Tree Improvement of Larch at Waldsieversdorf: Status and Prospects

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Summary

A report is given on the status and the prospects of the work started in 1968 at Waldsieversdorf on provenance research of *Larix decidua* MILL. and interspecific breeding of this species with *Larix kaempferi* (LAMB.) CARR. The investigations were aimed mainly at established basic material to produce tested reproductive material for the lowland and low mountainous sites of the eastern part of Germany. Results are given of two series of trials to test (A) progenies from stands in Germany, Poland and Czechoslovakia and (B) hybrid progenies of different cross combinations which were established in 1977 and 1974 respectively. The best performing progenies were from 2 stands in the eastern part of Germany of unknown origin. The necessity and possibilities for further provenance research in *Larix decidua* are presented.

Because of the hybrids with good stem form usually are not capable of growing above average, breeding work should be continued. Possibilities of doing this are pointed out.

Key words: *Larix decidua* MILL., *Larix decidua* MILL. x *Larix kaempferi* (LAMB.) CARR., provenance research, interspecific breeding.

Introduction

The breeding work of the present Department of Applied Forest Tree Breeding of the Forestry Research Institute Eberswalde within the genus *Larix* was initiated in 1968. It encompassed both provenance research on *Larix decidua* MILL. and interspecific breeding of this tree species with *Larix kaempferi* LAMB.) CARR. (BOLLAND et al., 1987; BRAUN and WEISER, 1981; WEISER, 1984a and b, 1985 a and b, 1986a and b, 1991, in press; WEISER and BRAUN, 1990; WEISER and GIESE, 1991). The investigations aimed at selecting and providing basic material to produce reproductive material mainly for the conditions of the lowland and low mountainous sites of the eastern part of Germany. It will ensure that the developing reproductive material is highly adaptable and fast-growing as well as of high quality, especially with respect to stem form.

A. Provenance Research

Material and Methods

Previously, investigations were focused on *Larix decidua*. In order to establish a first series of trials in the year

Table 1. — Provenances of *Larix decidua* in the progeny test of 1977.

No.	Country	Provenance	Area	Composition	Represented in the trial at			
					Wismar	Flößberg	Eigenrieden	Kiekindemark
1	Germany	Universitäts-FA Eldena	Hanshagen	25)) number of	x	x	x	x
2	.	FA Rothemühl	Johannisberg	25) single	x	x	x	x
3	.	AfF Templin	Brüsenwalde	27) tree	x	x	x	x
4	.	FA Beetzendorf	Wismar	26) progenies	x	x	x	x
5	.	AfF Müncheberg	Wilkendorf	23)	x	x	x	x
6	.	AfF Müncheberg	Heinersdorf	25)	x	x	x	x
7	.	FA Calvörde	Hasselburg	26)	x	x	x	x
8	.	FA Leinefelde	Hahn	25)	x	x	x	x
9	.	FA Sondershausen	Holzengel	25)	x	x	x	x
10	.	FA Brotenfeld	Zobes (ab 1992 Mechelgrün)	11))	x	x	-	-
11	.	Fuggersches FA Wellenburg bei Augsburg		) mixed pro-) genies of	x	x	x	x
12	.	Hofkammer-FA Bietigheim		) several) trees	x	x	x	x
13	.	FA Bad Brückenau		)	x	x	x	x
14	.	FA Pirmasens		)	x	x	x	x
15	.	FA Hinterweidenthal		)	x	x	x	-
16	.	FA Eschwege		)	x	x	x	x
17	Czechoslowakia	LZ Krnov	Krnov	)	x	x	x	x
18	.	LZ Zábreh	Jedli	)	x	x	-	-
19	.	LZ Ruda nad Moravou	Zdar	)	x	x	x	x
20	Poland	Obfö. Blizyn	Blizyn	) number of	x	x	x	x
21	.	Obfö. Grojec	Mala Wies	25) single	x	x	x	x
22	.	Obfö. Skarzysko-Kamienna	Ciechostowice	25) tree pro- genies	x	-	-	-
23	.	Obfö. Lezajsk	Wydrze	20)	x	x	-	-
24		Obfö. Proszkow	Przysiecz	24)	x	x	x	x
25	.	Ofö. Jugow	Scinawka Dolna	25)	x	x	x	x
26	Germany	FA Wermsdorf	Horstsee	) mixed pro- genies several trees	-	x	-	-

Table 2. — Site characteristics of the progeny tests of *Larix decidua* established in 1977.

