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EXPERIMENTAL PAPER

Passport data and valorisation data of 33 accessions from the collection of genetic resources of the species *Linum usitatissimum* L.

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Summary

Introduction: In 2020, the Institute of Natural Fibres and Medicinal Plants (INF&MP) implemented the contract No. 7/PW 1.2 – IWNiRZ Poznań/KCRZG/2020 for the performance of a research service under the long-term programme "Creating scientific foundations for biological progress and protection of plant genetic resources as a source of innovation and support for sustainable agriculture and safety food for country".

Objective: The aim of the research was to prepare passport and valorisation data for 33 accessions of flax (*Linum usitatissimum* L.) sown at the INF&MP Experimental Station in Pętkowo.

Methods: The field experiment was conducted on 33 samples of flax seeds, which were sown on an area of 1.6 m^2. Morphological features were presented by means of numerical data and their evaluation. The agricultural characteristics (numerical values and percentage of the collective pattern) and lengths of vegetation period were also presented. The evaluation of the performed characteristics of flax accessions was presented numerically and the data were given to the International Flax Database.

Results: On the basis of paper documentation, the country of origin of the accessions, the type of genotypes by origin (landrace, variety) and the date of inclusion of the accessions in the flax collection were determined. The results of the characterization of morphological trials were as follows: the total plant length of the flax plants ranged from 51.4 cm (La Estanzuella 117) to 76.5 cm (WUKR 06-417) According to the methodology of the International Flax Database, the total plant length were short (28 accessions), medium short (3) and medium (1). Technical length was usually short (28 accessions) and medium short (4 accessions). Stem thickness for all accessions was medium: 1.6–2.5 mm. The length of the panicle was long only for the Opal variety, for 25 accessions - medium and short for 6 accessions. A number of bolls from panicle was: 9.1–30.8. The 1000 seed weight was low for 25 accessions of flax and very low for 8 genotypes of flax.

Conclusions: Both studied vegetation periods were short in the following flax accessions: AC Linora, Manchwrian, Noralta and T-397. Flax genotype WUKR-846 (I2010/0031) should be deleted from the flax genetic resources collection and considered as worthless as breeding material. The WUKR 06-417 accession collected during the field expedition is distinguished by a high fibre content – 27%. The highest seed yield

per plot was obtained from the cultivation of the following linseed flax cultivars: Redwood, AC Mc Duff, Norlin, Noralta and Jenny.

Key words: ***genetic resources, flax, Linum usitatissimum L., morphological traits, biological features, agricultural traits***

Słowa kluczowe: ***zasoby genetyczne, len, Linum usitatissimum L., cechy morfologiczne, cechy biologiczne, cechy rolnicze***

INTRODUCTION

Currently, we are witnessing a large loss of biodiversity in agriculture. Fewer crop species are cultivated in the 21st century than in the 20th century. An important criterion in selecting species for cultivation is obtaining the greatest possible income. The loss of biodiversity necessitates the preservation of valuable plant species in seed banks. The seed bank of cultivated plants, in which genetic resources are stored for a long time, is located in the Plant Breeding and Acclimatization Institute (IHAR), Poland. The genotypes of crops stored there are characterized by many important morphological, biological or agricultural features that can be used by breeders to work on new varieties. Therefore, it is very important to know the passport data and valorisation data of flax accessions. Flax is a species of particular importance for human health, and its benefits have been appreciated for decades. In the 20th century, flax seed was popular both in the kitchen and in the field. Preserving the genetic resources of flax (*Linum usitatissimum* L.) is of great importance for society, because this plant is very important in the prevention of civilization diseases (cardiovascular, cancer, mental diseases and many others), in many branches of the economy and in environmental protection nature and climate. The importance of flax in medicine is primarily due to the extremely beneficial composition of the seeds: α-linolenic acid, valuable amino acids and fiber, many anti-aging antioxidants [1-4].

In the economy, flax is used in products characterized by valuable health properties and biodegradable. The flax species should be appreciated as having enormous health and ecological potential, because health problems, loss of biodiversity, problems with environmental pollution and climate warming are the biggest problems in the world.

