Title:

Validation of treatments for the conservation of native rhododendrons, the symbol of Satoyama, in the dry granite region of Japan

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Abstract:

To develop an appropriate method of conservation for the native *Rhododendron* sections *Brachycalyx* and *Tsutsusi*, the symbol of Satoyama, field experiments were performed in the dry and granite region in Japan. When the carpet-type landscape of native rhododendrons was desired, all plants were cut at 20 cm above the ground level of all trees and shrubs, and the herbs and ferns were weeded (once and three times, respectively). When the shrubby-type landscape of native rhododendrons was desired, all plants, excluding native rhododendrons, were cut at 20 cm above the ground level of all trees and shrubs, the herbs and ferns were weeded and the litter was swept. After three years of monitoring the percentage and depth of crowns with flower buds, the following major results were obtained. Cutting all plants excluding native rhododendrons was effective to keep the depth of crowns with flower buds. However, weeding and sweeping of litter on the ground caused desiccation of surface soil, which induced a transitory decrease in the percentage of crowns with flower buds. One weeding was effective in keeping the depth of crowns with flower buds; however, the second and third weeding had no distinct effect. In a dry granite region, considerable attention to the desiccation of surface soil is critical, in opposition to limiting attention to the maintenance of sunlight, which is the common practice.

Keywords:

cutting at the base of the stem, thinning from above, weeding, sweeping up litter, flower-bud formation, soil erosion

1. Introduction

In Japan, 20 species of the *Rhododendron* section *Brachycalyx* and 13 species of the *Rhododendron* section *Tsutsusi* grow naturally. They often form large colonies in low mountain areas, and had once been one of the most popular and important components of the Satoyama landscape in Japan (Ogura 1992). The Satoyama landscape is a rural landscape that is comprised of woodlands, farmlands, settlements, and reservoirs that were once strongly connected to each other through the agricultural land use system (Takeuchi et al. 2003). However, the decline of the native colonies of rhododendrons is serious in the abandoned secondary forests of Satoyama in the Kanto, Kansai, and Kyushu regions (see Fig. 1) after the 1960s, when chemical fertilizers and fossil fuels came into common use, the economic importance of coppice woodlands diminished (Morimoto and Yoshida 2005; Uehara and Shigematsu 2006). Their decline in mountains in the Kanto region is also exacerbated by the collecting of rhododendrons for gardening (Koga and Kobayashi 2004; Morimto et al. 2007). The decline of native rhododendrons is symbolic of the decline of biodiversity in Japan.

In the Seto-uchi area, which has warm and dry weather, pine trees and litter had been overused for natural salt production until the 1960s (Ozawa 2001). This led to many mountains in this region becoming denuded. *Rhododendron* species generally have ericoid mycorryhiza in their roots, which enable plants to receive nutrients from not-yet-decomposed materials via the decomposing actions of their ericoid partners. This function might have enabled native rhododendrons in our study area to survive even in oligotrophic conditions. Recently, frequent forest fires (Nonomura et al. 2007), which may have been caused by exuberantly growing ferns on the forest floor, have been a major disturbance in this region. On Naoshima Island in the Seto-uchi area, native rhododendrons mainly dominate in the area following forest fires. However, for the safety of residents and visitors, forest fires must be controlled despite their positive effects on the survival of native rhododendrons.

Treatments such as cutting at the base of the rhododendron's stem, thinning trees from above, and weeding, have been used to regenerate native rhododendrons by sprouting from stumps and to create beautiful flowered landscapes in secondary forests in the Kansai, Kanto, and Tohoku regions (see Fig. 1). Reports show that rejuvenation of plants through vigorous sprouting from stumps after cutting at the base of the stem occurs (Imanishi et al. 2009), thinning from above increases sunlight exposure for native rhododendrons, which promotes flower bud differentiation (Hatase et al. 2005; Shigematsu et al. 1985), and that weeding has no effect on the light environment in forest floors and flower bud differentiation (Hatase et al. 2005). Thinning from above should be completed before June because flower buds differentiate from late June to early August in the Kansai region (Shigematsu et al. 1985). As concerns seed reproduction, fine-grained soil and moss with no litter and grass are suitable for germination, and seedlings grow better on the fringe of a forest where there are fewer trees, compared to deep within a forest where there are numerous trees above (Morimoto et al. 2003). These regions have an annual precipitation of approximately 1,200 mm to 1,600 mm, and a volcanic ash and decomposed topsoil of mud stone, sand stone, and conglomerate have developed. In contrast, the annual precipitation of the Seto-uchi area is approximately 1,000 mm, and granite stone, which can be easily degraded and has a lower water-holding capacity, is predominant. Under these unique conditions, treatments that have been effective in a secondary forest in other regions cannot be expected to have the same effects. It is uncertain whether these effects, which include the rejuvenation of native rhododendrons by vigorous sprouting from stumps after cutting, increased flower bud formation, and the facilitation of germination of seeds and growth of seedlings by weeding and sweeping up litter, would be seen in the Seto-uchi area.

In 2006, we started field experiments that combined cutting plants at the base of stems, thinning from above, weeding, and sweeping up litter in a shrubby forest that had regenerated after a 1992 forest fire on Naoshima Island. In this paper, using the results of three years of monitoring, we discuss suitable treatments for this region. We focus on the effects of the treatments on the percentage of crowns with flower buds and the depth of the crowns with flower buds. The results gave suggestions for the conservation of the Satoyama landscape in this region and for the conservation of disturbance-dependent ecosystems, which are the declining ecosystems in Japan.

2. Methods

2.1 Study area

Naoshima Island (33°28'N, 133°59'E) is situated in the eastern sea of Setonaikai in Japan (Fig. 1). The boundary length of the island is approximately 16 km, its area is approximately 8 km^2, and its highest elevation is 123.3 m (Mt. Jizoyama). The annual precipitation and average annual temperature from 2006-2009 were 991 (standard deviation (sd): 117.8) mm and 16.4 (sd: 0.3) °C, respectively, which were recorded in Tamano city, the nearest meteorological weather station. The surface geology is granite, and weathered granite soil constitutes the top soil.