Trial	Federal Land Forest District Area	Latitude Longitude Attitude a.s.l.m.	Average Temperature °C Year .....January .....July .....May-August	Mean precipitation sum, mm per year May-August	Soil type
1. Wismar	Saxony-Anhalt Beetzendorf Wismar	52° 40' 10° 57' 85	8.6 0.0 17.9 16.0	568 225	loamy sand
2. Flößberg	Saxony Colditz Flößberg	51° 09' 12° 40' 180	8.9 0.0 18.1 16.3	666 290	"powdery" clay
3. Eigenrieden	Thuringia Mühlhausen Eigenrieden	51° 10' 10° 21' 410	6.6 -2.2 15.5 13.8	775 290	clay with a layer of "powdery" clay of different thickness on top
4. Kiekindemark	Mecklenburg- Vorpommern Marnitz Kiekindemark	53° 24' 11° 47' 90-95	8.3 -0.3 17.6 15.6	663 266	loamy sand

Table 3. — Experimental characteristics of the *Larix decidua* progeny test of 1977.

Trial	Lay-out	No. of progenies	No. of repetitions	Size including bordering trees	Plot-size	No. of plants /plot at establishment	Spacing
				ha	m²		m
1. Wismar	5 x 5 square lattice	25	6	5.00	324	81	2.00 x 2.00
2. Flößberg	5 x 5 square lattice	25	3	2.80	364	91	2.00 x 2.00
3. Eigenrieden	Youden-square	21	5	3.11	288	72	2.00 x 2.00
4. Kiekindemark	4 x 5 triple lattice	20	3	1.98	320	80	2.00 x 2.00

1977, the provenances were included as shown in *table 1*. The 3 provenances from Czechoslovakia and the 4 from Poland were presumed to be indigenous. Information about the origin of all the other provenances was not available.

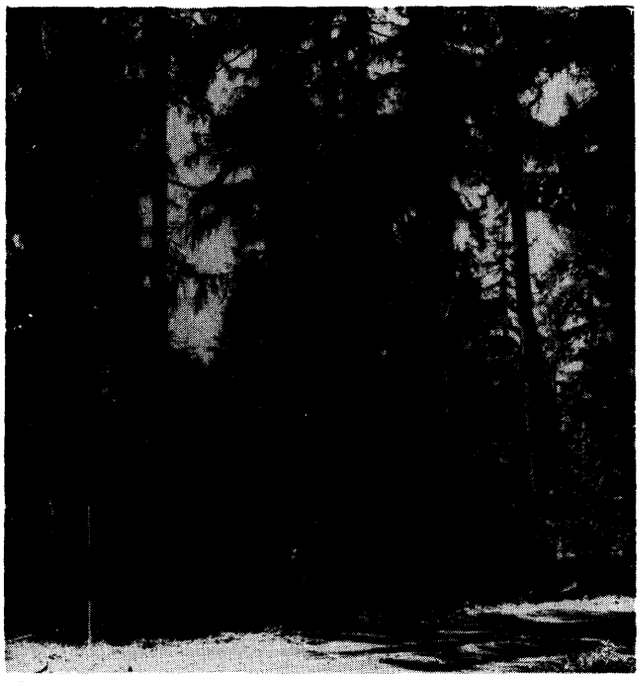

Photo 1. — Parent stand of progeny no 4 with outstanding stem quality.

The seeds of the different provenances were sown in 1975 at Waldsieversdorf. One year after seeding the plants were transplanted for one year into the nursery. In the spring of 1977, the seedlings were planted in 4 trials located at Saxony-Anhalt, Saxonia, Thuringia, and Mecklenburg-Vorpommern. At the same time the single tree progenies which had been kept separately were combined by provenance. *Table 2* shows the main site factors and *table 3* lists experimental details of the trials.

Mortality, height, diameter at 1.3 m, and stem form were recorded for each test. To characterize stem form, a 5-step scale was used with the values 9, 7, 5, 3, 1. The best stem were scored 9 or 7. They had to fulfill the following characters:

9 — not bowed, no or only few weak bends;
7 — little bowed, no or only few weak bends
or
— few weak bends, not or little bowed.

