ORGANIC PRODUCTION OF SUNFLOWER (*HELIANTHUS ANNUUS* L.) HYBRIDS IN THE REGION OF CENTRAL SOUTH BULGARIA

Galia PANAYOTOVA

Trakia University, Faculty of Agriculture, Stara Zagora, Bulgaria
Corresponding author: galia_panayotova@abv.bg

Abstract: *The purpose of this study was to establish the specific characteristics of organic farming sunflower hybrids in terms of seed yield and its structural elements as well as the efficiency of bioproduct Biophalfa (Alga 300) in rate 1 l.ha^{-1}. Seven sunflower hybrids were tested: Sanay, NK Meldimi, NK Alego, NK Ferti, DKF2120, P64LE10 and P64LE11 on the certified bio-field of the Field Crops Institute, Chirpan, Bulgaria, under non-irrigated conditions after durum wheat (Tr. durum Desf.). The soil in the field of organic farming was Pellic Vertisols (FAO). The following characteristics were reported: seed yield (t.ha^{-1}), weight of the whole head (g); head diameters D_1 (length) and D_2 (width) (cm) and the ratio between the diameters (D_1/D_2); head area (cm^2); specific head weight (g.cm^{-2}); weight of 1000 seeds (g). The results demonstrated that sunflower hybrids can be successfully grown under organic farming conditions. In favorable years a seed yield of 2.34 t.ha^{-1} can be realized, and in drought - about 1.45 t.ha^{-1}. The sunflower hybrid DKF2120 achieved higher seed yields without and with feeding - 1.83 and 1.96 t.ha^{-1}, respectively, i.e. it was most adaptable to be used in organic production out of the seven tested sunflower hybrids. The proven interaction Hybrid x Year showed that hybrids manifested different requirements to the conditions of the environment. For both fertilizing systems, the P64LE10 and P64LE11 hybrids had a significantly higher weight of 1000 seeds - from 56.2 to 57.3 g, and the values were found to be higher in the favorable 2014 (51.2 g). The weight of whole head ranging from 133 to 348 g, The foliar feeding additional stimulates weight of whole head, resulting in average of 227.7 g. while without feeding it was 200.3 g. The area of sunflower head was very good - 224 cm^2. There was a strong positive correlation between the diameters of the head with its area (0.95-0.96).*

Key words: *organic farming, sunflower hybrids, foliar fertilization, seed yield, 1000 seeds weight.*

INTRODUCTION

Organic farming is a integrated system of farm management and food production that combines best practices with regard to environmental protection, maintaining a high level of biodiversity, preservation of natural resources and the application of higher welfare standards to animals and production methods tailored to the preferences of a certain part of consumers towards products made using natural substances and processes (DIVER, 2001; ET AL., 2010; NANDWANI AND NWOSISI, 2016; MANOJLOVIC ET AL., 2010; OXOUZI AND PAPANAGIOTOU, 2010).

JONES AT AL. (2010) reported that selection of cultivars under conditions of high agrochemical inputs selects for cultivars that yield well under maximal conditions in terms of nutrient availability and pest, disease and weed control. The selection conditions for breeding have a tendency to select cultivars which perform relatively better in non-organic compared to organic systems.

In 2016 the areas covered by the control system for organic production in Bulgaria amounted to 162352 ha which is 6 times more than 2010 (25 588 ha (STOILOV V., K. NEDEVA, 2018; Byuletini „Agrostatistika", 2018). Industrial crops occupy a total area of 30512 ha. Compared to 2010, they heve increased by nearly 25 600 ha as a result of a significant increase in the areas occupied by sunflower and rape. In 2016 the areas with organically grown sunflower were 4 528 ha (EUROSTAT, 2017)

Sunflower (*H. annuus* L.) is one of the most common oil crops worldwide (ZHELJAZKOV V. ET AL., 2011). It is also considered as one of the major oil producing crops because of its moderate production requirements, high-quality oil, protein contents and consumable parts of this plant (ŠKORIĆ, 1992). Due to its

high oil content and balanced nutrient content, sunflower is suitable for preparation of baby/infant foods, for dietary nutrition, and for production of forage for animals.

