EXAMINATION OF SOME MORPHOLOGICAL FEATURES OF DOMESTIC POPULATIONS OF FLAX (*LINUM USTITASSIMUM* L.), IN THE AGRO ECOLOGICAL CONDITIONS IN STRUMICA, REPUBLIC OF MACEDONIA

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Abstract: The research was conducted in a period of two years (2007 and 2008) on five flax genotypes, 4 of which are domestic populations, intermediate (transitional) linen (*velusina, duferin , belan , belinka*) and an introduced french variety of fiber flax (*viking*).

The number of seeds in the fruit, in both years of research, is statistically different among different varieties. In two years of testing , the lowest number of seeds in the fruit had population *velusina* (3,3 in 2007 and 3,5 in 2008), and the most number of seeds reached population *duferin* (5.5 in 2007 and 5.7 in 2008).

There is a statistically valid difference for the number of fruits per flax plant among the tested varieties. The lowest number of fruits per plant had population *belan* (23,1 in 2007 and 24,8 in 2008), and the most had a variety *viking* (29,0 in 2007 and 29,3 in 2009).

In the two years of research, the largest absolute mass of the seed had population *velusina* (6,8 g and 6,6 g respectively), and the lowest population *belinka* (4,1 g and 4,5 g respectively). Among the many varieties there are statistically significant differences.

The highest average height, in the two-year research, regardless of the years of testing, had population *belinka* (78,9 cm), and the lowest population *velusina* (67,1 cm).

The highest average seed yield per flax plant in the two-year research, regardless of the year of investigation, had *viking* variety (0,73 g), and the lowest population *velusina* population (0,55 g).

Key words: flax, fruit, seed, height, yield, absolute mass

Introduction

Flax (*Linum usitatissimum* L.) is grown for fiber, for seed or for either of the others (Egumenovski. et all., 1988). It is known that flax grown old Egyptians, Greeks and Romans, therefore, the man was known for more than 5000 years (Šimetić S. 2008). The production of linen in the Republic of Macedonia is unjustifiably neglected. First, the flax was grown on about 50 ha, but since 1960 its surfaces are reduced to only 1 ha in 1972 (Gjogjevski J. et al. 1991). Today, it is grown on small surfaces for it seed (bird food and beverage industry), and in 2005-2006 is grown on the Faculty of Agricultural Sciences and Food in Skopje as a research project (I. Dimov, 2006). Worldwide, use of flax seed for human consumption is growing rapidly due to the high content of dietary fiber, omega - 3 fatty acids and anticancer lignin (Pospišil et all. 2011).

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Given the above, the purpose of our research was to determine the morphological properties of several populations and a variety of flax in agri-environmental conditions of Strumica region, Republic of Macedonia, to single out the most promising and to recommend them to the manufacturers and industry in the country and out of our state. and promote them as stable, yielding and quality varieties.

Material and methods

The research was conducted in field and laboratory conditions. The field trials were set up at the experimental field of the Faculty of Agriculture, Strumica, „Goce Delcev" University – Stip. The research was conducted in a period of two years (2007 and 2008) on five flax genotypes, 4 of which are domestic populations, intermediate (transitional) linen (*velusina, duferin , belan , belinka*) and an introduced french variety of fiber flax (*viking*). The experiment consisted of five variants in four iterations, divided by the method of random block system with the basic dimension of the parcel of 10 m^2. The distance between the variants was 0,50 m, and between repetitions - 1,0 m. The distance betwee the rows was 20 cm. The seeding rate was 1000 seeds/m^2.

In two years of testing the soil was prepared in the same way. The main treatment was plowing at a depth of 35 cm, followed by fertilization by methodological principle, so the surface was fertilized with granulated NPK 15:15:15 fertilizer in an amount of 300 kg/ha. Sowing was performed manually, in rows, at a depth of 3-4 cm. During the vegetation of flax the most important phenological and morphological traits are monitored (date of sowing, germination, blooming, flower color, maturity). In the full maturity stage, the height of all the flax plant is measured, on 25 plants of each of the repetition, and the average is taken from 100 plants (plants 25 x 4). Before harvest, material for laboratory analysis is taken from 1m^2. In laboratory were analyzed: number fruits per plant, number of seeds in the fruit, the absolute mass and seed yield per plant.

The results were statistically processed by the method analysis of variance, and differences were tested by LSD- test.

Climatic conditions

During the two-year trials were monitored meteorological indicators for medium temperatures in degrees Celsius and monthly sums of precipitation in millimeters.

The mean annual temperature in Strumica valley (Table 1), for a period of ten years 1996/2006 amounted to 13,1 °C. For a period of ten years 1996/2006 in Strumica valley fall 660,1 mm average rainfall (Table 2).

Schedule of precipitation (Table 2) after months and seasons is quite unbalanced. The most precipitations fall in December, with an average amount of 89,1 mm. The driest month, with the lowest average amount of rainfall is June, with 31,9 mm.

