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THE EFFECT OF SEED SIZE AND DURATION OF GROWTH ON THE HEIGHT OF SCOTS PINE *(Pinus sylvestris* L.) AND NORWAY SPRUCE *(Picea abies* (L.) Karst.) PROVENANCES AND PROGENIES AT THE NURSERY STAGE

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SIEMENEN KOON JA KASVUN KESTON VAIKUTUKSESTA MÄNNYN (PINUS SYLVESTRIS L.). JA KUUSEN (PICEA ABIES (L.) KARST.) ALKUPERIEN JA JÄLKELÄISTÖJEN PITUUSKASVUUN TAIMITARHAVAIHEESSA

1. INTRODUCTION

Forest tree breeders have endeavoured to develop testing methods for the selection of provenances and individuals, which would enable them to forecast the final value of the characteristics to be tested already from quite young plant material. Especially NANSON (1968) has shown that in Scots pine and Norway spruce satisfactory information about long term growth differences between provenances can be acquired from the variation in seed weight, annual growth rhythm and total growth even in early tests carried out at the nursery stage.

Tree populations which have adapted to different climatic conditions differ from each other in many physiological characteristics. For instance, southern and lowland provenances generally have a longer period of annual growth and correspondingly they grow more annually than northern or highland ones, which are adapted to shorter growing seasons (e.g. LANGLET 1936 and 1967). Many of the physiological differences due to adaptation to growing seasons of differing length are visible already at the early seedling stage and remain relatively similar at greater ages (SCHMIDT 1957).

Although seed size is partly determined by the genetic properties of the mother tree, it is also affected by many environmental factors. It is well known that seed size has a strong influence on the early development of the arising seedlings (HADDERS 1963, BURGAR 1963, ROHMEDER 1939). Usually, large seeds containing much reserve material produce fast-growing seedlings, but information about the duration of the effects of seed size is scant and variable (GIERTYCH 1974, ROHMEDER 1972, SIMAK 1955).

In this paper the connections between seed weight and amount and duration of growth are studied at the progeny level within stands or climatically uniform areas, and on the other hand, at the provenance level within larger geographic areas. The study is here limited to deal with the relationships between the three characteristics mentioned above using the correlations between data obtained at the nursery stage only. This work is connected with more extensive studies on early testing methods, particularly on the applicability of genetically controlled annual growth rhythm characteristics as early test criteria.

2. MATERIAL AND METHODS

The material of this study consists of materials of several experiments raised in the nursery of Maisala Tree Breeding Station of the Finnish Forest Research Institute between the years 1971 and 1976. The origins of the plant material used in the different experiments ranged from progenies of individual Scots pine or Norway spruce trees to provenance selections covering almost the whole natural range of these species. The composition of each experiment is summarized in Tables 1 or 2. During the first summer the material of each experiment was raised in a greenhouse, where special arrangements were made in order to produce homogeneous growing conditions. The experimental design was a complete randomized block system in all cases; 4, 6 or 8 replications were used and the plot size was 48 or 24 seedlings. In order to study closer the effects of seed weight the provenances or progenies included in three experiments (Nos. 514, 515 and 516 B) were further screened into 2 or 3 treatments according to seed size.

In all the experiments, observations were made of terminal bud formation in the late summer of the 1st year. Using bud development data, the dates when 50 % of the plants had reached the bud stage were determined for each plot. These dates were taken as the times of growth termination when the duration of the 1st year's height growth period (in days) was calculated. In a few cases the timing of growth was also followed during the 2nd growing season, by frequent measurement of the lengths of the developing top-shoots. The final height of the plants was measured in all experiments at the end of the 1st year. In addition, hypocotyl length and total height during the growing period (in July) were measured in some experiments.

It was originally planned that all plant material included in this study would be grown to a plantable size for the establishment of longer term experiments. The plants were thus transplanted in the nursery, in most cases at the age of 1 year. Since this procedure considerably disturbed the development of growth differences, the 2nd and 3rd year's growth in the nursery have been omitted from this study, except for a few interesting cases.

This paper is concerned with the study of correlations between 1000-seed weight, length of growing period and plant height at different seedling stages. The means and the ranges of progeny or provenance means of the characters studied in each experiment are shown in Tables 1 and 2. More detailed information about the observation data is not presented in this connection. However, it might be worthwhile mentioning that according to the analyses of variance there were statistically highly significant differences (at 0.1 % level) between the test members (progenies or provenances) in every experiment, both as regards the duration of growth and all heights measured at different stages. Especially the length of the growing period proved to be a property under strong endogenous control, the variation of which was much less subject to slight environmental changes within the greenhouse than the variation in total growth.

