



**PRODUCTION PARAMETERS OF SUNFLOWER (*HELIANTHUS ANNUUS*. L.)
INFLUENCED BY WEATHER CONDITIONS AND FOLIAR APPLICATION OF
PENTAKEEP - V AND ATONIK**

Ivan Černý and Alexandra Veverková*

Address: Slovak University of Agriculture in Nitra, Faculty of Agrobiological and Food Resources, Department of Crop Production, Tr. Andreja Hlinku 2, 94976, Nitra, Slovak Republic

*Corresponding author: ivan.cerny@uniag.sk

ABSTRACT

In field trials with sunflower was monitored the influence of yearly weather conditions and foliar applications of both Atonik and Pentakeep V on a yield and fat content in sunflower achenes (hybrids Alexandra PR, NK Alego and NK Brio) in years 2009 – 2010. Experimental task was realized by field polyfactorial experiments established in warm corn production area (climatic region: warm; climatic subregion: dry; climatic zone: warm, dry with mild winter and longtime sunshine, brown soil) in Center of Plant Biology and Ecology of FAFR SUA in Dolná Malanta. The trials were established by split plot design with randomized complete blocks base design. From two-year small plot trials was found statistically non-significant impact of weather conditions of year, hybrids and application of Atonik and Pentakeep – V on achene yield of sunflower. The impact of monitored factors on fat content was statistically high significant. In variable yearly weather conditions higher average yield and achene fat content was achieved in year 2010. The most adaptable for production on concrete agroecological conditions were hybrids NK Brio and Alexandra PR (3.03 t ha⁻¹), for fat content NK Brio (44.25 %). Foliar application of Pentakeep V in dose 0.1 l ha⁻¹, 0.5 l ha⁻¹ respectively most significant influenced the yield of achenes (3.43 t ha⁻¹), fat content (44.71 %) respectively.

Keywords: sunflower, weather conditions, hybrids, Atonik, Pentakeep V

INTRODUCTION

Sunflower is considered as a market and ecologically attractive crop with significant impact for rational side of human nutrition (**Kováčik, 1995**). Sunflower seeds are a rich source of oil and proteins. In terms of dietetic the oil is evaluated positively for high representation of polyunsaturated fatty acids and high level of vitamins soluble in fats.

In connection with production process of sunflower **Brandt et al. (2003)** state that forming of achene yield and quality is a complex process, conditional by function and frequency of many factors, which in their interactions make complex structure of growth, physiological and biochemical processes.

The influence of yearly weather conditions on yield creation is possible consider as a dominant (**Lamm, 2006; Šrojtová, 2006**). By their cooperation goes to a regulation of growth stage length, where is forming the quality and quantity of yield – forming elements. **Murillo et al. (1998)** and **Passiour (2002)** perceive in the range of agroecological conditions, the water regime is considered as a main indicator of environment production performance, where the sunflower grades the requirements on the water during the vegetation period. Deficit of precipitation during increased physiological requirement on water impacts on the metabolism processes deregulatory, it increases by the differences between potential and real achenes yield. Sunflower has got increased requirements on temperature from the growth stage flowering to maturing of achenes.

Important intensification factor of sunflower cultivation, which influenced field crop production consider **Jankowski and Dubis (2008)** not only the nutrition and fertilization but application of substances, biological active preparations respectively. Many studies of **Černý, et al., 2009; Steer, Seiler, 1990** confirm, that leaf application is additional application, because it is not compensation of basic fertilization. Leaf application of fertilizers and biological active substances finds a place in dry period, when is nutrition intakes from soil difficult, during intensive growing period of plants, in deficiency of soil aeration, in chlorosis and latent physiological defects of plants. Increased using of plant production potential is possible support by leaf nutrition and ensures their quality (**Pulkrábek et al., 2007**).

The aim of study is, by achieved results, mention on influence of temperature and water conditions of experimental locality, of application of Atonik and Pentakeep V on yield and fat content of sunflower achenes in experimental years 2009 – 2010.

MATERIAL AND METHODS

Experimental task was solved by field polyfactorial trials in years 2009 – 2010, carried out in warm corn production area (climatic region: warm; climatic subregion: dry; climatic zone: warm, dry with mild winter and longtime sunshine, brown soil) in Center of Plant Biology and Ecology of FAFR SUA in Dolná Malanta.

The experiments were established by split plot design with randomized complete blocks base design in three replications. In the trial were monitored hybrids Alexandra PR, NK Alego, NK Brio.