The analysis of the temperature in the research period 2007-2008 (Table 1), showed difference with the annual mean temperatures, in the ten-year average. The mean annual temperature in 2007 was about 1,0 °C higher, and in 2008 is 0,9 °C higher, than theaverage.

According to the data in Table 1 it can be concluded that the monthly average air temperatures during the vegetation of flax, in both years of testing, are the lowest in the final month and the first month of each year, ie December, January and February (from 1,9 °C in December 2007 to 3,1 °C in 2008) and highest in July (25,3 °C to 27,6 °C). From germination to blooming flax requires temperature in the range of 16 °C to 18 °C. Higher temperature of 20 °C before blooming, accelerates the development, and flax plants remain low (Gjogjevski et al. 1991). The average monthly temperatures prevailing in the vegetation period are considered as good for growing flax.

Table 1. Average monthly temperatures in degrees Celsius

Year	Months												Ann. sum of temp.	Mean ann. temp.
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII		
2007	5,0	5,9	9,8	13,7	19,8	24,1	27,6	24,6	17,7	13,3	5,9	1,9	5146,5	14,1
2008	2,8	5,9	9,9	13,5	18,0	23,2	25,3	26,8	18,7	11,6	8,0	5,1	5135,6	14,0
1996/ 2006	2,5	3,3	6,8	12,5	18,6	22,5	25,0	24,2	18,6	13,5	7,4	2,7	4625,6	13,1

Table 2. Amount of monthly rainfall in mm

Year	Months												Год. сума на врнежи во mm
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
2007	16,5	24,0	39,7	2,2	107,5	45,6	0,3	73,9	41,0	12,7	74,8	41,4	593,7
2008	16,1	17,1	16,8	61,2	49,8	35,5	8,7	2,5	76,9	57,8	20,7	95,4	458,5
1996/ 2006	51,9	45,5	42,8	35,6	57,2	31,9	90,5	54,0	63,3	39,4	58,9	89,1	660,1

According Gjogjevski J. et al. 1991 transitional flax is grown mainly where the average annual sediment run varies from 450-750 mm. In Table 2 we can see that the annual amounts of rainfall in the Strumica region, during the test, is within the optimal needs of flax.

From the data in Table 2, it can be noted that in 2007 in the month of April marked the highest deficit of rainfall (only 2,2 mm). The other months and years, the distribution of rainfall is relatively good to meet the needs of water for growing flax, so it is not a need for intervention irrigation.

Results and discusion

Phenological observations

In our trials the following stages were registered: germination, tillering, booting, tasseling and maturity.

In the first year (Table 3) sowing was performed on 28th of March. In March 39,7 mm of rain fell, which allowed sowing in March, and is characterized by relatively good

conditions for flax germination. The period from sowing to germination was 10 days, at an average monthly temperature of 13,7 °C in April. The lowest temperature for flax germination is 2-3 °C, and the optimum temperature is 8-10 °C (Gjogjevski et al. 1991). Transitional flax grows well in warmer and drier areas, with more sunny days.

In the second year of research March was drier, so the sowing of flax was made on 04th of April, but in relatively good conditions for germination, and the period from sowing to germination was shorter, only 8 days. Flax seeds after sowing found in moist and warm soil and immediately began absorbing water and swelling. In such conditions physical, chemical and biological processes accelerated and fast matching root above the soil surface.

From the above, it can be clearly concluded that the temperature and especially humidity plays a decisive role in sprouting and germination of flax. A typical example is the second year compared with the first year when the sowing is done later, and was observed earler germination.

Table 3. Phenological observations of linen per year

	Sowing date	Germination date	Blooming date	Bloom colour	Full maturity date
2007					
velusina	28.03	07.04	21.05	blue	01.07
duferin	28.03	07.04	24.05	blue	04.07
belan	28.03	07.04	24.05	blue	06.07
belinka	28.03	07.04	21.05	white	01.07
viking	28.03	07.04	24.05	blue	06.07
2008					
velusina	04.04	11.04	18.05	blue	28.06
duferin	04.04	11.04	21.05	blue	01.07
belan	04.04	11.04	21.05	blue	04.07
belinka	04.04	11.04	18.05	white	29.06
viking	04.04	11.04	21.05	blue	05.07

The climatic conditions were more favorable in 2008 for development of flax because we had a proper schedule of lower precipitation and minimum temperature in May and June, which led to a larger number of fruits per plant and number of seeds in almost all tested genotypes. Our research coincides with research of Pospišil et al., 2011.

Morphological properties

From the results for the number of fruits per plant in flax (Table 4), we can see that in both years of research, there is statistically valid difference between varieties. In two years of testing, the lowest number fruits per plant had *belan* population (23.1 in 2007 and 24.8 in 2008), and the most had *viking* variety (29.0 in 2007 and 29.3 in 2008).

In studies of other authors is present an increase of the fruit number per plant in different varieties (Pospišil et al., 2011, Butorac et al. 2010).

