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RESULTS OF 90 YEARS OF FLAX BREEDING IN LITHUANIA

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Fibre flax breeding was started in Lithuania in 1922 at the Dotnuva Plant Breeding Station. Later flax breeding was carried out at Savitiškis Experimental Station, and since 1965 this work has been continued at the Uptytė Experimental Station of the Lithuanian Research Centre for Agriculture and Forestry (former Uptytė Research Centre of the Lithuanian Institute of Agriculture). In the period between 1922 and 2005, eighteen fibre flax varieties have been developed with the main aim to increase fibre yield per hectare, fibre quality (being suitable for textile purposes), and flax resistance to lodging and diseases. Considering growing interest in healthy life and nutrition, linseed breeding was also started. Between 2005 and 2012, three fibre flax and three linseed varieties were developed. The aim of the breeding work consists of many duties, the most important of which are developing high yielding fibre flax and linseed varieties, resistant to lodging, with a high fibre yield and quality, high seed yield, resistance to fungal diseases, with a moderately long vegetative growth period, and which are well adapted to Lithuania's soil and climate conditions.

Key words: breeding, fibre flax, linseed, variety, yield.

THE VERY BEGINNING OF FLAX BREEDING IN LITHUANIA, BREEDING INSTITUTIONS AND MAIN FLAX BREEDERS

Until the end of 19th century, farmers did not pay too much attention to what kind of flax seed to sow — the main requirements for seed were to be clean, large and viable. Flax seed could be harvested by themselves, bought in the market or exchanged with neighbours. Some local, Russian and Polish kinds of flax seed were distributed between flax growers. At the beginning of the 20th century, a local flax seed called 'Kondratavičiaus', named after a farmer, was widespread in Lithuania (Vyšniauskaitė and Laniauskaitė, 1977).

The first reports on the study of flax varieties (as well seed rate testing and fertilisation) in Lithuania, conducted at the Baisiogala Experimental Station, were printed already in 1913 in the issue "Earth" (Žemė) (Zimkuvienė, 1997). But the real birth of flax variety testing in Lithuania can be considered to be 1922, when professor Dionizas Rudzinskas returned from Moscow with a collection of various flax breeding lines (Mackevičius, 1939; Rudzinskas, 1977). At that time the focused fibre flax breeding in Lithuania was started (Bačelis, 1998). Generally, all flax breeding in 1922–1940 was managed by Prof. Dionizas Rudzinskas. Since 1932, Zigmas Mackevičius was involved in flax breeding also (Vyčas, 1968).

In 1930, in Vilnius, the Central Flax Testing Station (LCSD (Lniarska Centralna Stacja Doswiadczalna)) was founded

(managed by Prof. Janusz Jagmin). It was involved in flax breeding (among other activities related to flax and hemp), variety developing and testing. Over a period of seven years (1930–1937), the following flax varieties were developed: LCSD I, LCSD II, LCSD 207, LCSD 210, LCSD 200 (Lniarska, 2000). At the beginning of the Second World War, in 1941, when the station building was destroyed, the left seed material and laboratory equipment that survived were transferred to the newly founded Savitiškis Experimental Station (close to Panevėžys) where flax breeding work was continued by A. Vyčas (Valatka and Švilpienė, 1980). In 1942, part of the flax breeding material from Dotnuva was transferred to Savitiškis, and the remaining breeding material—in 1945 (Anonymous, 1997; Zimkuvienė, 1997). Thus, flax breeding was continued in a new location.

In 1965, the Savitiškis Experimental Station was transferred to Uptytė (also close to Panevėžys) and received the name Uptytė Experimental Station (Anonymous, 1997). Flax breeding was continued there with large flax collections and initial seed multiplication of newly developed varieties was carried out.

The following persons were involved in flax breeding: Jonas Bulavas (1942–1943), Antanas Vyčas (1944–1970), Irena Vazonienė (1957–1959), Alma Iržikevičienė (1961–1966), Valdonė Mikaliūnienė (1966–1968), Marijona Gaižiūnienė (1969–1984). Kęstutis Bačelis dedicated forty years (1966–2005) to flax breeding (Bačelis, 1998). Since 2005, flax breeding has been continued by Z. Jankauskienė.

Some references report that linseed breeding was carried out in Savitiškis in 1952 (Anonymous, 1953), but no about later studies are available. Interest in linseed in Lithuania appeared again only after renewed independence in 1991.

The general aim of flax breeders is to develop high yielding fibre flax varieties, resistant to lodging, with a high fibre yield and quality, resistance to fungal diseases, with a moderately long or short vegetative growth period, and which are well adapted to Lithuania's soil and climate conditions. Improved seed yield is the main aim of linseed breeding.

AGROTECHNOLOGY, MATERIALS AND METHODS USED FOR FLAX BREEDING

Eutri-Endohypogleyic Cambisol soils with pH 5.8–7.5 dominate in the trial fields in Dotnuva, Savitiškis and Upytė (Buivydaite *et al.*, 2001). In earlier trials, the amounts of available phosphorus and potassium were low (<100 mg·kg⁻¹ soil), but now the levels are 160–260 mg·kg⁻¹ of available phosphorus and 116–326 mg·kg⁻¹ available potassium. The amount of total nitrogen in the soil changed only slightly during the years of investigation (0.09–0.15%), while humus content showed great variation (1.1–3.5%).

Meteorological conditions during the period of 90 years were very diverse and, no doubt, had great influence on the annual quantity and quality of flax yield. The wide variability of abiotic factors allowed to make better selection of the most resistant and well adopted accessions, to develop better varieties adapted to local conditions.

Generally, flax was sown after various preceding crops — perennial grasses, winter wheat, and cultivated crop (beets). Conventional cultivation practices for flax were used. Fibre flax breeding was carried out according to the following scheme: 1) nurseries of initial material (accessions from collection, mutant nursery, various selected accessions), 2) breeding nursery, 3) hybrids nursery, 4) selection nursery, 5) control nursery, 6) initial variety trials, 7) competitive variety trials, 8) multiplication of perspective varieties and farm scale trials. Since 1966, testing of resistance to diseases (*Fusarium oxysporum* f. *lini* (Bolley) W. C. Snyder & H. N. Hansen, *Melampsora lini* (Ehrenb.) Lévy, *Septoria linicola* (Speg.) Garass.) was carried in an infective-provocative background.

At the beginning of flax breeding work, mainly the selection method was used. Since 1932, flax crossing (inter-variety breeding) was started. This method was the basis of later flax breeding work. Later (1971), mutagenesis was applied for flax variety development; biotechnology is presently being explored at the University of Aleksandras Stulginskis (ASU).