The trees with the poorest stem form were characterized as follows:

— strongly bowed, with or without bends, or
— several strong bends without or with weak bends, not weakly or moderately bowed, or
— forked stem

All other trees were scored according to their quality with level 5 or 3.

Results

The results present the most recent data collection, taken in the fall of 1989. This corresponds to a tree age of 15 years from seed. The presentation includes 24 prove-

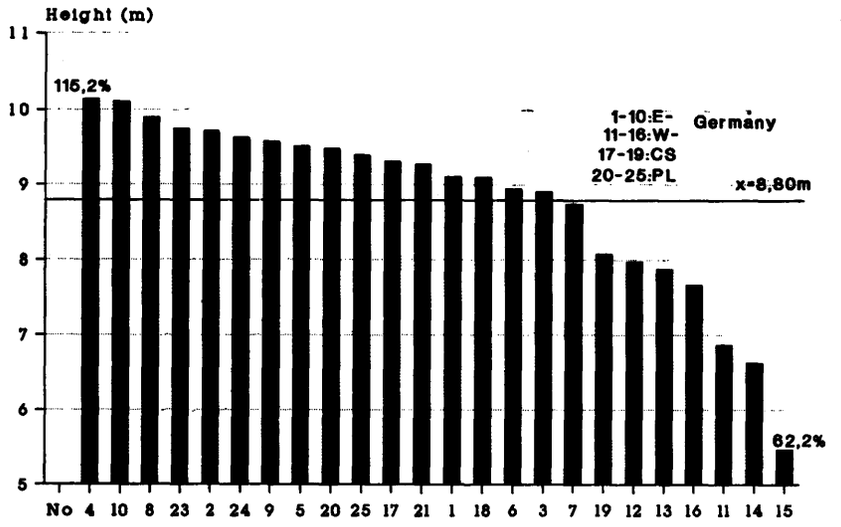

Figure 1. — Progeny test of *Larix decidua;* mean heights in 1989.

nances. The provenances Horstsee and Ciechostowice, present in only one trial, were disregarded.

Mortality

Including a minor thinning measure, the mortality was 27% averaged over all provenances and sites. Between the sites, differences were small, but between provenances they were large. The lowest mortality rate, 21.8% was found in trees of the provenance Przysiecz, and the highest 37.6%, in trees of the provenance Hinterweidenthal. Overall, trees of the faster growing provenances usually had a lower mortality rate.

Height

The mean height over all provenances and all trials was 8.8 m. This is 1 m higher than the height given for the first yield class of *Larix decidua* (Schober, 1946). In relation to site, mean height varied from 9.6 m in Kiekindemark to 8.3 m at Eigenrieden.

The mean height of the provenance samples, averaged over the trials, ranged from 10.1 m (No. 4, Wismar) to 5.5 m (No. 15, Hinterweidenthal), i. e. from to 115% to 62% of the global mean, (*Fig. 1*). Almost all to the east German provenance samples (No. 1 to 10) were above average in growth rate whereas the west German provenances (No. 11 to 16) grew more slowly.

Diameter

The results for diameter growth were similar to those for height growth. Mean diameter over all provenances and trials was 10.5 cm. The trial means varied between 11.4 cm at Kiekindemark and 9.4 cm at Flössberg.

The diameter of the different provenance samples, averaged over the trials, varied from 11.7 cm (No. 21 Mala Wies) to 7.7 cm (No. 15, Hinterweidenthal), i. e. from 111% to 73% of the global mean. The provenance sample ranking first in height (Wismar) ranked third in diameter growth.

Stem Form

Mean stem form scores and a ranking by provenance are shown in *figure 2*.

The best stem form score was 6.2 in trees of provenance Bietigheim. The worst was 4.4 in trees of the well-known Polish provenance Mala Wies. On the whole, the west German provenances (No. 11 to 16) had good stem form with the exception of No. 13, Bad Brückenau. In contrast, progenies of the east German stands (No. 1 to 10) usually scored below the global average of 5. 7.

