Studies on the Growth of a Sugi (Cryptomeria japonica) Stand Planted in Clumps (II)

汰木, 達郎

荒上, 和利

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Studies on the Growth of a Sugi (*Cryptomeria japonica*) Stand Planted in Clumps (II)

Tatsuro YURUKI and Kazutoshi ARAGAMI

Abstract

A 23-year-old Sugi stand planted in clumps was surveyed.

1) Because of the wide clump spacing, plots A and C were not closed by tree crowns. However, plot B with narrow clump spacing was completely closed.

2) A large number of trees had died due to oppression by adjacent trees over the previous ten years and the difference in survival rates increased among the clumps. An especially large number of trees had died in the clumps of six trees. Almost the whole clump of six trees had disappeared from plot B with narrow clump spacing.

3) The greater the number of trees per clump, the smaller the individual mean became. The difference between the individual mean for the clumps of single trees and that for the clumps of six trees was increased. Even if the number of trees per clump increased the basal area per clump showed a tendency to reach a ceiling, but this trend was not observed in plot B with narrow clump spacing.

4) The greater the number of trees per clump, the smaller the largest tree in the clump became. It is considered that this phenomenon demonstrates intraspecific competition.

5) The greater the number of trees per clump, the more steady the individual ranking was fixed. The difference between the superior and inferior trees was obvious in the clumps of several trees.

Introduction

As to clump planting (nest planting), there have been a number of investigations from the viewpoint of the prevention of weather disaster (DOI *et al.*, 1970) (SASANUMA *et al.*, 1967), interspecific competition (SHIDEI *et al.*, 1958) and planting methods (SATO *et al.*, 1963) (FORESTRY AGENCY, 1973). YURUKI, one of the present authors, reported the development of trees in Sugi stands planted in clummps (YURUKI, 1963) (YURUKI, 1979). However, there are many unknown areas regarding the development of forest trees planted in clumps. An experimental stand was, therefore, established in order to elucidate the growth of Sugi (*Cryptomeria japonica* D. Don) trees planted in clumps in 1964. In the previous paper, the survival rate, form ratio and diameter growth of this stand (13-year-old) as of 1977 were reported. The growth of the stand was surveyed once again in 1987. In this paper, we discuss and explain the effect of intraspecific

competition on the growth of individual trees and their individual ranking in clumps from the results obtained in 1977 and 1987.

Materials and Methods

The experimental Sugi stand planted in clumps is located in Compartment 15 (latitude: 33°39′N, longitude: 130°33′E, altitude: 520～540 m, topography: upper part of west to north slope, inclination of slope: 10°, soil type: moderately moist brown forest soil (BD)) of the Kyushu University Forest in Kasuya. In March 1964, Sugi cultivar (Yaichi) were planted according to the design shown in Fig. 1. The arrangement of the clumps and method of mesurement were described in the previous paper. The average clump-spacings were 5.83 m in plot A, 3.99 m in plot B, and 5.98 m in plot C, respectively.

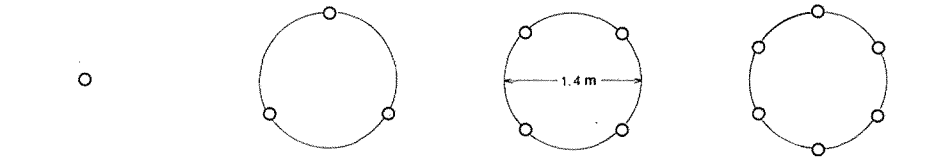

Fig. 1 Arrangement of trees in the complete clump.

Results

1. Number of survivors

The numbers of survivors are shown in Table 1. Over the past ten years, no dead individual trees occurred in the clump of single trees. The greater the number of trees per clump, the more the number of dead trees increased. This trend was remarkable in plot B which had narrow clump spacing.