Sunflower is the second most widely distributed crop in Bulgaria after wheat and it is ranked first among oil crops. Bulgaria is characterized by favorable conditions for high quality production. Sunflower is a major crop in field crop rotations. With its deep root system it is able to use of soil moisture and nutrients better than other crop species, especially in heavy soils and during dry summer. Sunflower is a good opportunity for inclusion in organic farming systems also due to its high competitiveness against weeds.

The use of foliar fertilizers during vegetation creates an opportunity to increase the effect of fertilization and to reduce environmental pollution by reducing the fertilizing rates AKBARI ET AL., 2011; AHMAD AND JABEEN, 2009; ENTZ ET AL., 2001; HELMY AND RAMADAN, 2009; KANAZIRSKA (2012), MARRIOTT & WANDER (2006) and others pointed out that the efficiency of organic farming is increased by enhancing soil fertility. In this type of fertilization the nutritional and biologically active substances are completely absorbed by the plants. Through the use of vegetative feeding, the plants can quickly overcome functional diseases if there is a shortage of nutrients by vegetative feeding. The doses of foliar treatment during vegetation should be in accordance with the plant needs during the respective stages.

MAZZONCINI AT AL. (2006) indicate for crop rotation (sugar beet, common wheat, sunflower, beans and durum wheat) under conditions of organic and conventional farming systems in the Central Italy that the seed yield of organically grown sunflower was 17 to 44% lower than that obtained with conventional farming. The authors found no significant differences in the oil percentage between traditionally and organically grown sunflowers.

The purpose of this study was to establish the specific characteristics of organic farming sunflower hybrids in terms of seed yield and its structural elements as well as the efficiency of bioproduct Biophalfa (Alga 300).

MATERIAL AND METHODS

The investigation was carried out during the period 2014-2016 on the certified bio-field of the Field Crops Institute, Chirpan, Bulgaria, under non-irrigated conditions after durum wheat (*Tr. durum* Desf.). Randomized block design with four replications was used. The size of individual trial plots was 25 m^2 (PANAYOTOVA AND KOSTADINOVA, 2018).

The hybrids were grown without fertilization and with two-fold foliar feeding with organic seaweed fertilizer Biophalfa (Alga 300) in dose of 1 $l.ha^{-1}$. According to information by the producer Leili Agrochemistry Co. LTD, Alga 300 is a completely natural extract, ecologically clean, derived from brown seaweed, a highly concentrated liquid product. It contains 5% N, 15% P_2O_5, 4% K_2O (5:15:4), seaweed extract ≥ 15%, amino acid ≥ 1%, organic matter ≥15%, minerals, plant hormones, complex sugars. The product is approved for use in organic production after inspection of Ecocert SA.

Experiments were carried out on seven sunflower hybrids created by different breeding programs: Sanay, NK Meldimi and NK Alego (Clearfield® hybrids of Syngenta), NK Ferti (mid-early high oleic hybrid), DKF2120 (high oleic Syngenta hybrid), P64LE10 (conventional high oleic simple hybrid, linoleic type of DuPont Pioneer) and P64LE11 (conventional, simple hybrid, oleic type of DuPont Pioneer).

All farming activities for the sunflower hybrids were realized through the use of obligatory methods, rules and principles of organic production with the use of authorized organic consumables but without application of synthetic fertilizers and pesticides. Sunflower seeds were sown at depth of 5-7 cm within the optimal period March 20 - April 5, at soil temperature of over 8-10°C, with density of the plant population – 5.5 seeds/m^2. All hybrids were sown with pneumatic sowing machine with inter-row distance of 70 cm and in-row distance of 26 cm. Before sowing the seeds were decontaminated with Polyversum before sowing against fungal

soil pathogens. Weeds in vegetation period were controlled by inter-row machine operation and manual earthing-ups. Treatments against diseases and pests were not necessary.