Table 1. General information of the *progeny test* materials: composition of experiments and means and ranges of the parameters studied.

Experim. No. and tree species	General description of experimental material	Parameters studied, means of the experiments and ranges of progeny means within experiments[1]) (min. — max.)						
		Weight of 1000 seeds g	Hypocotyl length mm	Height during the 1st growing season cm	Height at the age of 1 year cm	Height at the age of 2 years cm	Duration of height growth, 1st year days	Timing of height growth, 2nd year % of total growth passed on June 7th
427 Scots pine	21 plustree progenies (wind-pollinanted and controlled crosses) and 6 stand seedlots, all from South Finland.	5.3 (3.5—7.4)	21.0 (18.4—25.8)	4.1 (3.0—5.7)	11.5 (8.6—14.3)	23.9 (16.3—27.6)	112.1 (90—122)	62.7 (49—81)
464 Scots pine	16 wind-pollinated progenies of South Finnish plustrees from two clone collections.	5.6 (3.5—7.5)	22.7 (18.9—26.9)	6.2 (5.4—7.9)	9.3 (7.8—11.2)	. .	93.0 (81—109)	. .
465 Norway spruce	Wind-pollinated progenies of 10 individual trees from a single stand and 2 stand seedlots, all from South Finland.	5.8 (4.1—7.8)	. .	5.0 (4.0—5.5)	8.6 (6.9— 9.3)	22.5 (20.1—25.0)	83.5 (79— 89)	. .
489 Scots pine	Wind-pollinated progenies of individual trees from 4 stands in South or Central Finland (5 mother trees per stand).	4.2 (2.9—6.3)	. .	. .	10.9 (8.4—14.6)	. .	114.0 (104—129)	. .
490 Scots pine	Wind-pollinated progenies of 15 South Finnish plus-trees from a clone collection.	5.5 (3.5—7.1)	. .	. .	12.3 (10.5—14.8)	. .	114.6 (107—121)	. .
514 Scots pine	Wind-pollinated progenies of individual trees from 3 stands in South or Central Finland (5 mother trees per stand), each progeny divided into 3 seed weight classes.	4.6 (3.6—5.6)	19.7 (16.2—24.0)	4.1 (3.0—5.2)	9.9 (7.2—12.2)	. .	119.5 (110—129)	. .
515 Scots pine	Wind-pollinated progenies of 15 South Finnish plus-trees from a clone collection, each progeny divided into 2 seed weight classes.	5.7 (4.0—7.8)	21.1 (17.3—25.3)	4.9 (4.0—6.1)	9.2 (6.9—12.4)	. .	122.5 (114—133)	. .
565 Scots pine	40 controlled crosses of South Finnish plustrees (10 mothers × 4 fathers) plus wind-pollinated progenies of the 4 father trees from 2 clone collections, and 2 stand seedlots.	6.5 (4.0—8.5)	22.7 (17.7—26.6)	6.6 (4.8—8.5)	17.0 (13.9—19.8)	. .	111.3 (85—125)	. .
566 Norway Spruce	15 controlled crosses of trees of a single stand in Sout Finland (half dialled of 5 trees).	5.3 (3.2—6.9)	18.6 (16.3—22.5)	4.2 (3.6—4.9)	8.0 (6.3—10.3)	. .	110.1 (104—129)	. .

[1]) . . = data missing.

Table 2. General information of the *provenance test* materials: composition of experiments and means and ranges of the parameters studied.