An experimental site of 1,500 m^2 was set in the regenerating shrubby forest after a forest fire in January of 1992 (50 m – 75 m of elevation, towards the east, 34° slope angle). The dominant species in the shrub layer are *Rhododendron reticulatum* and *Eurya japonica* Thunb., and the dominant species in the herb layer is *Dicranopteris linearis*. In the tree layer, only three individuals of trees survived the fire: *Ilex rotunda* Thunb., *Alnus sieboldiana* Matsumura, and *Acacia melanoxylon* R. Br. (specific sizes are described later). With regard to native *Rhododendron* species*, R. kaempferi* also grows, but it is less dominant than *R. reticulatum*. The area, including this experimental site, is the second designated area for ecological preserve in Setonaikai National Park.

2.2 Field experiment

In the experimental site, four different treatments (treatments A, B, C, and D) and a control were prepared in late June 2006. Three quadrats (7 m x 7 m) per treatment were settled. Spaces of 2 m along 15 quadrats in total were set up (Fig. 2). The landscape of treatments A and B aimed at the carpet-type landscape of native rhododendrons, and treatments C and D aimed at the shrubby-type landscape of native rhododendrons.

Figure 3 shows the specific work in each treatment. In treatments A and B, all trees and shrubs whose diameter at breast height (DBH) was under 10 cm were cut down at 20 cm above the ground and herbaceous plants and ferns weeded out in late June 2006. *Acacia melanoxylon* R.Br. (H=788 cm, DBH=16.5 cm, in A-3) was the only tree in treatments A and B. For treatment A in June 2007 and June 2008, additional cutting of plants, excluding rhododendrons, at 40 cm above the ground was performed to prevent other plants from covering the native rhododendrons.

In treatments C and D, all trees and shrubs, excluding rhododendrons, whose DBH was under 10 cm, were cut down at 20 cm above the ground, and all herbaceous plants and ferns were weeded out in late June 2006. *Ilex rotunda* Thunb. (H=340 cm, DBH=6.6 cm, in D-1) and *Alnus sieboldiana* (H=360 cm, DBH=11.4 cm, in D-1) were the only tree species in treatments C and D. Although DBH was under 10 cm for the *I. rotunda*, it was left uncut by mistake. Additional sweeping up of litter on the ground was also performed in treatment D at the same time. After these treatments, no more work was performed in treatments C and D. The effect of the three trees left uncut on environments in each treatment was negligibly-small as shown later.

2.3 Monitoring of environment and vegetation

In each treatment, the relative photon flux density (PFD), the dry weight of herbs and ferns, and litter, and the soil water content were measured in early September 2009, which is the last stage of flower formation and the period in which the severity of water stress on plants is high (Fig. 4). Soil water content was measured only in the control in September 2006, 2007, and 2008 besides September 2009, to analyze the yearly fluctuation.

PFD was simultaneously measured at 5 points in each quadrat (Q_1-Q_5) and at a point under the entire sky (G) at 1.5 m high, which is approximately the height of native rhododendrons, using light sensors (LI-250A light sensor, LI-COR) on a cloudy day. The time of measurement was from noon to 14:00, which was when the culmination altitude was the highest in a day. Two measurements were performed per point, which resulted in 10 measurements per quadrat. Removing the highest and lowest value of PFD, the relative percent of PFD in each quadrat was calculated using the 8 measured values in a quadrat (Q_1-Q_8) and under the entire sky (G_1-G_8).

$$(Q_1+ Q_2+ Q_3+ Q_4+ Q_5+ Q_6+ Q_7+ Q_8) / (G_1+ G_2+ G_3+ G_4+ G_5+ G_6+ G_7+ G_8) \times 100\ (\%)$$

The water content of the soil was measured at 5 points in each quadrat from noon to 14:00 (25 days after the last rainfall) using TDR (HydroSense, Campbell Scientific, Inc). A cross-sectional diagram of soil and the distribution of roots in the study area indicated that most of the rhododendrons' fine roots were distributed in the topmost 5.5 cm in layers A and B (Fig. 5). Because the soil was generally too hard to insert sensors, we measured at 3 cm below layer A0 (see Fig. 5).

Living plants, including the herbs and ferns and the litter in the four sub-quadrats (50 cm x 50 cm), were collected separately in each quadrat. They were dried for 4 days at 80°C in a dry oven, and the dry weight of the herbaceous plants and litter was measured.

Before the treatments in early June 2006, the heights of all trees and shrubs whose DBHs were greater than 2 cm were measured in the control quadrats. Two species of native rhododendrons, *R. reticulatum* and *R. kaempferi* survived there. As for the native rhododendrons whose DBHs were greater than 1 cm, their heights, diameters at the base of the stems, and widths of crowns were measured.

Every April, from 2007 to 2009, the percentage of crowns with flower buds (PF) and the depths of crowns with flower buds (DF) were surveyed for the two species of native rhododendrons. PF and DF are calculated as follows:

PF = (Area of a crown with flower buds) / (Area of a crown with all buds) x 100

DF = (Height of the highest flower buds in a crown) - (Height of the lowest flower bud in a crown)

PF was visually recorded as 0 (PF = 0), 1 ($0 < PF \leq 10$), 2 ($10 < PF \leq 25$), 3 ($25 < PF \leq 50$), 4 ($50 < PF \leq 75$), and 5 ($75 < PF \leq 100$). DF indicates the extensiveness of flower buds in a crown.

2.4 Analyses

The differences in the relative PFD, the DW of the herbs and ferns, and the litter, and the water content of the soil among treatments were tested by a one-way ANOVA followed by a Bonferroni's correction.