The following characteristics were reported: seed yield (t.ha^{-1}) of sunflower hybrids, weight of the whole head (g); head diameters D_1 (length) and D_2 (width) (cm) and the ratio between the diameters (D_1/D_2); area of the head (cm^2) by the formula $S = \pi.a.b$, where *a* and *b* are the two half-axes of the ellipse; specific head weight (g.cm^{-2}); 1000-seed weight (g).

Analysis of variance in program Statistica 7 was used to determine differences and interaction between the studied factors and as proven were accepted the differences at significance levels $p \leq 0.05$. Correlational relationships between the head parameters and seed yield were established.

The soil in the field of organic farming was *Pellic Vertisols* (FAO). It was clay, with high humidity capacity and small water-permeability, defined by the sand-clay composition.

In terms of weather conditions (Table 1) the three studied years showed higher temperatures and lower levels of rainfall compared to the average values both in individual months and the vegetation period as a whole. As more unfavourable was reported 2015 – 252 ^{o}C higher temperature sum and 125 mm less rainfall compared to the average values.

Table 1

Meteorological data during the vegetation period (V-X) in the region of Chirpan, 2014-2016

Years	Months						Σ IV-IX	Σ VI-VIII
	IV	V	VI	VII	VIII	IX		
Temperature sum, Σ t ^{o}C								
1928-2016	343	519	622	720	711	561	3476	2053
2014	535	538	645	772	743	558	3791	2160
2015	412	519	688	830	787	623	3859	2305
2016	416	604	639	710	785	581	3735	2134
Rainfall, mm								
1928-2016	45	63	65	52	41	34	300	158
2014	46	46	31	24	58	50	255	113
2015	14	128	16	7	10	10	185	33
2016	41	14	61	91	1	10	218	153

RESULTS AND DISCUSSIONS

As with seed yield from sunflower hybrids per 1 hectare, very well was proven the effect of the three tested factors – cultivation system without and with feeding, hybrid, and year conditions, as well as all interactions between them. The effect of years was significant – 92.71% of the total effect. The effects of hybrid and feeding system were proven to a lower degree - 2.43 and 2.12%, respectively. The proven interaction Hybrid x Year showed that the hybrids manifested different requirements to the environment.

The seed yield was lowest in 2015 – an average of 1.45 t.ha^{-1}, and significantly higher in 2014 – 2.34 t.ha^{-1} (Table 2). The total average yield for all tested factors was 1.81 t.ha^{-1}, which is very good for the conditions of organic farming.

On average for the period, the highest yield was obtained from hybrid DKF2120 – 1.83 and 1.96 t.ha^{-1}, respectively, without and with feeding compared to the accepted standard P64LE11, which was 10.8 and 11.7% more. Productivity higher than the standard average for the period was observed for NK Ferti and NK Meldimi. Out of the remaining hybrids, the yield from hybrid Alego was the lowest – 1.69 and 1.79 t.ha^{-1}, respectively for the two feeding systems.

Table 2

Seed yield from organically grown sunflower hybrids for the period 2014-2016, t.ha^{-1}

Hybrid	2014	2015	2016	Average		
				t.ha^{-1}	% to P64LE11	% to unfertilized
A. Without feeding						
Sanay	2.335^{a}	1.355^{a}	1.530^{a}	1.740	105.3	-
NK Meldimi	2.268	1.450^{b}	1.595	1.771	107.1	-
NK Ferti	2.301^{a}	1.458^{b}	1.712^{b}	1.824	110.3	-
DKF2120	2.320^{a}	1.507^{c}	1.665^{c}	1.831	110.8	-
Alego	2.143	1.373^{a}	1.558	1.691	102.3	-
P 64 LE 10	2.207^{b}	1.458^{b}	1.522^{a}	1.729	104.6	-
P64LE11	2.173	1.348^{a}	1.438	1.653	100.0	-
Average	2.249*	1.421*	1.574*	1.748*	-	-
B. Two-fold foliar feeding						
Sanay	2.562	1.413^{d}	1.678^{c}	1.884	107.7	108.3
NK Meldimi	2.432^{c}	1.513^{c}	1.652^{c}	1.866	106.6	105.3
NK Ferti	2.470	1.538^{e}	1.755	1.921	109.8	105.3
DKF2120	2.653	1.505^{c}	1.708^{b}	1.955	111.7	106.8
Alego	2.313^{a}	1.446^{d}	1.612^{d}	1.790	102.3	105.8
P64LE10	2.437^{c}	1.550^{e}	1.682^{c}	1.899	108.0	109.3
P64LE11	2.203^{b}	1.425^{d}	1.622^{d}	1.750	100.0	105.9
Average	2.439*	1.484*	1.673*	1.865*	-	-
Average A+B	2.344	1.453	1.624	1.807	-	-
SD	*46*	*24*	*30*	*402*		
SEE	*23*	*12*	*15*	*31*		
Min	*2.11*	*1.32*	*1.42*	*1.32*		
Max	*2.72*	*1.56*	*1.80*	*2.72*		