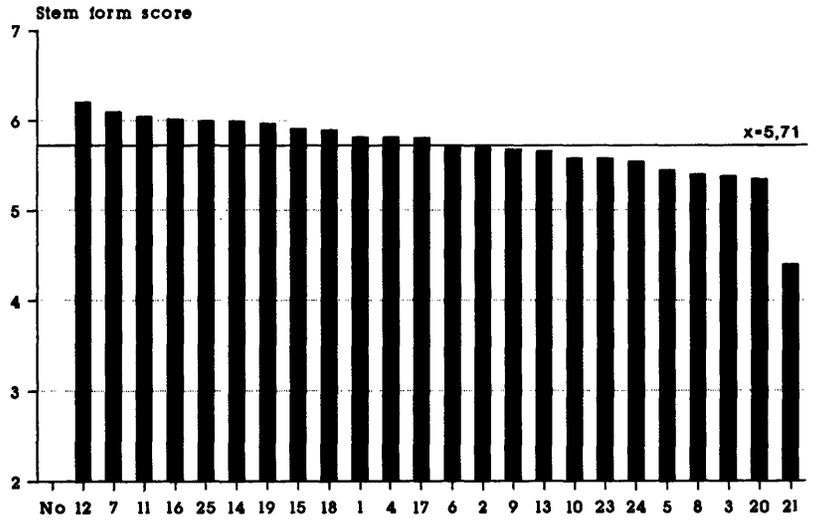

Figure 2. — Progeny test of *Larix decidua*; stem form scores in 1989.

Relationship between stem form and height

Studies of the relation between stem form mean height of the provenance samples yielded a significant (a = 0.5) negative correlation of r = —0.42. This showed that provenances producing trees with better stem forms usually grew slower than those characterized by fast growth. An extreme example is the progeny from Bietigheim, with best-formed stems but slow growth. In contrast, trees of the provenance Mala Wies had the poorest stem form but were above average in height growth.

A simple method was used to determine which of the provenances can be recommended for the production of reproductive material. The ranks of the provenances in each of the characters were multiplied with a weighted factor and summed up. The following weight factors were used:

— diameter	4	— stem	3
— height	5	— mortality	1

The lowest values (best recommendation) were found in trees from provenances Wismar (No. 4) and Zobes (No. 10), which had scores of 53 and 86, respectively. The third-best provenance was Hahn (No. 8) with a score of 106. The highest score (264) was in trees of the west German provenance Hinterweidenthal (No. 15).

Discussion

The aim of the research was to find material suitable for the lowland of the eastern part of Germany. This objection has been reached with the demonstration of superiority of trees of the 2 provenances Wismar and Zobes. It is noteworthy that these stands are located in east Germany, because their superiority in important characters documents a high level of adaptation to the local conditions. The photograph shows the mother stand of the provenances Wismar at the age of 140 years, in which the straight stem forms are clearly evident.

It is also noteworthy that most of the progenies originating in east Germany (No. 1 to 10) had above-average height growth, whereas the west German provenances (No. 11 to 16) ranked last. The comparison is similar for diameter growth. The reserve situation was found in stem form. An explanation for this could be the origin of the material which was used to establish the stands tested in this study. All of Germany except for the Alps is outside the natural range of distribution of *Larix decidua*. Therefore all stands were man-made. Most reproductive material of stands in the Alps is not suited for other regions, especially in lower altitudes, whereas reproductive material from Sudeten mountains of Czechoslovakia showed fast growth outside of its native area. The presumption is that the stands in east Germany originated in the Sudeten mountains, whereas the west German material came from the Alps. This is strongly indicated by differences in tree form, and especially stem form.

B. Breeding

Material and Methods

Breeding within the genus *larix* at Waldsieversdorf was initially intraspecific as well as interspecific. Later breeding was only interspecific between *Larix decidua* and *Larix kaempferi*. Choice of cross combinations depended on the flowering of the trees. Later, crossing partners were increasingly selected on the basis of cross-compatability. Also, clones were frequently used which had many female flowers and could be crossed with a number of different male crossing partners. If these combinations should prove to be suitable, it will be preferable to have more than one male partner in a seed orchard to produce seed because this will broaden the genetic base. Finally, first crossings with F1-hybrids performed recently were successful.

In controlled crossings clonal archives were used which had been established in 1956, 12 years before the actual breeding work. At present, the clonal archive for the genus *Larix* includes 1035 clones, as follows:

Larix x decidua MILL.	780
Larix x *kaempferi* (LAMB.) CARR.	190
Larix x *decidua* MILL. x *L. kaempferi* (LAMB.) CARR.	40
Larix x *sukatschewii* DYLIS.	21
Larix x *sibirica* LEDEB.	2
Larix x *gmelini* (RUPR.) KUZEN.	2

clones.

