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Crown Competition on the Relation of Crown Width to Diameter at Breast Height of Trees

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樹木의 胸高直徑과 樹冠너비와의 關係로 본 樹冠競爭

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ABSTRACT

The relations of crown width and DBH for *Pinus densiflora, Pinus rigida, Pinus koraiensis,* and *Ginkgo biloba* were accomplished to estimate the level of crown competition. Measurements of the relations revealed that crown width and DBH were highly correlated for the same species. Also it seems that these relations are independent of age and site quality. The results of regression analysis were as follow:

P. densiflora, $Y=0.3477X+0.3828$ $r=0.95$

P. rigida, $Y=0.3537X+0.1645$ $r=0.95$

P. koraiensis, $Y=0.2895X+0.6310$ $r=0.92$

G. biloba, $Y=0.4360X+0.0995$ $r=0.90$

The significant differences between *G. biloba* and pine species seems due to their structural differences of crown formation according to tree species. As results of computing Maximum Crown Area and Crown Competition Factor as indices of crown competition, they indicated that *P. densiflora* would grow better under the natural conditions.

INTRODUCTION

Using measures of stand density to express the level of intertree competition is important in analyzing tree and stand growth relationship. Several models have been proposed to assess intertree competition, or the degree of crowding of trees on an area (Lemmon and Schumacher, 1962; Opie, 1968; Bella, 1971; Bell and Smith, 1983).

Density is the relation between the number of trees or some volumetric or areal units to a specific area. Then a density measure is contributed to determine the relation of tree in the stand to the maximum growing space it could utilize, or the minimum growing space necessary to live(Krajicek *et al.*, 1961; Bella, 1971). Within this range trees in the stand maintain density to fully utilize the site for maximum production of desirable volume.

Moreover, models that attempt to estimate the intertree competition in more direct have been developed to quantify the relative level of stand density

as a function of the size, proximity, number and spatial arrangement of trees in the stand around a specific point (Keister, 1972; Keister and Tidwell, 1975; Mack and Harper, 1977; Weiner, 1984).

The relation of growing space to the tree size is complicated by density on both stem diameter and crown size. So the crown size may vary greatly for a given specified diameter at breast height(DBH). The adequate place where the crown/DBH relations are not confounded by competition from other trees is in the open-grown trees.

In the present study, the relations of crown width and DBH for pines and ginkgo species grown in open areas were measured to estimate the level of crown competition.

MATERIAL AND METHOD

The relations between crown width and DBH were measured in 155 trees of open stand: 43 *Ginkgo biloba*, 36 *Pinus rigida*, 45 *Pinus koraiensis* and 31 *Pinus densiflora*. A quadrat of 10×10m was sat up at each stand for the investigation, respectively. The survey was accomplished in afforested area at Ewha Womans University(*G. biloba*, *P. rigida*, and *P. koraiensis*) and Mt. Hwangsŏk at Hamyang-gun, Kyŏngsangnam-do (*P. densiflora*). *P. densiflora* was planted in areas around 590m elevation at Mt. Hwangsŏk.

To maintain uniformity in selecting sample trees, crown free of competition on all sides and no evidence of pruning, shearing, browsing, decadence, storm damage, or serious insect damage were included in samples. Crown width of each tree was measured in use of tape-ruler from one end toward the opposed one of canopy twice, the second measurement at right angles to the first and the results averaged. The relations between crown width and DBH were expressed as the regression analysis.

RESULTS AND DISCUSSIONS

As results of analysis, Fig. 1 showed that the crown width of sample trees was closely related to its DBH. The relation between crown and stem diameter among the pines had small differences.

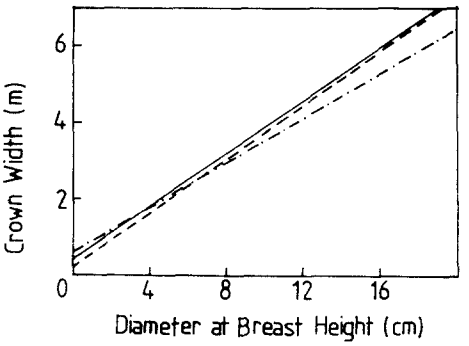

Fig. 1. The relation of crown width to DBH for *Pinus densiflora*(—), *Pinus rigida*(– – –) and *Pinus koraiensis*(—·—) stands.

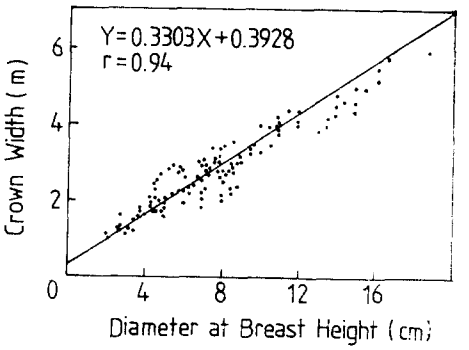

Fig. 2. The relation of crown width to DBH for combined *Pinus densiflora*, *Pinus rigida* and *Pinus koraiensis* stands.

