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Quality of Japanese larch stands in Poland

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Abstract: The quality of 39 Japanese larch stands, mainly in north-western Poland, was characterized. On the basis of the presented results it can be concluded that properly managed forest stands of Japanese larch can compete in trees quality with stands of native larches. The alien species is more susceptible to a lower stand density and exposure to strong winds. This is no correlation between forest stand quality and growth dynamics.

Additional key words: acclimation, forest productivity, introduction, *Larix kaempferi*, silviculture

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Introduction

Nowadays in the time of pro-ecological forestry, most foresters are not interested in introduction of exotic species. On the contrary, they often remove the alien trees from forest stands. Nevertheless, it would be a mistake to stop evaluation of its earlier introductions. Negative effects of introduction of alien species to forest stands usually result from our poor knowledge about these.

As reported in earlier publications (Filipiak 1996, 1999) Japanese larch (*Larix kaempferi* Sarg.) is one of the most frequent exotic species in Polish woodlands. In some provinces, for example in Pomerania, it is more widespread than the native European larch (*Larix decidua* Mill.) Paradoxically, this is due mainly to the common belief that Japanese larch trees are of poor quality. Because of this belief, good-quality forest stands of Japanese larch were often misidentified and treated as plus seed stands of European larch. This has lead to uncontrolled spread of this species and of its genes (hybrids with European larch).

This article presents the evaluations concerned of quality of Japanese larch stands. The data come from forest stands located mostly in north-western Poland, where this species comes up most frequently. Since those parts of Poland are outside the natural ranges of Polish and Sudetian varieties of European larch, the cultivation of Japanese larch seems to be justifiable there.

Published results of evaluation of Japanese larch stands indicate that their quality varies considerably. One of the main disadvantages of this species is that in less dense forest stands it has a tendency to form a broad crown with branches thicker than that of European larch (Dengler 1944; Lindquist 1955; Eisenreich 1956; Bellon et al. 1977; Dolatowski and Seneta 1997) and to retain dead branches on the trunk for a long time (Schober 1953; Otto 1987; Fedoruk 1987). Because of this, some researchers – especially in Germany – suggest that the lowest branches should be trimmed (Eisenreich 1956; Eggert 1987). According to Schober (1953), young Japanese larch trees often have more tappered stem than European larch trees, but later on the difference fades away. In respect of stem straightness, Japanese larch gained high scores in works by Maciejowski (1951), Schober (1953), and Fowler et al. (1988). By contrast, Otto (1987) reports that this species has a greater tendency to develop bent stem than the European larch. According to Mann and Schmidt-Mölholm (1980), 70% of Japanese larch wood produced in private forest stands in Germany was assigned to quality class B, and the other 30% to class C, while in the case of European larch 90% belonged to class B and 10% to class C. Also the results of the 2nd International Provenance Larch Experiment (Schober 1985) indicated that the quality of Japanese larch stands was lower than that of the majority of European larch stands. However, Schober and Rau (1992) showed that the results of the above experiment maybe misleading, because in most plots European larch trees were spaced 2 m×2 m, while Japanese larch trees were usually spaced more widely. This hypothesis seems to be confirmed by the fact that in Busscherwald, were Japanese larch was more crowded (3500 trees/ha), its quality was much higher than average. That author (Schober 1987) suggests that the poor quality of some Japanese larch stands, especially the old ones, is due to their wide spacing, favouring the development of broad crowns and thick branches. This disturbs tree statics, as the root system of Japanese larch is rather shallow, so the trees are prone to deformations caused by wind and snow. The proposal to plant Japanese larch trees more densely was made also by many other authors (Eisenreich 1956; Hiners and Stratmann 1984; Eggert 1987; Wachter 1987). Lines (1987) reports that in Britain the quality of Japanese larch stands is the worst on sites rich in nitrogen and exposed to strong winds.