Some of the *Larix decidua* clones were collected by SCHÖNBACH in Czechoslovakia. During preparations of provenance trials, the author was able to also collect scions from 30 trees of each of 15 stands in Poland and Czechoslovakia. About half of the clones of *L. kaempferi* were collected in Japan by LANGNER.

The results of crossings performed so far have led to 3 series:

1. 1974, 3 trials at Brandenburg. Saxony, and Mecklenburg-Vorpommern;
2. 1986, 2 trials at Brandenburg and Saxony-Anhalt;
3. 1992, 6 trials at Brandenburg, Hesse, Mecklenburg-Vorpommern, Lower Saxony and Saxony-Anhalt as well as in France.

Progenies of seed stands of European larch were also planted for comparison.

Results of the 1974 trials will be reported. The crosses were performed in the years 1968 to 1970. Because of the few female flowers of Japanese larch, in most hybrid combinations the European larch is the female partner (*table 4*). Because of their high age only a few of the original clones from Czechoslovakia could be included. Most of the female partners were selected trees of east German stands or selected clones from the provenance trials established 1932 to 1934 by RUBNER (1941). Most of the male partners were those collected in Japan by LANGNER.

Seed was collected in 1970 to 1971 and 1971 to 1972 in 4 seed stands of European larch. This material was also included in the provenance trial described earlier. These stands are:

1. Brüsewalde (forest district of Templin);
2. Hasselburg (forest district Calvörde);
3. Wilkendorf (forest district Müncheberg);
4. Heinersdorf (forest district Müncheberg).

These seeds from the stands and from the crosses were sown in the spring of 1972 at Waldsieversdorf. The seedlings were transplanted into the nursery after one year and planted in the spring of 1974 in the 3 trial plots at Brandenburg, Saxony and Mecklenburg-Vorpommern (*table 4*). The numbers of progenies in each test depended on the availability of material. The plants originating from the 2 stands at Müncheberg had to be combined into one accession number.

Table 5 lists site conditions and *table 6* gives information on the layout of the trials. Height, diameter at 1.3 m height, and stem form were recorded repeatedly. To characterize stem form, the same five-step scoring system was used as in the provenance trial described earlier.

Table 4. — Distribution and number of progenies of crosses between *Larix decidua* and *Larix kaempferi*, their hybrids, and their reciprocal hybrids in the year 1974.

	Represented in trials at		
	Pfefferteich	Flößberg	Lübz
	number		
Progenies from stands			
- Larix decidua Mill.	3	3	3
Progenies from controlled crosses			
- Larix kaempferi (Lamb.) Carr. x L. kaempferi (Lamb.) Carr.	2	-	2
- Larix decidua Mill. x L. kaempferi (Lamb.) Carr.	57	36	20
- Larix kaempferi (Lamb.) Carr. x L. decidua Mill	10	10	9
- Larix decidua Mill. x L. decidua Mill.	9	-	2
Total:	81	49	36

Table 5. — Site characteristics of the progeny tests of crosses between *Larix decidua* and *L.* kaempferi, their hybrids, and reciprocal hybrids in the year 1974.

Test	Federal Land	Latitude Longitude Attitude a.s.l.m.	Average Temperature °C Year ..... January ..... July ..... May-August	Mean precipation sum, mm per year ..... May-August	Soil type
1. Pfefferteich	Brandenburg	53° 00'	8.3	553	loamy sand
	AfF Altruppin	12° 42'	-1.0	231	
	Pfefferteich	62	18.2		
			16.1		
2. Flößberg	Saxony	51° 08'	8.9	666	"powdery" clay
	FA Colditz	12° 37'	0.0	290	
	Flößberg	172	18.1		
			16.3		
3. Lübz	Mecklenburg-	53° 30'	8.3	596	sandy "powdery" clay
	Vorpommern	12° 05'	-0.3	242	
	FA Karbow	57	17.6		
	Lübz		15.6		

Table 6. — Experimental design characteristics of tests of *Larix decidua* x *L. kaempferi*.