As for the percentage and depths of crowns with flower buds for *R. reticulatum,* differences between treatments and years were tested by two-way repeated measures ANOVA followed by a Tukey's HSD (Honestly Significant Difference) test. Data from *R. kaempferi* were not tested because its number per quadrat was too small to perform the statistical analysis.

3. Results

3.1 Vegetation in the control

Figure 6 shows the average histogram for each species per quadrat before treatments. *R. reticulatum* and *E. japonica* were the dominant species of the shrubby forests in the experimental site. The number of plants less than 190 cm was large. Table 1 shows the number and size of native rhododendrons per quadrat before treatments. The density of *R. reticulatum* was higher than *R. kaempferi*. The mean height of *R. reticulatum* was approximately half of *R. kaempferi*.

3.2 Features of the environment in each treatment

Table 2 shows the relative PFD, the dry weight of the herbs and ferns, and the litter, and the soil water content in each treatment. The standard deviations of PFD in treatments A and D were larger than other treatments, which may have been caused by trees that were left uncut in part of the area of treatments A and D. No difference was observed in the relative PFD between treatments A and B (one-way ANOVA, $p<1.00$), which aimed for the carpet-type landscape of the native rhododendrons. However, relative PFD in treatment B was significantly higher than the control (Bonferroni, $p<0.05$). No difference was observed in relative PFD between treatments C and D (one-way ANOVA, $p<0.067$), which aimed for the shrubby-type landscape of native rhododendrons. However, relative PFD in treatment C was significantly higher than the control (Bonferroni, $p<0.05$). Causal interrelations between treatments and relative PFD were unclear.

No difference in the dry weight of the herbs and ferns among treatments was detected (one-way ANOVA, $p<0.057$). However, the dry weight of the litter in the control was higher than any other treatments (Bonferroni, $p<0.05$).

The soil water content was the highest in the control, and no difference was detected among the four treatments (Bonferroni, $p<0.05$). The mean value of the water content in the soil for the control from 2006 to 2010 was 3.8 (sd: 0.09) %, which shows that there was little fluctuation in yearly soil water content.

3.3 The percentage and depth of crowns with flower buds

Yearly changes in PF for treatments A, B, and the control (Fig. 7a) and for treatments C, D, and the control (Fig. 7b) are shown. Yearly changes in DF for treatments A, B, and the control (Fig. 8a) and for treatments C, D, and the control (Fig. 8b) are shown.

In treatments A and B, flower buds developed after 2008 (Fig. 7a). The PF in both treatments A and B increased from 2008 to 2009, while no change was detected in the control. Three years after the treatment, in 2009, the PF in treatments A and B were the same as the control. No change in the DF from 2008 to 2009 was detected in treatments A and B (Fig. 8a). In the control, DF decreased from 2008 to 2009. The DF in treatments A and B was still lower than the control in 2009. No difference in the PF and DF between treatments A and B was observed (Fig. 7a, Fig. 8a).

In treatments C and D, the PF decreased in 2008, but it recovered to the same level as 2007 in 2009 (Fig. 7b). However, in the control, no yearly change was detected for the PF. No yearly change in the DF was detected in treatments C and D (Fig. 8b). In the control, the DF decreased from 2007 to 2009. Three years after the treatment, in 2009, the PF and the DF in treatments C, D, and the control were similar (Fig. 7b, Fig. 8b).

4. Discussion

4.1 Environmental changes due to treatment

The fact that no differences were found in environmental factors between treatments A and B and between C and D (Table 2) indicated that no bias was caused by any trees that were left uncut in treatments A and D. Cutting all plants, including native rhododendrons (treatments A and B), at 20 cm above the ground and cutting all plants, excluding native rhododendrons (treatments C and D), at 20 cm above the ground did not have any distinct effects on the light environment at the height of native rhododendrons (Table 2). There were few trees covering the native rhododendrons, even prior to the treatments, which was why no marked response was observed in the light environment after the treatments. In our experimental site, even in the darkest control, the relative PFD was 65% (Table 2), which is enough for the differentiation of flower buds according to Shigematsu et al. (1985).

The dry weight of litter and soil water content in treatments A, B, C, and D were less than those of the control (Table 2). Weeding out living plants in the herb layer in treatments A, B, and C seemed to cause the washing away of the litter piled there and had the same effect as the sweeping up of litter in treatment D (Table 2). The steep slope (34°) of this site might have further facilitated the washing away of the litter. Additionally, the biomass of *D. linearis*, which had been cut three times (treatment A), was similar to that of *D. linearis*, which had been cut only once (treatments B, C, and D), indicating that *D. linearis* had a vigorous capacity for regeneration (Russell et al. 1998), even in the dry region.

In general, once the herbaceous layer disappears, soil erosion by rainfall is accelerated, and the infiltration capacity of the soil is reduced (Okura 1997). In particular, granite is an easily degradable system, especially where slopes are steep (Claassen and Zasoski 1998). That is why treatments A, B, C, and D, which had small amounts of the herbs and ferns, and the litter, had a reduced amount of water content (Table 2).

These results were completely different from the results obtained in other regions. In the case of experiments in *Quercus* secondary forests on weathered sedimentary rocks, which had an annual precipitation of 1,200 mm, thinning from above and weeding supplied the forest floors with enough sunlight but had no effects on soil water content (Hatase et al. 2005). However, for the current study, in shrubby forests on granite soil, where the annual precipitation is approximately 1,000 mm, the same treatment had no distinct effect on the light environment but caused the desiccation of topsoil.