In the nursery of initial material, the varieties and accessions were sown in very small plots (of 0.2–1.0 m²), and in the breeding, selection and control nurseries — in plots of 0.2–4.0 m². In the control nursery flax was sown already in 4–5 replications. Initial and competitive variety trials in-

involved 3–4 replications; the size of a record plot was 11.2 and 16.0 m², respectively. Field trials and observations were conducted following standard breeding methods, generally in compliance (with some modifications) with published methods (Аноним, 1978; Рогаш и др., 1987).

At the beginning, all flax plots were sown and harvested manually, but later on using contemporary machinery. Presently, in the competitive and initial variety trials, the plots are sown with a sowing machine SNL-16 (Russian origin) at a seed rate of 25 million seed per hectare, 10 cm space between rows. In the other nurseries, the plots have been sown manually at a seed rate of 22 million seed per ha. Rates of linseed for sowing are approximately three times lower.

In initial years flax nurseries were de-weeded manually. Later on herbicides were used to control weeds (depending on need; flax nurseries need to be de-weeded manually additionally); insecticides have been applied against flax flea beetles and other pests.

Phenological, morphological and other observations were made during the vegetative growth period. Resistance of accessions to lodging was evaluated before harvesting or after heavy rains. The resistance of accessions to fungal diseases during specific years was evaluated in different ways (in the field in natural background or in contaminated background), using different methods of evaluation (Лошакова и др., 2002).

Usually, fibre flax was harvested at the stage of early yellow ripeness, linseed at yellow ripeness, then dried and threshed by a MS thresher. The stems were retted in warm (33–37 °C) water; then the stems were scutched by a scutching tool SMT-200, and fibre was hackled using combs (numbers 9 and 13). The number of long fibres was determined in the laboratory, flexibility by a device G-2, strength of fibre by a device DK-60 and thinness (divisibility) by counting separate fibres in a fibre sample, the length of which was 1 cm, mass 10 mg. Long fibre rupture length (in km) was calculated using the formula (Аноним, 1961): $RL \text{ (in km)} = 0.1 \times \text{flexibility (in mm)} + 0.2 \times \text{firmness (in kg F)} + 0.013 \times \text{fineness (in units)} + 2.1$; where: 0.1; 0.2; 0.013 and 2.1 are constants.

Statistical analysis was used to process data. Stem, seed and fibre yield and other parameters were evaluated using analysis of variance, calculating averages and LSD₀₅. In recent years, statistical software developed at the Lithuanian Institute of Agriculture was used (Tarakanovas and Raudonius, 2003).

Flax varieties developed in Dotnuva and those received from abroad were tested in various testing stations: Dotnuva (1931–1938), Joniškėlis (1929–1933, 1935–1943), Samališkės (1937–1938), Rumokai (1938). Later in 1948–1950, flax variety testing was carried out in the variety testing stations in Joniškėlis, Panevėžys, Kaunas, Vievis, Kretinga, since 1961 in Vilkaviškis, Pakruojis, Plungė, Utena, since

1962 in Pasvalys, Ukmergė, Plungė, Pakruojis, and from 1988 till today only in Plungė and Pasvalys.

BREEDING PROCESS AND DEVELOPED FLAX VARIETIES

Flax breeding in the Dotnuva breeding station. After foundation of the Dotnuva breeding station in 1922, already in spring the first flax plots for breeding purposes were sown. Russian varieties developed by Prof. Rudzinskas in Moscow, '806/3', '823/3', 'A-776' and breeding lines 812, 813, 815, 841, 843 were the first flax accessions there. Generally, selection was focused on flax height, evenness and resistance to diseases. With these aims, two fibre flax varieties 'Dotnuvos pluoštiniai' and 'Dotnuvos ilgūnėliai I' were developed. By improving the latter, a more productive and resistant to lodging variety was developed — 'Dotnuvos ilgūnėliai II' (Bačelis, 1992).

In the Dotnuva breeding station in 1923, already 36 flax accessions distinguishing for different colour of petals were sown in the collection nursery. In the selection nurseries mainly breeding lines from Russia (A 776, A 776₂, A 776₃, N 805₃, N 806₂, N 815₄, N 823₃, N 841₅, etc.) were sown for investigation (Anonymous, 1923).

In 1924, 14 accessions (including already a few of Lithuanian origin (Lietuviškas "dolgunc", Vietiniai Nr. 11)) were sown in the selection nursery and 34 flax accessions with different colour of petals were sown in the collection nursery (Anonymous, 1924).

The above was repeated in 1925 (Anonymous, 1925). Despite literature that reports on the beginning of flax crossing in 1932 (Bačelis, 2001), in the list from 1925, as well as in 1926, some flax hybrids are mentioned (Anonymous, 1925; 1926). In the collection, 33 flax accessions were then investigated (Anonymous, 1926). In 1927, the same number (33) of flax accessions was investigated in collection nursery, various breeding lines were selected from Russian accessions, and some with Lithuanian origin (vietiniai (Lietuvos ilgunc) obtained from P. Kondratavičius, Mažeikiai district) were tested. The first reproduction of flax seed was already given for multiplication to farmers in different regions of Lithuania (Anonymous, 1927).

Between 1924 and 1927, a few linseed accessions (Nr. 227/23 Linai baltažiedžiai, Iš Althauzeno 249/21, Iš Althauzeno 268/21, Iš Althauzeno 250/21, etc.) were investigated also (Anonymous, 1927).

In 1929, the studied flax collection had enlarged to 49 accessions and some other *Linum* accessions were acquired: *Linum grandiflorum* L., *Linum grandiflorum* L. rubrum, and *Linum angustifolium* L. The selection nursery was diversified by new local accessions, also from Latvia, Germany, Russia (Anonymous, 1929).

The same flax accessions (49) of 1929 were investigated in 1930. The selection nursery was again supplemented by

various selected flax lines from local and foreign accessions. It was interesting that the seed multiplying nurseries already contained the first promising Lithuanian flax varieties (Dotnuvos ilgūnėliai-A 766, Dotnuvos pluoštiniai-823₁₁₁, and Dotnuvos pluoštiniai-812₃, etc.) (Anonymous, 1930).

In 1930–1938, of 27 flax varieties tested in the testing stations, the varieties 'Rota', D.s.s 'Ilgūnėliai' II and Svaloef 'Hercules' were selected as the most productive (accordingly, stem yield 3.2; 3.03 and 3.26 t·ha⁻¹, fibre yield 0.49; 0.47 and 0.44 t·ha⁻¹, seed yield 0.62; 0.51 and 0.59 t·ha⁻¹). Variety 'Concordia', which gave the highest seed yield (0.75 t·ha⁻¹), was resistant to lodging (Šumskis, 1942).