Table 2 shows the influence of an increased number of dead trees on the constitution of the clump. This influence was remarkable in clumps of six trees. In plot B, only one out of thirty clumps of six trees was still complete. The causes of death are shown in Table 3. Only one individual had died due to oppression from adjacent tree crowns as of 1977, while a large number of individual trees had died because of such oppression as of 1987. It was judged that individuals damaged slightly by snow in 1975 had the highest possibility of survival. However, no survivors were found at all in 1987.

2. Diameter growth

Figure 2 expresses the mean basal area of an individual. Evidently, the difference in the number of trees per clump makes a large difference among individual mean

sizes. On the other hand, as shown in Fig. 3, the greater the number of trees per clump, the smaller the largest tree in the clump became.

Table 1 Changes in number of trees.

Number of trees per clump	Plot A			Plot B			Plot C			Total		
	1964*	1977	1987	1964	1977	1987	1964	1977	1987	1964	1977	1987
1	18 (100.00)	18 (100.00)	17** (100.00)	30 (100.00)	29 (96.66)	29 (96.66)	20 (100.00)	19 (95.00)	19 (95.00)	68 (100.00)	65 (95.58)	65 (95.58)
3	39 (100.00)	37 (94.87)	35 (89.74)	78 (100.00)	72 (92.30)	69 (88.46)	60 (100.00)	59 (98.33)	58 (96.66)	177 (100.00)	168 (94.91)	162 (91.52)
4	84 (100.00)	81 (96.42)	78 (92.85)	124 (100.00)	113 (91.12)	105 (84.67)	56 (100.00)	53 (94.64)	52 (92.85)	264 (100.00)	247 (93.56)	235 (89.01)
6	132 (100.00)	120 (90.90)	111 (84.09)	180 (100.00)	164 (91.11)	121 (67.22)	90 (100.00)	83 (92.22)	71 (78.88)	402 (100.00)	367 (91.69)	303 (75.37)

( ) : Proportion of number of surviving trees to number of planted trees %.
* : Planting year
** : An individual was cut down for stem analyze in 1977.

Table 2 Changes in number of complete clumps.

Number of trees per clump	Plot A			Plot B			Plot C			Total		
	1964	1977	1987	1964	1977	1987	1964	1977	1987	1964	1977	1988
1	18 (100.00)	18 (100.00)	17 (94.44)	30 (100.00)	29 (96.66)	29 (96.66)	20 (100.00)	19 (95.00)	19 (95.00)	68 (100.00)	65 (95.58)	65 (95.58)
3	13 (100.00)	11 (84.61)	10 (76.92)	26 (100.00)	21 (80.76)	18 (69.23)	20 (100.00)	19 (95.00)	18 (90.00)	59 (100.00)	51 (86.44)	46 (77.96)
4	21 (100.00)	19 (90.47)	17 (80.95)	31 (100.00)	23 (74.19)	18 (58.06)	14 (100.00)	11 (78.57)	10 (71.42)	66 (100.00)	53 (80.30)	45 (68.18)
6	22 (100.00)	13 (59.09)	12 (54.54)	30 (100.00)	16 (53.33)	1 (3.33)	15 (100.00)	9 (60.00)	3 (20.00)	67 (100.00)	38 (56.71)	16 (23.88)

Complete clump : clump where initial individuals were maintained.
( ) : Proportion %

Table 3 Number of trees dead in ten years (1977~1987).

Causes of death	Plot A				Plot B				Plot A				Subtotal				Total
	1	3	4	6*	1	3	4	6	1	3	4	6	1	3	4	6	
Snow damage						1	3	26				5		1	3	31	35
Oppression		2	3	4		2	5	22		1	1	12		5	9	38	52
Total		2	3	4		3	8	48		1	1	17		6	12	69	87

* : Number of trees per clump at the planting time.

