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THE VARIABILITY OF SUNFLOWER (*HELIANTHUS ANNUUS* L.) YIELD AND QUALITY INFLUENCED BY THE WEATHER CONDITIONS

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Abstract

ČERNÝ IVAN, VEVERKOVÁ ALEXANDRA, KOVÁR MAREK, MÁTYÁS MARTIN: *The variability of sunflower (Helianthus annuus L.) yield and quality influenced by wheater conditions.* Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 2013, LXI, No. 3, pp. 595–600

The field polyfactorial trials were carried out on experimental fields in Nitra – Dolná Malanta in two experimental years 2010 and 2011. Experimental locality is situated in the maize production area (climatic region: warm; climatic sub-region dry; climatic zone: warm, dry with mild winter and long sunshine), in altitude 250 m above sea level, with brown soil. In the trials was observed the influence of both temperature and moisture conditions of experimental area on sunflower yield of achenes and fat content (conventional hybrids NK Kondi and NK Tristan). Technological system of sunflower cultivation was realized in accordance with conventional technology of cultivation. The basic fertilization was made by balance method on the base of soil agrochemical analysis for expected yield 3 t ha^{-1}. The results show, in the range of achieved both achenes yield and fat content, that the year 2011 was statistically high significantly more favorable for yield formation than 2010. The variability of hybrids was statistically high significant, where the most productive was hybrid NK Kondi in comparison with NK Tristan in yield and quality the point of view. In the 2010 was found small negative correlation between yield of achenes and fat content. The correlation was slightly positive in the 2011, when the lower amount of precipitation and higher temperature influenced positively the yield formation and achene quality.

sunflower, yield, achene, fat content, correlation analysis

The formation of crop production is very complex process conditioned by function and multiplicity factors that create the complex dynamic structure of growth, physiological and biochemical processes in the interactions. The sunflower development and metabolism processes are fully reflected in the growth and depends on environmental conditions (BAJČI *et al*., 1997).

The process of yield formation of field crops is significant affected by presence and abundance of many factors, where agro-ecological factors are dominant. Their mutual interaction influence respectively. The yield variability and final production of crops influenced mainly the weather conditions. The influence a weather conditions is decisive in the yield creation process of oilseeds and other crops. Their interaction leads to regulation of particular growth phase, due to be forming quantity and quality of final production (BRANDT *et al*., 2003; SZABÓ, 2008; ČERNÝ *et al*., 2011).

ZUKALOVÁ *et al*., (2009) think that the most important factor for successful cultivation is the right choice of sunflower hybrid according to cultivation area of Slovak Republic. KOVÁČIK and GALIKOVÁ (2012) attributes to the impact of genotype (or hybrid) the considerable importance. His results confirm the more significant differences between hybrids in fat composite cultivated in warmer and dryer production areas than in colder and wetter. COLE *et al.* (1998) found the minimal influence of production areas with different weather conditions on high oleic hybrids. The hybrids influenced not only achene yield but fat amount in achenes (FLAGELLA *et al*., 2002; ANASTASI

et al., 2010). The very important is the using of final production, maturity hybrids, achieved yield and tolerance against unwanted pathogens (VARGA *et al*., 2012). The current commercial hybrids for the farmers obtain about 39–49% of fat; the amount of oleic acid can be more than 90% (KOVÁR *et al*., 2012).

The aim of this paper was to evaluate the influence of both weather conditions of production locality and biological material on achene yield and quality sunflower hybrids in experimental years 2010 and 2011 and to indetify degree of correlation dependence of fat content and achene yield sunflower hybrids.

MATERIAL AND METHODS

The field polyfactorial experiments were carried out on the Experimental base of the Centre of Plant Biology and Ecology, Faculty of Agrobiology and Food Resources, Slovak University of Agriculture in Nitra – Dolná Malanta.

The fore crop of sunflower (*Helianthus annuus* L.) was spring barley (*Hordeum vulgare* L.). Basic fertilization was made using the balance method on the base of agrochemical soil analysis for yield level of 3 tons per hectare. In 2010 was applied urea (46% N) in dose 120 kg N ha^{-1}. Content of phosphorus and potassium in soil was good to high.