Test	Lay-out	No. of progenies	No. of repititions	Size incl. bordering trees	Plot size	No. of plants per plot at establishment	Spacing
				ha	m^2		m
1. Pfefferteich	9 x 9 double-lattice	81	4	2.25	68	16	1.70 x 2.50
2. Flößberg	7 x 7 double-lattice	49	4	1.30	64	16	2.00 x 2.00
3. Lübz	6 x 6 double-lattice	36	4	0.96	62.4	16	1.56 x 2.50

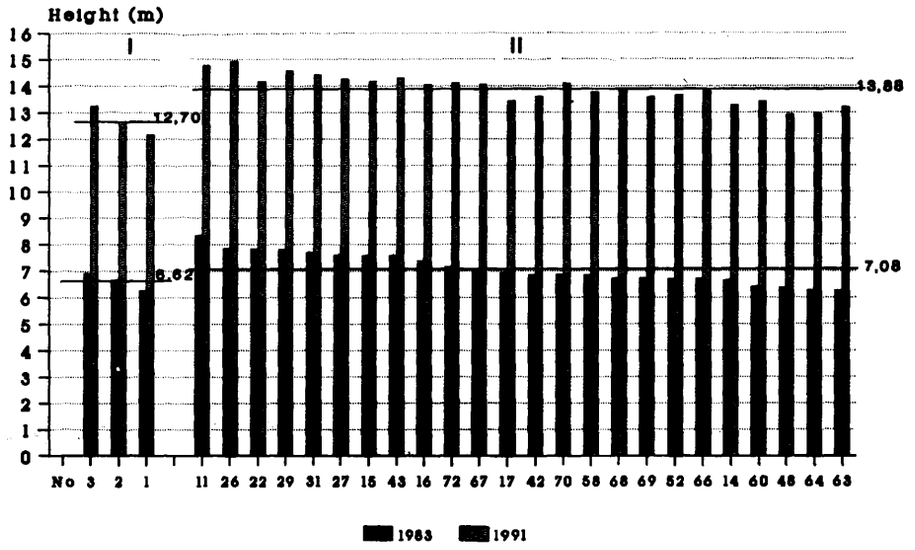

Figure 3. — Progeny test of *Larix decidua* and *Larix decidua* x *Larix kaempferi*; mean heights in 1983 and 1991.

Results

The results presented are based on data collected in the fall of 1991 at age 20, with 1983 data included for comparison. The 1991 data include the three seed stand progenies of European larch and 24 of the 29 hybrid progenies which are represented on all three sites.

Mortality

Mortality differences were small, including the losses due in light thinning. The European larch progenies had a mortality rate of 25.8% and the hybrid progenies 22.6%. Differences became evident between some of the hybrid progenies. Their values, averaged over the trials, varied between 13.6% and 30.1%.

Height

The results of the height measurements are presented in *figure 3*. The pure European larch (Group I) and the hybrids (Group II), are shown separately as well as growth to 1983 and 1991. Comparison can be made between the growth of the hybrids and that of European larch. The order represents the ranking in 1983.

Mean height in 1991 was 12.7 m for European larch and 13.9 m for the hybrids. This is an average superiority of the hybrid progenies of 1.2 m over the European larch progenies, i. e. 9.3%. The height of the hybrid progenies averaged over the three trials varied from 14.9 m (No. 26) to 12.9 m (No. 48), i. e. 117.5% respective 101.6% of the mean of the European larch progenies.

In 1983 the height growth superiority of the hybrids was 0.5 m or 6.9%. In every hybrid progeny there was an increase in superiority in 1991 compared to 1983. Also by 1991 all hybrid progenies were superior to the pure European larch progenies. This was true of four hybrid progenies in 1983.

A trial-specific and therefore site-relevant examination of differences between the hybrid and European larch progenies gave the following interesting result. With decreasing site quality, especially with decreasing water