Alexandra PR: two-lines, medium early hybrid

NK Alego: two-lines, medium early, imidazoline resistant hybrid

NK Brio: two-lines, mid-late hybrid

The preceding crop of sunflower (*Helianthus annuus* L.) was winter wheat (*Triticum aestivum* L.). Tillage (stubble ploughed under, deep autumn plowing), the way of setting up of sunflower (sowing date II. decade of April, spacing 0.70 x 0.22 m), treatment during the vegetation (pre-emergent herbicide application, double application of fungicides) and harvesting 2009 – III. decade of September, 2010 – I. decade of October, non-desiccated canopy, were made by conventional technology of sunflower cultivation. Basic fertilization was made using the balance method on the base of agrochemical soil analysis for yield level 3 tons per hectare.

SOIL CHARACTERISTICS

soil type	brown soil		
		2009	2010
content	available N _{an}	8.7 mg kg ⁻¹	11.1 mg kg ⁻¹
	available P	29 mg kg ⁻¹	22 mg kg ⁻¹
	available K	254 mg kg ⁻¹	265 mg kg ⁻¹
	available Ca	850 mg kg ⁻¹	600 mg kg ⁻¹
	available Mg	458 mg kg ⁻¹	463 mg kg ⁻¹
	humus	1.98 %	1.97 %
pH/KCl		5.65	6.19

In 2009 were applied of mineral fertilizer NPK (15:15:15) in dose corresponding 47 kg N ha⁻¹, 22.6 kg P ha⁻¹ and 39.3 kg K ha⁻¹. In 2009 were applied of mineral fertilizer NPK (8:24:24) in dose corresponding 38kg N ha⁻¹, 35.4 kg P ha⁻¹ and 53.8 kg K ha⁻¹.

In experiments were realized following application of Atonik and Pentakeep V:

Variant - Dose		Date of treatment		
control – non - treatment		-	-	-
Pentakeep V	0.1 l ha ⁻¹	18 BBCH	22 BBCH	32 BBCH
	0.25 l ha ⁻¹	18 BBCH	22 BBCH	32 BBCH
	0.5 l ha ⁻¹	18 BBCH	22 BBCH	32 BBCH
Atonik	0.8 l ha ⁻¹	-	22 BBCH	32 BBCH

Atonik: plant stimulator, effective substances are aromatic nitro-compounds ortho - phenolate sodium (2 g l⁻¹), para - nitrophenolate sodium (3 g l⁻¹) and 5-nitroguajacolate sodium (1 g l⁻¹).

Pentakeep - V: main effective substance of solution is 5 – amino – levulinic acid (ALA), precursor of chlorophyll and plant pigment. It is produced by photosynthetic bacteria in plant.

Sunflower yield was calculated per area 1 hectare with moisture 12 %. The values of fat content were achieved by extraction method. Fat content was set by extraction with extraction reagent with using of extraction machine Soxhlet. Weather characteristics of experimental locality were achieved from Agrometeorological station FHLI SUA in Nitra (Figure 1 – 2).