MATERAL AND METHODS

The passport data of flax accessions sown in 2010 in Pętkowo on 1.6 m^2 plots are presented in table 1. Most of studied flax accessions – 27, (Institution code) were collected by the Institute of Natural Fibres, now Institute of Natural Fibres and Medicinal Plant (INF&MP). Five genotypes of flax were included in the collection of genetic resources of the *Linum usitatissimum* L. species by the Plant Breeding and Acclimatization Institute (IHAR) during field expedition. One cultivar from Breeding Strzelce also participated in the experiment. The flax accessions were collected from 1984 (Manchwrian, Noralta, Redwood) to 2010 (WUKR 06-268, WUKR-723, WUKR 06-417, WUKR-846, WIG 09-14) (acquisition date). The largest number of flax genotypes comes from Poland (6 accessions); Czech Republic, Canada, Denmark, Great Britain (3 accessions of flax); Argentina, Uruguay, Germany (2 genotypes) and India, USA, France, Morocco, Sweden (1 flax accession) (fig. 1). The tested genotypes are 25 varieties of flax and 8 breeding lines (origin).

The summary of meteorological data for the growing season in 2010 in Experimental Station in Pętkowo are showed in table 2 and the morphological characteristics and valorisation of 33 accessions of flax are showed in table 3. The collected accessions are stored as seeds in the National Centre for Plant Genetic Resources at the IHAR in Radzików near Warsaw [5]. The valorisation of 33 accessions of flax was carried out using the traditional method and the method used in the development of the International Flax Database (IFDB), using the descriptor states [6-8].

In the paper of J. Nôžková we can find ranges of numerical values for individual morphological, biological and agricultural features. At INF&MP, we introduce the new methods of characterisation of flax genotypes. Morphological features are presented as numerical values and a specific evaluation of 5 features (tab. 3). Each tested accession was classified into one of the following groups: very short, short, medium, long, very long [8]. In 2010 growing season in Pętkowo phenological phases were observed, on the basis of which two vegetation period were determined presented in table 4 (biological features): vegetation period from sowing to beginning of flowering, and vegetation period from sowing to yellow maturity.

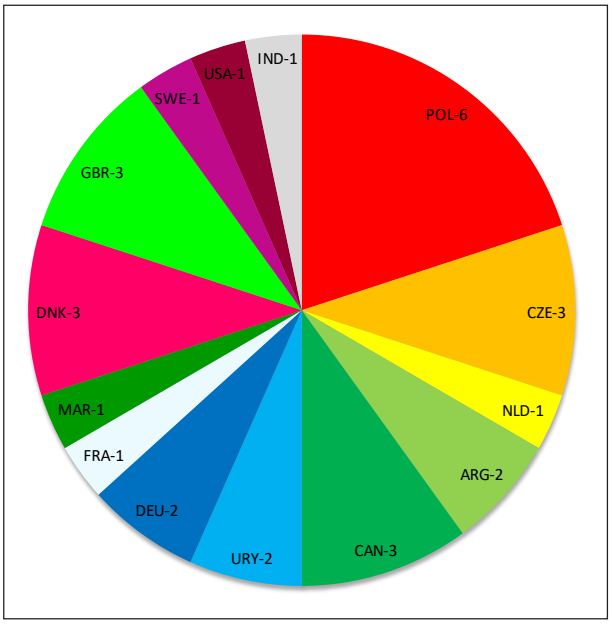

Figure 1.

Characteristics of accessions of flax (*Linum usitatissimum* L.) according to the country of origin

legend: POL – Poland; CZE – Czech Rep.; NDL – Netherlands; ARG – Argentina; CAN – Canada; URY – Uruguay; DEU – Germany; FRA – France; MAR – Morocco; DNK – Denmark; GBR – Great Britain; SWE – Sweden; USA – United States of America; IND – India

Each tested accession was classified into one of the following groups: very short, short, medium, long, very long [8]. The agricultural characteristics consisted of determining the following features: fibre content in straw, total yield, yield of straw and seed yield (tab. 5).