Experim. No. and tree species	General description of experimental material	Parameters studied, means of the experiments and ranges of provenance means within experiments[1]) (min. — max.)							
		Weight of 1000 seeds g	Hypocotyl length mm	Height during the 1st growing season cm	Height at the age of 1 year cm	Height at the age of 2 years cm	Height at the age of 3 years cm	Duration of height growth, 1st year days	Duration of height growth, 2nd year days
516 A Norway spruce	Provenances from a wide geographic area (lat. 47° 20′—68° 00′ N, long. 6° 53′—40° 00′ E):	7.7	16.3	4.2	6.6	12.1	26.3	105.5	61.2
	15 from Finland, 5 from Soviet Union (Estoria, Latvia, Lithuania, Arkangel, White Russia) and 4 from Central Europe (Poland, Czechoslovakia, Romania, France)	(4.3—9.5)	(12.9—19.4)	(1.4—5.5)	(1.9—10.9)	(3.1—19.1)	(5.4—42.0)	(35—158)	(13—84)
516 B Norway spruce	Procenances from a small geographic area (lat. 60° 39′—63° 17′ N, long. 23° 27′—29° 50′ E):	5.8	15.0	3.8	5.3	10.0	. .	97.3	. .
	6 provenances from South and Central Finland, each one divided into 2 seed weight classes.	(4.3—7.3)	(12.6—17.7)	(2.8—5.0)	(3.4—13.8)	(6.2—13.8)		(84—105)	
552 A Scots pine	Provenances from a wide geographic area (lat. 39° 58′—69° 42′ N, long. 4° 19′—131° 00′ E):	5.2	. .	. .	11.1	. .	. .	120.4	. .
	19 from Finland, 4 from Soviet Union (Arkangel, Latvia, Novosibirsk, Yakutsk), 6 from Central or Western Europe (Poland, Scotland, France, Belgium, Hungary, Bulgaria) and 1 from Turkey.	(3.1—9.2)			(5.3—16.6)			(88—152)	
552 B	Provenances from a smaller geographic area (lat. 60° 03′—69° 42′ N, long. 23° 02′—29° 49′ E):	4.3	. .	. .	9.4	. .	. .	107.7	. .
	19 provenances from Finland (= the Finnish provenances of exp. 552 A studied separately).	(3.1—5.6)			(5.3—13.7)			(88—140)	

[1]) . . = data missing.

3. RESULTS

3. 1. Seed weight and amount of height growth

In most experiments a strong positive correlation existed between the seed weight and the heights measured at different stages of the 1st growing season (Tables 3 and 4). Immediately after germination, correlation was statistically significant in all cases in which the hypocotyl length was measured, except in one experiment (566). Furthermore, the effect of seed weight on the seedling heights decreased almost in every case while growth continued, but the correlations were generally still significant at the end of the 1st growing season. Exceptional development in experiment 566 may be due to differing storage time of the seedlots (range 1—6 years).

Correlations between the seed weight and the heights in later years are available from three experiments only. In pine progeny test 427, the correlation disappeared almost completely already during the 2nd year, even though the material was not transplanted after the 1st year. In spruce provenance test 516 A, representing a wide geographic variation, the effect of seed weight on the height growth seems to have strengthened after the germination stage and has remained strong at least until the 3rd year, although the material was transplanted at the age of 1 year. On the other hand, in the narrower seed-weight screened provenance material of experiment 516 B the correlation has diminished steadily.

3. 2. Duration and amount of height growth

In progeny tests (Table 3) there was no obvious connection between the duration and the amount of height growth during the 1st year. However, in provenance tests (Table 4) the situation was quite different. The duration of growth was positively and highly significantly correlated with the total amount of growth in all cases, clearly even stronger than the seed weight. It is interesting to see in the spruce provenance tests that in the wider geographic material the 1st year's growing period was just as well correlated with the current year's as with two following year's total heights, and in the geographically narrower material even better with the height of later years.

3. 3. Seed weight and duration of height growth

The obvious correlation of both seed weight and growing period with total growth in the provenance tests suggests that these two characteristics might be correlated with each other, too. This seems to be true in the wide geographical materials (Table 4), but no clear connection can be seen in the progeny tests (Table 3). It is commonly known from provenance research that seed weight and annual growth rhythm in trees are both genetic properties which are closely connected to the geographic origin of material. Thus they are correlated with each other indirectly through the locality of origin, although seed weight as such, hardly has any direct effect on the timing of height growth in seedlings arising from it.

In the light of the above observations, the correlations shown by Finnish provenance materials are contradictory. However the discrepancies can be explained. In the Finnish pine provenance material (experiment 552 B) the northern material represents the seed harvested in 1972, which was an unusually good seed year in North Finland. Thus the whole selection of Finnish provenances deviated as regards seed weight from the normal pattern of geographical variation in the seed weight of Scots pine, according to which seed size diminishes from south to north. In the case of Finnish spruce provenances (experiment 516 B), on the other hand, only the direct effects of seed weight on growing period are in question, becauce the original differences between provenances as regards seed weight were eliminated when the material was screened into seed weight classes.

Table 3. Correlations between seed weight, amount of height growth and duration of growing period in Scots pine and Norway spruce *progeny tests* at the nursery stage.