4.2 Treatment for making the carpet-type flowering landscape of native rhododendrons

Differentiation of the flower buds of *R. reticulatum* begins from late June and is completed in late August (Shigematsu et al. 1985). Their flower buds grow and bloom the early next spring. Most leaves were lost in late June of 2006 for treatments A and B; thus, remaining plant resources should have been allocated mainly for the regeneration of the photosynthetic apparatus during the next summer. This may be the reason why no flower buds were initiated during the spring of 2007 (Fig. 7a). Even under dry conditions, such as in treatments A and B, flower buds formed after 2008, and the PF increased from 2008 to 2009 (Fig. 7a). This indicates that the capacity of the vigorous sprouting of native rhododendrons (Imanishi et al. 2009) was retained under a condition of water stress, which enabled the accumulation of assimilation products that were allocated for reproduction. Positive effects of cutting above the ground on flowering have been observed (Fig. 7), but this is the first time that a quantitative positive effect was confirmed.

Generally, the amount of understory plants is increased due to a positive response to solar radiation after thinning (Thomas et al. 1999; Wayman and North 2007). The competition of native rhododendrons and other shrubs growing densely in the same shrub layer became more severe every year in the control; however, in treatments A and B, where all of the plants were cut at the base, the size of the regenerated plants was small enough that every crown could be exposed to the sunlight. This also induced the differentiation of flower buds in lower crowns. At the same time, the second and third weeding in treatment A had no apparent effect on the formation of flower buds (Fig. 7a, Fig. 8a). This might be because the amount of regeneration of the other species after cutting at 20 cm above the ground level was still too small to cover the native rhododendrons.

In summary, cutting the plants at 20 cm above the ground level and the first weeding was effective in maintaining the DF. However, the second and third weeding of the other species had no distinct effect on formation of flower buds.

4.3 Treatment for making the shrubby flowering landscape of the native rhododendrons

The formation of flower buds that contributed to the percentage of crowns with flower buds in 2007 could have started before the treatment given the season of flower bud differentiation (Shigematsu et al. 1985). However, flower buds that contributed to the percentage of crowns with flower buds in 2008 were formed under the water stress that was caused by the weeding and sweeping up of the litter. Water stress generally induces a reduced amount of assimilation products (Hsiao 1973), which leads to a reduction of products allocated for reproduction (Morimoto and Yoshida 1999). This seems to be the reason for the decrease in DF in 2008 (Fig. 7b).

However, in both treatments C and D, the PF increased in 2009 and reached to the same level as the control (Fig. 7b), which indicates an acclimation of native rhododendrons to the new condition after the treatments. Thinning, excluding native rhododendrons, and weeding contributed to the maintenance of the depth of crowns with flower buds (Fig. 8b). A decrease in the growing density gave enough resources, including light, to the remaining plants (Thomas et al. 1999; Wayman and North 2007) as mentioned in section 4.2. An adequate supply of sunlight, even at the lower part of crowns of the remaining *R. reticulatum*, enabled differentiation of the flower buds at the lower part of crowns.

In summary, thinning, excluding native rhododendrons, and weeding were effective to keep the DF, because they may have increased the supply of sunlight at the lower part of crowns. However, weeding and the sweeping up of the litter on the ground caused desiccation of the surface soil, which induced a transitory decrease in the PF in the next year of treatment.

5. Management implication

In the Seto-uchi area, which has warm and dry weather, it has been suggested that after a forest fire, the vegetation becomes dense and that the formation of flower buds of native rhododendrons gradually decline. This speculation was proven to be true because of the spatial competition between plants in the shrub layers, which darkened the light environment at the lower part of the crowns of the native rhododendrons.

In an attempt to remove these difficulties for the formation of flower buds and to create the carpet-type and shrubby-type landscape of the native rhododendrons, the common practices that were effective in other regions did not have the same effects in this study region.

First, cutting all plants at 20 cm above the ground level, both including and excluding the native rhododendrons, did not change the light environment at the height of crowns of the native rhododendrons; however, a decrease in the vegetation density around the native rhododendrons caused by a thinning of other trees and shrubs and weeding of the herbs and ferns increase sun radiation at the lower crown of the native rhododendrons. This practice contributes to maintaining the depth of crowns with flower buds.

Weeding the herbs and ferns, however, have also the negative effect on the formation of flower buds of the native rhododendrons. In cases of a steep slope, weeding also causes the litter to wash out.

The decrease in the litter causes water stress and transitory declines in the percentage of crowns with flower buds. This is a unique response in a dry granite zone. In cases of the Tohoku region (Hatase et al. 2005) and the Kansai region (Shigematsu et al. 1985), the negative effect on the formation of flower buds after these kinds of treatments are not reported.

We cannot expect immediate changes in landscaping from our treatments. Reducing the water stress on native rhododendrons is necessary if immediate effects are needed. For example, developing weeding methods to keep the soil’s infiltration capability caused by a disturbance of the ground surface should be considered. One option is weak weeding, i.e., leaving some of the herbs and ferns to cover the ground surface, which enables the infiltration of light to the lower crown of native rhododendrons. Another option is to avoid sweeping the litter on the ground to keep the soil’s infiltration capability.

In a dry and granite region like Seto-uchi area, considerable attention to the desiccation of surface soil is critical and must be given priority over attention to maintaining sunlight, which is the common practice.

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Legends of Figures

Fig. 1 – The study area

Fig. 2 – The arrangement of quadrats

Fig. 3 – The four types of treatments

Fig. 4 – Places where the environment was measured for each quadrat

(PFD: Photon Flux Density, DW: Dry Weight of the herbs and ferns, and litter)

Fig. 5 - Cross-sectional diagram of soil in the study area, the distribution of roots, and the place of measurement of soil water content

Fig. 6 - Average histogram of each species per quadrat before treatments

Fig. 7 - Yearly changes in the percentage of crowns with flower buds (a) in treatments A, B, and the control and (b) in treatments C, D, and the control.

Different letters on points indicate significant differences between years and treatments by Tukey's HSD ($p<0.05$). Bars mean 95% confidence interval

Fig. 8 - Yearly changes in the depth of crowns with flower buds (a) in treatments A, B, and the control

and (b) in treatments C, D, and the control.

Different letters on points indicate significant differences between years and treatments by Tukey's HSD ($p<0.05$). Bars mean 95% confidence interval.