The following states of descriptors, according to J. Nozkova for 7 morphological traits, listed below, were used [8]:

1. Total plant length
   short: 310–649 mm
   medium short: 650–769 mm
   medium: 700–879 mm
2. Technical length
   short: 250–549 mm
   medium short: 550–649 mm
   medium: 650–749 mm
3. Stem thickness
   thin: <1.2 mm
   medium: 1.2–2.0 mm
   thick: >2.0 mm
4. Panicle-like size
   short: 7–21% of plant natural height
   medium: 22–34% of plant natural height
   long: 35–48% of plant natural height
5. 1000 seed weight
   very low: <4.50 g
   low: 4.5–7.49 g
   medium: 7.50–10.49 g

The results were calculated as average of 20 plants. In our examination it was not possible to evaluate the economic traits for International Flax Database, because in this methodology seed plots should have 10 m^2. The work presents the data from experimental plots with an area of 1.6 m^2. The value of the collective pattern (mean of all tested accessions) was calculated for all agricultural traits. For each accessions of flax, the percentage of the collective pattern was calculated (tab. 5).

Ethical approval: The conducted research is not related to either human or animal use.

Table 1.

The passport data of 33 accessions of flax (*Linum usitatissimum* L.)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
INF01010	WUKR 06-268	POL003	2010	POL	4	*Linum*	*usitatissimum*	POL003	fibre	I2010/0028
INF01011	WUKR-723	POL003	2010	POL	4	„	„	POL003	linseed	I2010/0029
INF01012	WUKR 06-417	POL003	2010	POL	4	„	„	POL003	fibre	I2010/0030
INF01013	WUKR-846	POL003	2010	CZE	4	„	„	POL003	linseed	I2010/0031
INF01014	WIG 09-14	POL003	2010	GRB	4	„	„	POL003	linseed	I2010/0038
INF00685	Abby	POL026	1998-02-17	CZE	3	„	„	POL003	linseed	165786
–	AC Linora	POL026		-	3	„	„	POL003	linseed	-
INF00648	AC Mc Duff	POL026	1999	NLD	3	„	„	POL003	linseed	166155
INF00683	Alfonso Inta	POL026	1999	ARG	3	„	„	POL003	linseed	166177
–	Amon	POL026	2000	CZE	3	„	„	POL003	linseed	-

Table 2. (*continued*)

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
INF00540	Duffern	POL026	1999	CAN	3	„	„	POL003	linseed	166070 166113
INF00592	Jenny	POL026	1999	POL	4	„	„	POL003	linseed	166089
INF00061	Kotowicki	POL026		POL	3	„	„	POL003	linseed	165574
INF00692	Kreola	POL026	1998	GER	3	„	„	POL003	linseed	166185
–	La Estanzuela 17	POL026		URY	4	„	„	POL003	linseed	-
INF00575	La Estanzuela 117	POL026	1991	URY	4	„	„	POL003	linseed	166073
INF00578	La Prevision	POL026	1999	ARG	3	„	„	POL003	linseed	16676
INF00065	LCSD 200	POL026		-	3	„	„	POL003	linseed	
INF00580	Lino de Pedre	POL026	1991	DEU	3	„	„	POL003	linseed	166078
INF00843	Lola	POL026		CAN	3	„	„	POL003	linseed	166270
–	Manchwrian	POL026	1984	FRA	3	„	„	POL003	-	165583
INF00273	Medra	POL026	1987	DEU	3	„	„	POL003	linseed	165787
INF00584	Maroc	POL026	1999	MAR	3	„	„	POL003	linseed	165787
INF00080 INF00617	Noralta	POL026	1984	CAN	3	„	„	POL003	linseed	165591 166111
INF00547	Norlin	POL026	1999		3	„	„	POL003	linseed	166106
INF00687	Olinette	POL026	1998-02-18	DNK	3	„	„	POL003	linseed	166180
INF00635	Opal	POL054	1994-02-28	POL	3	„	„	POL003	linseed	166125
INF00686	Peak	POL026	1998-02-17	GBR	3	„	„	POL003	linseed	166179
INF00290	Rau	POL026	1987	SWE	3	„	„	POL003	linseed	165808
INF00096	Redwood	POL026	1984	USA	3	„	„	POL003	linseed	165552
INF00689	Royale	POL026	1998-02-18	DNK	3	„	„	POL003	linseed	166182
INF00604	T-397	POL026	2005	-	3	„	„	POL003	-	166212
INF00602	Tawahar 17	POL026	2006	IND	3	„	„	POL003	-	16282

1. Accession number; 2. Accession name; 3. Institution code POL003-PBXAI, POL026-INF, POL054-Strzelce; 4. Acquisition date – time of including accession into collection of flax; 5. Country of origin; 6. Origin (type of accession based on its origin): 4 – landrace, 3 – variety; 7. Genus: *Linum*; 8. Species: *Linum usitatissimum* L.; 9. Institute code; 10. Type of use; 11. Collecting number (number of National Centre for Plant Genetic Resources – IHAR Radzików)

Table 2.

