FIBRE FLAX BREEDING FOR HIGH FIBRE QUALITY
Linu šķiedru audzēšana augstai šķiedru kvalitātei

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Abstract
The objective of flax breeding at the Upyte Research Station of LIA is to develop new varieties with a high yielding capacity, satisfactory resistance to lodging and diseases, as well of adequate quality to meet the demands of the textile industry. Two high yielding varieties with a good fibre quality 'Vega 2' and № 1547-11-7 have been developed at the Upyte Research Station of LIA recently.
In the present paper we have provided a description of the origin of those 2 varieties, main yielding characteristics and fibre quality parameters.
The variety 'Vega 2' produced 20 % higher stem yield, 18.3 % higher seed and 47 % higher long fibre yield than the standard variety 'Orshanskij 2'. Long fibre quality of the variety 'Vega 2' is good: fibre is firm, flexible, fine and meets the demands of the textile industry.
Stem yield of the variety № 1547-11-7 was similar to that of 'Orshanskij 2' and 'Belinka'. Seed yield was 0.13 t/ha higher than that of the variety 'Orshanskij 2' and equal to the seed yield of 'Belinka'. Long fibre quality of № 1547-11-7 is good and also meets the demands of the textile industry.
The variety 'Vega 2' has been registered in Lithuania since 1997, in Latvia since 2001. The seed samples of the variety № 1547-11-7 have been transferred to the Genebank.
Keywords: *breeding, flax, fibre, quality, flexibility, firmness, fineness, yield.*

Introduction

The main characteristics of a flax variety are fibre content and quality. Only high quality fibre can secure high quality of the final product. Flexibility, firmness, fineness, softness are among the key quality parameters of flax fibre, firstly depending on the variety genetic code. Flax cultivation techniques, weather and soil conditions have a great effect on fibre quality as well as on the primary flax straw processing (scutching, hackling) [6,11].

Many authors have reported that improvement of fibre quality could primarily be achieved by creating new flax varieties, using different breeding methods [1, 2, 5, 10]. Before creating a new variety it is necessary to investigate the inheritance of fibre quality parameters [4, 7].

Crossbreeding and selection of individual plants - as methods of breeding - lead to the development of varieties possessing a high fibre quality. This group includes the following fibre flax varieties: 'Svetoch', '1288/12', 'Orshanskij 2', 'Saldo', 'Belinka', 'Batist'. The varieties 'Belochka', 'T-9', 'P-359', 'Kijevskij', 'Dashkovskij', 'Baltuchiai', 'Rodnik', 'Pskovskij 85', 'Regina', 'Laura', 'M-5', 'K-65' could be attributed to the group of varieties characterised by a slightly lower fiber quality [3, 8, 14, 15]. Fibre quality of 'T-10', 'Slavnyj 82', 'K-6', 'Torzhokskij 4' etc. is low (less flexible and fine, more course) [16].

The Variety 'Zoria 87' which is notable for a good fibre quality was developed in the Ukraine using the method of chemical mutagenesis [3, 12].

The main task of flax breeders is to create new productive fibre flax varieties with high quality fibre. Also those varieties should be resistant to lodging and disease [2, 5, 9, 10].
'Vega 2' and № 1547-11-7 are the latest fibre flax varieties distinctive for high fibre quality created at the Upyte Research Station of LIA.

Materials and methods

Flax varieties 'Vega 2' and № 1547-11-7 were created by crossing geographically

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distant varieties.