Material and methods

Observations were made in 39 Japanese larch stands, mainly in north-western Poland (Table 1). More details on those forest stands can be found in an earlier publication (Filipiak 1999). In each stand, 100 trees were selected randomly. The quality of each larch stand was characterized by assigning the trees to three Bellon's (1980) classes of quality based on Schadelin's suggestions (Szymański 1986).

- class I: predominant and dominant trees with trunks of a high quality and crowns of a good or medium quality (according to Schadelin classification: 111, 112, 211, 212);
- class II predominant, dominant, co-dominant and intermediate trees with trunks of medium quality and crowns of good or medium quality (according to Schadelin: 121, 122, 221, 212, 222, 311, 312);
- class III: remaining trees of high social classes but with trunks or crowns of poor quality and trees of lower social classes.

In selected forest stands, trunk quality was classified on a 5-point scale based on assortment standards (see Table 2).

The statistical analyses were made using Excel 97 computers program.

Results and discussion

Columns 7–9 of Table 1 show the percentage contribution of trees to Bellon's (1980) forest stand quality classes. Mean values for all classified forest stands are: 53% in class I, 33% in class II, and 14% in class III. The total number of trees per 1 ha is shown in column 10, while the number of trees of class I per 1 ha is given in column 11. The studied forest stands are listed in Table 1 according to their ranking in respect of the values in column 11. Column 12 includes data on the degree of exposure of the forest stands to winds.

The most frequent defects decreasing the value of the studied forest stands is sabre shape or leaning trunks (the latter with a curved base). Such defects were observed in nearly all stands, although on most sites the defects were only slight. The number of trees with defects varied. As a rule, the majority of trees on a given site are leaning in one direction. Most frequently this was the eastern or south-eastern direction. Trees with multidirectional curves were rare. Most of them were found on plot 32 near Dobrzany.

If there are gaps in the canopy of the forest stand, lateral shoots develop from dormant buds on trunks of Japanese larch trees. As a result, the quality of tree trunks in many stands is poor. Fortunately, the lateral shoots, especially those formed in the lower part of the trunk, usually die quickly because they do not receive enough light when the canopy is closed again. The parts of dead branches remaining on the trunk are usually thin, about 3–4 mm in diameter, rarely over 5 mm. However, if the increased access of light is maintained for a long time, for example at an exposed edge of the forest stand, then the lateral shoots develop further into thick branches. This results in deterioration of trunk quality. Remains of dead laterals are found in most of the stands where no other tree species grow under the canopy of larch trees. In forest stands with a lower tree layer composed of shade-tolerant species, larch trunks are usually much "cleaner".

In most of the studied stands the trees developed under conditions of a high density. Consequently, the tree crowns are usually narrow, branches short and thin. In less dense stands, tree crowns look very different. An example of such a stand is plot 57 near Jarocin. Crowns of many trees are broad and irregular, with thick branches. Irregular but narrower tree crowns were frequent also on plot 8 near Kolbudy. This is due to the gaps formed in the canopy as a re-

Table 1. Results of trunk quality evaluation in selected Japanese larch stands in north-western Poland