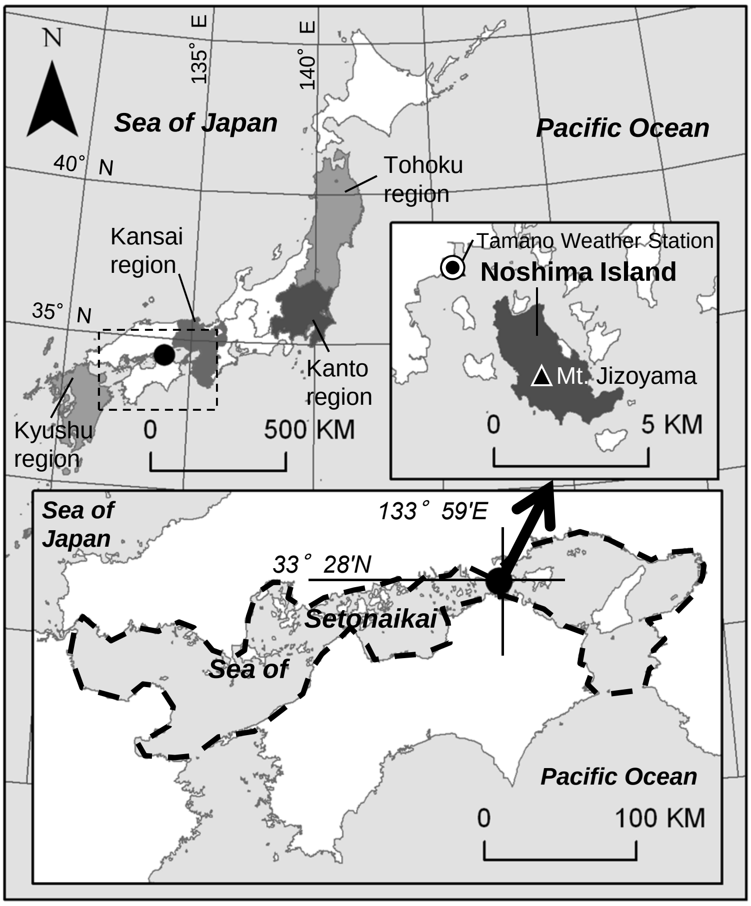

Fig.1 - Study area

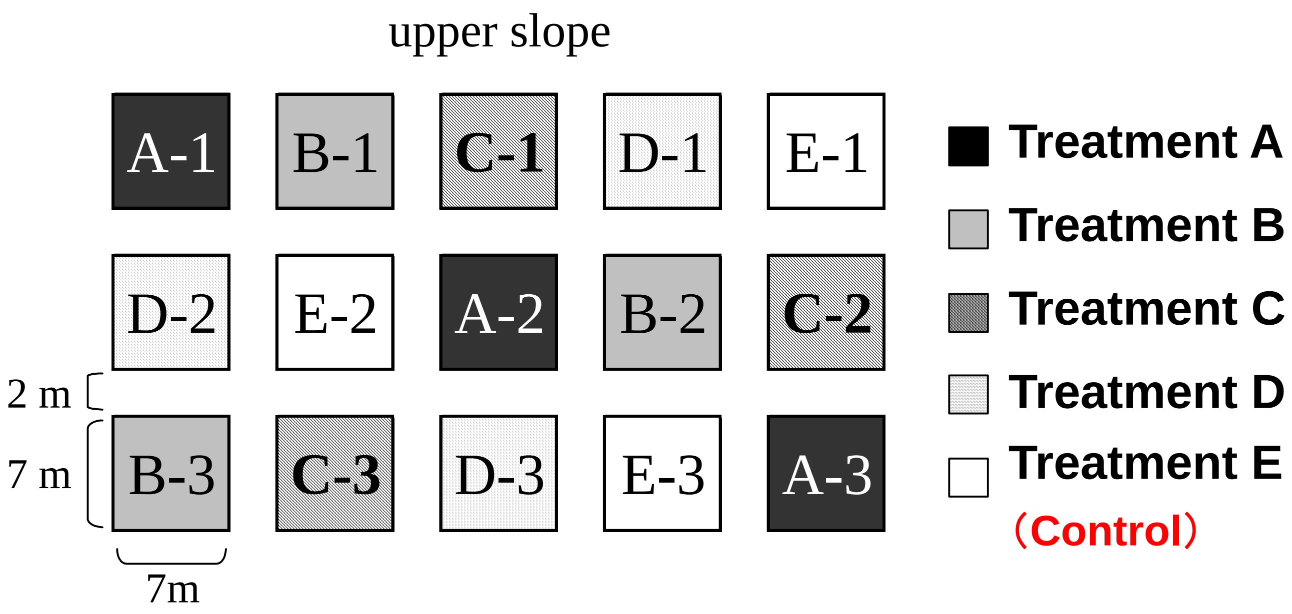

Fig. 2 - Arrangement of quadrats

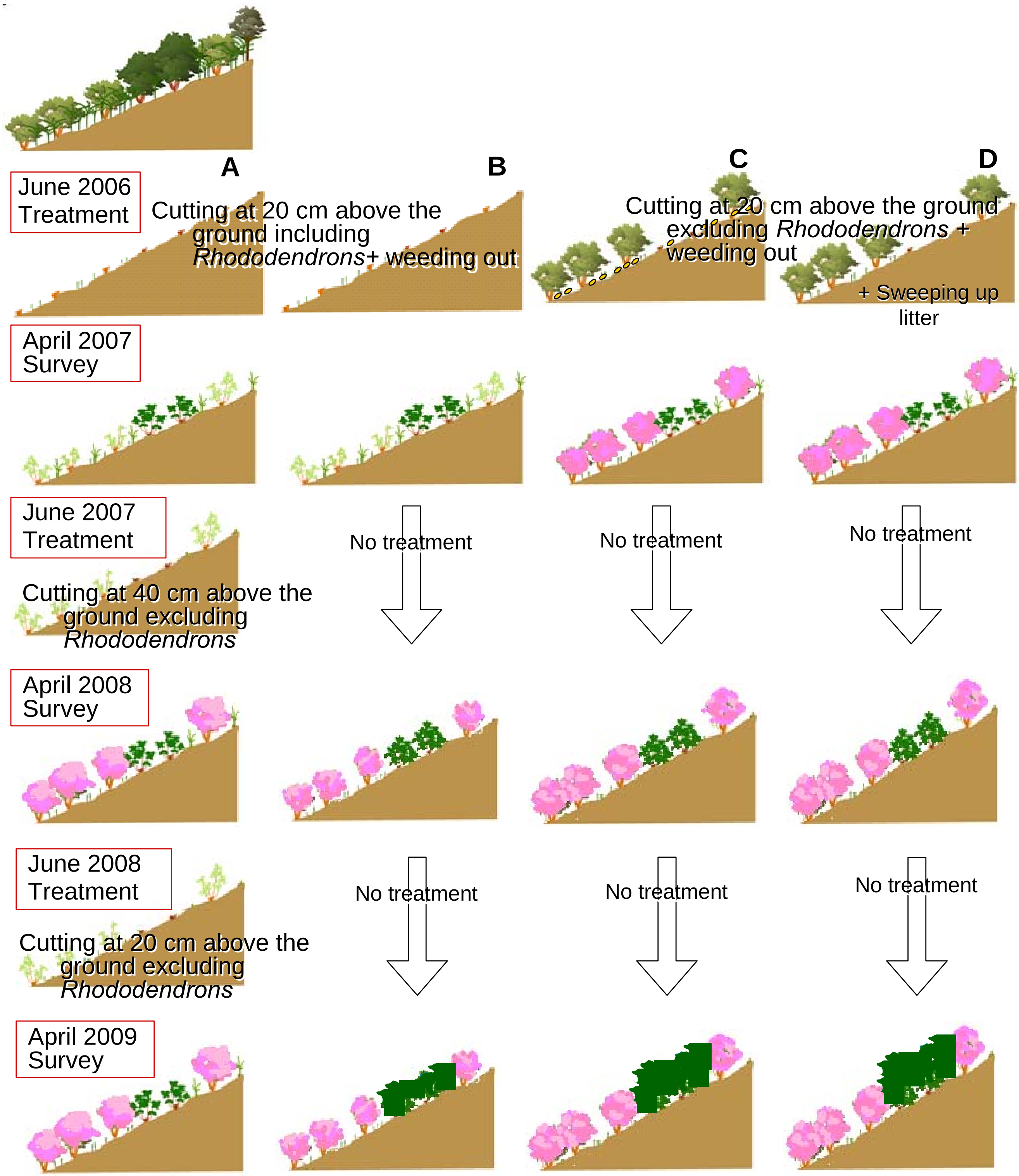