Fibre flax breeding was carried out according to the following scheme: 1) nursery of initial material (collection, hybrids, mutants); 2) breeding nursery; 3) check nursery; 4) initial variety trials; 5) competitive variety trials; 6) multiplication of promising varieties and farm scale trials. In the nursery of initial material varieties and samples were sown in the plots of 0,2-1,0 m^2, in the breeding nursery – in the plots of 0,2-4,0 m^2, in 4 replications. Initial and competitive variety trials involved 4 replications, the size of a record plot was 11,2 and 16,0 m^2 respectively. In the competitive trials and initial variety trials plots were sown by a sowing machine SNL-16 at a seed rate of 25 million seed per hectare, with 10 cm interrow spacings. In the breeding nursery the plots were sown by hand at a seed rate of 22 million germinable seeds per ha. Insecticides were sprayed against flax flea beetles, herbicides were used to control weeds (except some nurseries). During flax vegetative growth period, phenological observations were conducted and resistance to lodging and fungal diseases on the natural background was assessed. [14]. Flax was pulled at the stage of early yellow ripeness, threshed by a MS thresher. Stems were retted in warm water (33-37 ºC), then scutched by a machine tool SMT-200. Fibre was hackled by combs Nb 9 and 13. The number of fibre was determined in the laboratory organoleptically, flexibility was measured by a device G-2, fibre firmness (strength) by a device DK-60, fineness by counting separate fibres in the described fibre sample. Long fibre quality (in km) was calculated using the formula: Q (in km) = 0.1 x Flexibility (in mm) + 0.2 x Firmness (in kg F) + 0.013 x Fineness (in units) + 2.1; where: 0.1; 0.2; 0.013 and 2.1 are constants [13]. Varieties ‘Orshanskij 2’ and ‘Belinka’ were standard varieties for fibre quality evaluation in the competitive variety trials. Morphological plant analysis was carried out also, stem and seed yield was calculated using ANOVA method (Tarakanovas P., 1996; Доспехов Б.А., 1985).

Meteorological conditions during 1998-2000 were diverse and gave the opportunity to evaluate flax varieties’ characteristics in different conditions. The 1990, 1991, 1993, 1996 1997 and 2000 were favourable for flax and stem and seed yield was obtained high. Medium favourable weather conditions for flax were in 1988, 1989 and 1998. Dry and warm weather in 1992 and 1999 significantly reduced flax yield and quality.

Results and discussion

Fibre flax variety ‘Vega 2’

In 1973 a female variety ‘Reina’ (№ K-6653 in the catalogue of N.I. Vavilov Research Institute of Plant Industry (VIR)) of Dutch origin was crossed with a fibre flax variety ‘Shokinskij’ (K-6784, VIR), developed in the Smolensk Research Station (Russia). ‘Reina’s fibre output is medium, fibre is firm, but the flexibility is lower, less fine. Plants are resistant to lodging. The variety ‘Shokinskij’ is late, high yielding, medium resistant to lodging. Fibre quality is good. In 1978 elite plants were selected. ‘Vega 2’ was tested in the competitive trials over the period 1988-1992.

Averaged data of 5 years' competitive trials showed that the new variety ‘Vega 2’, compared with standard ‘Orshanskij 2’, produced 20 % higher stem yield, 18.3 % higher linseed yield and 47 % higher long fibre yield (Table 1). Fibre content was 3.3 % higher than that of the standard ‘Orshanskij 2’. The quality of long fibre is good: it is flexible (43.4-60.4 mm), firm (19.4-29.1 kg F) and fine (193-236 units). The calculated fibre quality is 14.9-15.4 km, so it meets the demands of the textile industry. Good fibre quality (flexibility and fineness) was inherited from the variety ‘Shokinskij’.

Flax plants of the variety ‘Vega 2’ were on average 6.8 % taller than those of the variety ‘Orshanskij 2’. 1 000 seed weight was 0.88 g, or 19.1 %, higher than that of the standard variety.

‘Vega 2’ is a white flowering fibre flax variety, the stems are less affected by fungal

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diseases.

Table 1.

Biological characteristics and qualitative fibre indicators of the fibre flax varieties 'Vega 2' and 'Orshanskij 2'. Upyte, 1988-1992 average data

Parameters	Standard 'Orshanskij 2'	'Vega 2'	Compared with the standard 'Orshanskij 2'
Yield, t/ha:			
stem (LSD_{05} – 0.52)	5.34	6.41	120
seed (LSD_{05} – 0.07)	0.82	0.97	118.3
long fibre (LSD_{05} – 0.17)	0.66	0.97	147.0
Long fibre content, %	11.8 ± 0.8	15.1 ± 0.5	128.0
Quality of long fibre:			
number	11.3 ± 0.5	11.6 ± 0.5	102.7
flexibility, mm	60.6 ± 4.7	53.8 ± 3.7	88.8
firmness, kg F	23.8 ± 2.0	23.6 ± 2.6	99.2
fineness, units	206 ± 16	202 ± 10	98.1
quality, km	15.6 ± 0.3	14.8 ± 0.2	94.9
Plant height, cm	66.3 ± 3.0	70.8 ± 1.9	106.8
Technical stem length, cm	56.2 ± 3.1	61.7 ± 2.3	109.8
Vegetation period, days	82 ± 5	83 ± 3	101.2
Resistance to lodging, points	7.1 ± 0.4	7.6 ± 0.2	112.2
1 000 seed weight, g	4.62 ± 0.13	5.50 ± 0.14	119.1
Stem infection by diseases, %:			
Fusarium spp.	9.0 ± 2.6	3.2 ± 1.0	35.6
Colletotrichum lini M. et B.	11.0 ± 1.6	8.4 ± 2.1	76.4