Forest district	Compart-ment	No. of plot	Forest site type	Age (year)	h_{g55}	Percentage contribution of trees in quality classes			N/ha	N_I/ha	Exposure of stands to winds
						I	II	III			
1	2	3	4	5	6	7	8	9	10	11	12
Myślibórz	369 a	52	FMCF	42	24.0	73	20	7	655	478	0
Warcino	173 d	27	FMDF	33	27.3	52	35	13	895	465	0
Starogard*	70b	38	FMDF	48	26.2	60	28	12	737	442	0
Gryfice*	380 h	5	FMDF	58	29.8	88	10	2	432	380	0
Gdańsk	134 b	12	FDF	47	28.8	55	31	14	672	370	0
Kolbudy	134 b	10	FDF	46	29.0	64	28	1	517	331	0
Gdańsk	206 b	42	FMDF	52	25.8	51	34	15	648	330	↓
Warcino*	173 d	13	FMDF	61	28.7	70	20	10	454	318	0
Gdańsk	141 d	23	FMCF	24	27.5	70	25	5	447	313	0
Złotów*	66 g	16	FDF	59	28.5	71	27	2	426	302	0
Starogard	133 g	37	FMDF	48	26.5	48	40	12	604	290	↓
Jarocin*	300 c	43	FMDF	53	25.8	56	27	17	515	288	0
Kolbudy*	132 c	8	FMDF	76	29.2	84	16	0	336	282	0
Kłodawa*	345 i	4	FMDF	66	30.1	65	26	8	426	277	0
Gdańsk	151 a	29	FDF	32	27.3	61	34	5	447	273	0
Namysłów*	87a	48	FMDF	50	25.4	52	35	13	501	261	↓
Sarbia	196 g	44	FMDF	55	25.7	44	39	17	590	259	0
Damnica*	145 d	11	FDF	58	28.9	59	32	9	424	250	0
Szczecinek*	96 a	31	FMDF	45	27.0	48	41	11	497	239	0
Dobrzany*	140 i	18	FDF	63	28.0	48	35	17	462	222	0
Resko	263 a	17	FMDF	54	28.3	60	35	5	370	222	0
Międzychód	207d	56	FMCF	49	23.2	43	37	20	493	212	↓
Resko*	252 e	21	FMCF	54	27.6	71	27	2	289	205	0
Kłodawa*	381 b	15	FMDF	66	28.5	57	20	23	360	205	↑
Świdwin	513 i	25	FMCF	52	27.4	52	34	14	387	201	→↓
Głęboki Bród	5 f	30	FDF	53	27.0	51	37	12	391	199	↑
Szklarska Poręba	208 b	49	MMF	74	24.9	43	32	25	456	196	←
Wronki	183 d	59	FCF	46	17.4	54	31	15	340	184	0
Karczma Borowa	16 d	47	FMDF	89	25.5	53	40	7	341	181	0
Jędrzejów	17 a	41	FMDF	86	26.0	50	38	12	345	173	0
Barlinek	137 b	22	FMDF	47	27.5	41	40	19	416	171	↓
Leśny Dwór*	598 I	2	FDF	57	30.6	36	41	23	462	166	↓→
Kościan	148 d	45	FMDF	48	25.6	40	40	20	402	161	←→
Wisła	29 b	46	MMF	94	25.6	34	46	20	462	157	0
Szczecinek	154 d	26	FDF	80	27.4	45	42	23	326	147	0
Barlinek	149 a	14	FMDF	59	28.6	34	58	8	344	117	→
Dobrzany*	984	32	FMDF	55	26.8	19	31	50	343	65	→
Jarocin*	302r	57	FMDF	49	22.9	7	46	47	330	23	←→↓

H_g55 – height corresponding to average basal area of main crop at an age 55 years; N/ha – Number of trees of main crop per 1 hectare; N_I/ha – Number of trees of main crop in I quality class per 1 hectare; meaning of abbreviation in column 4: FDF – fresh deciduous forest, FMDF – fresh mixed deciduous forest, FMCF – fresh mixed coniferous forest, FCF – fresh coniferous forest, MMF – mixed mountain forest; meaning of abbreviation in column 12: 0 – forest stand is surrounded on all sides by stands of the same or higher height, → – the forest stand neighbour on: lower stand; small open area; big open area but not for a long time, → – the forest stand neighbour on: big open area for a long time; forest stand is exposed to: ↓ – northerly winds, → – westerly winds, ← – easterly winds, ↑ – southerly winds, ←→ – westerly and easterly winds etc.