In 1935, the flax collection in Dotnuva consisted already of 107 accessions. In 1935, 35 crossing combinations were done, 14 crossings were made, 418 local flax accessions were investigated, and 2977 lines were selected for breeding (Mackevičius, 1936). Some resources report that variety 'Vaižgantas' was developed by Z. Mackevičius before the Second World War, but during the war flax breeding material greatly suffered — part was destroyed, part was mixed, and part was transferred to Savitiškis Experimental Station (Bačelis, 1998),

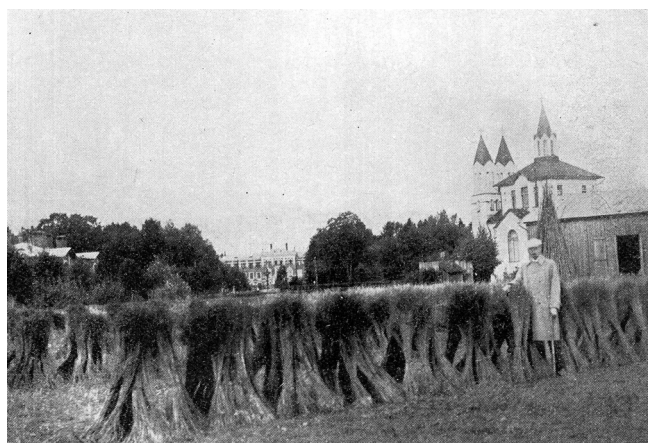


Fig. 1. Multiplication of flax 'Dotnuvos ilgūnėliai II' in Dotnuva (approximately 1935).



Fig. 2. Sowing flax in breeding nurseries (date and place unknown, could be in 1924–1925, Dotnuva).

The varieties developed in Lithuania or exported from abroad were tested at experimental stations in Rumokai, Joniškėlis, Dotnuva, and Samališkės. In 1930–1938, 27 varieties (Kondratavičiaus, Svaloef 'Hercules', 'Rota', Dotnuvos selekcijos stoties (D.s.s.) 'Ilgūnėliai' II, Svaloef 'Blenda', D.s.s. 524, D.s.s. 494, Excello', 'Gigantha', I.W.S., 'Perfekta', 'Texala', 'Concordia', 'Slow. Meder F. 496', D.s.s. 'Ilgūnėliai' I, 'Balva', 'Ligo', D.s.s. 493, D. 85, D.s.s. 533, 'Besings', 'Slow. Meder F. 134', Gruno v. prof. Brock, 'Concurent', and D.s.s. Pluoštiniai vietiniai, 'Almenum') were investigated (Šumskis, 1942).

Flax breeding in Savitiškis Experimental Station. Flax breeding in Savitiškis was carried out in 1941–1964, generally by A. Vyčas. He rectified mixed seeds of variety 'Vaižgantas', and in 1950 this variety was registered in Lithuania. The flax collection was enlarged to include accessions from different countries. The most suitable accessions shown in testing included inter-variety crossings. In 1945–1964, five fibre flax varieties ('Lietuvos 230', 'Žydriai', 'Lietuvos 392', 'Banga' and 'Vega') were developed, but the seeds of them were not disseminated. The latest two varieties were distinguishing for fibre quality (Bačelis, 1998). A. Vyčas was the breeder of flax varieties 'Lietuvos 230' and 'Žydriai' (Булавас, 1955).



Fig. 3. Savitiškis Experimental Station (1941–1964).



Fig. 4. Director of the Savitiškis Experimental Station, breeder Antanas Vyčas (approximately 1960).

Flax variety 'Vaižgantas' was found to have a vegetation period of 86 days, resistance to lodging and frost, and to anthracnose and rust. Stems were 82 cm (in average) in height, 1000 seed weight — 4.7 g, total fibre content — 20.6 %, and fibre quality is good. It was registered in Lithuania in 1950 (Булавас, 1955).

Flax variety 'Lietuvos 230' was observed to have a vegetation period of 83 days. Stems were 90 cm (in average) in height. It was tested in state stations starting in 1952 (Булавас, 1955).

Flax variety 'Žydriai' was more productive than that of the standard variety 'Vaižgantas' (on average, it gave an additional 0.11 t·ha⁻¹ of fibre). It was distinguishing for high seed yield (0.6–0.7 t·ha⁻¹), resistance to lodging, and a vegetation period of 83 days. It was tested in state stations starting in 1952 (Булавас, 1955).

In 1955, 1956 and 1958, in Savitiškis, productivity and quality of flax variety 'Lietuvos 392' was investigated. Averaged data showed that the vegetation period of the new variety was by 13 days longer than that of standard variety 'Svietoč'. Moreover, yield of the new variety was higher than of the standard — stem yield by 12.5% (or 0.52 t·ha⁻¹), seed yield by 19.2% (or 0.104 t·ha⁻¹), but fibre content of new variety by 5% lower. According to the results of the investigation, the decision to submit a new variety for State variety testing was taken (Vazonienė, 1959).

Following trial data in testing stations in 1948–1950, accession 01420 was the most productive, but it was discarded because it was not resistant to the rust. 'Vaižgantas' showed good results in straw yield (4.08 t·ha⁻¹). Highest fibre yield was obtained from 'Priekulės 665' and I-9 (Anonymous, 1951). In industrial scale trials, 'Vaižgantas' overstepped 'Svietoč' by 6% in straw yield, and by 25% in seed yield (Šumskis, 1942).

In 1948–1950, flax varieties 'Vaižgantas', 'Svetoč', vietiniai, 'Rota-2', 'Priekulės 665', 'Pobieditel', 1288₁₂, 'Stachanoviec', 806₃, I-9, and 014200 were tested at variety testing stations in Joniškis, Panevėžys, Vievis, Kretinga and Kaunas (Anonymous, 1951).



Fig. 5. Flax threshing in Savitiškis (approximately 1960).



Fig. 6. New building of the Upytė Experimental Station (since 2001).

Flax breeding in Upytė experimental station. Flax breeding was carried out at Upytė starting in 1965, and in the period up to 2005 nine fibre flax varieties were developed (generally, by K. Bačelis): ‘Viltis’ (in 1968), ‘Banga 2’ (in 1974), ‘Upytė’ (in 1980), ‘Upytė 2’ (in 1982), ‘Baltučiai’ (in 1987), ‘Vega 2’ (in 1993), ‘Alfa – B’ (in 1993), Nr. 1547-11-7 (in 1994) and ‘Kastyčiai’ (in 1997). The varieties were registered a few years later after official variety testing, excepting some. Three of them (‘Baltučiai’, ‘Upytė 2’ and ‘Vega 2’) were registered abroad (Bačelis, 1998). Fibre flax variety ‘Upytė 2’ in 1987 was registered in Estonia, ‘Baltučiai’ in 1991 in Belorussia and in 1993 in Russia (West region), ‘Vega 2’ since 2001 has been registered in Latvia.

