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Growth Performance of *Betula platyphylla* var. *japonica* Hara Introduced from Japan[1]

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ABSTRACT

Three half-sib families of *Betula platyphylla* var. *japonica* had been introduced from Japan and tested for their growth potentiality by comparing with control trees originating from previously introduced and cultivated stands of unknown seed origin. Two of the three introduced family groups from Japan showed superior tree growth in both diameter and height to control one up to the age of four. But only one family group remained superior to the control trees at age six. It appeared from the results that *Betula platyphylla* var. *japonica* families, introduced from Japan, can be directly used for the production of planting stocks for commercial planting and/or as parental trees for the production of intra- and interspecific hybrids.

Key words : Betula platyphylla var. japonica. *species introduction*. *growth performance of seedlings*.

要 約

日本産 자작나무 3 家系의 種子(自然 受粉된 것)를 導入 大邱 地域에 植栽하여 國內 栽培種(種子 起源 未詳)과 幼時 生長力을 比較 分析 하였다. 導入된 3 家系 中 2 家系는 4年 生 때 樹高 및 直徑 生長이 國內 比較木에 비해 越等히 빨랐다. 6年 生 때에는 3 家系 중 1 家系만이 比較木에 비해 樹高 및 直徑 生長이 빨랐다. 日本産 자작나무의 生長力을 國內産 比較木과 比較 分析한 結果 이들은 生長 및 其他 特性이 國內産 자작나무에 비해 優秀하여 造林用 苗木 生産 또는 種內 및 種間 雜種 種子 生産用 交配 母樹로서 利用 價値가 높은 것으로 나타났다.

INTRODUCTION

The pioneer species *Betula platyphylla* var. *japonica* is distributed in Korea, northeastern China and Japan. The wood can be used for specialty products such as toothpicks, ice cream sticks, spools, tool handles, chopsticks, toys, wood carvings, wooden wares, and plywood as well as pulpwoods.

Canadian research workers investigated the possibility of syrup production from paper birch by tapping wood sap in spring(Jones and Alli 1987, Kok *et al* 1978). In Korea, villagers near high mountains used to tap wood sap from *Betula costata*, *Betula ermani* and *Acer mono* for drinking, which, they believed endows peoples with a fast recovery from weakness, and helps maintaining good health. Villagers used to tap the wood sap from *Betula costata*, *Betula ermani*

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and/or *Acer mono* since only those were available tree species for sap tapping in Republic of Korea. Since the 1970's, forest owners in Republic of Korea began to establish *Betula platyphylla* var. *japonica* stands in small scale expecting fast rewards with short rotation from this tree species.

At present, in most cases, forest owners in Korea do not willingly establish stands of economically important tree species mainly because of the high cost involved in establishing and managing the stands up to rotation, total expenses of which may exceed the total yielded income from rotation. However, the species *Betula platyphylla* var. *japonica* has enough reasons to attract forest owners in establishing new stands extensively due to its fast growth and the economic value of wood sap in Korea.

The author, at present work, observed that the growth of *Betula platyphylla* var. *japonica* in new plantings was not even with mixtures of tall trees and some stunted ones. This observation logically assumes that the trees are originated from a few parental families which may cause severe inbreeding depression in their progenies. The author realized that introduction of new gene resources and breeding is necessary to improve the yield and stand quality of *Betula platyphylla* var. *japonica* in Korea.

The aim of this study was to evaluate the growth performance of newly introduced *Betula platyphylla* var. *japonica* from Japan for the breeding of birch species in Korea.

MATERIALS AND METHODS

Three half-sib families of *Betula platyphylla* var. *japonica* were introduced from Japan in 1988. The seeds are from latitudes between 42°38'N~43°20'N. Seedlings had been grown in small plastic pots for about two months in plastic-greenhouse and transplanted outside in late June in 1989. Six seedlings of the three introduced families and control trees were planted side by side in rows on shale deposit between two buildings in campus of Kyungpook National University(35°N, 128°E). Control trees are originated from four families selected for their good growth in Pyungchang Kangwon Province(37°25'N 128°29'E. The seed origin of the parental trees was not known).

The trees were watered from time to time during severe drought in late springs every year and fertilized with about 60 grams of N12-P16-K4 solidified complex fertilizer in spring of 1990. Some of the seedlings had died or were broken by accident during the first year of planting and thus planted again in the following year with newly raised seedlings. The trees grown from complementary planting were excluded from measurements. Tree height and diameter at breast height were measured three times : on June 15th (middle of fourth year growth) 1992, about one week before the beginning of summer monsoon rain, on March 15 1993(fourth growth year), and on the 28th of February 1995(sixth year growth). Four trees of each family group including controls were measured for their height and diameter at breast height.