*Differences in each column are statistically proven at $p < 0.05$ if they have different letters

During the meteorologically favourable year 2014, the highest yield without feeding was obtained by hybrid Sanay – 2.34 t.ha^{-1}. High yields in this year were also obtained by hybrids DKF2120 and NK Ferti, and the lowest yield was by Alego. With vegetation feeding in this year high yields of the standard were obtained by DKF2120 and Sanay, 2.65 and 2.56 t.ha^{-1}, respectively.

During the comparatively dry 2015, the average yield was 1.45 t.ha^{-1}, and high yields without feeding were reported for DKF2120, NK Ferti and NK Meldimi – which was 7.1-10.8% more than the yield of P64LE11. After treatment with Alga 300, the highest grain yield was reported for P64LE10, NK Ferti and DKF2120 – 8.0-11.7% above P64LE11. Low yield – 1.45 t.ha^{-1} was obtained by hybrid Alego.

The weight of whole head of the tested sunflower hybrids was changed significantly both over the years and under the influence of feeding. The average weight of the head was 214.0 g, ranging from 133 to 348 g (Table 3). Without feeding there was no proven difference between the hybrids, and the values for the period were from 177.7 g for NK Meldimi to 234,0 g for DKF2120. The foliar feeding additional stimulates the weight of whole head, resulting in average of 227.7 g, ranging from 164.3 (P63LE10) to 268.3 g (P64LE11). With feeding hybrid Alego also manifested a high head weight - 250.7 g. In 2014 the weight of the head was considerably higher than the weight in the other year - an average of 260.6 g, 53.6% more than the weight in 2015 and 23.1% above the 2016. The hybrid had a significant influence - 19.6% and the feeding system - 6.38% influence on the weight of whole head (Table 4).

The diameters of the head and their ratio are essential indicators for ellipsoid-oval shape of the head for the different varieties. Differences between values for D_1 were not statistically proven. The diameter was an average 18.0 cm, without feeding - 17.9 cm, and with two-fold foliar feeding - 18.0 cm. During the favourable 2014 D_1 was 19.1 cm, in 2015 and 2016 - 17.1 and 17.7 cm, respectively (Table 5). Diameter D_2 was 15.6 cm on

average, without feeding was average 15.4 cm, and 15.8 cm with feeding. During the favorable 2011 D_2 was an average of 17.0 cm, in 2012 and 2013 - respectively 15.0 and 15.3 cm. The variation between the hybrids was considerable.