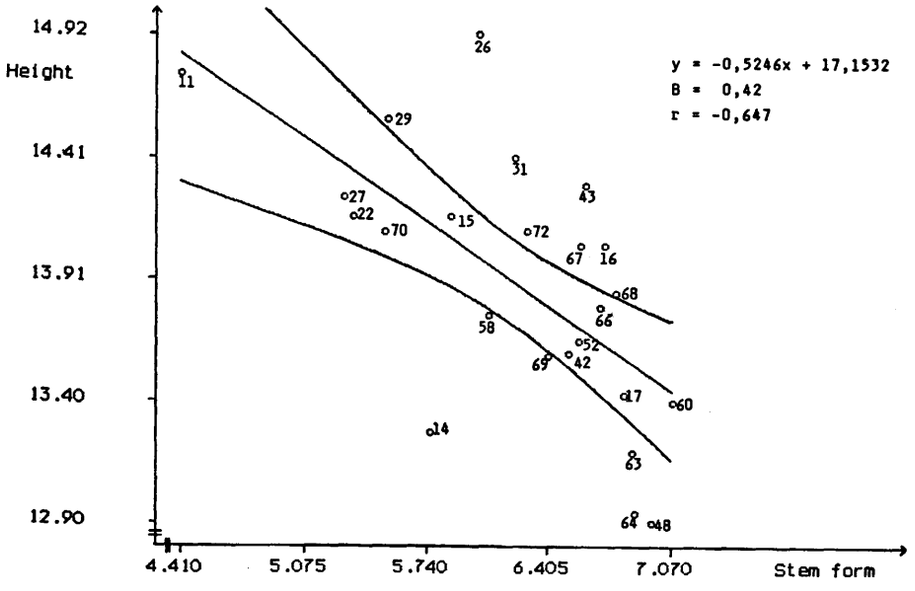

Figure 4. — Progeny test of *Larix decidua* x *L. kaempferi*; regression of stem form on height in 1991.

supply, the growth superiority of the hybrid progenies over the European larch progenies was less pronounced. The superiority was 113.9% on the best site (Lübz) and 103.7% on the poorest site (Pfefferteich). Flößberg was also intermediate in its site quality.

Diameter

Diameter growth differences were similar to those observed in height growth.

Mean diameter was 12.4 cm in the European larch progenies and 13.8 cm in the hybrid progenies, i. e. there was an 11.2% hybrid superiority, or the diameter of the hybrid progenies varied from 15.4 cm (No. 26) to 12.7 cm (No. 64), or 124.2% and 102.4%, respectively, of the mean of the European larch progenies.

In 1983, the average superiority of the hybrid progenies over the European larch was 0.7 cm or 9.8%. An increase in hybrid superiority was observed between 1983 and 1991 in all but two progenies. Because of this increase, there was no hybrid progeny in 1991 with a smaller mean diameter than the European larch progenies. In 1983 this was still the case in five progenies.

The effect of site conditions on growth of the hybrid progenies was even more distinct in diameter than in height growth. This is evident in a comparison of the tests with the greater difference in site quality, namely Pfefferteich and Lübz.

Stem form

Overall mean stem form score was 6.2 for the hybrids and 5.9 for European larch. However, the difference was not statistically significant. Some hybrid progenies were, however, significantly different from the European larch progenies. Stem form variation among the hybrid progenies was large, ranging from 7.1 to 4.4.

Relationship between stem form and height growth

There was a significant negative correlation at $p = 0.05$ ($r = -0.65$) between stem form and mean height of the hybrid progenies, showing that progenies with better stem form tend to grow slower than progenies with poorer stem form. However, hybrid progeny No. 43, which ranked fifth in height growth, was ninth in stem form. Thus this progeny was above average in both characters.

Discussion

An important result of the study of the performance of hybrid progenies of *Larix decidua* x *L. kaempferi* was the observation that up to age 20 the hybrid progenies continued to be superior in comparison with European larch progenies. In fact, during the 8 years between ages 12 and 20, the hybrid progenies increased their superiority over the European larch progenies. This leads to a different view of the breeding of larch than the negative assessment of Scamoni (1977), who continued the interspecific hybridisation work of Dengler (1941, 1942, 1944). However, Scamoni's conclusions differed from those of other workers, included Dimpflmeier (1959) and Langner (Anonymus, 1966).

It is of interest that with decreasing water supply the advantage of the hybrids over the European larch decreased, Langner (1951) and Keiding (1962) came to the opposite conclusion. A possible explanation of the finding of this study might be higher water requirements of the hybrids as compared to European larch. This could be a characteristic of Japanese larch. The choice of hybrids vs European larch for forest planting should take this into consideration.

Finally, the negative correlation found between stem form and growth capacity seems remarkable. If, as basic material for tested reproductive material, above average growth capacity were to be combined with good stem form, then only progeny no. 43 could be considered. The selection of the other progenies would increase gain in one character but at the same time loss in the other. Progeny no. 26, for example, ranking first in productivity but 17th in stem form, could only be considered for use in plantations for high wood production where stem form is unimportant.

