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Original article

Preliminary results of an experiment with Polish provenances of pedunculate oak (*Quercus robur* L) and sessile oak (*Q petraea* [Matt] Liebl)

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Summary — The paper contains results of the preliminary stage of a provenance experiment, using the 1984 acorn crop. The acorns were harvested in pure seed stands of *Quercus robur* and of *Q petraea* and in mixed stands. In total, 36 Polish provenances were collected. Height and diameter were measured in the nursery and height in the field test. Significant differences among provenances were found for all characters. Acorn diameter was correlated with height of the seedlings in the nursery; however the correlation was not significant with height of 5-year-old plants.

Quercus robur / Quercus petraea / provenance experiments / Poland

Résumé — **Résultats préliminaires d'un test de provenances polonaises de chênes pédonculé et sessile.** *Cette contribution présente les résultats d'un test de provenances établi à la suite des récoltes de glands faites en 1984 en Pologne. Les glands proviennent de peuplements classés purs de* Quercus robur *et* Q petraea *ainsi que de peuplements mélangés. Trente-six provenances polonaises ont été plantées dans 2 sites différents. Au stade pépinière, la hauteur et le diamètre ont été mesurés et des différences significatives ont été observées. La taille des glands est corrélée avec la taille des plants à 2 ans mais non avec la hauteur des plants à 5 ans.*

Quercus robur / Q petraea / *provenance* / *Pologne*

INTRODUCTION

Pedunculate and sessile oaks are the only oak species having an important production in Poland. The exotic oaks, among which *Q rubra* Du Roi is the most important, are of marginal significance. *Q robur* and *Q petraea* are regarded in Poland as equally valuable, and forest statistics treat them jointly. *Q robur* occurs throughout the territory of Poland to an altitude of 600 m. The range of *Q petraea* is similar except that it is absent from the NE corner of lowland Poland and that it reaches up to 750 m. The interest in genetics, morphology, ecology and cultivation of oaks is not as great as that focused on *Pinus sylvestris* and *Picea abies*.

Sokolowski (1921) carried out the first preliminary comparison in Poland of 2 *Q robur* populations originating from Malopolska and Slavonia. In spite of the limited knowledge of provenance differentiation of oaks in Poland in 1937, a seed areas project was elaborated for oaks by Sokolowski (Sowinski, 1937).

From the provenance trials with oaks undertaken in Poland, no published material known to the author has appeared so far.

MATERIALS AND METHODS

The experiment was started in 1984 with the collection of acorns. They were usually collected in registered seed stands, but also in other stands. The provenance list is contained in table I. Locations of the provenances are shown in figure 1. The majority of stands consist of *Q robur*, but there are also stands composed of both species, perhaps including hybrids. A morphological and genetic analysis of the collected material will be made in the future. In the spring of 1985, the acorns were sown in the nursery in a randomized complete block design with 6 replications. The seedlings remained in the nursery for 2 years without transplantations. In 1987, 2 experimental plots were established: in forest district Taczanów and in forest district Smolarz. Both experiments were established on clear felled areas in a randomized complete block design with 6 replications. On a single plot, 16 trees were planted, spaced 2 x 2 m. The soils were proper brown composed of loamy formations. In 1989, the heights of the trees were measured. In forest district Smolarz, much damage was caused by stags; therefore only the results from Taczanów were analyzed.

RESULTS

Before sowing acorns, their length and diameter were measured. The mean values of these characteristics and the statistical parameters are presented in table II.

Table I. Origin of acorns used in the experiment.