Table 2. Assessment of Japanese larch stem assortment value

Assortment	Stem quality class				
	I	II	III	IV	V
Mine guide	x	–	–	–	–
Sow timber I class	x	x	–	–	–
Mine timber	x	x	–	–	–
Blind veneer soft wood	x	x	x[1]	–	–
Sow timber II and III class	x	x	x	–	–
Wood tele-energetic poles	x	x	x	–	–
Standing timber for props	x	x	x	–	–
Pales	x	x	x	–	–
Venner wood	x	x	x	x	–
Split wood	x	x	x	x	x
Posts	x	x	x	x	x
Stage wood	x	x	x	x	x
Thin wood	x	x	x	x	x
Forest dstrict, compartment, no. of polts	% of trees				
Kłodawa, 345 i, 4	30	44	22	4	–
Gryfice, 380 h, 5	53	40	5	2	–
Gryfice, 626 g, 7	2	31	43	18	6
Kolbudy, 132 c, 8	22	68	10	–	–
Damnica, 145 d, 11	17	44	30	9	–
Warcino, 173 d, 13	22	45	24	9	–
Kłodawa, 381 b, 15	32	29	16	23	–
Złotów, 66 g, 16	14	61	23	2	–
Dobrzany, 96 a, 19	10	48	23	13	6
Resko, 252 a, 21	36	48	16	–	–
Szczecinek, 96 a, 31	19	44	30	7	–
Dobrzany, 984 n, 32	–	21	31	33	15
Starogard, 70 b, 38	27	49	24	–	–
Jarocin, 300 c, 43	13	51	23	9	4
Namysłów, 87 a, 48	20	50	25	5	–
Jarocin, 302 r, 57	3	12	41	28	16

X – The wood meet the norm; 1. – short blocks.

sult of removal of beech trees from that forest stand. Similar effects can be observed on plot 34 (Szczecinek), 16 (Złotów), and 17 (Resko).

A comparison of the ranking of forest stands in respect to h_g55 (height corresponding to average basal area of main crop at the age 55 years, see Filipiak 1999) with the data on stand quality (Table 1) suggests that there is no correlation between forest stand quality and growth dynamics. High-quality forest stands included not only "tall" ones, such as plots 5 (Gryfice, 8 and 10 (Kolbudy), 12 (Gdańsk), 13 (Warcino,), and 16 (Złotów), but also some poorer stands, such as plots 38 (Starogard), 42 (Gdańsk), and 52 (Myślibórz). The correlation between h_g55 and N_I/ha (see Table 1) is presented on Figure 1.

Forest stand quality seems to depend to a large extent on exposure to wind. This is confirmed by comparison of data from columns 7, 8, 9, 11 and 12 in Table 1. The percentage contribution of trees in I quality class in the stands unexposed and exposed to winds is presented in Figure 2. The difference between means for the two groups (60% and 42% respectively) was statistically significant (T-Student test, $p = 0.00013$). This dependence is well exemplified by forest stands near Jarocin. Plot 57 (forest division 302r, covers a small area (0.5 ha) and is surrounded by extensive fields from the west, south and east. Thus it is exposed to strong winds. This forest stand is characterized by a low density, broad and irregular tree crowns, with many branches broken by wind. Trees are strongly leaning (in the south-eastern direction), and trunk cross-sections are elliptic, with eccentric annual rings. Because of the low height ($h_g55 = 22.9$ m), the stems are strongly tapered. In that forest stand only 7% of trees were assigned to stem quality class I. The nearby plot 43, located only 2 km away (forest division 300c), is very different. Many trees are leaning in one direction, but only slightly (see the results of quality evaluation shown in Table 1). Stand density is much higher, with few gaps in the canopy, and trees are taller ($h_g55 = 25.8$ m). That forest stand covers a slight depression of terrain and is surrounded on all sides by pine stands of the same age class. Also the above-mentioned plot 32 (Dobrzany) is exposed to strong, mainly westerly winds (and is characterised by a poor quality). High-quality stands, such as plots 27 (Warcino), 52 (Myślibórz), 38 (Starogard), 5 (Gryfice) and 12 (Gdańsk), are located inside extensive woodlands and thus are protected from strong winds.