Fig. 3 - Four types of treatments

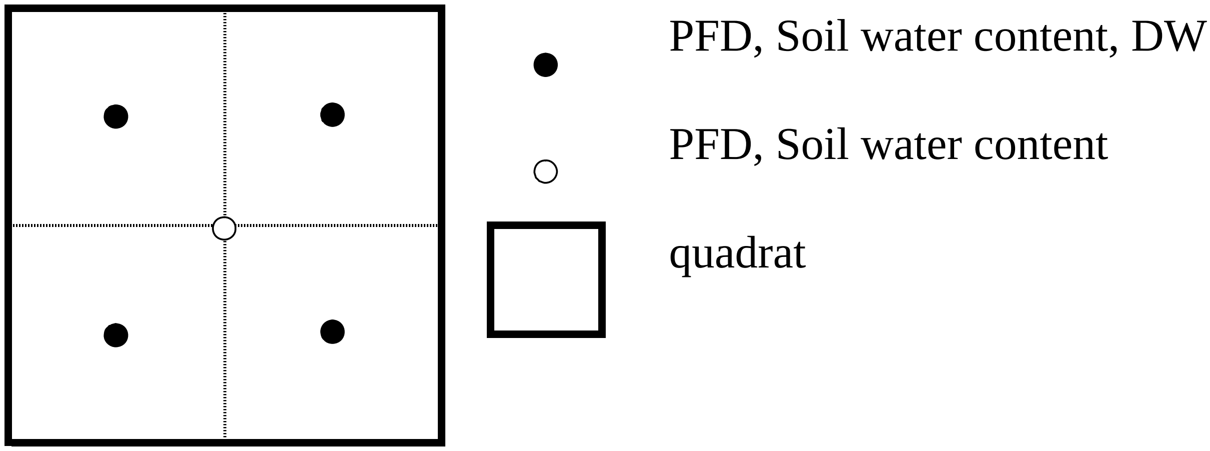

Fig. 4 - Places of measuring environments in each quadrat
(PFD: Photon Flux Density, DW: Dry Weight of herbs and ferns, and litters)

