4	3.7	0.7	0.3	0.3
Ibaraki 15	1993	2.2	3	1	0.3	0.3
Ibaraki 13	1993	3.4	3.5	1.7	0.3	0.3
Chiba 4	1993	3.2	3.8	5	0.3	0.3
Ibaraki 12	1993	3.3	4	1	0.6	0.3
Ibaraki 5	1993	3	3	1.3	0.6	0.3

Kamitsuga 12	1993	3.6	3.6	1.7	0.7	0.7
Chiba 20	1993	2.8	2.9	2	1	1
Sanbusugi	1993	3.2	3.9	4.7	1	1
Ibaraki 4	1993	4	4.8	1.3	1.3	1
Ibaraki 10	1993	4	4.9	3	1.3	1
Ibaraki 9	1993	2.7	3.3	2.7	2	1.7
Ibaraki 32	1993	2.8	3.3	3	2	1.7
Ibaraki 1	1993	2.9	3.4	6.3	4.6	4.3
Ibaraki 16	1993	3.1	4	5.7	5.3	3.3
Ibaraki 31	1994	3.6	3.8	0	0	0
Ibaraki 41	1994	3.2	3.4	0	0	0
Ibaraki 39	1994	3.5	3.8	0.7	0	0
Ibaraki 29	1994	3.4	3.9	1	0	0
Chiba 15	1994	3.4	3.1	1	0	0
Ibaraki 35	1994	3.2	2.9	2	0	0
Bokasugi	1994	2.8	2.7	2	0.3	0.3
Ibaraki 40	1994	3.4	3.2	1.3	0.7	0.7
Kumotoshi	1994	2.9	2.6	1	1	1
Ibaraki 21	1994	3.3	3.9	1	1	1
Ibaraki 17	1994	2.5	3.2	1.3	1.3	1.3
Ibaraki 25	1994	3.3	3.6	2.3	1.3	1.3
Kasama-tsukuba 20	1994	3.2	3.3	2	1.7	0.7
Shirakawa-sumito 1	1994	3.5	3.5	2.3	1.7	1.7
Kasama-tsukuba 24	1994	3.2	3.3	2	2	1.3
Kasama-tsukuba 9	1994	3	3	3.3	2	1.3
Ibaraki 37	1994	3.4	4.2	3.3	3.3	1.7
Izu 11	1994	3	2.8	5.3	5	4.7
Gifu 17	1994	3.3	4	6	5	4.7
Gifu 24	1994	3.7	4.6	7	7	6.7
Gifu 1	1995	3.2	3.6	2	0	0
Nishikawa 3	1995	3.6	3.7	2.7	0	0
Tochigi 5	1995	4.5	4.1	2.7	0	0
Shirakawa-sumito 2	1995	3.4	3.6	1	0	0
Bokasugi	1995	3.1	3.3	3	0.7	0.7
Gifu 14	1995	3.9	4.2	5	0.6	0.3
Kasama-tsukuba 14	1995	3.4	3.6	9.3	1.3	0.3
Gifu 18	1995	3.6	4	8.7	1.4	0.7
Tochigi 4	1995	3.8	3.6	10.7	1.3	0
Iiyama 1	1995	3.1	3.4	7	1.5	0.5
Kasama-tsukuba 4	1995	4.1	4	9.3	1.7	0.7
Gifu 7	1995	3	3.2	6	1.6	0.3
Tochigi 1	1995	4	3.8	9.3	1.6	0.3
Tochigi 6	1995	3.5	3.3	6.7	1.7	0.7
Tochigi 7	1995	3.9	3.9	10.7	2	0.7
Tochigi 3	1995	3.7	3.7	4.3	2.7	0.7
Kasama-tsukuba 23	1995	3	3	3.7	2.7	1
Sanbusugi	1995	3.8	4.2	12	3.4	1.7
Gifu 21	1995	3.8	4.6	12	3.3	1
Gifu 20	1995	3.8	4.6	12	4.4	2.7
Aichi 16-4	1996	3.4	4.3	0.7	0.7	0.7
Tochigi 8	1996	3.6	5.1	6.3	1	0
Aichi 16-3	1996	3.6	3.9	4	1.6	1.3
Aichi 16-5	1996	3.5	4.2	3.3	1.6	1.3
Aichi 7-6	1996	3.2	4	3	1.7	0.7
Aichi 12-2	1996	3.8	4.5	6.3	2	1.3
Aichi 15-6	1996	3.4	4.1	5	2	1.7
Aichi 8-6	1996	3.3	3.9	3.7	2	1.3
Aichi 12-6	1996	3.2	3.6	4	2.3	1.3
Ibaraki 11	1996	4.6	5.4	7.7	2.3	1.3
Aichi 20-3	1996	3.1	3.5	3.7	2.7	2