Tillage (stubble ploughed under, deep autumn plowing), the way of setting up of sunflower (interline distance 0.70 m, distance in row 0.22 m), treatment during the vegetation (preemergent herbicide application, double application of fungicides), were made by conventional technology of sunflower cultivation.

In the this experiment were used hybrids NK Kondi (conventional, mid-late, with above the average of production potential, high oleic content 49–50%) and NK Tristan (conventional earl hybrid for Clearfield technology resistant against herbicides on base of imidazoline with oil content more than 44%).

The yield of achenes was calculated on yield per hectare in the range of each experimental treatment. The fat content was determined by extraction method on Soxhlet in labs of Centre of Plant Biology and Ecology Dolná Malanta.

Basic meteorological data (monthly precipitation in mm, average daily temperature in °C) were obtained from meteorological station the Faculty of Horticulture and Land Engineering, SUA in Nitra (Tab. I). Experiments were carried out by the split plot design with randomize complete blocks base design (EHRENBERGEROVÁ, 1995). Statistical evaluation of the experimental factors was processed by the multifactor analysis of variance and correlation analysis by STATISTICA software (StatSoft, Inc. Tulsa, Oklahoma, USA).

RESULTS AND DISCUSSION

The yield formation of sunflower, as well each crop, is significant affected by both temperature and moisture requirements during the vegetation (ČERNÝ *et al*., 2011). The oil production as a final product of sunflower cultivation is expressed from achene yield and fat content in achenes.

I: *Climatic and soil conditions of experimental locality*

Characteristics		Value	
altitude		250 m	
production area		maize	
climatic region		warm	
climatic subregion		very dry	
climatic district		warm, dry with mild winter and long sunshine	
CLIMATIC CHARACTERISTIC			
		2010	2011
average air temperature	per year	10.3 °C	9.9 °C
	per vegetation	18.4 °C	17.1 °C
sum of precipitation	per year	581.2 mm	409.9 mm
	per vegetation	385.8 mm	299.4 mm
SOIL CHARACTERISTIC			
soil type		**Loam haplic luvisol**	
		2010 spring	**2011 spring**
content	available N_{an} (by Kjeldahl method)	4.4 mg kg^{-1}	3.3 mg kg^{-1}
		2009 autumn	2010 autumn
	available P (by Mehlich III method)	38 mg kg^{-1}	62 mg kg^{-1}
	available K (by Mehlich III method)	395 mg kg^{-1}	435 mg kg^{-1}
	humus (by Ťjurin method)	1.51%	2.18%
pH/KCl		6.34	6.25

II: *Temperature and moisture conditions*

Month	Ideal requirement (i)		2010		2011	
	Σ mm	X_{td} °C	Σ mm	X_{td} °C	Σ mm	X_{td} °C
IV.	27.5	10	83.8	11.1	13.2	13.7
V.	77.6	12	182.2	15.6	48.4	16.1
VI.	13.6	16	147.5	19.4	91.1	19.6
VII.	14.6	19	72.4	22.8	121.6	19.7
VIII.	95.4	18	54.2	19.6	152.3	22.1
IX.	12.2	15	70.1	14	92.1	19.2

Where Σ mm is sum of precipitation; X_{td} °C is average daily air temperature

III: *Average yield and fat content used hybrids*

Indicator	Hybrid	2010	2011
Achene yield (t ha^{-1})	NK Kondi	2.89	4.19
	NK Tristan	2.58	3.44
Fat content (%)	NK Kondi	42.22	56.30
	NK Tristan	41.95	43.19