In 2009, three newly developed fibre flax varieties (‘Snaigiai’, ‘Dangiai’ and ‘Sartai’) were included to the Lithuanian National List of plant varieties (Anonymous, 2009) and EC common catalogue of varieties of agricultural plant species (Jankauskienė, 2009; Jankauskienė and Bačelis, 2009).

Some authors have reported a lower amount of developed flax varieties, excluding varieties that were not registered in the country (Ruzgas, 2009).

Generally, flax breeding in Upytė was carried out by K. Bačelis with some assistance of other researchers. The main tasks at the station were to obtain and evaluate primary breeding material.

In Upytė, Dr. K. Bačelis developed and tested (in 1961–1973) the new fibre flax variety ‘Banga-2’. Investigation of yield and morphological characteristics showed this variety to be resistant to lodging and seed scattering, and was submitted to state variety testing. Starting in 1974 it was also tested in stations in Latvia and Estonia (Bačelis, 1977).

The new fibre flax variety ‘Upytė’, developed by K. Bačelis, was investigated in 1964–1979 regarding advantageous features over standard varieties (Bačelis, 1981). Then it was submitted to state variety testing.

The new fibre flax variety ‘Upytė 2’ (authors K. Bačelis and M. Gaižiūnienė) was developed and tested in 1970–1982. Flax of this new variety gave higher stem yield, it was more resistant to lodging, and therefore more suitable for harvesting using machinery than the standard variety ‘K-6’. In 1982, this variety was submitted to state variety testing (Bačelis and Gaižiūnienė, 1990).

Over the period 1978–1982, K. Bačelis utilized chemical (nitrozo-ethyl-urea, nitrozo-methyl-urea ethyl-methan-sulphonate, ethylene-imine, dimethyl-sulphate and physical (^{60}Co gamma-rays) in flax breeding. The frequency of induced mutations and its relationship to intensity of chemical mutagens were investigated. The most valuable flax mutants were segregated and used in flax breeding. The successful investigation gave many promising results (Bačelis, 1992) and more than 40 publications were published on these results (Bačelis, 1975a; 1975b; 1975c; 1984; 1986; 1988).

The new fibre flax variety ‘Baltučiai’ developed in 1971–1988 by K. Bačelis was thoroughly investigated. This variety was developed by mutagenesis. It is exclusively early-ripening, ripens five days earlier than that of standard variety ‘Oršanskij’, it is more resistant to lodging and hence more suitable for harvesting with machinery, and has slightly higher (by $0.3 \text{ t}\cdot\text{ha}^{-1}$) fibre yield (Bačelis, 1991). In 1987, it was sent to state variety testing.

The new fibre flax variety ‘Alfa-B’ (author K. Bačelis) was investigated in 1972–1991. It produced by $0.85 \text{ t}\cdot\text{ha}^{-1}$ higher stem yield, by $0.38 \text{ t}\cdot\text{ha}^{-1}$ higher fibre yield, it had a shorter (by two days) vegetation period, and was more resistant to lodging when compared to standard variety ‘Oršanskij 2’. This variety was not submitted to variety testing trials, but was sent to the Gene Bank (Bačelis, 1993).

The new fibre flax variety ‘Vega 2’ (author K. Bačelis) was investigated in 1973–1992. It is semi-early, resistant to lodging, and has higher yields: by $1.07 \text{ t}\cdot\text{ha}^{-1}$ stem yield, by $0.15 \text{ t}\cdot\text{ha}^{-1}$ seed yield, and by $0.31 \text{ t}\cdot\text{ha}^{-1}$ fibre yield, when compared to the standard variety ‘Oršanskij 2’. In 1993, this variety was submitted to state variety testing (Bačelis, 1997).

In 1971–1993, K. Bačelis investigated the new fibre flax variety No. 1547-11-7. Valuable parameters of this breeding line showed it to be equivalent to that of standard varieties ‘Belinka’ and ‘Oršanskij 2’. In 1994, this variety was sent to the Gene Bank as a valuable accession for flax breeding programmes, but was not submitted for state variety testing (Bačelis, 1995).

The new fibre flax variety ‘Kastyčiai’ (author K. Bačelis) was investigated in 1979–1999. Fibre content was higher by 19.4% than that of standard varieties ‘Oršanskij 2’ and ‘Belinka’. Fibre had good quality; it was firm and flexible. Flax was semi-late, resistant to lodging, and less susceptible to anthracnose and wilt. In 1997, this variety was sent to state variety testing (Bačelis, 2000). In 1997–1999, State



Fig. 7. Long-year flax breeder Dr. Kęstutis Bačelis with the award for fibre flax variety 'Kastyčiai', the first Lithuanian flax variety included in the EU catalogue (2004).

variety testing showed that this variety gave average stem yield $6.2 \text{ t} \cdot \text{ha}^{-1}$; highest stem yield ($7.5 \text{ t} \cdot \text{ha}^{-1}$) was recorded in 1998. Scutched fibre content was 22.8% of stem weight. The fibre flax variety 'Kastyčiai' has blue flowers, it is moderately late ripening (88–90 days since germination), and resistant to lodging. Average plant height is 93 cm. The seeds are brown and 1000 seed weight is 5.17–6.12 g. It exhibits high fibre quality and is suitable for textile production. In 2000, it was registered in Lithuania (Anonymous, 2012a). It has been used as a standard variety in breeding nurseries for many years.

'Kastyčiai' was the first Lithuanian fibre flax variety included to the EC common catalogue of varieties of agricultural plant species in 2004 (Anonymous, 2011).

Inter-varietal crossing resulted in three new fibre flax varieties, 'Dangiai', 'Snaigiai' and 'Sartai' (authors K. Bačelis and Z. Jankauskienė), which were tested for VCU and DUS in 2007–2008. Tests were found to be positive (main characteristics of breeding lines tested were superior to those of the standard varieties) and they were included in 2009 in the National (Lithuanian) List of plant varieties and EC Common catalogue of varieties of agricultural plant species.

The fibre flax variety 'Dangiai' has blue flowers, it is moderately early ripening, has high yield, it is resistant to lodging, seeds are brown, 1000 seeds weight is 4.73 g, fibre quality is good, and fibre is suitable for textile purposes (Jankauskienė and Bačelis, 2007; Jankauskienė, 2009; Anonymous, 2011; 2012a).

The new fibre flax variety 'Snaigiai' has white flowers, ripens moderately late, has high yield, and is resistant to lodging. Seeds are brown, 1000 seed weight is 5.53 g. It exhibits high fibre quality and is suitable for the textile production (Jankauskienė and Bačelis, 2008b; Jankauskienė, 2009; (Anonymous, 2011; 2012a).