Summary of meteorological data for the growing season in 2010 – Experimental Station in Pętkowo

Decade	Rainfall [mm]						Temperature [°C]											
							III		IV		V		VI		VII		VIII	
	III	IV	V	VI	VII	VIII	Aver-age	Min.	Aver-age	Min.	Aver-age	Min.	Aver-age	Min.	Aver-age	Min.	Aver-age	Min.
I	1.1	18.5	17.0	8.6	18.5	27.8	–1.9	–5.4	7.0	2.6	11.0	7.3	18.0	12.1	21.6	14.8	19.6	14.8
II	11.4	3.0	65.0	17.0	2.5	36.6	2.7	–0.7	8.8	3.5	10.8	8.2	16.2	9.5	24.4	17.4	19.5	15.2
III	23.0	9.5	14.0	0.0	75.0	56.0	8.6	4.3	10.1	3.9	13.8	9.2	17.8	9.5	20.3	15.4	16.8	13.0
Total rainfall [mm]	35.5	31.0	96.0	25.6	96.0	120.4	–	–	–	–	–	–	–	–	–	–	–	–
Average month temperatures [°C]	–	–	–	–	–	–	3.3	–	8.6	–	11.9	–	17.4	–	22.0	–	18.6	–
Long–term average	33.0	29.0	41.1	41.7	66.7	59.0	3.2	–	9.1	–	14.3	–	17.5	–	19.5	–	18.9	–

Note: rainfall in III and VIII and temperature in III-VIII – data from Experimental Station in Słupia Wielka; long-term period 1996–2018

Table 3.

Morphological characteristics and valorisation of 33 accessions of flax (*L. usitatissimum* L.) in Pętkowo – 2010 (plot – 1.6 m²)

Accession number and accession name		Stem							Panicle				Flower	Seed	
		Total plant length		Technical length		Stem thickness		Slenderness of plants	Panicle lenght			Number of bolls from panicle	Petal colour of corolla	1000 seed weight	
		[cm]	state of descriptor	[cm]	state of descriptor	[mm]	state of descriptor	number	[cm]	[%]	state of descriptor	number	colour	[g]	state of descriptor
INF01010	WUKR 06–268	51.7	short	37.8	short	1.6	medium	238	13.9	27	medium	16.9	blue	4.97	low
INF01011	WUKR–723	54	short	41.4	short	1.59	medium	262	12.6	23	medium	14.1	blue	3.87	very low
INF01012	WUKR 06–417	76.5	medium	61.5	medium short	1.85	medium	340	15	20	short	13.5	blue	3.70	very low
INF01013	WUKR–846	–	–	–	–	–	–	–	–	–	–	–	blue	6.80	low
INF01014	WIG 09–14	60.7	short	44.1	short	2.13	thick	211	16.6	27	medium	23.9	blue	4.53	low
INF00685	Abby	57.2	short	46	short	1.68	medium	279	11.2	20	short	15.1	blue	4.10	very low
	AC Linora	63.3	short	46.3	short	1.97	medium	242	17	27	medium	19	blue	4.53	low
INF00648	AC Mc Duff	59.8	short	46.4	short	1.82	medium	261	13.4	22	medium	14.5	blue	4.47	low
INF00683	Alfonso Inta	58.2	short	38.5	short	2.5	thick	156	19.7	34	medium	30.8	blue	5.27	low
	Amon	58	short	44.6	short	1.57	medium	285	13.4	23	medium	14.2	white	4.43	very low
INF00540	Dufferin	64.5	short	48.4	short	1.75	medium	281	16.1	25	medium	17.6	blue	4.40	very low
INF00592	Jenny	64.7	short	49.5	short	1.95	medium	259	15.2	23	medium	16.1	blue	4.73	low
INF00061	Kotowiecki	59.7	short	48.3	short	1.62	medium	301	11.4	19	short	11.7	blue	5.60	low
INF00692	Kreola	53.1	short	34.8	short	1.78	medium	199	18.3	34	medium	16	blue	6.60	low
	La Estanzuela 17	59.8	short	42.6	short	1.74	medium	247	17.2	29	medium	18.2	blue	5.50	low
INF00575	La Estanzuela 117	51.4	short	35.7	short	1.63	medium	221	15.7	31	medium	13.5	blue	5.50	low
INF00578	La Prevision	53.6	short	36.8	short	1.72	medium	218	16.8	31	medium	16.9	blue	5.80	low
INF00065	LCSD 200	61.8	short	50.3	short	1.66	medium	304	11.5	19	short	10	light blue	6.13	low
INF00580	Lino de Pedre	62	short	47.9	short	1.66	medium	299	14.1	23	medium	12.5	blue	4.97	low
INF00843	Lola	58.8	short	42.3	short	2.03	thick	209	16.5	28	medium	22	blue	4.40	very low
–	Manchwrian	71.3	medium short	53.9	medium short	1.86	medium	294	17.4	24	medium	12.6	blue	5.27	low
INF00273	Medra	72.6	medium short	60.3	medium short	1.7	medium	359	12.3	17	short	9.1	blue	4.90	low
INF00584	Maroc	73.6	medium short	55.4	medium short	1.99	medium	284	18.2	25	medium	17.9	blue	4.90	low
INF00080 INF00617	Noralta	61.2	short	45.4	short	1.87	medium	247	15.8	26	medium	15.3	blue	4.40	very low