Experim. No. and tree species	Material (see closer in table 1)	Number of observations	Parameters compared [1]: x = seed weight; y = hypocotyl length	x = seed weight; y = height during the 1st growing season	x = seed weight; y = height at the age of 1 year	x = seed weight; y = height at the age of 2 years	x = seed weight; y = duration of height growth during the 1st year	x = seed weight; y = duration of height growth during the 2nd year	x = duration of height growth during the 1 st year; y = height at the age of 1 year	x = duration of height growth during the 1 st year; y = height at the age of 2 years
			Correlation coefficients, r_{xy} [2]							
427 Scots pine	21 plustree progenies and 6 stand seedlots	27	0.79***	0.66***	0.42*	0.17	0.00	0.05	0.16	0.27
464 Scots pine	16 plustree progenies	16	0.81***	0.63**	0.33	. .	−0.05	. .	−0.26	. .
465 Norway spruce	Progenies of 10 trees of a single stand and 2 stand seedlots	12	.	0.62*	0.30	. .	−0.49	. .	0.38	. .
489 Scots pine	Progenies of 20 trees in 4 stands	20	. .	. .	0.83***	. .	0.14	. .	0.28	. .
490 Scots pine	15 plustree progenies	15	. .	. .	0.74**	. .	−0.07	. .	−0.09	. .
514 Scots pine	Progenies of 15 trees in 3 stands, each progeny divided into 3 seed weight classes	45	0.77***	0.70***	0.63**	. .	0,34*	. .	0,35*	. .
515 Scots pine	15 plustree progenies, each progeny divided into 2 seed weight classes	30	0.84***	0.83***	0.66***	. .	0.22	. .	−0.11	. .
565 Scots pine	Plustree progenies, 40 controlled crosses and 10 wind-pollinated	50	0.70***	0.53***	0.50***	. .	0.08	. .	0.13	. .
566 Norway spruce	Controlled crosses of 5 trees of a single stand	15	0.50	0.69***	0.89***	. .	0.49	. .	0.44	. .

[1]) . . = not calculated (data missing)
[2]) *** = significant at 0.1 % level, ** = 1 %, * = 5 %

Table 4. Correlations between seed weight, amount of height growth and duration of growing period in Scots pine and Norway spruce *provenance tests* at the nursery stage.

Experim. No. and tree species	Material (closer in table 2)	Number of observations	Parameters compared [1]) x = seed weight: y = hypocotyl length	y = height during the 1st growing season	y = height at the age of 1 year	y = height at the age of 2 years	y = height at the age of 3 years	y = duration of height growth during 1st year	y = duration of height growth during the 2nd year	x = duration of height growth during the 1 st year: y = height at the age of 1 year	y = height at the age of 2 years	y = height at the age of 3 years
			Correlation coefficients, r_{xy} [2])									
516 B Norway spruce	24 provenances, wide geographic variation	24	0.61**	0.61**	0.82***	0.82***	0.77***	0.82***	0.71***	0.96***	0.96***	0.95***
156 B Norway spruce	6 provenances, narrow geographic variation. Each provenance divided into 2 seed weight classes	12	0.84***	0.68*	0.61*	0.54	0.43	0.24	. .	0.67*	0.80**	0.87***
552 A Scots pine	30 provenances, wide geographic variation	30	. .	. .	0.49**	. .	. .	0.60***	. .	0.86***	. .	. .
552 B Scots pine	19 provenances, part of the material of exp. 552 A (narrower geographic variation)	19	. .	. .	−0.22	. .	. .	−0.42	. .	0.88***	. .	. .

[1]) and [2]) see table 3.

3. 4. Connections between geographic origin and seed weight, growing period and total growth

Since all the three characteristics studied showed clear connections with each other in the materials which included large geographic variation, it was considered justifiable to examine separately their relationships with the locality of origin. Correlation coefficients for the three characteristics and the latitude of origin of the provenance materials are presented in Table 5. Latitude was chosen to represent the locality of origin because it alone was better correlated with growth characteristics than any other available single variable representing the origin of provenances. In fact in the Finnish pine and spruce materials the average annual temperature sum of the localities explained the genetic differences between provenances even better, but precise information about temperature sums was not available in the case of foreign provenances. By the way, for the Finnish provenances, the latitude and the annual temperature sum of the origins proved to be strongly correlated with each other, in the pine material r = −0.98*** and in the spruce material r = −0.90***.

Correlation between latitude and seed weight could not be calculated for the

Table 5. Correlations between seed weight, height growth and duration of growing period of Scots pine and Norway spruce provenances at the nursery stage and the latitude of origin.