No	Forest district	Compt [a] no	Longitude (E)	Latitude (N)
1	Syców	255a	17°40'	51°20'
2	Karnieszewice	49 g	16°25'	54°20'
3	Durowo	Reserve	17°10'	52°47'
4	Kozienice	75 d,k	21°35'	51°35'
5	Legnica	315 d	16°10'	51°10'
6	Ostrów	–	17°50'	51°40'
7	Wyrzysk	139 a	17°27'	53°10'
8	Wyrzysk	135 g	17°27'	53°10'
9	Rumowo	45 c	17°25'	53°20'
10	Kozienice	58 1,m	21°31'	51°35'
11	Wyrzysk	151 a	17°27'	53°10'
12	Kozienice	76 a,b	21°31'	51°35'
13	Wołów	52 h,i	16°29'	51°20'
14	Piaski	204 f	17°05'	51°53'
15	Kozienice	59 d,f	21°31'	51°35'
16	Wichrowo	60 g	20°31'	54°05'
17	Żmigród	215 f	16°50'	51°30'
18	Piaski	122 a	17°05'	51°53'
19	Piaski	250 a	17°05'	51°53'
20	Piaski	143 c	17°05'	51°53'
21	Brzeg	232 a	17°40'	50°50'
22	Brzeg	231 a	17°40'	50°50'
23	Brzeg	231 c	17°40'	50°50'
24	Jamy	96 b	18°55'	53°37'
25	Góra Ślaska	108 b,c	16°42'	51°35'
26	Miękinia	106 a	16°45'	51°15'
27	Góra Śląska	65 g	16°43'	51°35'
28	Płock	–	19°32'	52°32'
29	Krotsozyn	92 h	17°28'	51°42'
30	Młynary	179 g	19°40'	54°15'
31	Krotoszyn	39 k+other	17°30'	51°37'
32	Młynary	165 a,130 a	19°40'	54°15'
33	Krotoszyn	90 f	17°28'	51°42'
34	Krotoszyn	179 c	17°35'	51°50'
35	Tułowice	1 h	17°40'	50°35'
36	Czarna Biał	67c	23°15'	53°20'
37	Wyrzysk	132 h	17°27'	53°10'
38	Wyrzysk	133 g	17°27'	53°10'
39	Miękinia	98 p	16°45'	51°15'
40	Durowo	88 c	17°15'	52°45'
41	Świdwin	654 c, 655 a	15°45'	53°45'
47	Oborniki Wkp	–	16°45'	52°40'
51	Smolarz	–	15°47'	52°54'
52	Zielonka	94 b	17°03'	52°31'
53	Łopuchówko	90 a	17°07'	52°35'
54	Bolewice	–	16°10'	52°22'
Prov plot Taczanów		146 h	17°50'	51°50'

[a] Compt: compartment with a forest district.

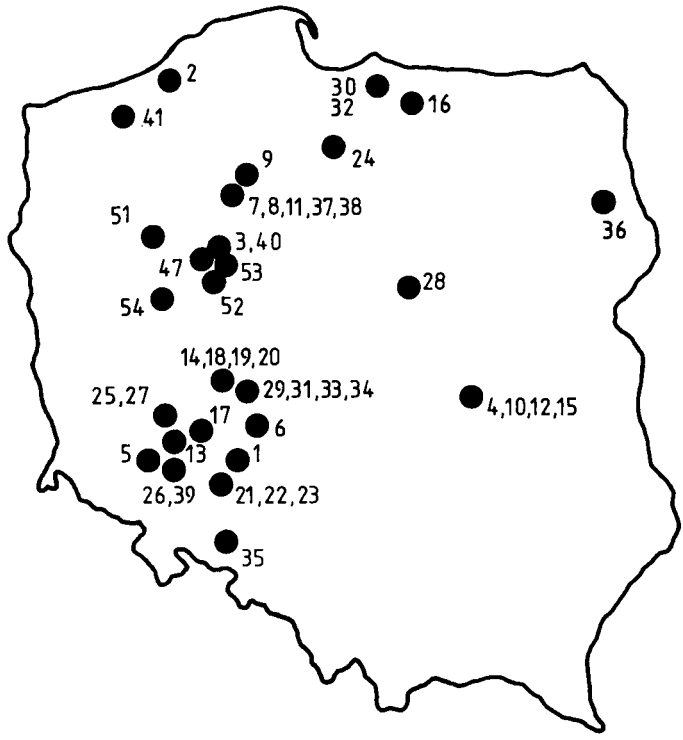

Fig 1. Locations of the provenances.