Fibre flax variety № 1547-11-7

In 1971 a female variety 'Diana' (K-6230, VIR) of Dutch origin was crossed with a flax breeding line B-96 ('L-1120'x'Severianin'x'Viera'), bred at the Upyte Research Station of LIA. Plants of the variety 'Diana' are white flowering, resistant to lodging. Vegetative growth period is long. The breeding line B-96 is high yielding, medium late, with a good fibre quality.

In 1976 elite plants were selected. The flax variety № 1547-11-7 was tested in the competitive variety trials in 1990-1993 and 1999-2000. Averaged data of 6 years showed that the stem yield of the new variety was similar to that of 'Orshanskij 2' and 'Belinka'. The seed yield of the variety № 1547-11-7 was 13.5 % higher than that of the standard 'Orshanskij 2'. The seed yield was equal with the yield of 'Belinka' (Table 2). Fibre content was on average 1.5 % higher than that of 'Orshanskij 2'. Long fibre quality is good: fibre is firm (29.5-32.3 kg F), flexible (38.2-52.6 mm), fine (164-236 units), quality index (in km) – 12.8-15.9. The long fibre quality also meets the demands of the textile industry.

Plants of the variety № 1547-11-7 are resistant to lodging, less susceptible to fungal diseases – *Fusarium spp*. and *Coletotrichum lini* B. et M. The flax variety Nb. 1547-11-7 belongs to the group of medium early flax varieties, plants are blue flowerig. 1000 seed weight is by 0.70 g, or 14.4 %, higher than that of the standard variety 'Orshanskij 2'.

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Table 2.

Biological characteristics and qualitative fibre indicators of the fibre flax varieties 'Orshanskij 2', 'Belinka' and № 1547-11-7. Upyte, 1990-1993 and 1999-2000 average data

Parameters	Standard	Standard	№ 1547-	Compared with the standard	
	'Orshanskij 2'	'Belinka'	11-7	'Orshanskij 2'	'Belinka'
Yield, t/ha:					
stem (LSD_{05} – 0.62)	5.82	5.97	6.05	104.0	101.3
seed (LSD_{05} – 0.08)	0.96	1.18	1.09	113.5	92.4
long fibre (LSD_{05} –0.11)	0.79	0.95	0.90	113.9	94.7
Long fibre content, %	13.0 ± 1.4	15.4 ± 1.0	14.5 ± 1.5	111.5	94.2
Quality of long fibre:					
number	11.5 ± 0.7	11.5 ± 0.7	11.5 ± 0.7	100	100
flexibility, mm	50.4 ± 3.4	50.6 ± 3.2	46.3 ± 2.9	91.9	91.5
firmness, kg F	25.8 ± 1.8	27.1 ± 3.5	27.9 ± 3.1	108.1	103.0
fineness, units	195 ± 10	187 ±17	201 ± 18	103.1	107.5
quality, km	14.8 ± 0.4	15.0 ± 0.9	15.0 ± 0.7	101.4	100
Plant height, cm	67.1 ± 4.3	67.6 ± 5.6	64.6 ± 5.1	96.3	95.6
Technical stem length, cm	57.8 ± 5.1	57.8 ± 5.7	56.5 ± 5.2	97.8	97.8
Vegetation period, days	89 ± 9	92 ± 10	89 ± 10	100	96.7
Resistance to lodging, points	7.2 ± 0.4	7.9 ± 0.2	9.0 ± 0.0	119.1	102.0
1000 seed weight, g	4.78 ± 0.20	5.11 ± 0.17	5.57 ± 0.23	114.4	109.0
Stem infection by diseases, %:	12.3 ± 2.4	16.5 ± 6.6	9.3 ± 4.1	75.6	56.4