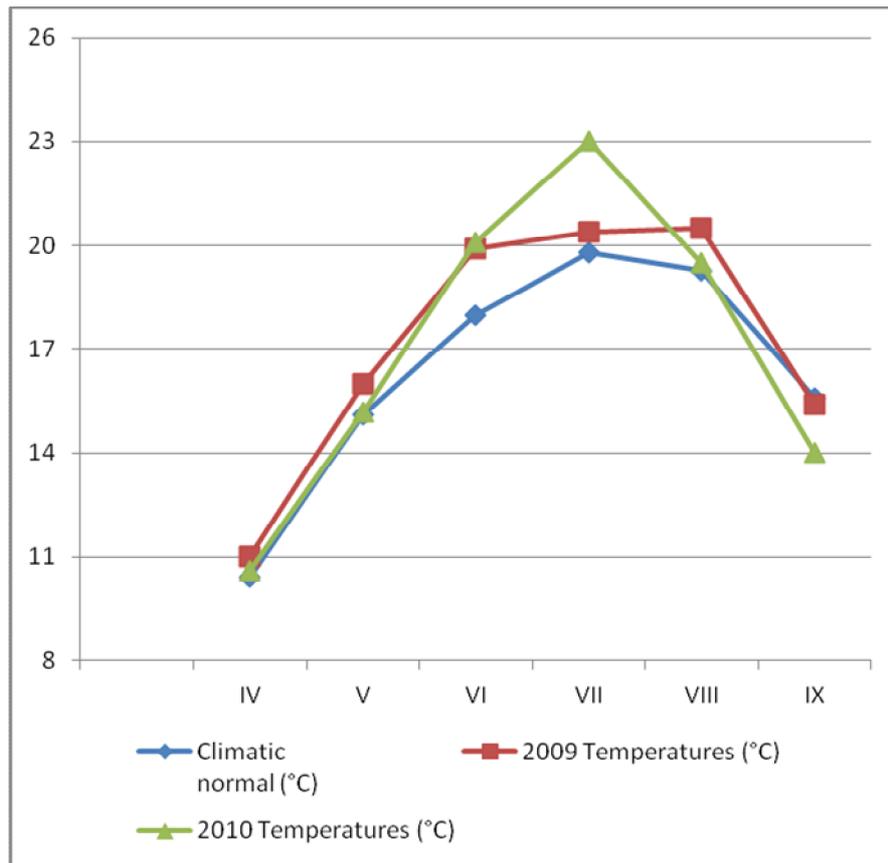


Figure 1 Temperature course (°C) of experimental period 2009 – 2010

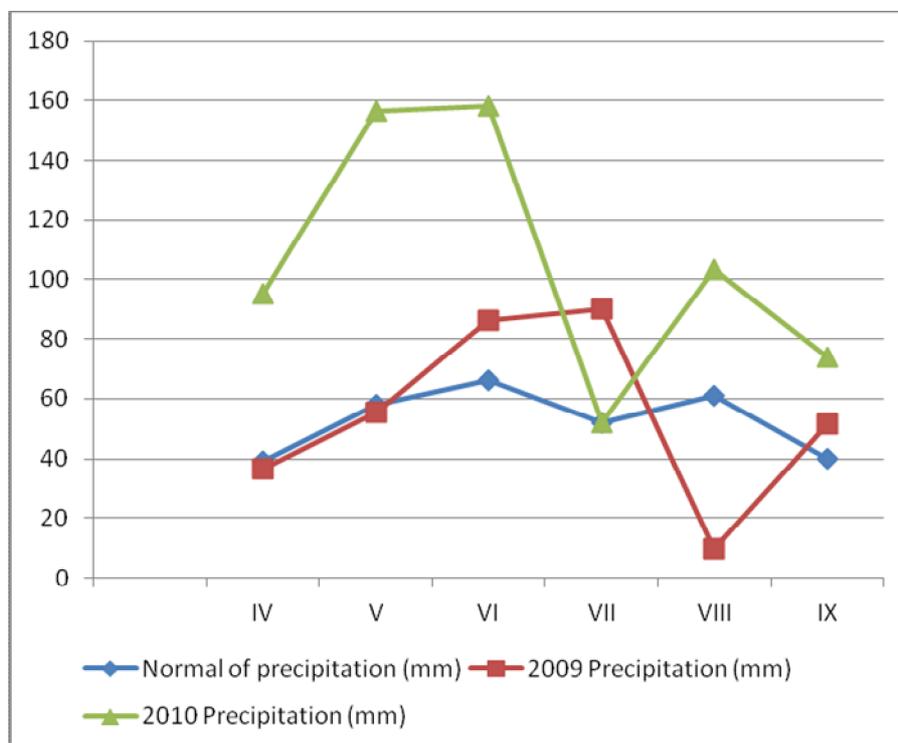


Figure 2 Precipitation course (mm) of experimental period 2009 – 2010

Biometric and graphic evaluation of results was realized by programs Statgraphics Plus (multifactor analysis of variance) Microsoft Excel.

RESULTS AND DISCUSSION

The creation of field crops is significantly influenced by reconciliation requirements of temperatures and precipitation during of whole vegetation period. Level of sunflower adaptability is different on concrete agroecological conditions of land, used biological material and variants of Atonik and Pentakeep V applications. In terms of experimental tasks is necessary point out, that weather conditions of experimental years were considerably unbalanced (Figure 1 – 2). It means, the real temperature and precipitation balance was differentiated during individual years, it manifested in a discrepancy between the concrete state and physiological requirements of crop on the temperature and water ensure. In terms of yield forming, the year 2009 had more balanced the weather conditions. The year 2010 was typical by above average precipitation amount for whole vegetation period. More problematic was course of precipitation in first half of vegetation period, it decreased number of members per unit area and it manifested on compensation on level of higher average weigh of achenes, average heads and weigh of heads. For that reason, for much differentiated course of weather conditions as well, within experimental years the achene yields (Table 1) were balanced (2.6 t ha⁻¹ in 2009, 2.7 t ha⁻¹ in 2010 respectively).

The hybrids NK Brio and Alexandra PR best adapted on concrete agroecological conditions. Monitored hybrids achieved average achene yield on level 3.03 t ha⁻¹. Lowest average achene yield was achieved on hybrid NK Alego (2.60 t ha⁻¹). Achieved results confirmed long-know tendencies, every biological material has got different economic and technological properties, which in interaction with various agroecological conditions manifested on different level (**Bajčí *et al.*, 1997**).