Table 2 show the ranking of the studied forest stands in respect of 5 trunk quality classes. The classification is based on the Polish standards of various wood assortments. Mean values for all classified stands are as follows: 20% of trees in class I, 42% in class II, 24% in class III, 10% in class IV, and 3% in class V.

In 10 forest stands (marked with asterisks in Table 1), stem straightness was also assessed on the basis of the simplified criteria (trees straight and defective) used by Chylarecki (2000) for evaluation of European larch stands. Although most of assessed this way Japanese larch stands were relatively poor (see table 1), the average percentage contribution of straight trees was only 5.5% lower than in European larch stands (assessed by Chylarecki 2000). The difference between means for the two species (65.9% and 71.4% respectively) was not statistically significant (T-Student test, p = 0.40).

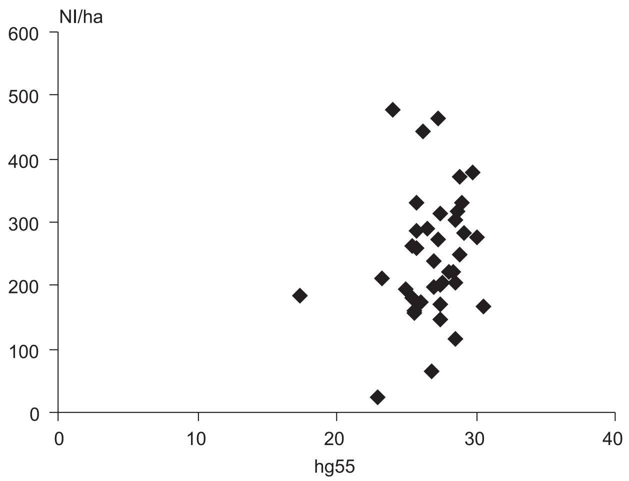

Fig. 1. The correlation between h_g55 and N_I/ha (see table 1). Correlation index = 0,1880 (no correlation)

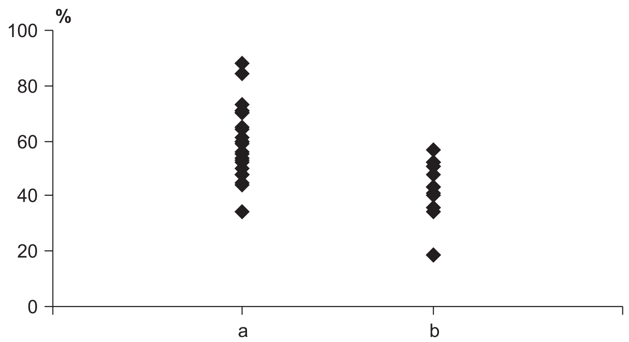

Fig. 2. Number of trees in I quality class per 1 hectare in the stands of Japanese larch in Poland (see table 1)
a – stand unexposed to winds (in table 1 marked with 0); b – stand exposed to winds (in table 1 marked with arrow).

Conclusions

On the basis of the presented results it can be concluded that properly managed forest stands of Japanese larch in Poland are characterized by a high quality, comparable with that of European larch stands. However, the alien species is more susceptible to a lower stand density and exposure to strong winds. On the whole, the quality of exotic larch is better than it is in commonly believed. Our results agree with Schober's (1987) opinion, that differences in evaluation of Japanese larch quality arise from its growing in different crown closure condition. The presented data suggested, that alien species can compete with native larches not only in productivity (Filipiak 1999) bat also in trees quality. But the planting of this species in seminatural forest and in the area of natural occurrence of Sudetian and Polish races of European larch, seems to be also undesirable (due to the risk of hybridisation). However Japanese larch can be a valuable material for fast growing trees plantation whose role, in our opinion, will systematically increase. Therefore, it appears, the stands of this larch of the best quality and productivity should be preserved.

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