Conclusions

1. Conventional breeding methods (crossing and individual selection) enable to create varieties with high fibre quality inherited from parental forms.
2. The variety 'Vega 2' produced 20 % higher stem yield, 18.3 % higher seed and 47 % higher long fibre yield than the standard variety 'Orshanskij 2'.
3. Long fibre quality of the variety 'Vega 2' is good: fibre is firm (19.4-29.1 kg F), flexible (43-60 mm), fine and meets the demands of the textile industry.
4. Stem yield of the variety № 1547-11-7 was similar to that of 'Orshanskij 2' and 'Belinka'. Seed yield was 0.13 t/ha higher than that of the variety 'Orshanskij 2' and equal to the seed yield of 'Belinka'.
5. Long fibre quality of № 1547-11-7 is good and also meets the demands of the textile industry.
6. The variety 'Vega 2' has been registered in Lithuania since 1997, in Latvia since 2001. The seed samples of the variety № 1547-11-7 have been transferred to the Genebank. Variety № 1547-11-7 is included in the intervarietal crossings.

References

1. Dylenok L.A., Yatsevich A.P., Kudelko L.I. Genetic analysis of anatomomorphological stem parameters in fibre flax // Natural fibres. 1998 .T. 2. P. 144-145.
2. Doronin S. V., Dudina A. N., Tikhivinsky S. F. Fibre flax breeding for fibre quality // Natural fibres. 1998. T. 2. P. 93.
3. Karpets I.P, Dynnik V.P., Ganganov V.N.. Results of research on practical application of fibre flax genetic fund // Natural fibres. 1997. XLI. P. 19-20.
4. Karpunin B. The perspective flax line with good quality of fibre // Breeding for fiber and oil quality in flax. France, St. Valery en caux, 1995. P. 57-63.
5. Loshkov M.I.. Flax breeding for fibre quality // Breeding, growing technology and processing of flax and hemp. Gluhov, 1977. P. 61-69.

ISBN 9984 – 585 – 68 – 9

6. Pawula E., Mazur E. Bast fibres fineness measured by objective methods // Proceedings of the second global Workshop Bast plants in the New Millennium, 3-6 June, 2001, Borovets, Bulgaria. P. 429.
7. Polonetskaya L.M., Panifedova L.M., Sakovich V. I.. Analysis of gene effects controlling elements of productivity and fiber quality in fiber flax cultivars // Proceedings of the second global Workshop Bast plants in the New Millenium, 3-6 June, 2001, Borovets, Bulgaria. P. 180-182.
8. Sharma H.S.S., Faughey G. J.. Comparison of subjective and objective methods to asses flax straw cultivars and fibre quality after dew-retting // Annals of Applied Biology. 1999. 135 (2). P. 495-501.
9. Trouve J.P. L'amelioration variatale du lin textile face aux besoins des marches // Comptes rendus de e'academie d'agriculture de France. France, 1996. 82 (8). P. 55-63.
10. Wlaswinkel L. Fibre flax breeding in Western Europe. In: *New trends in the use of flax and its waist*. Minsk 1994, p. 35-39.
11. Гращенко М. Г. О гибкости льноволокна // Труды по прикладной ботанике, генетике и селекции. Москва-Ленинград, 1963, Т. 35. Вып.3, С. 99-105.
12. Дынник В.П. Сорт льна-долгунца «Заря», полученный методом химического мутагенеза. Москва, 1988. С. 73-76.
13. Методики технологической оценки продукции льна и конопли. Москва, 1961. 182 с.
14. Рогаш А.Р., Марченков А.Н., Александрова А.А. и др. Методические указания по селекции льна-долгунца. Торжок, 1987. 63 с.
15. Шаров И.Й., Киселев И.М., Гришина Л.Н. Характеристика новых сортов и форм льна-долгунца по хозяйственно ценным признакам и свойствам // Растениеводство, генетика и селекция технических кулльтур. Ленинград, 1991. Т. 144. С. 48-61.
16. Шаров И.Й., Ливанская Г.А., Логинова Л.А. и др. Состояние льноводства и характеристики новых сортов льна-долгунца // Ботаника, генетика и селекция технических культур. Санкт-Петербург, 1999. Т. 156. С. 55-62.

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