Experim. No. and tree species	Material (closer in table 2)	Number of observations	Parameters compared [1]) x = latitude of origin: y = seed weight	y = height at the age of 1 year	y = height at the age of 2 years	y = height at the age of 3 years	y = duration of height growth, 1st year	y = duration of height growth, 2nd year
			Correlation coefficients, r_{xy} [2])					
516 A Norway spruce	24 provenances (lat. 47° 20′ – 68° 00′ N)	24	−0.86***	−0.92***	−0.91***	−0.90***	−0.93***	−0.83***
516 B Norway spruce	6 provenances (lat. 60° 39′ – 63° 17′ N) divided into 2 seed weight classes	12	. .	−0.21	−0.46	−0.57	−0.75***	. .
552 A Scots pine	30 provenances (lat. 39° 58′ – 69° 42′ N)	30	−0.82***	−0.71***	. .	. .	−0.87***	. .
552 B Scots pine	19 provenances (lat. 60° 03′ – 69° 42′ N)	19	0.49	−0.87***	. .	. .	−0.97***	. .

[1]) and [2]) see table 3.

Finnish spruce provenance material because the original differences in seed weight were eliminated by screening. Furthermore, the contradictory result given by the Finnish pine provenances as compared to wider provenance material is understandable in the light of the preceding.

The latitude of origin was highly significantly correlated with the 1st year's total height in all provenance experiments except in the Finnish spruce material, which also had the narrowest variation in geographic origin. In the wide spruce provenance material the correlation has remained almost unchaged for the next two years, too, and even in the Finnish spruce material it has increased year by year. In the pine experiments the correlation between the latitude of origin and the 1st year's total growth was stronger in the Finnish material than in the wider geograpical material.

Of the three characters studied, the length of the height growth period seems to be most closely connected to the geographical origin of the material. Especially in the Finnish pine material, it seems that the duration of 1st year's height growth was almost completely determined by the location of origin in the south — north direction.

4. DISCUSSION

The correlations between seed weight and plant heights at different stages during the 1st growing season acquired in this study are consistent with earlier results. Generally speaking, the effect of seed weight is strongest immediately after germination and subsequently decreases steadily, when the genetic growth properties of the plants themselves become effective. Anyhow, the strong effect of seed weight on growth is usually visible at least until the end of the 1st growing season.

The relationships between seed weight and growth vary considerably depending on the nature of the material studied. If genetic differences in the physiological characteristics of the test material are slight, the growth differences appearing at the nursery stage are mainly due to differences in seed size. This seems to be the normal situation at the individual or family level in progeny tests and maybe also at the population level within a small geographic area. However, in the case of large geographic vatiation, the direct effect of seed size obviously is only of very short duration. Even then seed weight may be indirectly correlated with height growth for a long time, but as early as in the 1st growing season the genetic growth properties of the plants themselves become dominant in determining the total amount of growth.

The connections between the duration and the amount of height growth also proved to differ according to the nature of the genetic variation of the study material. In wide selections of provenances, which show clear genetic differentiation as regards annual growth rhythm, the variation in the duration of growth accounts for most of the differences in total height growth. On the other hand, at the individual and family level or between provenances of a limited area, when the genetic differences in growth rhythm are not directly due to the adaptation to specific growing conditions, but more or less accidental, there seems to be no clear connection between the duration and the amount of growth. The different results obtained from progeny and provenance tests may be partly due to differences in total variability, which of course was much larger in provenance tests than in progeny tests, both as regards the duration and the amount of growth. However, it should be repeated here, that according to the analyses of variance there were statistically significant differences between provenances or progenies in all experiments, both as regards the total growth and the lenght of growing period.

No clear connection between the seed weight and the duration of growth could be detected in the progeny test materials, and even the positive correlations in provenance tests can be understood to be indirectly caused by the growth factors prevailing at the locality of origin. Generally it seems that the duration of the annual growing period of seedlings is a genetic property, which is not affected by seed weight. In particular, the almost complete correlation showed by the Finnish pine provenances between the length of the growing period, even in unnatural greenhouse conditions, and the latitude of origin ($r = -0.97^{***}$) indicates that the timing of terminal bud formation of seedlings in their first year of life is a phenomenon which is very strongly genetically determined and characterizes the adaptation of their annual growth rhythm to certain growing conditions. In Finland the length of the growing season is the most important factor causing genetic differentiation between populations within tree species, and it changes gradually from south to north according to the latitude. This also explains why growth duration and amount were more closely connected to latitude in the Finnish pine provenances than in the larger geographic material. In Finland the variations in growing conditions with respect to altitude and continentality are slight and follow closely the change in latitude. As far as the whole distribution area of Scots pine is concerned, the situation is of course much more complicated.