The new fibre flax variety 'Sartai' has white flowers, it is moderately late ripening, has high yield and resistance to lodging. Seeds are brown, 1000 seed weight is 5.41 g. Fibre

quality is also good, fibre is suitable for the textile production (Jankauskienė, 2009; (Anonymous, 2011; 2012a).

LINSEED BREEDING

More than 150 linseed accessions were collected and investigated in 1998–2003 in Uplytė for their productivity, vegetation period, plant height, seed size, fat content, resistance to lodging and diseases, etc. These studies identified the best donors for breeding (Bačelis, 2004). Some accessions, like 'Mikael', 'Barbara', 'Lirina', 'Szapfir', were utilised in biotechnological breeding at the University of Aleksandras Stulginskis in Kaunas. A collection of selected accessions with distinguishing properties, such as yellow-seed mutants, was created by K. Bačelis, and then selection was continued by Z. Jankauskienė. The linseed breeding in Uplytė gave results. After DUS and VCU tests, in 2012 the first two Lithuanian linseed varieties 'Rasa' and 'Edita' were included in the Lithuanian National List of plant varieties and EC common catalogue of varieties of agricultural plant species, and linseed variety 'Rūta' in 2013 (Juciuvienė, 2013; Anonymous, 2012c; 2013b).

Linseed variety 'Rasa' (authors Z. Jankauskienė and K. Bačelis) was one of the first Lithuanian linseed varieties. State testing of the variety were conducted in 2010–2011. According to the results, it is white flowering, semi-late (102 (92–110) days after germination), plant height is between 58 and 84 cm. Seed yield varies from 1.02 to $2.12 \text{ t} \cdot \text{ha}^{-1}$, 1000 seed weight is 6.54 (6.14–7.11) g, crude fat content in seeds — 40.0%. The resistance to lodging is 7.0–9.0 points (depending on year) (Anonymous, 2012a; 2012b). The new variety was included to the National (Lithuanian) List of plant varieties and EC Common catalogue of varieties of agricultural plant species in 2012.

Linseed variety 'Edita' (authors Z. Jankauskienė and K. Bačelis) also is one of the first Lithuanian linseed varieties. State tests for the varieties' value were conducted also in 2010–2011. Flax of this variety has very light blue flowers, it is semi-late ((94–110) days after germination), plant height is between 55 and 77 cm. Seed yield is from 1.08 to $1.98 \text{ t} \cdot \text{ha}^{-1}$, 1000 seed weight 6.38 (5.91–6.98) g, crude fat content in the seeds – 40.6%. The resistance to lodging is 7.0–9.0 points (depending on year) (Anonymous, 2012a; Anonymous, 2012b). In 2012, this new variety was included to the National (Lithuanian) List of plant varieties and EC Common catalogue of varieties of agricultural plant species (Anonymous, 2012a; 2012b).

State tests of linseed variety 'Rūta' (authors Z. Jankauskienė and K. Bačelis) 2010–2012 gave the following results: white flows, semi-late ((92–122) days after germination), plant height between 50 and 79 cm, seed yield from 1.61 to $2.29 \text{ t} \cdot \text{ha}^{-1}$, 1000 seed weight 7.01 (6.09–7.52) g, crude fat content in seeds — 39.5% and resistance to lodging 6.0–9.0 points (depending on year). The new variety was included to the National (Lithuanian) List of plant vari-

eties and EC Common catalogue of varieties of agricultural plant species in 2013.

Currently registered flax and linseed varieties in Lithuania. Currently (in 2013), there are four fibre flax varieties of Lithuanian origin ('Kastyčiai', 'Snaigiai', 'Dangiai' and 'Sartai') in the 2013 National (Lithuanian) list of plant varieties and three linseed varieties of Lithuanian origin ('Rasa', 'Edita' and 'Rūta') in the 2013 National (Lithuanian) list of plant varieties. Four foreign fibre flax varieties: two Polish ('Artemida' and 'Modran') and two French ('Alizee' and 'Drakkar') are also included in the list (Anonymous, 2013a).

Flax collection as initial breeding material and collection of genetic resources. Generally, a collection of various flax accessions forms the basis of initial breeding material needed for successful flax breeding (Rašals *et al.*, 1999).

Firstly, the accessions of a collection should be carefully investigated with the aim to assess their value for breeding programmes (Jankauskienė and Bačelis, 2006; 2008a; Jankauskienė and Gruzdevienė, 2008).

Flax collections serve as a source of genetic resources, the variability of which should be studied and preserved (Bacelis and Jankauskiene, 2005; Jankauskienė, 2007; Razukas *et al.*, 2009; Jankauskienė and Gruzdevienė, 2011; 2012; 2013; Burbulis *et al.*, 2012;).

At the beginning of 2006, the collection of *Linum ussitatissimum* L. in Lithuania consisted of 922 accessions as an active collection (short time preservation) and 51 accessions in long-term preservation collection. The main part of these collections has Lithuanian origin (in the active collection, accessions from Lithuania constitute 44.4%, Russia – 17.9%, Ukraine – 3.9%, Canada – 3.8%, Belorussia – 3.4%, France – 3.4%, Czech Republic – 2.7%, Netherlands – 2.5%, Austria – 2.2%, Germany – 2.1%, USA – 2.1%, Poland 2.1%, India – 1.1%, Belgium – 0.8%, Hungary – 0.7%, Latvia – 0.7%, China – 0.5%, Great Britain – 0.5%, and less than 0.5% – accessions from other countries (Jankauskienė, 2007).

The number of accessions of *Linum ussitatissimum* L. in the Lithuanian collection is not stable; it changes due to introduction of new accessions or discarding of some breeding lines, as well as of knelling or some accessions. Valuable new breeding lines or other accessions from breeding need to be transferred to the flax collection. Valuable flax accessions are transferred to the Gene Bank. The exchange of flax seed accessions between breeders from various countries is going on continually.

Other activity related to flax breeding. Flax breeders were involved in COST 847 Textile Quality and Biotechnology in 2001–2005, projects of Baltic countries for preservation of flax gene pool, participated in ECP/GR (European Cooperative Programme for Crop Genetic Resources Networks), Fibre Crops (Flax and Hemp) working group meeting in 2006. Since September 2012, flax breeding work

will be reflected in the EU project FIBRA. The research work is presented in papers in national, international journals and many national and international conferences.