Table 3. (*continued*)

Accession number and accession name		Stem							Panicle				Flower	Seed	
		Total plant length		Technical length		Stem thickness		Slender-ness of plants	Panicle lenght			Number of bolls from panicle	Petal colour of corolla	1000 seed weight	
		[cm]	state of descriptor	[cm]	state of descriptor	[mm]	state of descriptor	number	[cm]	[%]	state of descriptor	number	colour	[g]	state of descriptor
INF00547	Norlin	57.6	short	44.2	short	1.78	medium	252	13.4	23	medium	13.7	blue	4.50	low
INF00687	Olinette	57.9	short	40.6	short	1.93	medium	213	17.3	30	medium	21.8	violet blue	5.30	low
INF00635	Opal	61.2	Short	38.7	short	2.28	thick	174	22.5	37	long	27.9	blue	5.97	low
INF00686	Peak	53.8	short	39.7	short	1.67	medium	246	14.1	26	medium	13.9	blue	5.60	low
INF00290	Rau	62.5	short	48.1	short	1.84	medium	268	14.1	23	medium	13.1	blue	4.97	low
INF00096	Redwood	62.4	short	47.6	short	1.62	medium	297	14.8	24	medium	13.6	blue	4.70	low
INF00689	Royale	58.3	short	44.6	short	1.64	medium	278	13.7	23	medium	13.4	blue	6.37	low
INF00604	T–397	63.4	short	50.8	short	1.78	medium	293	12.6	20	short	13	blue	5.00	low
INF00602	Tawahar 17	56.9	short	42.4	short	1.80	medium	238	14.5	25	medium	18	blue	4.30	very low
Min		51.4	–	34.8	–	1.57	–	156	11.2	17	–	9.1	–	3.7	–
Max		76.5		61.5		2.5		359	22.5	37		30.8		6.8	

Table 4.

Biological characteristics and valorisation of 33 accessions of flax (*Linum usitatissimum* L.) in Pętkowo – 2010

Accession number	Vegetation period- according International Flax Data Base									
	Sowing – beginning of flowering					Sowing – yellow maturity				
	Very short <41	Short 41–52	Medium 53–61	Long 62–73	Very long >73	Very short <83	Short 83–102	Medium 103–121	Long 122–141	Very long >141
INF01010					WUKR 06-268				WUKR 06-268	
INF01011					WUKR-723			WUKR-723		
INF01012					WUKR 06-417					WUKR 06-417
INF01013					WUKR-846				WUKR-846	
INF01014					WIG 09-14				WIG 09-14	
INF00685					Abby				Abby	
-	AC Linora					AC Linora				