Annual growth rhythm is a genetic property which is unlikely to change to any great extent during the lifetime of a tree, unlike, for instance, the growth rate. It is difficult to imagine that the adaptation of a population or an individual to the climatic conditions of its natural habitat might vary at different ages. Therefore it seems evident that growth period differences which are noticed between populations, progenies and even individuals in early tests, would stay relatively the same up to greater ages.

Conclusions made about the annual growth rhythm at the seedling stage offer an interesting opportunity in the development of early testing methods for forest trees. Certainly in this study the duration of growth seemed to have no influence on the same year's total growth in the progeny tests of individual trees, but neither the total height alone in 1-year old test material grown in a greenhouse has hardly any value in the forecasting of growth capacity. The growth differences were caused mainly by the variation in seed size and growth rate differences during the growing period. The effect of seed size will undoubtedly lose its importance for the amount of total growth sooner or later. The differences in growth rate which occur during the growing period are obviously mainly due to differences in net photosynthetic rate, which quite possibly may vary at different ages. Up to now, the research results which support the applicability of early tests (NANSON 1968, SCHMIDT 1957 and 1964) are based on provenance material. Anyhow, the development of methods suitable for application at the individual and family level, e.g. for the early testing of the breeding values of phenotypically selected plus trees, remains open.

5. LITERATURE

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SELOSTE:

SIEMENEN KOON JA KASVUN KESTON VAIKUTUKSESTA MÄNNYN (PINUS SYLVESTRIS L.) JA KUUSEN (PICEA ABIES (L.) KARST.) ALKUPERIEN JA JÄLKELÄISTÖJEN PITUUSKASVUUN TAIMITARHAVAIHEESSA

Tutkimuksessa tarkastellaan siemenen koon ja kasvuperiodin pituuden merkitystä männyn ja kuusen taimien kokonaiskasvun kannalta. Aineistona on käytetty useita taimitarhavaiheen kokeita, ns. varhaistestejä. Mainittujen ominaisuuksien välisten yhteyksien todetaan vaihtelevan suuresti, pääasiassa sen mukaan miten laajaa ja minkä luonteista tutkittavassa materiaalissa esiintyvä geneettinen vaihtelu on. Suhteellisen yhdenmukaisilta ilmastollisilta alueilta peräisin olevien yksittäisten puiden *jälkeläiskokeissa* jälkeläistöjen väliset kasvuerot syntyvät aluksi pääasiassa siemenen koossa esiintyvien erojen seurauksena, mutta siemenen painon merkitys kasvuerojen aiheuttajana vähenee tasaisesti ja usein nopeastikin itämisvaiheen jälkeen. Pituuskasvun kestossa (kasvurytmissä) esiintyy yleensä suurta vaihtelua; nämä kasvurytmierot todetaan voimakkaasti geneettisesti säädellyiksi ja siemenen koosta riippumattomiksi. Kasvurytmillä puolestaan ei näytä olevan mitään selvää vaikutusta jälkeläistöjen välisten taimivaiheen kokonaiskasvuerojen syntymiseen. *Provenienssikokeissa*, tutkittaessa populaationäytteitä laajemmilta maantieteellisiltä alueilta, tilanne osoittautui aivan toisenlaiseksi: eri alkuperien väliset kokonaiskasvuerot määräytyivät taimitarhavaiheessa pääasiassa geneettisten kasvurytmierojen tuloksena ja siemenen painon suoranainen vaikutus jäi vähäiseksi. Mänty- ja kuusiprovenienssien väliset geneettiset erot vuotuisessa kasvurytmissä ovat tulosta sopeutumisesta kunkin alkuperän kotiseudulla vallitseviin ilmasto-olosuhteisiin. Siemenen koon geneettinen vaihtelu on myös läheisessä yhteydessä materiaalin maantieteelliseen alkuperään, ja siten siemenen paino ja kasvurytmi korreloivat provenienssiaineistoissa alkuperän kautta välillisesti keskenään. Siemenen painolla tuskin on kuitenkaan mitään suoranaista vaikutusta kasvun kestoon sen enempää provenienssi- kuin jälkeläistötasollakaan.