RESULTS AND DISCUSSION

The height growth of birch seedlings was very rapid starting from the third year of transplanting when the root systems of the birch seedlings were well established. Birches grow continuously with sympodial growth behavior during the whole growth season, in contrast to the tree species, with some exceptions, that belong to pine family which show a monopodial shoot growth limited to spring flushes.

Birches appeared to have more height growth during the period of monsoon than during the spring flushes before the beginning of summer monsoon rain. Half of the investigated trees grew more than 1 meter during the rest of growth season after June 15th 1992. The diameter growth at breast height of introduced family groups during the rest of the growing season after June 15th 1992 was greater than 1cm. Comparing with diameter growth during the past three years from seeding, the growth of diameter during the later part of the growth season in 1992 appeared to be very large. It appeared from the observation that high temperatures and humidity with sufficient water supply during the summer monsoon apparently enhance the tree growth.

Generally, people believe that *Betula platyphylla* var. *japonica* requires cool temperatures for its optimal growth. However the author at present work observed that birch seedlings grow best under conditions of high temperatures up to 30~35℃ and of high relative humidity between 70~80% when the seedlings were supplied with sufficient water and nutrients(Chung *et al* 1995).

Height and diameter growth, and the differences among family groups are presented, respectively, in Tables 1 and 2. The height growth of introduced family groups was very high compared to the growth at the same age classes of birch seedlings raised by local farmers from unknown seed origin and planted in Kangwon Province by Donghae Pulp Company. Mean height growth of birch seedlings planted in Kangwon Province for 4the 4 and 6 years age classes were respectively 283 and 421cm(unpublished data) while the comparable values of the present work were 486 - 496cm and 772~824cm. The author at present work believe that the difference in height growth between the two planting sites is due mainly to genetic potentiality of the seed sources for growth. The growth of birch seedlings at plantings in Kangwon Province was not even and the differences in height growth were very much pronounced between the inferior and superior trees at ages four to six. The control plants of the present work showed the same growth pattern as those of the birch plantings in Kangwon Province while the seedlings of introduced family groups generally showed an even tree growth. The standard deviation of control trees in height growth was almost two times that of introduced families at age four. The same value of the control trees increased to almost three times that of the introduced family groups at age six(Table 2).

Two of the three introduced family groups showed superior growth both in diameter and

Table 1. Height and diameter growth of *Betula platyphylla* var. *japonica*.

Measurements	Diameter at breast height(cm)			Tree height(cm)		
& Tree no.	3+-year old*	4-year old	6-year old	3+-year old*	4-year old	6-year old
P 11-2(cont.)	2.8	4.0	7.6	346	478	797
P 11-3(cont.)	1.7	2.8	6.5	290	338	696
P 11-4(cont.)	1.6	1.8	4.3	235	254	470
P 11-5(cont.)	2.0	2.4	4.0	316	368	512
Mean±sd.	2.0±0.5	2.7±0.9	5.6±1.7	296.8±47.1	359.5±92.6	618.8±154.1
PJ 16-1	3.8	5.0	9.5	452	554	812
PJ 16-4	2.8	4.4	7.8	376	494	710
PJ 16-5	1.9	2.6	5.7	343	477	772
PJ 16-6	2.1	3.0	6.0	314	419	795
Mean±sd.	2.7±0.9	3.8±1.1	7.3±1.8	371.3±59.5	486.0±55.6	772.2±44.6
PJ 17-1	4.0	5.6	9.2	443	553	873
PJ 17-2	2.6	4.7	8.0	379	470	823
PJ 17-3	3.3	4.4	8.1	398	448	786
PJ 17-4	3.5	4.5	7.9	450	512	813
Mean±sd.	3.4±0.6	4.8±0.6	8.3±0.6	417.5±34.5	495.8±46.5	823.8±36.4
PJ 18-1	3.5	4.4	7.8	401	521	841
PJ 18-3	3.8	5.2	9.2	422	499	792
PJ 18-4	3.0	3.8	6.9	359	426	697
PJ 18-5	2.6	4.0	7.8	343	521	809
Mean±sd.	3.2±0.5	4.3±0.7	7.9±1.0	381.3±36.6	491.8±45.0	784.8±61.9

* measured on June 15th, 1992 about two and half months after spring flush and about one week before summer monsoon rain in the third year from seeding.

Table 2. Differences in diameter and height growth among family groups.