Table 3

Weight of whole head (g) of sunflower hybrids, 2014-2016

Hybrid	A. Without feeding				B. Two-fold foliar feeding			
	Year			Average, g	Year			Average, g
	2014	2015	2016		2014	2015	2016	
Sanay	212^{ab}	146^{ab}	185^{ab}	181.0	221^{ab}	192^{ab}	211^{ab}	208.0
NK Meldimi	178^{ab}	135^{ab}	220^{ab}	177.7	262^{ab}	166^{ab}	222^{ab}	216.7
NK Ferti	240^{ab}	150^{ab}	196^{ab}	195.3	316^{ab}	133^{b}	270^{ab}	239.7
DKF2120	289^{ab}	171^{ab}	242^{ab}	234.0	307^{ab}	177^{ab}	254^{ab}	246.0
Alego	286^{ab}	175^{ab}	191^{ab}	217.3	348^{a}	238^{a}	166^{b}	250.7
P64LE10	235^{ab}	147^{ab}	172^{ab}	184.7	180^{b}	133^{b}	180^{ab}	164.3
P64LE11	258^{ab}	184^{ab}	195^{ab}	212.3	316^{ab}	229^{ab}	260^{b}	268.3
Average	242.6	158.3	200.1	200.3	278.6	181.1	223.3	227.7
SD=54.7; SEE=8.4;Min=133; Max=348								

*Differences in each column are statistically proven at $p<0.05$ if they have different letters

Table 4

Influence of the factors on the weight of whole sunflower head

Factor	SS	DF	MS	F	p	%
Systema	7845	1	7845	2.57	0.12	6.38
Variety	24033	6	4006	1.31	0.28	19.55
Systema*Variety	5685	6	948	0.31	0.92	4.62
Error	85345	28	3048			69.44

The results for the ratio between the length and the width of the head (D_1/D_2) showed that for all tested hybrids the head was slightly elliptical with ratios ranging from 1.06 (NK Meldimi at feeding) to 1.24 (NK Ferti without feeding) (Table 6). The ratio between diameters at feeding was lower - an average of 1.13, indicating that the head was better fed. The conditions over the years have not significant influence.

The analysis of the obtained data showed that for the three years the sunflower hybrids formed heads with a very good area - average 224 cm^2. The average area without feeding was 218 cm^2 and with leaf treatment - 229.5 cm^2. There was a tendency for growing the head area for all hybrids when feeding with the biofertilizer (Figure 1). It was favorable when the area of the sunflower head was about 300 cm^2, which was achieved with optimal agro-technology, as in the conventional technology. Larger size of the head can lead to breaking and lodging of plants, which makes difficult their mechanized harvesting. In 2014 the hybrids had a larger area - an average of 256.9 cm^2, while in the other two years the values were 202.7 and 212.5 cm^2. Head with a size greater than 300 cm^2 in 2014 was formed by the hybrids P64LE11 and DKF2120. On average for the three-year period the Alego formed head larger than 250 cm^2. Hybrid P64LE10 had the smallest head area - 178.9 and 184.1 cm^2 for both fertilizing systems. The influence of the factor Hybrid was significant - 39.54% of the total variation.

The specific weight of the head ($g.cm^{-2}$) was proven to be affected by the specificity of the tested hybrids (19.55%), and the impact of the nutrition and the year was insignificant. The average specific weight of the head was 0.96 $g.cm^{-2}$, with a variation from 0.62 to 1.45 $g.cm^{-2}$ (Table 7). With the use of additional feeding during vegetation there was a tendency towards increase of the specific head weight, i.e. increased consistency density. The indicator increased from 0.92 without feeding to 0.99 $g.cm^{-2}$ with a two-fold treatment. In

meteorologically favorable years, such as 2014, the specific head weight was higher - an average of 1.01 g.cm^{-2}, while in 2015 and 2016 the average values were 0.84 and 1.0 g.cm^{-2}