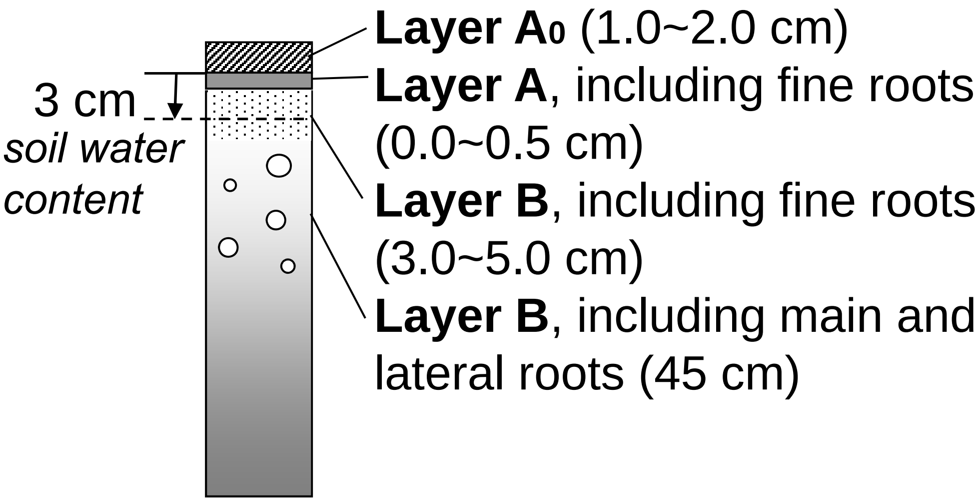

Fig. 5 - Cross-sectional diagram of soil in study area, distribution of roots, and the place of measurement of soil water content

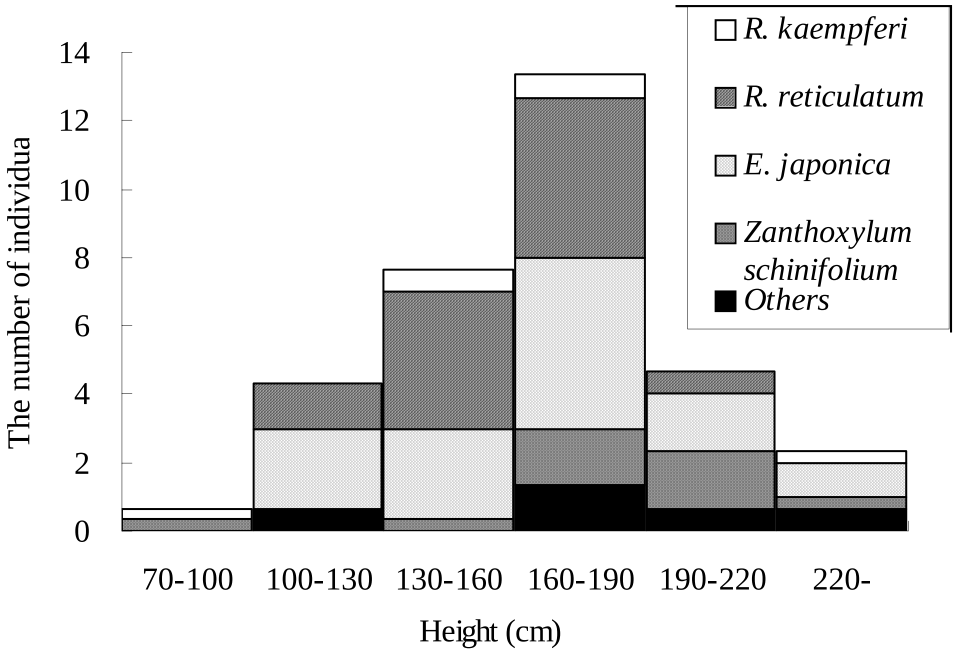

Fig. 6 - Average histogram of each species per quadrat before treatments

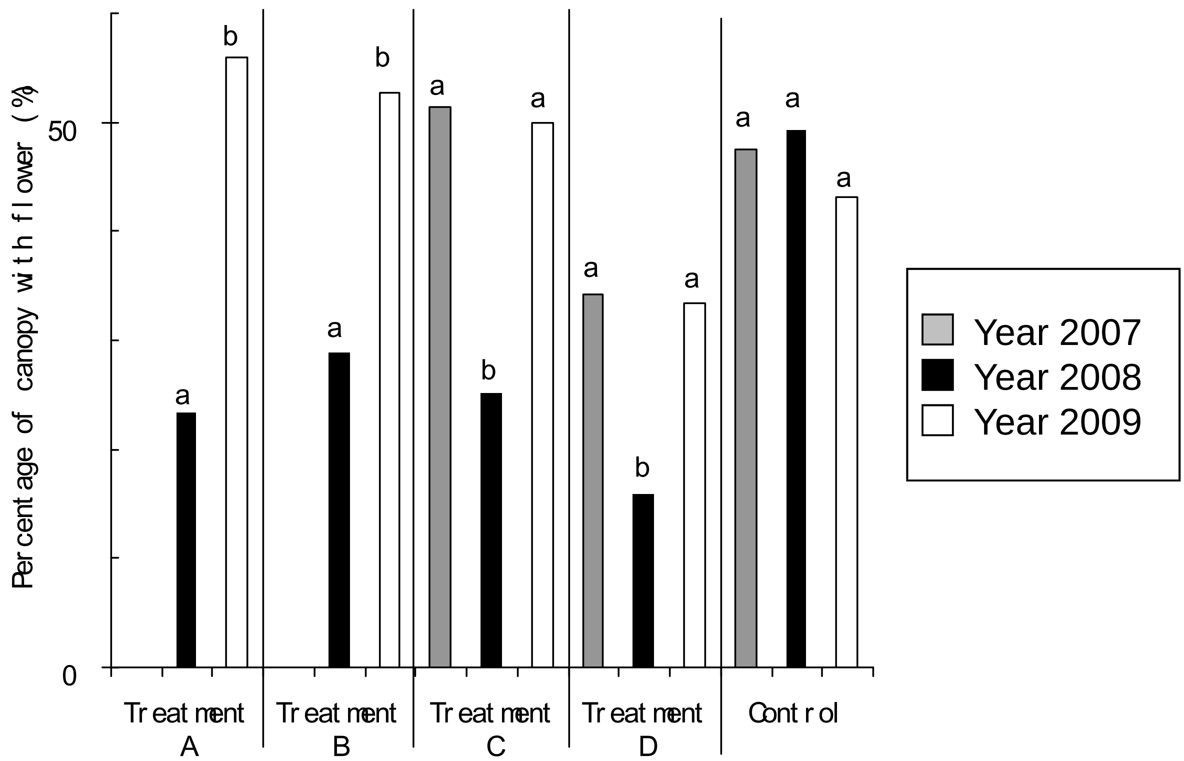

Fig. 7 - Yearly changes in the percentage of canopy with flower in each treatment