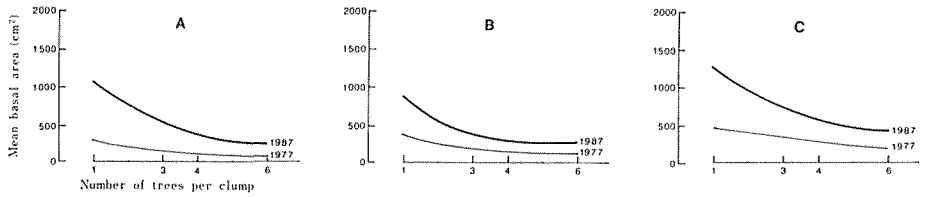

Fig. 2 Relation between the number of trees per clump and the mean basal area of an individual.

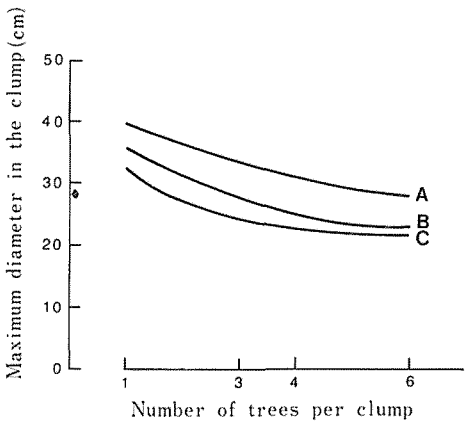

Fig. 3 Relation between the number of trees per clump and the maximum diameter in the clump.

Figure 4 shows the relation between the number of trees per clump and the basal area of the clump. The greater the number of trees per clump, the larger the basal area of each clump became. The extent of the increase was small and tended to reach a ceiling in plots A and C. However, this trend to reach a ceiling was not seen in plot B.

The ratio of the maximum diameter to the minimum diameter in a clump is shown in Fig. 5. Linear regression was conducted between the ratio in 1977 and the ratio in 1987. The regression coefficient was obviously over 1 for clumps of six trees and below 1 for clumps of three and four trees. That is, the ratio for clumps of six trees shows a tendency to increase. On the other hand, the ratio for clumps of three and four trees showed a decreasing trend.

3. Individual ranking

Table 4 shows the relation between the superior tree and the subordinate tree in complete clumps where initial individuals were maintained as of 1987. The relation between the superior and subordinate in clumps of six trees did not change much, but in clumps of three and four trees, the relation had changed appreciably. In other words, the individual ranking in a clump of six trees shows a tendency to be fixed.

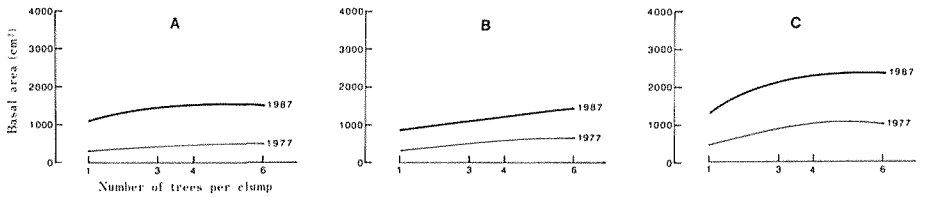

Fig. 4 Relation between the number of trees per clump and the basal area of the clump.

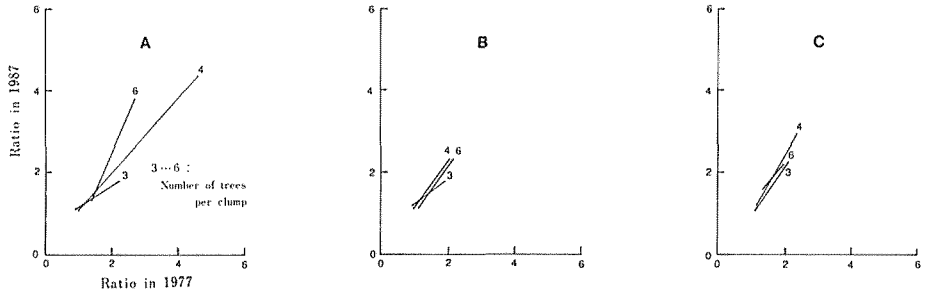

Fig. 5 Changes of the ratio of the maximum diameter to the minimum diameter in a clump.