The number seeds in fruit (Table 4), in both years of testing, are statistically different among different varieties. In two years of testing, the lowest number of seeds in the fruit had *velusina* population (3.3 in 2007 and 3.5 in 2008), and the most had *duferin* population (5.5 in 2007 and 5.7 in 2008). The number seeds in the fruit, theoretically, should be 10, but it is variety characteristic. The number seeds in the fruit depend on fertilization. According to some previous results, the number of seeds in fruit is between 5 and 6 (Butorac J. et all. 2010, Zedan et al 1999).

Absolute mass is characteristic of the variety, but it can be different at the same variety that depends on the conditions of production. By default, the seed of the same variety and the same play, which has a greater absolute mass, allows plant growth more vital in the initial stages of development.

In both years of the test (2007 and 2008), the largest absolute mass had *velusina* population (6,8 g and 6,6 g respectively), and the lowest (4,1 g and 4,5 g respectively) *belinka* population. Among the many varieties there are statistically significant differences. In studies of other authors is present increasing of the absolute mass in different varieties (Pospišil et al. 2011, Butorac J. et al. 2010).

Table 4. Average values of some morphological properties of flax production in years

Variance	Number of fruits per plant	Number of seed in fruit	Absolute mass (g)	Seed yield per plant (g)	Plant height (cm)
2007					
velusina	24,0	3,3	6,8	0,54	65,8
duferin	26,5	5,5	4,8	0,69	69,3
belan	23,1	5,1	5,2	0,60	67,3
belinka	28,5	4,9	4,1	0,57	78,2
viking	29,0	5,0	5,6	0,72	70,0
LSD 0,05	0,83	0,52	0,43	ns	0,90
0,01	1,36	0,86	0,70	ns	1,46
2008					
velusina	25,0	3,5	6,6	0,56	68,4
duferin	27,2	5,7	5,0	0,71	71,4
belan	24,8	5,4	5,4	0,63	69,4
belinka	27,5	5,0	4,5	0,59	79,7
viking	29,3	5,2	5,8	0,74	72,7
LSD 0,05	0,52	0,31	0,31	ns	0,37
0,01	0,86	0,50	0,51	ns	0,60

The height of the flax plant (Table 4), in both years of testing, is statistically different among different varieties. The highest average height, in the two-year research, regardless of the years of testing, had population *belinka* (78,9 cm), and the lowest population *velusina* (67,1 cm).

Seed yield per plant (Table 4), in both years of testing, is statistically insignificant differences among the tested varieties. The highest average seed yield per flax plant in the two-year research, regardless of the year of investigation, had *viking* variety (0,73 g), and

the lowest population *velusina* population (0,55 g). In research Pospišil et al. 2011, of eight flax varieties, there isn't statistically significant difference in seed yield per plant.

Conclusion

Based on two years of research on some morphological properties of flax in agri-environmental conditions of Strumica region, Republic of Macedonia, the following conclusions can be made:

- In both years of research, there is statistically valid difference between varieties. In two years of testing, the lowest number fruits per plant had *belan* population (23.1 in 2007 and 24.8 in 2008), and the most had *viking* variety (29.0 in 2007 and 29.3 in 2008).
- The number seeds in fruit (Table 4), in both years of testing, are statistically different among different varieties. In two years of testing, the lowest number of seeds in the fruit had *velusina* population (3.3 in 2007 and 3.5 in 2008), and the most had *duferin* population (5.5 in 2007 and 5.7 in 2008).
- In both years of the test (2007 and 2008), the largest absolute mass had *velusina* population (6,8 g and 6,6 g respectively), and the lowest (4,1 g and 4,5 g respectively) *belinka* population. Among the many varieties there are statistically significant differences.
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- The highest average seed yield per flax plant in the two-year research, regardless of the year of investigation, had *viking* variety (0,73 g), and the lowest population *velusina* population (0,55 g).

Literature

Butorac Jasminka., Pospišil M., Mustapić Z., Marković Zvjezdana.(2010): Utjecaj prihrane dušikom na neka morfološka I fenološka svojstva sorata predivog lana. Sjemenarstvo 27, (1-2): 19-29. Zagreb

Димов З. (2006): Можности за одгледување на лен во Р. Македонија. Министерство за образование и наука на Р. Македонија.

Ѓорѓевски Ј. Климов С. (1991): Индустриски култури. Универзитетски учебник. Скопје.

Егуменовски П., Боцевски Д., Фидановски Ф., Митковски П. (1998): Специјално поледелство. Скопје.

Pospišil M., Pospišil ana, Butorac jasminka, Škevin Dubravka, Kraljić Klara, Obranović M., Brčić Marina (2011): Yield and yield components of investigated linseed cultivar in Northwest Croatia. 46th Croatian and 6th International Symposium on Agriculture. Opatija. Croatia (728-731).

Šimetić S. (2008): Lan u proizvodnji i upotrebi. Sjemenarstvo 25, (3-4): 217-221. Zagreb.

Zedan s,Z., Kineber m. E., Mostafa S. H. (1999): Response of flax to potassium and nitrogen fertilization under sandy soil conditions Egyp J Agric Res 77: 729-743.