Table 4. (*continued*)

Accession number	Vegetation period- according International Flax Data Base									
	Sowing – beginning of flowering					Sowing – yellow maturity				
	Very short <41	Short 41–52	Medium 53–61	Long 62–73	Very long >73	Very short <83	Short 83–102	Medium 103–121	Long 122–141	Very long >141
INF00648					AC Mc Duff			AC Mc Duff		
INF00683					Alfonso Inta				Alfonso Inta	
-					Amon				Amon	
INF00540					Duffern				Duffern	
INF00592					Jenny				Jenny	
INF00061					Kotowicki				Kotowicki	
INF00692					Kreola				Kreola	
-				La Estanzuela 17				La Estanzuela 17		
INF00575			La Estanzuela 117					La Estanzuela 117		
INF00578				La Prevision				La Prevision		
INF00065	LCSD 200						LCSD 200			
INF00580				Lino de Pedre				Lino de Pedre		
INF00843					Lola					Lola
-	Manchwrian					Manchwrian				
INF00273		Medra						Medra		
INF00584					Maroc			Maroc		
INF00080 INF00617	Noralta					Noralta				
INF00547					Norlin				Norlin	
INF00687					Olinette				Olinette	
INF00635				Opal						Opal
INF00686			Peak						Peak	
INF00290	Rau						Rau			
INF00096			Redwood					Redwood		
INF00689		Royale					Royale			
INF00604	T-397					T-397				
INF00602					Tawahar 17				Tawahar 17	
Number of accessions	6	2	3	4	18	4	3	9	14	3

Table 5.

Agricultural valorisation of 33 accessions of flax (*Linum usitatissimum* L.) in Pętkowo – 2010

Accession number	Accession name	Fibre content in stem		Total yield		Yield of straw		Seed yield	
		[%]	the percentage of the collective pattern (14.3)	[kg/ plot]	the percentage of the collective pattern (0.87)	[kg/ plot]	the percentage of the collective pattern (0.50)	[kg/ plot]	the percentage of the collective pattern (0.18)
INF 01010	WUKR 06-268	15.6	109	0.826	95	0.241	48	0.122	68
INF 01011	WUKR-723	15.2	106	0.462	53	0.116	23	0.045	25
INF 01012	WUKR 06-417	27.0	189	0.473	54	0.186	36	0.047	26
INF 01013	WUKR-846	-	-	0.021	2	0.014	3	0.013	7
INF 01014	WIG 09-14	16.3	114	0.458	53	0.270	54	0.103	58
INF 00685	Abby	9.8	69	0.898	103	0.585	117	0.197	110
	AC Linora	20.4	143	0.904	104	0.548	100	0.207	116
INF 00648	AC Mc Duff	9.6	67	1.213	139	0.693	139	0.259	145
INF 00683	Alfonso Inta	11.1	78	0.890	102	0.642	128	0.110	61
	Amon	15.3	107	1.43	164	0.657	131	0.221	123
INF 00540	Dufferin	10.8	76	0.985	113	0.641	128	0.223	125
INF 00592	Jenny	12.6	88	0.812	93	0.562	112	0.227	127
INF 00061	Kotowiecki	14.1	99	1.099	126	0.615	123	0.194	108
INF 00692	Kreola	13.3	93	1.043	120	0.583	117	0.202	113
	La Estanzuela 17	9.6	67	0.720	83	0.387	77	0.183	102
INF 00575	La Estanzuela 117	7.9	55	0.901	103	0.621	124	0.130	73
INF 00578	La Prevision	13.4	94	0.895	103	0.678	136	0.149	83
INF 00065	LCSD 200	13.4	94	0.883	101	0.553	111	0.223	125
INF 00580	Lino de Pedre	11.9	83	0.877	101	0.548	110	0.194	108
INF 00843	Lola	17.8	124	1.027	118	0.666	133	0.224	125
–	Manchwrian	17	119	1.043	120	0.649	130	0.197	110
INF 00273	Medra	12.8	90	1.106	127	0.812	162	0.189	106
INF 00584	Maroc	13.5	94	0.930	107	0.557	111	0.209	117
INF 00080 INF 00617	Noralta	18.9	132	0.963	110	0.610	122	0.238	133
INF 00547	Norlin	16.6	116	1.109	127	0.651	130	0.246	137
INF 00687	Olinette	10.7	75	0.598	69	0.334	67	0.139	78
INF 00635	Opal	14.1	99	0.458	53	0.234	47	0.098	55
INF 00686	Peak	11.3	79	0.834	96	0.442	88	0.186	104
INF 00290	Rau	14	98	0.939	108	0.575	115	0.193	108
INF 00096	Redwood	12.8	90	1.330	153	0.857	171	0.315	176
INF 00689	Royale	18.8	131	0.725	83	0.429	86	0.206	115
INF 00604	T-397	14.6	102	0.872	100	0.540	108	0.213	119
INF 00602	Tawahar 17	17.7	124	0.951	109	0.566	113	0.212	118
	Min	**7.9**	**55**	**0,021**	**2**	**0.014**	**3**	**0.013**	**7**
	Max	**27**	**189**	**1.43**	**164**	**0.857**	**171**	**0.315**	**176**