Kasama-tsukuba-21	1996	3	3.6	10	2.7	0.7
Aichi 6-3	1996	3	3.5	7.3	3	1.7
Kasama-mashiko 19	1996	3	3.7	6.3	3	1.3
Kasama-mashiko 6	1996	3.2	3.3	4	3	2
Tochigi 2	1996	3.7	3.6	6.7	3	1.7
Shirakawa-sumito 3	1996	3.7	4.1	6	3	1
Gifu 19	1996	3.1	3.7	4.7	3.3	2.7
Aichi 5-3	1996	3.8	4.5	10.3	3.3	3.3
Yabukuguri	1996	3.5	4.2	5.3	4	3.7
Aichi 10-1	1996	3.4	3.5	4	4	1.7
Aichi 2-4	1996	3.4	4.2	9	4	1.3
Aichi 6-1	1996	2.8	3.3	4.3	4.3	3.7
Gifu 30	1996	3.8	3.9	9.7	4.7	3.7
Kasama-mashiko 24	1996	3.1	3.4	6	5	5
Aichi 5-2	1996	3.5	4.7	8.7	5.3	5.3
Kasama-tsukuba 15	1996	3.3	4.4	7.7	6.3	4.3
Ibi 2	1996	3.2	3.9	6.3	6.3	6
Kasama-tsukuba 20	1996	4	5.4	9.7	7.3	6
Kasama-mashiko 30	1996	3.9	4.7	12	9.7	8
Bokasugi	1997	4	5.1	8	0.7	0.3
Shirakawa－omotego 5	1997	3.6	4.1	3	1	0.7
Kasama-mashiko 5	1997	3.4	4.2	7.7	1.4	0.7
Aichi 20-6	1997	4	4.9	6.3	2.4	0.7
Kasama-mashiko 20	1997	4.4	5.5	8	2.6	1.3
Shirakawa-omotego 17	1997	4.1	4.8	5	2.6	1.3
Kumotoshi	1997	4.6	5.9	5.7	3.4	2.7
Kasama-mashiko 18	1997	3.7	4.3	6.3	3.3	2
Aichi 17-4	1997	3.9	5.3	8.3	3.3	2.3
Shirakawa-omotego 23	1997	4.7	5.9	6.3	3.7	2
Shirakawa-omotego 19	1997	3.6	4.2	5	4	2.3
Shirakawa-omotego 2	1997	3.5	4.4	7	5	5
Aichi 7-2	1997	4.2	5.2	6	5.6	5.3
Kasama-mashiko 26	1997	3.5	4.2	6.7	5.7	4.7
Kasama-mashiko 27	1997	4.1	5.1	9.3	6	4
Shirakawa-omotego 9	1997	4.6	5.3	11	6	5.3
Shirakawa-omotego 24	1997	3.8	4.9	7.7	7	6
Kasama-mashiko 29	1997	3.8	4.8	8.3	8	6.3
Kasama-mashiko 25	1997	4.1	4.7	9.3	8.4	7.7
Kasama-mashiko 28	1997	3.7	5	9.3	8.6	8.3
Shirakawa-omotego 6	1997	4	5.2	10	10	10
Shirakawa-omotego 8	1997	4.2	5.6	11.3	10	9.7
Shirakawa-omotego 4	1997	4.5	5.9	20.3	10.3	7.3
Tanakura 3	1997	3.3	4.3	21	10.3	9.3
Shirakawa-omotego 25	1997	4.7	5.9	11.7	11.3	11
Shirakawa-omotego 11	1997	4.5	6.1	19.7	12	11
Shirakawa-omotego 20	1997	4.2	5.4	19.3	13.7	12.7
Shirakawa-omotego 1	1997	4.3	6	17.3	16	13.7
Aichi 1-2	1997	4.1	4.9	18.7	17	17
Shirakawa-omotego 13	1997	4.6	6.1	24.3	22.3	19.3
Bokasugi ×Urasebaru	1998	4.3	6.6	29.3	0	0
Aichi 20-5	1998	3.7	4.9	19.7	0	0
Kasama-mashiko 10	1998	3.7	4.3	6.3	0	0
Bokasugi ×Urasebaru	1998	4.2	6.1	15.3	0.3	0
Bokasugi	1998	4.2	6.4	10.3	0.3	0
Shirakawa-omotego 3	1998	3.5	3.8	3	1	1
Shirakawa-omotego 15	1998	3.1	4	8	1.7	1
Shirakawa-omotego 16	1998	3.3	3.8	5.7	1.7	1.3
Bokasugi ×Urasebaru	1998	4.4	7.3	15.7	2.7	1.7
Aichi 18-3	1998	3.3	4.8	9.7	3	1.3
Gifu 4	1998	3.1	4	6.7	3	1.3