This table also contains mean values of height and diameter of 2-year-old seedlings in the nursery and height of 5-year-old trees in the Taczanów plot. The results were subjected to variance analysis and then to Duncan's new multiple range test. Tables II and III contain the results. For height and stem thickness, significant differences among provenances were obtained. For the number of trees in the plot, differences were obtained only among blocks. This means that survival of trees depends primarily upon the conditions in the blocks and not on the provenance. The Duncan's tests have shown that it is difficult to divide the provenances into separate groups. It is also difficult to distinguish geographical trends. Some significant differences were obtained between closely localized provenances, while trees from distant provenances sometimes had similar dimensions. In the permanent plot, a lesser variability in tree height was found (V = 7.72%), than was obtained in the nursery (V = 16.76%). There was also a high but positive deviation from normal distribution. The transfer of the plants from a small area in the nursery to a large area in the forest caused mean heights to level off. Only the provenance '21 Brzeg' had a substantially greater mean height than the others.

The mean values of traits were compared by correlation analysis. The values of linear correlation coefficients are shown in table IV.

Table 1l. Results of measurements of acorns and seedlings in the nursery and trees planted in the Taczanów plot for the experiment started in 1984.

	Provenance	*Acorn length (mm)*	*Acorn diameter (mm)*	*Height in 1986 (cm)*	*Diameter in 1986 (mm)*	*Height in 1989 (cm)*
1	Syców 255 a	27.2	16.6	20.09	4.15	–
2	Karnieszewice 49 g	25.6	15.1	20.92	3.98	68.47
3	Durowo rez	25.6	15.1	12.50	3.44	–
4	Kozienice 75 d,k	31.1	16.2	17.71	4.11	–
5	Legnica 315 d	24.4	14.4	16.72	3.99	65.26
6	Ostrów	27.2	13.9	16.82	4.11	–
7	Wyrzysk 139 a	23.2	16.9	17.01	4.10	66.67
8	Wyrzysk 135 g	23.4	14.7	19.30	3.87	62.53
9	Runowo 45 c	26.1	15.6	19.43	4.07	–
10	Kozienice 58 1,m	29.8	16.0	18.54	3.98	64.67
11	Wyrzysk 151 a	19.9	15.0	16.68	4.12	63.46
12	Kozienice 76 a,b	30.3	16.3	18.27	4.10	67.24
13	Wolów 52 h,i	29.9	14.6	23.84	4.67	–
14	Piaski 204 f	29.4	17.7	24.69	4.21	69.44
15	Kozienice 59 d,f	30.5	15.6	18.81	4.00	68.84
16	Wichrowo 60 g	23.6	14.9	14.93	3.90	–
17	Zmigród 215 f	29.5	17.2	–	–	–
18	Piaski 122 a	29.0	16.4	22.67	4.19	67.90
19	Piaski 250 a	26.5	17.1	17.57	3.74	61.06
20	Piaski 143 c	–	–	23.46	4.03	63.66
21	Brzeg 232 a	32.4	14.3	26.03	4.45	81.72
22	Brzeg 231 a	27.3	14.0	27.25	4.19	63.82
23	Brzeg 231 c	27.4	13.9	26.06	5.05	–
24	Jamy 96 b	29.1	16.2	23.46	4.39	68.51
25	Góra Sl 108 b,c	27.1	16.7	19.81	3.85	68.93
26	Miekinia 106 a	33.4	14.1	21.06	4.27	65.71
27	Góra Sl 65 g	27.8	16.1	24.04	4.21	58.26
28	Plock	25.5	14.7	18.79	3.68	60.66
29	Krotoszyn 92 h	26.4	15.0	21.77	4.34	59.22
30	Mlynary 179 g	24.7	13.9	17.45	3.92	57.12
31	Krotoszyn 39 k+in	27.7	15.5	19.55	3.80	56.58
32	Mlynary 165a, 130c	26.4	16.4	21.01	4.38	64.01
33	Krotoszyn 90 f	25.6	15.1	18.44	4.39	–
34	Krotoszyn 179 c	28.1	16.4	20.17	4.14	65.99
35	Tulowice 1 h	27.0	14.7	21.50	4.01	65.48
36	Czarna Bial 67 c	21.5	14.9	14.23	3.21	60.77
37	Wyrzysk 132 h	24.0	14.5	17.03	4.01	63.46
38	Wyrzysk 133 g	23.4	15.1	16.11	3.87	66.45
39	Miekinia 98 p	29.4	16.6	25.55	3.98	64.83
40	Durowo 88 c	25.3	14.4	25.47	5.07	63.64
41	Swidwin 654c, 655a	22.0	13.6	20.44	4.30	68.58
47	Oborniki Wkp	24.5	14.0	–	–	61.08
51	Smolarz	31.6	15.0	22.23	3.91	53.71
52	Zielonka 94 b	26.9	17.0	–	–	63.57
53	Lopuchówko 90 a	–	–	–	–	57.80
54	Bolewice	–	–	–	–	60.43