Achene yields were not statistically significant influenced by applications of Atonik and Pentakeep – V, experimental year and by hybrids (Table 2). The highest achene yield was on variant with application of Pentakeep V (dose 0.1 l ha⁻¹) in average per experimental period 3.43 t ha⁻¹. Lowest achene yield per experimental period (2.70 t ha⁻¹) was on variant with double application of Atonik.

Statistically more significant impact (Table 3) was found in evaluation of fat content within all monitored factors (weather conditions of year, hybrids and variants of preparation applications) and their interactions.

Per two-year period was average fat content in sunflower achenes 42.71 %. In accordance with found course of weather conditions was the value of fat content 41.43 % in 2009, was analyzed value 43.00 % in 2010. A tendency of fat content increase by influence of weather conditions is in accordance with achieved course of achene yields in the experimental locality. The results of both yield and fat content of sunflower achenes by influence of weather conditions, hybrids and foliar application of Atonik and Pentakeep V confirm that both yield and quality as the important indicators of production process is possible to impact not only on a level of concrete agroecological conditions but also the genetic fixed attributes of biological material and agrotechnic. **Pulkrábek *et al.* (2007)** from their experimental results consider the weather conditions of year as an important factor participates in the yield formation of all crops. For optimal course of yield creation of sunflower is decisive that with increase of daily temperatures, the amount of precipitation increased as well as appropriate conditions for growth and development are ensured. On the other side, in the end of vegetation period (for the achievement of maturation optimal level) is suitable gradual decline of average temperatures and precipitation (**Fábry, 1982**), it confirmed our results partially.

In terms of getting quality product, hybrid NK Brio (44.25 %) is most optimal adapted on concrete conditions, its fat content was in average 1.97 %, 3.7 % respectively higher than with hybrid Alexandra PR, NK Alego respectively.

The fat content on foliar treated variants was highest Pentakeep V variant (dose 0.5 l ha⁻¹) average per experimental period 44.71 %. The lowest fat content was with achene yield as well on variant with application of Atonik (40.81 %). Our achieved results agrees with conclusions of many authors (**Šimurková 2000; Słowiński 2008; Pruszyński, 2008**) who consider the growth stimulators, respectively fertilizers with supported and stimulated activity as the very important factors of whole crop production intensification. In accordance with found results we consider the affectivity of stimulated preparation and fertilizers dependent on several factors. To these factors, given in Table 2 and 3, ranks interaction effect of our monitored factors, their impact on achene yield and fat content were variable.

Table 1 The yield and fat content of sunflower

Hybrid	Year		Control	Atonik	Pentakeep -V		
					0.10 l ha ⁻¹	0.25 l ha ⁻¹	0.50 l ha ⁻¹
Alexandra PR	2009	t ha ⁻¹	2.6	3.2	3.3	2.8	2.7
		%	41.3	41.6	47.5	42.6	44.1
	2010	t ha ⁻¹	3.7	2.1	3.4	2.8	2.8
		%	46.1	41.3	44.7	42.4	45.7
NK Alego	2009	t ha ⁻¹	2.6	3.3	2.6	2.5	2.7
		%	38.5	38.0	37.8	45.5	42.4
	2010	t ha ⁻¹	3.3	2.0	2.9	2.3	2.1
		%	40.2	38.8	42.7	39.1	42.7
NK Brio	2009	t ha ⁻¹	2.9	2.9	2.8	2.9	3.8
		%	42.8	42.7	47.7	42.8	47.4
	2010	t ha ⁻¹	3.1	2.6	3.7	3.0	2.8
		%	41.1	42.5	47.1	41.1	46.1

Table 2 Analysis of variance achene yield

	SS	d.f.	MS	F - ratio	Sig. level
year	2228600	1	2228600	0.998993	0.320067
hybrid	8910430	4	2227608	0.998549	0.412301
variant	8920651	4	2230163	0.999694	0.411693
year*hybrid	8922463	4	2230616	0.999897	0.411585
year*variant	8929261	4	2232315	1.000659	0.411181
hybrid*variant	35694836	16	2230927	1.000037	0.463586

Legend: SS – sum of squares, d.f. – degrees of freedom, MS – mean of squares,

Table 3 Analysis of variance fat content

	SS	d.f.	MS	F - ratio	Sig. level
year	53.4	1	53.4	47.6	0.000000
hybrid	284.0	4	71.0	63.3	0.000000
variant	121.6	4	30.4	27.1	0.000000
year*hybrid	74.1	4	18.5	16.5	0.000000
year*variant	182.1	4	45.5	40.6	0.000000
hybrid*variant	181.1	16	11.3	10.1	0.000000