Table 4 Fluctuation of the individual ranking in the clump from 1977 to 1987.

Nummber of trees per clump	Pattern of fluctuation				Total
	I	II	III	IV	
3	34* (73.91)	4 (8.69)	5 (10.86)	3 (6.52)	46
4	33 (73.33)	5 (11.11)	6 (13.33)	1 (2.22)	45
6	14 (87.50)		1 (6.25)	1 (6.25)	16

I : Clumps that both the greatest and the smallest trees unchanged.
II : Clumps that the greatest tree unchanged and the smallest tree changed.
III : Clumps that the greatest tree changed and the smallest tree unchanged.
IV : Clumps that both the greatest and the smallest tree changed.
* : Number of clumps
( ) : Proportion %

Discussion

In the previous paper, YURUKI (1979) reported that no differences in survival rate existed between single planting and clump-planting in the experimental Sugi stand (13-year-old).

In the present survey, differences became obvious in plot B. The clump spacing in plot B was narrow, and this plot was already in a closure condition in 1977. As of 1987,

this closure condition had advanced further. Therefore, a large number of individuals had died because of oppression by adjacent trees. This pressure was remarkable in clumps of six trees.

On the other hand, the greater the number of trees per clump, the larger the basal area of each clump became. However, the extent of the increase was small and tended to reach a ceiling in plots A and C. This is related to the fact that the greater the number of trees per clump, the smaller the individual mean becomes. The trend to reach a ceiling was not seen in plot B. It is considered that trend in plot B was due to small differences among the mean basal area of an individual as shown in Fig. 2. Clump spacing in plot B was narrow and the plot was completely closed by the tree crowns. Therefore, each clump trend to lose its function as a clump. It is conceivable that this has had an influence on the individual growth.

The phenomenon shown in Fig. 3 is similar to the result of SHIDEI *et al*'s survey (SHIDEI *et al*., 1958). They reported that without the interspecific competition, the greater the number of seedlings per nest, the smaller the biggest seedlings in the nest became. Judging from these results, it is considered that this phenomenon demonstrates intraspecific competition.

The ratio of the maximum diameter to the minimum diameter in a clump shows a tendency to increase for clumps of six trees as shown in Fig. 5. On the other hand, the individual ranking in a clump of six trees did not change much, but the individual ranking in clumps of three and four trees had changed appreciably. Judging from the results of diameter ratio and ranking fluctuation, it seemed that the competition between individuals was intense in clumps of six trees, but comperatively weak in clumps of three and four trees. This phenomenon suggests the existence of severe competition between individuals in clumps of several trees.

The foregoing results indicate that not only the number of trees fer clump but also the clump spacing influence the individual growth. But, from the present growth, it is difficult to speculate whether the ranking of individuals will continue in the experimental stand. It will be necessary to continue this survey.

We do not mention the relation with other species in this paper. The interspecific competiton is left as future problem.

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スギ巣植林の生長（II）

汰木達郎・荒上和利

要　　旨

この報告は植栽後23年経過したスギ巣植林の生長を調べたものである．

1) 巣間隔の広いA，C区は樹冠によって閉鎖されていないが，巣間隔の狭いB区は完全に閉鎖されていた．

2) この10年間に被圧のため多数の個体が枯死し，巣間の生存率の差が増大した．とくに6本植えで枯死する個体が数多く発生した．巣間隔の狭いB区では完全な6本植えはほとんど見られなくなった．

3) 平均個体の大きさは巣本数が多いほど小さく，1本植えと6本植えの差は増大している．一方，巣本数が増加しても，巣断面積の増加は頭打ちの傾向を示した．しかし巣間隔の狭いB区では頭打ちの傾向は見られなかった．

4) 巣の最大個体は巣本数がふえると小さくなった．この現象は巣内の同種個体間のせりあいを示していると考えられる．

5) 巣本数が多いほど，巣内の個体順位が固定しており，巣内における個体間の優劣は明らかであった．