IV: *Analysis of variance*

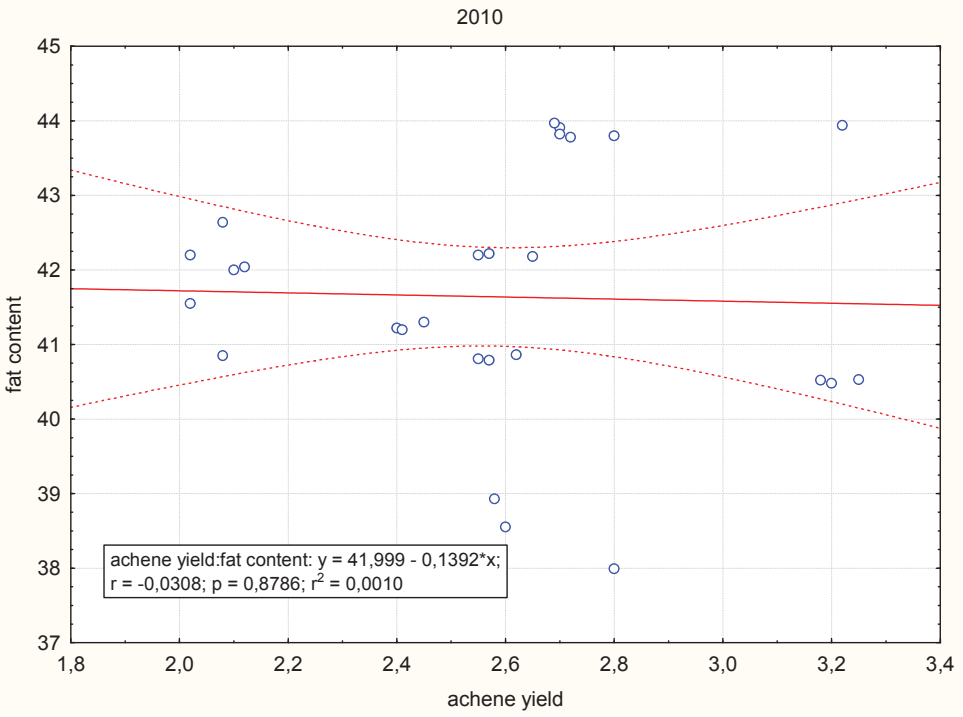
	Degree	SS	MS	F	p-value
Achene yield					
Abs. member	1	570.3100	570.3100	9788.951	0.000000
year	1	24.3076	24.3076	417.223	0.000000
hybrid	2	3.0145	1.5072	25.870	0.000000
Fat content					
Abs. member	1	114659.0	114659.0	34778.19	0.000000
year	1	1064.3	1064.3	322.81	0.000000
hybrid	2	403.3	201.7	61.17	0.000000

The achieved results showed that in both experimental years influenced statistically high significantly the achene yield and fat content (Tab. IV). The weather conditions of year 2010 were characterized by above of average precipitation mainly in May, June, July and September in comparison with ideal requirement of sunflower (ČERNÝ *et al.*, 2010). The average month temperatures were optimal (Tab. II). In 2011 were higher amount of precipitation observed in June, July and the temperatures were higher than ideal requirement (Tab. II). The results confirmed fact that for sunflower cultivation was statistically high significantly more favorable year 2011 in term of not only achieved yield but fat content (Tab. III, IV). This knowledge confirmed the experiments (SIMIC *et al.*, 2008) where in year with higher precipitation was achieved lower achene yield.