Table 5

Diameter D_1 and diameter D_2 of head from sunflower hybrids, 2014-2016, cm

Hybrid	Diameter D_1				Diameter D_2			
	Year			Average, cm	Year			Average, cm
	2014	2015	2016		2014	2015	2016	
A. Without feeding								
Sanay	17	17	16	16.7	16	15	13	14.7ab
NK Meldimi	17	15	21	17.7	15	14	17	15.3ab
NK Ferti	19	16	17	17.3	15	14	13	14.0ab
DKF2120	20	18	17	18.3	19	16	15	16.7a
Alego	21	19	19	19.7	18	16	17	17.0a
P 64 LE 10	17	16	17	16.7	14	13	14	13.7b
P 64 LE 11	23	17	17	19.0	19	15	16	16.7a
Average	19,1	16,9	17,7	17.9	16.6	14.7	15.0	15.4
B. Two-fold foliar feeding Алга 300								
Sanay	18	17	16	17.0	16	16	14	15.3ab
NK Meldimi	17	15	20	17.3	16	15	18	16.3ab
NK Ferti	19.5	17	17	17.8	16	14,5	14	14.8b
DKF2120	20	19	17.4	18.8	19,5	16	15	16.8ab
Alego	20	19	19	19.3	19	17	18	18.0a
P64LE10	17	17	17,5	17.2	15	13	14	14.0b
P64LE11	22	18	17,5	19.2	20	15,5	16	17.1a
Average	19,1	17,4	17,8	18.0	17,4	15,3	15,6	15.8
AverageA+B	19,1	17,1	17,7	18.0	17,0	15,0	15,3	15.6
	SD=1.8; SEE=0.27;Min=15; Max=23				*SD=1.9; SEE=0.3; Min=13; Max=20*			

*Differences for diameter D_1 are not statistically proven

*Differences for diameter D_2 are statistically proven at $p<0.05$ if they have different letters

Table 6

Ratio between the head diameters (D_1/D_2) of sunflower hybrids, 2014-2016

Hybrid	A. Without feeding				B. Two-fold foliar feeding			
	Year			Average, cm	Year			Average, cm
	2014	2015	2016		2014	2015	2016	
Sanay	1.06	1.13	1.23	1.14ab	1.13	1.06	1.14	1.11ab
NK Meldimi	1.13	1.07	1.24	1.15ab	1.06	1.00	1.11	1.06b
NK Ferti	1.27	1.14	1.31	1.24a	1.22	1.17	1.21	1.20ab
DKF2120	1.05	1.13	1.13	1.10b	1.03	1.19	1.16	1.12ab
Alego	1.17	1.19	1.12	1.16ab	1.05	1.12	1.06	1.08ab
P64LE10	1.21	1.23	1.21	1.22ab	1.13	1.31	1.25	1.23a
P64LE11	1.21	1.13	1.06	1.14ab	1.10	1.16	1.09	1.12ab
Average	1.16	1.15	1.19	1.16	1.10	1.14	1.15	1.13
SD=0.07; SEE=0.01;Min=1.00; Max=1.30								

*Differences are statistically proven at $p<0.05$ if they have different letters

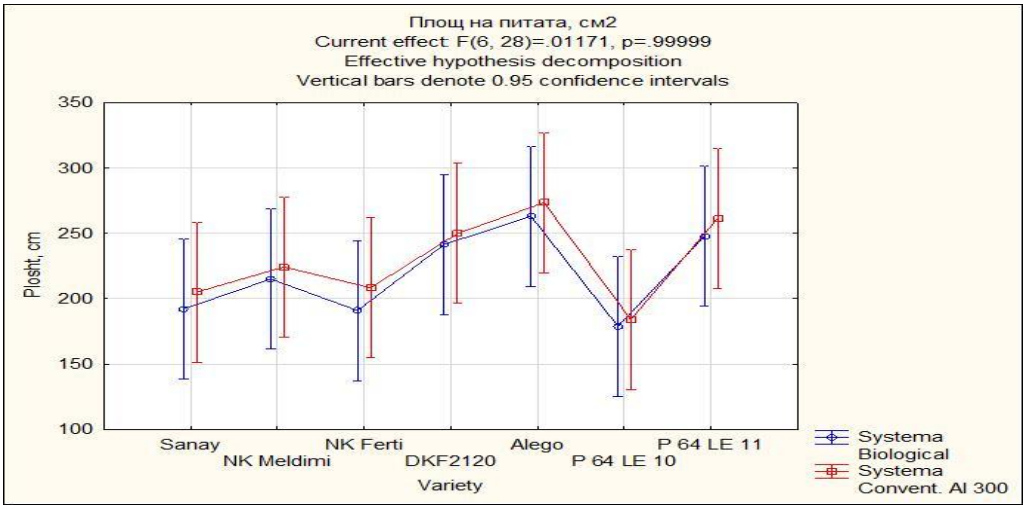

Fig. 1. Variation of head area (cm^2) of sunflower hybrids, 2014-2016

Table 7

The specific weight of the head ($g.cm^{-2}$) of sunflower hybrids in organic farming, 2014-2016