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REFERENCES

- Anonymous (1923). *Dotnavos selekcijos stoties pasėlių rodyklis, 1923 m.* [Index of the Crops at Dotnava Breeding Station, Year 1923]. Kaunas. 24 pp. (in Lithuanian).
- Anonymous (1924). *Dotnavos selekcijos stoties pasėlių rodyklis, 1924 m.* [Index of the Crops at Dotnava Breeding Station, Year 1924]. Kaunas. 41 pp. (in Lithuanian).
- Anonymous (1925). *Dotnavos selekcijos stoties prie žemės ūkio akademijos pasėlių rodyklis, 1925 m.* [Index of the Crops at Dotnava Breeding Station, related to the Academy of Agriculture, year 1925]. Kaunas. 45 pp. (in Lithuanian).
- Anonymous (1926). *Dotnavos selekcijos stoties prie žemės ūkio akademijos pasėlių rodyklis, 1926 m.* [Index of the Crops at Dotnava Breeding Station, related to the Academy of Agriculture, year 1926]. Kaunas: Valstybinė spaustuvė. 41 pp. (in Lithuanian).
- Anonymous (1927). *Dotnavos selekcijos stoties prie žemės ūkio akademijos pasėlių rodyklis Nr. 5, 1927 m.* [Index of the Crops at Dotnava Breeding Station, related to the Academy of Agriculture, No. 5, year 1927]. Kaunas: Valstybinė spaustuvė. 63 pp. (in Lithuanian).
- Anonymous (1929). *Dotnavos selekcijos stoties prie žemės ūkio akademijos pasėlių rodyklis Nr. 6, 1929 m.* [Index of the Crops at Dotnava Breeding Station, related to the Academy of Agriculture, No. 6, year 1929]. Kaunas: Varpo. 71 pp. (in Lithuanian).
- Anonymous (1930). *Dotnavos selekcijos stoties prie žemės ūkio akademijos pasėlių rodyklis Nr. 7, 1930 m.* [Index of the Crops at Dotnava Breeding Station, related to the Academy of Agriculture, No. 7, year 1930]. Kaunas: M. ir K. spaustuvė. 79 pp. (in Lithuanian).
- Anonymous (1951). *Linų veislių bandymai Lietuvos TSR 1948–1950 m.* [Flax varieties' trials in Soviet Lithuania in 1948–1950] Vilnius. 36 pp. (in Lithuanian).
- Anonymous (1997). *Lietuvos žemdirbystės institutas* [Lithuanian institute of Agriculture]. Akademija, pp. 17–18 (in Lithuanian).
- Anonymous (2009). *Nacionalinis augalų veislių 2009 m. sąrašas* [National list of plant varieties 2009]. Vilnius, pp. 13, 72–75 (in Lithuanian).
- Anonymous (2011). Aliejiniai ir pluoštiniai augalai. Sėjamieji pluoštiniai linai [Oil and fibre plants. Fibre flax]. (2011). In: *Lietuvos agrarinių iš miškų mokslų centre sukurtų žemės ūkio augalų veislių aprašymai* [Description of Varieties of Agricultural Plants Developed at Lithuanian Research Centre for Agriculture and Forestry] (pp. 24–26). Akademija (in Lithuanian).
- Anonymous (2012a). Linų, įrašytų į nacionalinį augalų veislių sąrašą, charakteristikos [Characteristics of flax included to National list of plant varieties]. http://www.vatzum.lt/uploads/documents/augalu_veisles/veisliu_aprasymai/pdf_12_linu_veisliu_irasytu_i_ns_characteristikos.pdf (accessed 19 April 2013) (in Lithuanian).
- Anonymous (2012b). *Naujausios rekomendacijos žemės ir miškų ūkiui 2012* [The newest recommendations for agriculture and forestry 2012]. Akademija, pp. 34–35 (in Lithuanian).
- Anonymous (2012c). Naujienos. Žemdirbiams — naujos augalų veislės, 2012 m. vasario 2 d., Valstybinė augalinkystės tarnyba prie žemės ūkio ministerijos [News. For farmers — new plant varieties, 2 February 2012, State Plant Growing Service related to the Ministry of Agriculture].