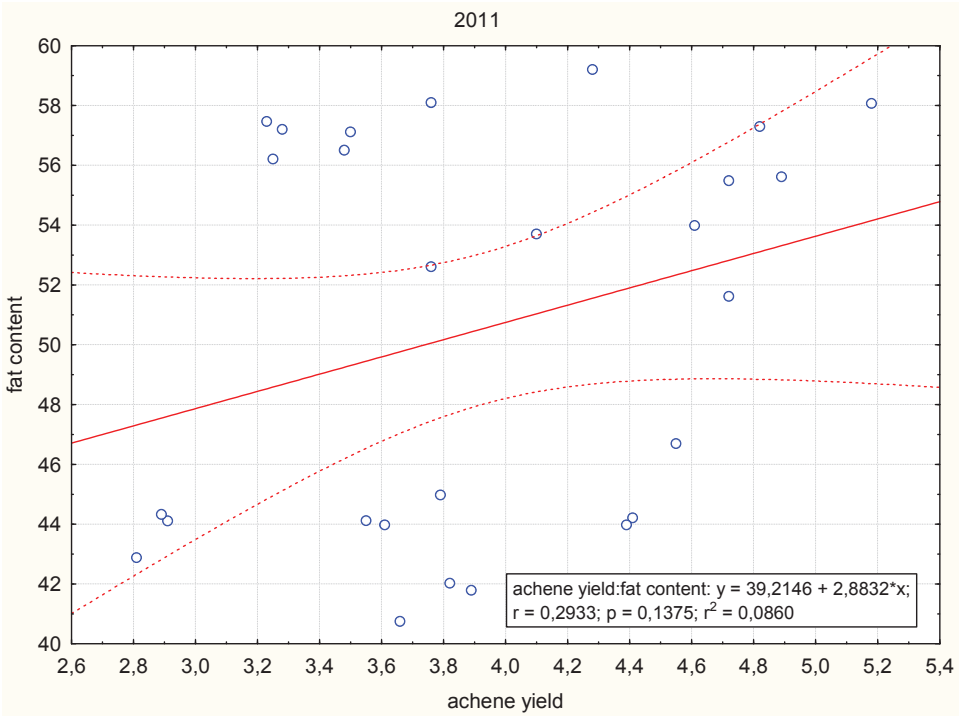
To achieve the high yield and quality of achenes is necessary to ensure not only optimal cultivation technology but right choice from a range of all available hybrids (BARANYK, 2010). ČERNÝ *et al.* (2010) compared many hybrids planting on different production areas during two years and concluded to lower variability of fat content than variability of achene yield. The achieved results (Tab. III, IV) confirmed statistically high significantly different response of used hybrids on sunflower final production, regardless of the year impact were found higher yields even higher fat content in the NK Kondi (Tab. III).

The dependence between fat content and achenes yield was determined by correlation analysis. The results from 2010 we found negative correlation of achieved yield and amount of fat content (Fig. 1). Follows form the foregoing fact that in year with higher precipitation the higher yield negatively impacted the fat content in achenes. The negative correlation between achene yield and fat content described PECHOVÁ *et al.* (1999).

Opposite correlation dependence was found in the year 2011. More proportional distribution of both temperature and precipitation increased not only yield but also a fat content in achenes. The dependence between fat content and achene yield was slightly positive in 2011 (Fig. 2). ANASTASI *et al.* (2010) concluded that the level of fat content is in positive correlation with achene yield. The favourable influence of sunflower water status on lipogenesis and oil content in sunflower achenes



1: *The correlation dependence between fat content (%) and achene yield (t ha^{-1}) in the year 2010*



2: *The correlation dependence between fat content (%) and achene yield (t ha^{-1}) in the year 2011*

findings FLAGELLA *et al.* (2002) and ROCHE *et al.* (2006). BOTELLA *et al.* (1997) also considered the achene yield as a most important factor of oil yield.

Diametrically different weather conditions of experimental year 2011 reaffirmed fact that lower precipitation and higher temperatures during the vegetation period positively influence on yield formation and quality of sunflower.

SUMMARY

In two years field polyfactorial experiments, carried out in 2010 and 2011, was determined the impact of weather conditions of locality and hybrids of sunflower (NK Kondi and NK Tristan) on the yield and quality of achenes. As well determine dependence of fat content from achene yield sunflower hybrids. The results show, in the range of achieved both achene yield and fat content, that the year 2011 was statistically high significantly more favorable. The variability of hybrids was statistically high significant, where the most productive was hybrid NK Kondi in comparison with NK Tristan in yield and quality. In the 2010 was found small negative correlation of yield and fat content. The correlation was slightly positive in the 2011, when the lower amount of precipitation and higher temperature influenced positively the yield formation and achene quality.

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