RESULTS

Morphological trials were investigated according to the descriptors of characterization and evaluation for International Flax Database (IFDB) [6, 7]. Descriptors state is evaluated in "Descriptor list for flax (*Linum usitatissimum* L.)" [8].

Plant growth habit for all flax accessions were erect. Plant life cycle of 33 flax accessions was annual. According to the IFDB the total plant length refers to the plant natural height and the technical length is the same that stem length [5]. The total plant length of the flax plants ranged from 51.4 cm – short (La Estanzuella 117) to 76.5 cm – medium (WUKR 06-417) (tab. 3). According to the methodology of the International Database, they were usually short (28 accessions), medium short (3) and medium (1) (tab. 3). There were no genotypes of the following total plant length: extremely short, medium long, long and extremely long. The technical length ranged from 34.8 cm – short (Kreola – linseed) to 61.5 cm – medium short (WUKR-06-417 – landrace). There were no accessions of extremely short, medium, medium long, long and extremely long technical length. The following genotypes were also distinguished in terms of stem length: Medra (60.3 cm – medium short), Maroc (55.4 cm – medium short) and Manchwrian (53.9 – medium short) (tab. 3). The technical length of 28 flax accessions was short. The thickness of the stem in the middle of the technical length of 28 accessions was medium (IFDB) and ranged from 1.57 (Amon – linseed) to 1.99 mm (Maroc – linseed) (tab. 3). The thickness of the stem in the middle of the technical length was thick for the following genotypes: Lola – 2.03 mm, WIG 09-14 – 2.13 mm, Opal – 2.28 mm and Alfonso Inta – 2.5 mm. The range of panicle length variation was from 11.2 cm – short (Abby – linseed) to 22.5 cm – long (Opal – linseed) (tab. 3). The panicle lenght (like – size) [20] was short (7–21% of plant natural height) for 6 genotypes, medium (22–34% of plant natural height) for 25 flax accessions and long (35–48% of plant natural height) for 1 accession of flax (Opal – linseed). Petal colour of corolla of flax flower was light blue for 1 genotype (LSCD 200), blue for 30 accessions of flax, violet-blue for 1 accession (Olinette), and white for 1 variety Amon (tab. 3). The 1000-seed weight was low for 25 genotypes and very low for 8 accessions of flax (tab. 3).

Table 4 presents the valorisation of two vegetation periods. The growing season from sowing to the beginning of flowering was very long for the majority of plants (18 accessions), and from sowing to yellow maturity it was long for the largest number of genotypes (14 accessions). The accessions of flax that stood out in terms of fibre content in stem were WUKR 06-417 (27%) and AC Linora (20.4%). The following genotypes achieved the highest total yield: Amon, Redwood, AC Mc Duff Medra and Norlin. The highest straw yield was obtained in the cultivation of the following flax accessions: Redwood, Medra, AC Mc Duff, La Prevision and Lola. Taking into account the fact that most of the valorised flax genotypes are flax of the linseed-type, the seed yield is the most important among agricultural trials presented in table 5. The highest seed yield per plot was obtained after ginning seed bags of the following linseed flax varieties: Redwood, AC Mc Duff, Norlin, Noralta and Jenny.