- <http://www.vatzum.lt/lt/naujienos/nid.40> (accessed 19 April 2013) (in Lithuanian).
- Anonymous (2013a). Aliejiniai ir pluoštiniai augalai — Oil and fibre plants. In: *Nacionalinis augalų veislių 2013 m. sąrašas* [Lithuanian National List of Plant Varieties 2013] (p. 8). http://www.vatzum.lt/uploads/documents/augalu_veisles/vat_nacionalinis_sarasas_2013_04.10.2.pdf (accessed 28 May 2013) (in Lithuanian).
- Anonymous (2013b). Naujienos. Žemdirbiams – apie augalų veislių naujoves, 2013 m. sausio 30 d., Valstybinė augalinkystės tarnyba prie žemės ūkio ministerijos [News. For farmers — about new plant varieties, 30 January 2013, State Plant Growing Service related to the Ministry of Agriculture]. http://www.vatzum.lt/lt/naujienos/zemdirbiams_-_apie_augalu_veisliu_naujoves (accessed 19 April 2013) (in Lithuanian).
- Bačelis, K. (1975a). Chlorofilinės mutacijos linų veislėse, paveiktose cheminiais mutagenais [Chlorofilic mutations in the flax varieties affected by chemical mutagens]. In: *Mutageninių faktorių veikimas ir genetinių metodų taikymas selekciijoje* (pp. 33–34). Vilnius (in Lithuanian).
- Bačelis, K. (1975b). Etilmetansulfonato sukelti pakitimai linuose [Flax' changes caused by ethyl-methan-sulphonate]. In: *Mutageninių faktorių veikimas ir genetinių metodų taikymas selekciijoje* [Effect of mutagenic factors and application of genetic methods in breeding] (pp. 35–36). Vilnius (in Lithuanian).
- Bačelis, K. (1975c). Nitrozoalkilinančių junginių mutageninis poveikis linams [Mutagenic effect of nitrozo-alcilic compounds on flax]. In: *Mutageninių faktorių veikimas ir genetinių metodų taikymas selekciijoje* (pp. 34–35). Vilnius (in Lithuanian).
- Bačelis, K. (1977). Nauja linų veislė 'Banga 2' [New flax variety 'Banga 2']. *Agromonija*, **35**, 119–123 (in Lithuanian).
- Bačelis, K. (1981). Nauja ilgaplauščių linų veislė 'Uptytė': 1964–1979 m. Uptytės bandymų stotyje vykdytų lauko bandymų ir laboratorinių tyrimų ataskaita [New fibre flax variety 'Uptytė': A report on field trials and laboratory investigation held in 1964–1979 at Uptytė Research Station]. Uptytė, 23 pp. (in Lithuanian).
- Bačelis, K. (1984). Cheminė mutagenėzė linų selekciijoje [Chemical mutagenesis in flax breeding]. *Linai*, **48**, 76–80 (in Lithuanian).
- Bačelis, K. (1988). Effect of the chemical mutagen dimethyl sulphate on the variability of fibre flax in M1. *Biologija*, No. 1, 8–10.
- Bačelis, K., Gaižiūnienė, M. (1990). Nauja linų veislė 'Uptytė 2' [New flax variety 'Uptytė 2']. *Agromonija*, **65**, 88–95 (in Lithuanian).
- Bačelis, K. (1991). Ilgaplauščiai linai 'Baltučiai' [Fibre flax 'Baltučiai']. *Agromonija*, **68**, 115–121 (in Lithuanian).
- Bačelis, K. (1992). Techninių augalų selekcija. Linai [Breeding of technical plants. Flax]. In: *Lauko augalų selekcija Lietuvoje* (pp. 115–121). Vilnius: Mokslas (in Lithuanian).
- Bačelis, K. (1993). Nauja pluoštinių linų veislė 'Alfa-B': 1972–1991 m. Uptytės bandymų stotyje vykdytų bandymų ir laboratorinių tyrimų ataskaita [New fibre flax variety 'Alfa-B': A report on field trials and laboratory investigation held in 1972–1991 at Uptytė Research Station]. Uptytė. 30 pp. (in Lithuanian).
- Bačelis, K. (1995). Pluoštinių linų veislė Nr. 1547-11-7: 1971–1993 m. Uptytės bandymų stotyje vykdytų lauko bandymų ir laboratorinių tyrimų ataskaita [New fibre flax variety Nr. 1547-11-7: A report on field trials and laboratory investigation held in 1971–1993 at Uptytė Research Station]. Uptytė, 29 pp. (in Lithuanian).
- Bačelis, K. (1997). Nauja pluoštinių linų veislė 'Vega 2' [New fibre flax variety 'Vega 2']. *Žemdirbystė/Agriculture*, **59**, 118–124 (in Lithuanian).
- Bačelis, K. (1998). Pluoštinių linų selekcija [Fibre flax breeding]. In: *Augalų selekcija* [Plant breeding] (pp. 97–105). Vilnius (in Lithuanian).
- Bačelis, K. (2000). Pluoštinių linų veislė 'Kastyčiai' [Fibre flax variety 'Kastyčiai']. *Žemdirbystė/Agriculture*, **70**, 235–244 (in Lithuanian).
- Bačelis, K. (2001). Pluoštinių linų selekcijos pasiekimai [Achievements of fibre flax breeding]. *Žemdirbystė/Agriculture*, **75**, 206–214. (in Lithuanian).
- Bačelis, K. (2004). Sėmeninių (aliejinių) linų kolekcijos rinkimas ir įvertinimas Uptytėje: 1998–2003 m. Uptytės bandymų stotyje darytų lauko bandymų ir laboratorinių tyrimų ataskaita [Collection and Evaluation of Linseed Accession in Uptytė: A report on field trials and laboratory investigation held in 1998–2003 at Uptytė Research Station]. Uptytė, 28 pp. (in Lithuanian).
- Bačelis, K., Jankauskienė, Z. (2005). Investigation and use of Lithuanian flax genetic resources in the breeding programs. In: *Environment. Technology. Resources, 5th International Scientific and Practical Conference, 16–18 June 2005* (pp. 95–102). Rezekne.
- Buivydytė, V. V., Vaičys, M., Juodis, J. ir kt. (2001) *Lietuvos dirvožemių klasifikacija* [Classification of Lithuanian Soils]. Vilnius. 76 pp. (in Lithuanian).
- Burbulis, N., Blinstrubienė, A., Masienė, R., Jankauskienė, Z., Gruzdevienė, E. (2012). Genotypic and growth regulator effects on organogenesis from hypocotyls' explants of fiber flax (*Linum usitatissimum* L.). *Int. J. Food Agr. Environ.*, **10** (1), 397–400.
- Jankauskienė, Z., Bačelis, K. (2006). Investigation and application of valuable fiber flax characters in breeding programs. In: *Opportunities and Problems of Economic Development, International Conference, Rezekne, 24 March 2006* (pp. 411–417). Rezekne.
- Jankauskienė, Z. (2007). Preservation of the collection of *Linum usitatissimum* L. in Lithuania. In: *Innovative Technologies for Comfort, 4th Global Workshop (General Consultation) of the FAO/SCORENA European Cooperative Research Network on Flax and Other Bast Plants, Arad, Romania, 7–10 October, 2007* (pp. 45–49). Bucuresti: Certex.
- Jankauskienė, Z., Bačelis, K. (2007). New fibre flax variety 'Dangiai'. *Žemdirbystė/Agriculture*, **94** (4), 56–61.
- Jankauskienė, Z., Bačelis, K. (2008a). Evaluation of long fibre quality of fibre flax varieties and breeding lines by different methods. *Žemdirbystė/Agriculture*, **95** (1), 93–106.
- Jankauskienė, Z., Bačelis, K. (2008b). New Lithuanian fibre flax variety 'Snaigiai'. *Agromonijas Vēstis (Latvian Journal of Agronomy)*, **11**, 67–72.
- Jankauskienė, Z., Gruzdevienė, E. (2008). Resistant cultivar: A biological way to control flax fungal diseases. *Žemdirbystė/Agriculture*, **95** (3), 312–319.
- Jankauskienė, Z., Bačelis, K. (2009). Naujų pluoštinių linų veislių 'Dangiai', 'Snaigiai' ir 'Sartai' sukūrimas bei tyrimai [Development and investigation of new fibre flax varieties 'Dangiai', 'Snaigiai' and 'Sartai']. *Žemės ūkio mokslai*, **16** (1), 31–40 (in Lithuanian).
- Jankauskienė, Z. (2009). Achievements of Lithuanian fibre flax breeding — new varieties 'Dangiai', 'Snaigiai' and 'Sartai'. *Scientific bulletin of SCORENA*, **1**, 7–9.
- Jankauskienė, Z., Gruzdevienė, E. (2011). *Linum usitatissimum* L. rūšies augalų aukščio variacijos tyrimai [Investigation of variation of plant height in sp. *Linum usitatissimum* L.]. *Dekoratyviųjų ir sodo augalų sortimento, technologijų ir aplinkos optimizavimas*, **2** (7), 33–38 (in Lithuanian).
- Jankauskienė, Z., Gruzdevienė, E. (2012). *Linum usitatissimum* L. rūšies augalų biometrinų rodiklių tyrimai kolekcijoje [Investigation of biometrical indices of plants in collection of sp. *Linum usitatissimum* L.]. *Dekoratyviųjų ir sodo augalų sortimento, technologijų ir aplinkos optimizavimas*, **3** (8), 35–40 (in Lithuanian).
- Jankauskienė, Z., Gruzdevienė, E. (2013). *Linum usitatissimum* L. rūšies augalų žiedų spalvos įvairovės selekciniuose augnuose tyrimai [Investigation of variability of petal colour in breeding nurseries of sp. *Linum usitatissimum* L.]. *Dekoratyviųjų ir sodo augalų sortimento, technologijų ir aplinkos optimizavimas*, **4** (9), pp. 54–59. (in Lithuanian).
- Juciuvienė, S. (2013). Naujos augalų veislės, įrašytos į 2013 m. Nacionalinį augalų veislių sąrašą [New varieties included to the National list of plant varieties in 2013]. *Ūkininko patarėjas* [Advisor to Farmer], 5 February 2013, No. 15 (2972). http://www.up.lt/straipsniai/skaitykite/?article_id=3964 (accessed 19 April 2013) (in Lithuanian).
- Lniarska Centralna Stacja Doswiadzalna w latach 1930–1939 [Central flax testing station in 1930–1939]. (2000). In: *Instytut Włókien Naturalnych w*