Table II. *(continued)*

Provenance	*Acorn length (mm)*	*Acorn diameter (mm)*	*Height in 1986 (cm)*	*Diameter in 1986 (mm)*	*Height in 1989 (cm)*
Statistical parameters [a]					
n	42	42	41	41	36
mean	26.93	15.39	19.87	4.11	64.15
min	19.9	13.6	12.5	3.21	53.71
max	33.4	17.7	26.06	5.07	81.72
± ($\alpha = 0.05$)	0.91	0.33	1.07	0.12	1.62
V%	11.11	7.16	16.76	8.74	7.72
Ax	–0.064	0.24	0.08	0.46	0.79*
Ex	–0.0468	–1.18	–0.65	1.41*	2.53**

* $\alpha = 0.05$; ** $\alpha = 0.01$. [a] *V*: coefficient of variation; *Ax*: skewness ; *Ex*: Kurtosis.

Table III. Significance levels in the differentiation of trees.

Parameters	*Significance levels α for:*	
	Provenances	*Blocks*
Height (1986)	0.0000	–
Diameter (1986)	0.0152	–
No of trees (1989)	0.4823 NS	0.0000
Height (1989)	0.0283	0.0000

DISCUSSION

The low correlation between length and thickness of acorns was unexpected. Therefore, the form of the fruit may be a significant characteristic for a given population. A similar result was obtained by Goetz (1931). The only significant correlation was obtained between the length of the fruit and the height of 2-year-old seedlings. The influence of acorn size was studied by Cieslar (1923) and by Eitingen (1926). In our exper-

Table IV. Values of linear correlation coefficients between provenance means for traits.

Parameter		*2*	*3*	*4*	*5*
1	Acorn length	0.2435	0.5509***	0.2579	0.1235
2	Acorn diameter	–	0.0139	–0.1894	0.1320
3	Height in 1986		–	0.0480	0.2486
4	Diameter in 1986			–	0.3355
5	Height in 1989				–

*** $\alpha = 0.001$.

iment, this correlation disappeared for 5-year-old trees, which may be explained by the transfer of the trees to conditions with a higher variability than in the nursery.

The most important conclusion drawn from these preliminary results is that significant differences in the range of the investigated features were found even between neighboring populations. This may have been caused by: 1) the transfer of acorns practised in the 19th century; 2) the existence of sharply outlined ecotypes; or 3) the comparatively poor outcrossing of oaks and the consequent genetic drift in small populations.

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