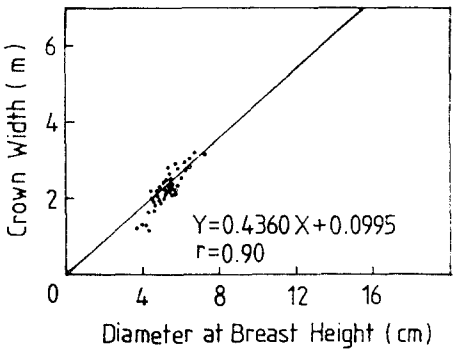

Fig. 3. The relation of crown width to DBH for *Ginkgo biloba* stands.

The differences between *Pinus densiflora* and *Pinus rigida* were not statistically significant at the 5% level. But the differences between *Pinus koraiensis* and them were significant. All pines data were com bined in Fig. 2 for simplicity in application.

Crown width and DBH for *Ginkgo biloba* also were highly correlated(Fig. 3). The differeences between pines and ginkgo were highly significant at 5% level.

In considering the relations described above, it may be inferred that the crown width of a tree with a given DBH cannot occupy more than a certain area in spite of an unlimited growing space. One can easily calculate an area that the crown of a tree can grow at the maximum(Maximum Crown Area, MCA). MCA value can be obtained by the percentage of an area occupied by a vertical projection of the crown per areas.

$$MCA=\pi(CW/2)^2/areas=0.0785(CW)^2$$

where CW; Crown Width

From the regression analysis of ginkgo stand data (Fig. 3),

$CW=0.4360D+0.0995$ where D; DBH

and $(CW)^2=0.1901D^2+0.0868D+0.0099$

Therefore, $MCA=0.0149D^2+0.0068D+0.0008$

In case of combined pines data,

$MCA=0.0086D^2+0.0204D+0.0121$

Then, the number of trees per areas that are theoretically required to produce a complete canopy can readily calculate with MCA values. For example, if a tree(in ginkgo) has a DBH of 10cm and MCA of 1.56, the areas can be completely covered by 64 trees with that size.

In view of a stand density, according to Krajicek's Crown Competition Factor(CCF), the summation of MCA value for all trees in the stand per areas can be expressed as an index of crown competition. For example, in case of ginkgo stand,

$$CCF=0.0149(\sum Di^2Ni)+0.0068(\sum DiNi)+0.0008(\sum Ni)/A$$

where Di; individual DBH or DBH class
Ni; number of trees in DBH class
A; areas(m^2)

Table 1. The CCF values for *Pinus densiflora*, *Pinus rigida*, *Pinus koraiensis*, and *Ginkgo biloba* stands

Stand	CCF
P. densiflora	55.4
P. rigida	12.1
P. koraiensis	29.0
G. biloba	19.2

Through the above procedures, CCF values of each stand were given in Table 1. *P. densiflora* stand had the highest CCF value and next orders were *P. koraiensis*, *G. biloba*, and *P. rigida*. Though CCF value does not represent essentially crown closure, it estimates the area available to the average tree in the stand in relation to maximum area it could use, if it were open grown. So, in regarding CCF value as a indicator of crown competition, it suggests that *P. densiflora* grown in afforested areas in the vicinity of natural forests has grown better.

It is apparent that maintaining stand density below CCF 10 until maturity would produce low quality trees, especially if they were not pruned artificially. If the trees get gradually old, the crowns of each tree will overlap each other much more. From then, competition between trees may be viewed in terms of influence zone overlap of individual trees rather than stand density(Opie, 1968; Bella, 1971; Daniels, 1976).

The similarity of crown widths among the pine species suggested that perhaps a given crown width /DBH relation may be rather common within a genus. A comparison of pines and ginkgo stands as measured by crown competition revealed a structural differences. This agreed with the results that oak-hichory and Norway spruce stands showed different structures with respect to crown competition (Krajicek *et al.*, 1961).

摘 要

소나무, 리기다소나무, 잣나무와 은행나무의 樹冠

너비와 胸高直徑과의 關係를 樹冠競爭의 側面에서 調査하였다. 回歸分析 結果, 樹冠너비와 그 胸高直徑은 높은 相關關係를 보였으며, 그 結果는 다음과 같다.

소나무	$Y=0.3477X+0.3828$, $r=0.95$
리기다소나무	$Y=0.3537X+0.1645$, $r=0.95$
잣나무	$Y=0.2895X+0.6310$, $r=0.92$
은행나무	$Y=0.4360X+0.0995$, $r=0.90$

銀杏나무는 세 소나무類와 有意的인 差異를 나타냈는데 이는 樹種에 따른 樹冠形成의 構造的인 差異에 起因하는 것으로 생각된다.

樹冠競爭의 한 指標로서 最大樹冠面積(MCA)과 樹冠競爭要素(CCF)를 計算하여 比較해 본 結果, 黃石山의 *Pinus densiflora*가 가장 잘 成長하였음을 알 수 있었다.

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