Age class	Family	DBH, the ratio, & the differences				Tree height, the ratio & the differences			
	P 11(cont.)	2.0±0.5	100.0%			296.8± 47.1	100.0%		
3+-year old[1]	PJ 16	2.7±0.9	135.0%	**	**	371.3± 59.5	125.1%	***	*
	PJ 17	3.4±0.6	170.0%			417.5± 34.5	140.7%		
	PJ 18	3.2±0.5	160.0%			381.3± 36.6	128.5%		
	P 11(cont.)	2.7±0.9	100.0%			359.9± 92.6	100.0%		
4-year old	PJ 16	3.8±1.1	140.7%	**	**	486.0± 55.6	135.0%	*	*
	PJ 17	4.8±0.6	177.8%			495.8± 46.5	137.8%		
	PJ 18	4.3±0.7	159.3%			491.8± 45.0	136.7%		
	P 11(cont.)	5.6±1.7	100.0%			618.8±154.1	100.0%		
6-year old	PJ 16	7.3±1.8	130.4%		*	772.3± 44.6	124.8%		*
	PJ 17	8.3±0.6	148.2%			823.8± 36.4	133.1%		
	PJ 18	7.9±1.0	141.1%			784.8± 61.9	126.8%		

[1] measured on June 15th, 1992 about two and half months after spring flush and about one wee' before summer monsoon rain in the third year from seeding.
t-test by pooled variances. * significant at probability of 0.050, ** significant at probability of 0.025, *** significant at probability of 0.010.

height to control trees up to age four(Table 2). But only one family group was superior to the control trees at age six. Some of the fast growing trees of introduced families had been decapitated by typhoons during fourth- and fifth-year growth seasons and the height growth was retarded from that time with tapering of the tree apex.

One of the sixteen investigated trees began to develop a few female catkins at the third year of seeding. The precocious flowering of the investigated trees appeared to be caused by the partial two and a half months treatment of flowering induction during the seedlings growth. All the investigated trees were raised in a plastic-greenhouse designed and treated culturally for flowering induction(refer to Ryu *et al* 1995). The trees of introduced families were treated with growth retardant succinic acid 2,2-hydroxymethylhydrazide in their fourth- and fifth-year(included half of the control plants) growth seasons to induce abundant flowering(Chung *et al* 1995) at early ages on one hand and to reduce the height growth for the convenience of operation for cross pollination on the other. The treatments by growth retardants in two successive years appeared to reduce the height growth in some extent and thus mitigated the differences in height growth between the investigated families and the controls at age six. It also appeared from the observation that a long-lasting dry and hot spell during the summer in 1994 affected more the height growth of the fast growing introduced family groups than that of the slow growing controls.

Most of the investigated trees began to develop female catkins at seedling age five including half of the control. Some of the trees also began to develop a few male catkins. All the investigated trees began to develop female catkins at age six. Some of the trees with abundant female flowering showed a reduced tree growth most probably due mainly to an energy balance system between vegetative and reproductive growth.

Large variation in height growth within control trees also contributed to mitigating the differences in statistical treatment. Two of the four control trees grew as fast as some of the introduced ones while the other two trees showed a stunted growth at age six(Table 1). The large variation in control trees is suspected to be caused by inbreeding. This kind of variation in tree growth can be observed in many birch plantings originated from a narrow genetic base in Korea.

It appeared from the result that growth potentiality of the progenies of family PJ17 is promising for immediate and practical use in commercial birch plantings as well as for breeding stocks. Though there was no statistical differences(the possible reasons of which were explained before) between the control trees at age six, the progenies of the families PJ 16 and PJ 18 also appeared to be useful for commercial plantings, from a present practical point of view, because their growth in diameter and height appeared to be even and better than the control ones. The seedlings of introduced family groups grew 25~33% better than the controls in height at age six (Table 2).

Birch species have a high potentiality for genetic improvement as shown by Lepistö(1981). Studies on interspecific hybrids were reported by Johnsson(1949) and Clausen(1970). Species hybrids between *Betula platyphylla* var. *japonica* and *Betula pendula* being made since 1992. A large quantity of hybrid seeds that can produce more than six millions of planting stocks are produced every year from a few tens of clonal and/or familial collections of birch species in Taegu. The interspecific hybrid between *Betula platyphylla* var. *japonica* and *Betula pendula*(Finnish origin), particularly, the F_1-hybrid originated from the introduced family groups from Japan, appeared to be very promising as far tested under controlled environment but their growth potentiality must be tested under natural outside conditions. Interspecific hybrid between *Betula alleghaniensis* and *Betula papyrifera* grows very fast(Burton *et al* 1974) while hybrid between *Betula alleghaniensis* and *Betula lenta*(Sharik and Barnes 1971) does not. However, there seems to be neither genetic barriers nor hybrid inferiority between *Betula platyphylla* var. *japonica* and *Betula pendula*. as far as concerned with breeding materials at present work(unpublished).

In conclusion, growth of *Betula platyphylla* var. *japonica* families introduced from Japan at ages four and six appeared to be better than that of control trees originated from Korean collections. The birch families can thus be directly used for the production of planting stocks for commercial planting and/or as parental trees for the production of intra- and interspecific hybrids.

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