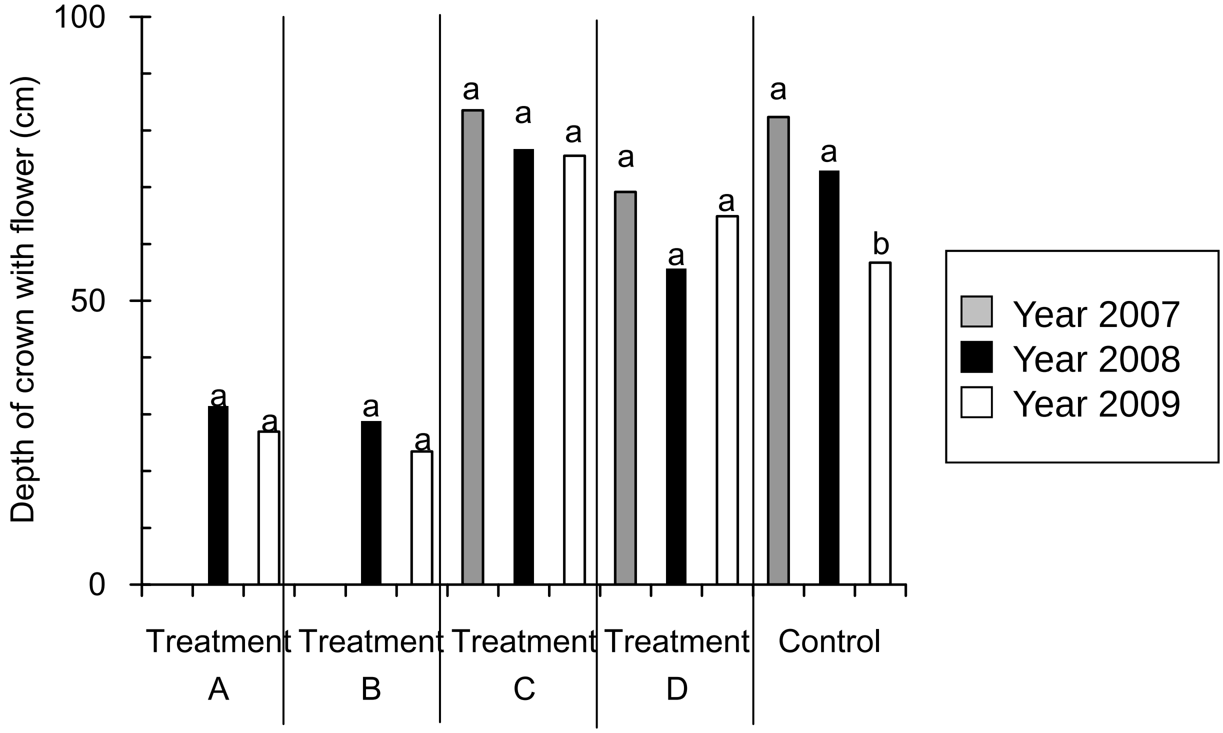

Fig. 8 - Yearly changes in the depth of crowns with flower buds in each treatment

Tab.1 – Average size of native rhododendrons per quadrate before treatments

(cm)

	N	Diameter of a stem*		Height		Diameter of a crown	
	(/m^2)	average	sd	average	sd	average	sd
R. reticulatum	0.22	2.4	0.30	87	21.88	88	26.39
R. kaempferi	0.04	2.2	0.19	163	39.67	98	30.78

* Diameter of a stem at 5 cm above the ground.

Table 2 - Environments in each treatment

		Relative PFD (%)			Dry weight of ground cover (g/m^2) Herbs and ferns		Dry weight of ground cover (g/m^2) Litter		Soil water content (%)	
Treatment	N	average	min	max	average	sd	average	sd	average	sd
A	3	89 ab	30.7	100.0	44.7 a	41.26	181.4 a	29.02	2.8 a	0.7
B	3	96 a	90.1	100.0	18.3 a	22.27	195.4 a	70.55	2.9 a	0.6
C	3	94 ac	86.4	98.7	63.9 a	49.35	236.4 a	78.55	3.1 a	0.6
D	3	71 bc	7.6	99.9	49.0 a	41.35	245.5 a	69.79	3.0 a	0.5
control	3	65 b	9.0	99.0	154.4 a	77.24	834.5 b	61.15	3.9 b	0.5

Different letters indicate signifficant differences ($p<0.05$).

Tab. 3 – The percentage of canopy with flower buds and the depth of crowns with flower buds in 2009 in the treatments aimed for the carpet-type landscape of native rhododendrons

Treatment	Percentage of flower bud (%)					Depth of crown with flower (cm)				
	N	Median		Min	Max	N	Median		Min	Max
A	37	63	a	0	87.5	41	28.0	a	2.0	59.0
B	61	63	a	0	87.5	59	24.0	a	2.0	58.0
control	61	38	a	0	87.5	67	53.0	b	7.0	178.0

Different letters after mean value indicate the significant differences ($p<0.05$).

Tab. 4 – The percentage of canopy with flower buds and the depth of crowns with flower buds in 2009 in the treatments aimed for the shrubby-type landscape of native rhododendrons

Treatment	Percentage of flower bud (%)					Depth of crown with flower (cm)				
	N	Median		Min	Max	N	Median		Min	Max
C	36	37.5	a	0	87.5	45	81.0	a	0.0	178.0
D	62	17.5	a	0	87.5	62	64.5	a	0.0	152.0
control	61	37.5	a	0	87.5	67	53.0	a	7.0	178.0

Different letters after mean value indicate the significant differences ($p<0.05$).