Yabukuguri	1998	4	5.7	13.3	3	2
Aichi 12-1	1998	3.8	4.6	11	3.7	3.7
Aichi 20-4	1998	3.6	4.7	3.7	3.7	3
Kasama-mashiko 8	1998	3.2	4.3	4	3.7	3.3
Kasama-mashiko 3	1998	3.2	4.3	9.3	4	3.7
Shirakawa-omotego 12	1998	3.1	3.6	4.7	4	3
Kasama-mashiko 9	1998	3.6	5	13	4.3	3.7
Kumotoshi	1998	4.8	5.9	12	4.3	3.3
Kasama-mashiko 31	1998	3.5	4.5	10.7	4.7	4.3
Kasama-mashiko 7	1998	3.5	4.5	8.7	4.7	3.3
Aichi 16-2	1998	3.4	4.8	9.7	5.3	5
Tochigi 9	1998	3.8	5.5	14.7	5.7	4.3
Shirakawa-omotego 22	1998	3.7	5.1	17	11.3	10.3
Ibaraki 36	1998	4	6.2	28.3	13	10
Bokasugi	1999	4	5.8	10.3	1	0
Fukushima 25	1999	3.6	4.4	7.3	1.3	1.3
Fukushima 26	1999	3.5	5	12	1.3	1.3
Shirakawa-omotego 18	1999	3.2	3.9	6	2	0.7
Aichi 16-4	1999	4.4	6.4	9.7	2	0.3
Aichi 15-2	1999	3.3	4.1	8.3	2.3	1.3
Fukushima 14	1999	3.6	4.5	12.5	3	1.5
Fukushima 28	1999	3.5	4.6	5.3	3.3	2
Aichi 16-5	1999	3.8	5.3	13	3.3	2.7
Chiba 2	1999	3.2	4.5	9	3.3	1.7
Kasama-tsukuba 17	1999	3.3	3.9	12.7	3.3	0
Shimotakai 1	1999	4.7	6.6	22.3	3.7	2.7
Fukushima 16	1999	4	4.8	9.3	4.3	3
Fukushima 36	1999	3.5	4.3	11	4.5	2
Fukushima 15	1999	4.2	6.4	9.3	5	2.7
Fukushima 9	1999	3.7	5	21.3	5	4
Fukushima 37	1999	3.4	4.6	16.3	6.3	5.7
Fukushima 17	1999	3.7	4.9	15	6.5	4
Fukushima 29	1999	4.2	6	12	7.3	5.3
Kumotoshi	1999	4.8	6.5	26	8.3	6.7
Fukushima 19	1999	3.9	6.6	26	10	10
Fukushima 34	1999	3.3	4.1	15	10.7	5.3
Fukushima 31	1999	4.4	6.5	16.7	12.3	10.3
Fukushima 33	1999	4.7	6.2	23	15.7	13
Fukushima 35	1999	3.9	4.9	30.5	21	16
Kasama-tsukuba 26	2000	3.2	3.2	0	0	0
Bokasugi	2000	4	4.2	3	0	0
Fukushima 32	2000	3.1	2.9	1.3	0.7	0.3
Shirakawa-omotego 9	2000	4.7	4.8	16.3	0.7	0.3
Fukushima 12	2000	3.9	4.3	2.5	1	1
Kasama-tsukuba 25	2000	4	4	7	1	0
Fukushima 22	2000	3.3	3.3	3	1.3	1.3
Fukushima 1	2000	4	4.6	11.3	1.3	1.3
Tone 5	2000	2.8	2.9	6	1.7	0.7
Kasama-tsukuba 13	2000	3.1	2.8	4	1.7	1.7
Kasama-mashiko 22	2000	2.7	2.8	5.3	1.7	1.7
Fukushima 2	2000	3.2	3	6	2	1.5
Fukushima 4	2000	3.3	3.3	4.5	2.5	2
Gifu 11	2000	3	3.2	6.7	4	4
Kasama-mashiko 5	2000	4.5	4.2	15	4	2.7
Fukushima 13	2000	3.9	3.6	13.7	4.7	4.3
Fukushima 21	2000	3.1	3	11	6.3	6
Kasama-mashiko 21	2000	3.2	2.7	13	8	8
Shirakawa-omotego 1	2000	3.5	3.6	10	9.3	9
Fukushima 24	2000	3.9	4	17.3	11.3	11.3
Kumotoshi	2000	4.3	4.3	22.3	14.7	14.7

関東育種基本区において実施したスギカミキリ抵抗性育種事業における一次検定の10年間の調査

加藤一隆[1]・谷口　亨[1]

要旨：関東育種基本区において簡易検定で選抜されたスギカミキリ抵抗性候補木200クローンについて10年間に亘って一次検定を行った。各年次の検定木の平均樹高および胸高直径とも年次間で非常にばらつきがあった。これらの値が大きい年次には，検定木あたりの内樹皮穿孔幼虫数，木部穿孔幼虫数および羽化成虫数も増加する傾向がみられたが，内樹皮穿孔から木部穿孔までの生存率および内樹皮穿孔から羽化までの生存率とも増加するわけではなかった。200クローンのうち，内樹皮穿孔から木部穿孔までの生存率が０％を示したのは14クローンであった。内樹皮穿孔から羽化までの生存率が０％を示したのは，32クローンであった。スギカミキリに対するスギの抵抗性を判断する上で一次検定の信頼度は高いので，以上の結果から関東育種基本区においても最終的に合格木として認定されるクローンが存在することが期待される。

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