Legend: SS – sum of squares, d.f. – degrees of freedom, MS – mean of squares,

CONCLUSION

In two-year small plot experiments, carried out on experimental fields of Centre of Plant Biology and Ecology FAFR SUA in Nitra, was found statistically non-significant impact of weather conditions, hybrids and application of Atonik and Pentakeep V on achene yield of sunflower. More yield stabile was the year 2010, hybrid NK Brio and Alexandra PR and application of Pentakeep V in dose 0.1 t ha⁻¹.

The forming of fat content was statistically highly significantly influenced by course of weather conditions, hybrids and application preparations on base of biological active substances. To that extent was dominant year 2010, hybrid NK Brio and application of Pentakeep V in dose 0.5 l ha⁻¹.

Acknowledgments: This work was supported by Scientific Grant Agency of Ministry of Education in Slovak Republic, number of project VEGA 1/0388/09/8 Rationalization of cultivation system of sunflower (*Helianthus annuus* L.) in the conditions of climatic change.

REFERENCES

- BAJČI, P. - PAČUTA, V. - ČERNÝ, I. 1997. Cukrová repa. Nitra: ÚVTIP NOI, 1997, 111 s., ISBN 80 - 85330 - 35 - 0.
- BRANDT, S. A. - NIELSEN, D. C. - LAFOND, G.P. - RIVELAND, N. R. 2003. Oilseed Crops for Semiarid cropping systems in the Northern Great Plains. In *Agronomy Journal*, Vol. 94, 2003, p. 231 – 240.
- ČERNÝ, I. - PAČUTA, V. - ADAMČINOVÁ, B. - KOVÁČIK, P. - KOZAK, M. 2009. Produkčné parametre repy cukrovej vplyvom cielenej aplikácie Atoniku a listového hnojiva Campofort. In *Listy cukrovarnícké a řepařské*, roč. 125, 2009, č. 4, s. 259 – 264.
- de la VEGA, A. J. - HALL, A. J. 2002. Effect of planting date, genotype and their interaction on sunflower yield. II. Components of oil yield. In *Crop Science*. vol. 42, p.1202 – 1210.
- FÁBRY, A. 1990: Jarné olejniny. Praha, MZaV ČR, 1990, 240 s.
- JANKOWSKI, K. - DUBIS, B. 2008. Biostimulators for field crops. In *Biostimulators in modern agriculture*. Warsaw: Wieś jutra Sp. Z.o.o., 2008, p. 24, ISBN 83-89503-50-6.
- MURILLO, J. R. - MORENO, F. - PELEGRIN, F. - FERNANDEZ, J. E. 1998. Responses of sunflower to traditional and conservation tillage under rainfed conditions in southern Spain. In *Soil and Tillage Research*, vol. 9, 1998, no. 3, p. 233 – 241.

- PASSIOURA, J. B. 2002. Environmental biology and crop improvement. In *Functional Plant Biology*, 2002, vol. 29, p. 537-546.
- PRUSZIŃSKI, S. 2008. Biostimulators in plant protection. In *Biostimulators in modern agriculture*. Part. General aspekts, 2008, p. 18.
- PULKRÁBEK, J. - URBAN, J. - BEČKOVÁ, L. 2007. Atonik utilization for acceleration of poststress regeneration and lessening impact of herbicide stress on sugar beet plants. In *Listy cukrovarnické a řepářské*, vol. 123, 2007, no. 2, p. 43-46.
- SLOWIŃSKI, A. 2008. Biostimulatory w polowej produkcji roślinnej. In *Wieś Jurta*, vol. 5, 2008, p. 29.
- STEER, B. T. – SEILER, G. J. 1990. Changes in fatty acid composition of sunflower (*Helianthus annuus* L.) seeds in response to time of nitrogen application, supply rates and defoliation. In *Journal Science Food Agriculture*, vol. 51, 1990, p. 11 – 26.
- ŠIMURKOVÁ, J. 2000. Vplyv stimulátora Atonik na produkciu, kvalitu a ekonomiku výroby cukrovej repy. In *Agrochémia*, roč. 40, 2000, č.4, s. 20-23 ISSN 1335-2415.
- ŠROJTOVÁ, G. 2006. Závislosť úrod slnečnice od poveternostných podmienok. In *Bioklimatológia a voda v krajine*. Nitra: SPU, 2006, s. 57 - 62, ISBN 80-89186-12-2.