Outlook

In future tree improvement work with *Larix decidua*, progeny testing will continue to be important. From numerous provenance trials, we know that in certain localities material from the Sudeten mountains in Czechoslovakia and provenances from Austria have performed very well. However, the results presented also showed that there were large differences in productivity, quality, and adaptability between progenies of different stands of the same provenance. This was shown, for instance, in the progenies Krnov (No. 17), Jedli (No. 18), and Zdar (No. 19) all of which originate in the Sudeten mountains. Larch from Poland also varies.

Another important finding is that larch forests existing for long time in eastern Germany yielded the best performing progenies. It seems possible that more such stands could be found. Another reason for the recommendation to test additional stands is the observed positive relationship between fast growth and poor stem form. Less intensively-tested provenances from Slovakia and stands of *Larix sukatschewii* Dylis. should be included in such tests. In the past, it was possible to collect seed in some outstandingly straight-stemmed stands of Slovakia. Further progeny testing also including stands of the Sudeten region and eastern Germany will be initiated in 1993.

Breeding of larch should aim at creating adaptable, highly productive, and straight-stemmed F2-hybrids, and also triple hybrids. Clones of the progeny tests carried out at Waldsieversdorf of European and hybrid larch as well as selected trees of eastern larch species such as *L. sukatschewii* are available for this purpose. The transfer of scions to plastic greenhouse or other means of stimulating flowering may accelerate the breeding work. This applies also to the reproduction of tested hybrid seed. Subsequent bulk propagation can facilitate the production of reproductive material on a large scale to the extent that legal regulations allow this form of propagation.

To avoid too much narrowing of the genetic base, hybridization should not be limited to a few pairs of crossing partners. This applies especially when propagation takes place in biclonal seed orchards. When using such orchards females should be included which produce above average progenies with different males. The best approach, of course, would be to find a large number of suitable combinations of crossing partners. However, the results presented show that this is not easily done. In order to take into account hybrid-specific growth patterns, special afforestation techniques should be tested. One example might be the mixing of seeds resulting from certain crossing combinations before growing the plants, or small-scale local mixtures of full-sib-families.

The products of larch improvement through breeding can be used in several ways. A use is conceivable for short rotation plantations or as a pioneer phase forest, for example on abandoned agricultural land. The material can also be used in longer-rotation plantations. In such cases, because of ecological consideration, suitable broad-leaved tree species should be interplanted with the larch at the time of afforestation or later.

Literature

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Some Results of Douglas-fir Breeding at Graupa

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Summary

Due to its high productivity and good ecological and silvicultural characteristics, Douglas-fir plays a special role among foreign species in Germany. A decisive factor in successful cultivation is the genetic suitability of the plants for the specific cultivation site. Therefore, the work undertaken in Graupa was focused on provenance research as well as on studies of established stands and on the supply of tree types from hybrid breeding. Results will be presented of (1) progeny experiments of 1982—83 based on the harvesting of older stands, and (2) hybrid breeding that began in the 1960s. Progenies from interspecific hybridization have highly heterotic rate of growth and are also highly resistant to frost. Quantitative genetic methods were used to analyze hybrid effects.

Key words: *Pseudotsuga menziesii*, progeny test of seed stands, hybrid breeding.

1. Introduction

Forestry's central role is the culture of ecologically-stable and productive forest ecosystems, while at the same time maintaining their beneficial functions. Suitable exotic species may help to attain this goal by supplementing the comparatively scanty spectrum of tree species encountered in Central Europe.

Among the exotic species, Douglas-fir (*Pseudotsuga menziesii* /Mirb./ Franco) plays a particular role. Douglas-fir has been grown in Central Europe for more than 100 years, its success being dependent on provenance of seeds. Its special position among the exotics is due to its high productivity linked with favourable ecological and silvicultural characteristics.

According to Hermann (1981), the genus *Pseudotsuga* was native to Europe before the glacial epochs. If so, we are, in effect, discussing a "reintroduction" rather than an exotic.

For various reasons, partly due to unfavourable managerial regulations and partly due to trade-policy constraints (foreign currency for imports), the increase in the proportion of forest in Douglas-fir in East Germany was far below expectations, except in a few districts. At present in