DISCUSSION

The Programme for Genetic Resources of Cultivated Crops Protection in Poland is coordinated by the Plant Breeding and Acclimatization Institute (IHAR) [5]. Institute of Natural Fibres and Medicinal Plants (INF&MP), formerly Institute of Natural Fibres, has been responsible for gathering and evaluation of genetic resources of *Linum* genus since 1982.

The Plant Breeding and Acclimatization Institute has a long-term storage of genetic resources of cultivated plants, in which local varieties, old breeding lines and varieties are deposited. The advantage of local varieties is that they are adapted to the given habitat conditions. An old varieties and breeding lines also show specific biological features. All the old lines and varieties of *L. usitatissimum* have seeds invaluable for humans and animals, although their yield is worse than that of new varieties. New varieties of flax may have been changed (modified) by breeders, which results in a change of seed quality. The seeds modified by breeders have an altered composition of fatty acids, which is not beneficial for human and livestock health, because we must, like endogenous amino acids, supply the body with fatty acids. The problem of contemporary civilized world is the lack or shortage of α-linolenic acid (omega-3) in food and too high intake of linoleic acid (omega-6). This fact and exceeding the recommended by WHO ratio of omega-6/omega-3 (4:1) causes many civilization diseases, mainly in Western Europe. This fact is reported by doctors and scientists [2, 9, 10-13]. Therefore, the widespread cultivation of flax to obtain flax seeds, which contain in

seed oil from 48.1% (Liflora) – 59.9% (Alfonso-Inta) α-linolenic acid [12, 3].

The *L. usitatissimum* species is very sensitive, therefore its morphological, biological and agricultural features depend on the meteorological conditions [14, 15]. Analysing the results of Opal and Jenny, which was also tested in 2008 and 2009, we see that the IFDB descriptors are sometimes the same and sometimes different. Total plant height for 2008, 2009 and 2010 were as follows for Opal: medium short (68.3 cm), medium (80.7 cm) and short (61.2 cm); for Jenny: medium (80.2 cm), medium long (91.8 cm) and short (64.7 cm) [16]. The technical length results in 2008, 2009 and 2010 were as follows for Opal: short (48.4 cm), medium short (61 cm), short (38.7 cm); Jenny: medium (65.2 cm), medium (70.3 cm), short (49.5 cm). Stem thickness does not differ much in consecutive years. Panicle length in 2008, 2009 and 2010 was as follows: Opal: medium (19.9 cm), medium (19.7 cm) and long (22.5 cm); Jenny: short (15 cm), medium (21.5 cm) and medium (15.2 cm). The 1000 seed weight results also differ from 2008 to 2010: Opal: low: 7.10 g (2008), 6.98 g (2009), 5.91 g (2010); Jenny: low: 5.63 g (2008), 6.22 g (2009) and 4.73 g (2010). The weight of 1000 seeds and the number of bags collected from the panicle largely affect the obtained seed yield. Accessions with a high seed yield are recommended for cultivation, for example, for their own needs (for health) in order to ensure the necessary α-linolenic unsaturated fatty acid.

CONCLUSION

Hereafter are the conclusions resulting from the valorisation of 33 flax accessions:

1. The determination of individual morphological, biological and agricultural features of flax helps breeders select starting material for the breeding of new flax varieties.
2. The most useful for cross breeders are genotypes that show high yields or have high values of morphological traits that affect yield.
3. The highest seed yields were obtained from following genotypes: Redwood, AC Mc Duff, Norlin, Noralta and Jenny.
4. Jenny is a line of oilseed flax that could be registered as a new variety.
5. For the Manchwrian linen accession you have to grant the accession number. The Noralta flax accessions has a duplicate - two accession number (INF00080 = INF00617) and two collecting number (165591 = 166111)
6. The following flax accessions should be submitted to IHAR for preparation of samples of these genotypes for long-term storage: AC Linora, Amon, La Estanzuela 117.
7. The two vegetation period studied were short for the following flax accessions: AC Linora, Manchwrian, Noralta and T-397.
8. The height of the tested flax plants was usually short, their technical length was short, the diameter of the stems - medium and the length of the panicles - medium.
9. Flax genotype WUKR-846 (I2010/0031) should be deleted from the flax genetic resources collection and considered as worthless as breeding material.

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Conflict of interest: Authors declare no conflict of interest.

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