- latach 1930–2000. *Historia-organizacija-kadra 2000* (pp. 8–12). Poznan (in Polish).
- Mackevičius, Z. (1936). *Dotnuvos selekcijos stoties darbų keli bruožai* [Some features of work at Dotnuva breeding station]. Kaunas, pp. 201, 203, 207, 208 (in Lithuanian).
- Mackevičius, Z. (1939). *Dotnuvos selekcijos stoties darbai ir jų nauda mūsų kraštui* [Works of Dotnuva breeding station and their value to our country]. Kaunas. 25 pp. (in Lithuanian).
- Rašals, I., Klovane, T., Stramkale, V. (1999). Latvijas linu ģenētisko resursu saglabāšana, izpēte un izmantošana selekcijā. *Agronomijas vēstis*, No. 1, 131–134.
- Razukas, A., Jankauskiene, Z., Jundulas, J., Asakaviciute, R. (2009). Research of technical crops (potato and flax) genetic resources in Lithuania. *Agron. Res.*, 7 (1), 59–72.
- Rudzinskas, D. *Rinkiniai raštai* [Selected papers] (1977). Vilnius: Mokslas. 283 pp. (in Lithuanian).
- Ruzgas, V. *Augalų selekcija* [Plant breeding] (2009). Akademija, pp. 109–111 (in Lithuanian).
- Šumskis, J. (1942). *Linų veislių bandymai Žemės Ūkio Tyrimo Departamento lauko Bandymų Stotyse 1930–1938 m.* [Flax varieties' testing in 1930–1938 in the field trial stations related to department of the investigation of agriculture]. Kaunas. 76 pp. (in Lithuanian).
- Tarakanovas, P., Raudonius, S. (2003). *Agronominių tyrimų duomenų statistinė analizė taikant kompiuterines programas Anova, Stat, Split-Plot iš paketo SELEKCIJA ir IRRISTAT* [Statistical analysis for data of agronomical investigation applying computer programs Anova, Stat, Split-Plot from package SELEKCIJA and IRRISTAT]. Akademija. 58 pp. (in Lithuanian).
- Valatka, P., Švilpienė, V. (1980). *Upytės bandymų stoties istorija. 1941–1980 m.* [History of Upytė Research Station. 1941–1980]. Upytė. 164 pp. (in Lithuanian).
- Vazonienė, I. (1959). Nauja ilgaplauščių linų veislė Lietuvos 392: 1955, 1956 ir 1958 m. Savitiškio bandymų stotyje vykdytų lauko bandymų ataskaita [New fibre flax variety Lietuvos 392: A report on field trials held in 1955, 1956 and 1958 at Savitiškis Research Station]. Savitiškis. 5 p. (in Lithuanian).
- Vyčas, A. (1968). Linų selekcija ir sėklininkystė Lietuvoje [Flax breeding and seed fanning in Lithuania]. In: *Lauko kultūrų selekcija ir sėklininkystė* [Field Crop Breeding and Seed Fanning in Lithuania] (pp. 159–178). Vilnius: Mintis (in Lithuanian).
- Vyšniauskaitė, A., Laniauskaitė, J. (1977). *Valstiečių linininkystė ir transportas* [Peasant flax husbandry and transport]. Vilnius: Mokslas, p. 25 (in Lithuanian).
- Zimkuvienė, A. (1997). *Žemės ūkio mokslo raida Lietuvoje iki 1945 metų* [Evolution of Agricultural Sciences in Lithuania Since 1945]. Dotnuva-Akademija. 86 pp. (in Lithuanian).
- Аноним (1961). *Методики технологической оценки льна и конопли* [Methodology for Technological Evaluation of Flax and Hemp]. Москва. 182 с. (in Russian).
- Аноним (1978). *Методические указания по проведению полевых опытов со льном-долгунцом* [Methodological Regulations for the Conducting Trials with Fibre Flax]. Торжок. 72 с. (in Russian).
- Бачялис К. [Banelis K.] (1986). Получение хозяйственно-ценных форм льна-долгунца под действием гамма-лучей ^{60}Co [Abstraction of valuable forms of flax under the influence of gamma-rays ^{60}Co]. В: *Радиационная генетика — селекции, материалы 1-ого Всесоюзного координационного совещания в Институте общей генетики АН СССР* (с. 11–13). Москва (in Russian).
- Булавас И. [Bulavas I] (ред.) (1955). *Литовская государственная селекционно-опытная станция* [Lithuanian State Breeding-Experimental Station]. Вильнюс: Государственное издательство политической и научной литературы Литовской ССР, с. 19 (in Russian).
- Литовская государственная селекционно-опытная станция. Тематический план на 1953 г.* [Lithuanian State Breeding-Experimental Station. Thematic Plan for Year 1953]. (1953). Доннува, с. 149 (in Russian).
- Лошакова Н. И., Крылова Т. В., Кудрявцева Л. П. (2000). *Методические указания по фитопатологической оценке устойчивости льна-долгунца к болезням* [Methodological Regulations for Phytopathological Fibre Flax Resistance to Diseases]. Москва. 52 с. (in Russian).
- Порах А. Р., Марченков, А. Н., Александрова Т. А. и др. (1987). *Методические указания по селекции льна-долгунца* [Methodological Regulations for Fibre Flax Breeding]. Торжок. 62 с. (in Russian).

90 GADU LINU SELEKCIJAS REZULTĀTI LIETUVĀ

Aprakstīta gan garšķiedru, gan eļļas linu selekcijas vēsture un sasniegumi Lietuvā pēdējo 90 gadu laikā.