Hybrid	A. Without feeding				B. Two-fold foliar feeding			
	Year			Average, cm	Year			Average, cm
	2014	2015	2016		2014	2015	2016	
Sanay	0.99	0.73	1.13	0.94	0.98	0.90	1.20	1.01
NK Meldimi	0.89	0.82	0.79	0.83	1.23	0.94	0.79	0.97
NK Ferti	1.07	0.85	1.13	1.02	1.29	0.69	1.45	1.15
DKF2120	0.97	0.76	1.21	0.97	1.00	0.74	1.24	1.01
Alego	0.96	0.73	0.75	0.83	1.17	0.94	0.62	1.01
P 64 LE 10	1.26	0.90	0.92	1.03	0.90	0.77	1.01	1.01
P 64 LE 11	0.75	0.92	0.97	0.86	0.91	1.05	1.18	1.01
Average	0.96	0.81	0.96	0.92	1.06	0.86	1.03	0.99
SD=0.19; SEE=0.03; Min=0.62; Max=1.45								

The weight of 1000 sunflower seeds is a characteristic for a variety, but the technology of growing, as in the case used in the study fertilization with Alga 300, and weather conditions over the years, have an impact on realized values. Analysis of variance showed that the strongest influence on the weight of 1000 seed had the hybrid - 95.29% (Table 8). The years had proven influence 3.12% of the total variation of factors. No proven dependence had been established for the weight of 1000 sunflower seeds depending on the factor fertilizing system. Low but proven was Hybrid x Year Interaction.

Table 8

Analysis of variance for the weight of 1000 sunflower seeds, 2014-2016

Factor	SS	DF	MS	F	p	%
F - Fetilizing system	0.3	1	0.3	2	0.125	0.01
H - Hybrid	3320.8	6	553.5	4225	0	95.29
Y - Year	108.7	2	54.3	415	0	3.12
F * H	1.1	6	0.2	1	0.245	0.03
F * Y	0.2	2	0.1	1	0.548	0.01

H * Y	42.2	12	3.5	27	0	1.21
F * H * Y	0.7	12	0.1	0	0.929	0.02
Error	11	84	0.1			0.32

During the period, under the conditions of the organic field were formed seeds with very good weight of 1000 seeds. Tracing the impact of the different fertilizing systems on the weight of 1000 seeds showed that on average the values with the feeding system were slightly higher (Table 9). For both fertilizing systems, the P64LE10 and P64LE11 hybrids had a significantly higher weight of 1000 seeds - from 56.2 to 57.3 g, followed by the hybrid Sanay - 49.7 to 50.1 g. The lowest weight was reported for the high-yielding hybrid DKF2120 - average 41.5 g. These differences between varieties occurred throughout the three tested years. The values were found to be higher in the meteorologically favourable 2014 (an average of 51.2 g) compared to the other two years. The highest positive correlations between the studied indicators were found between the length of the diameters of the head with its area - 0.95-0.96 (Table 10). The dependencies between weight of whole head and diameters of the head, and between weight of whole head and area of head were medium (0.62-0.66).

Table 9

Weight of 1000 seeds (g) of sunflower hybrids in organic production, 2014-2016

Hybrid	A. Without feeding				B. Two-fold foliar feeding			
	Year			Average, cm	Year			Average, cm
	2014	2015	2016		2014	2015	2016	
Sanay	51.8a	48.6a	48.8a	49.7a	52.2a	48.8a	49.2a	50.1a
NK Meldimi	48.6b	46.8a	46.2b	47.2b	48.5b	46.9	46.8b	47.4b
NK Ferti	49.5b	48.0a	49.1a	48.9a	49.6b	48.2a	49.0a	48.9a
DKF2120	42.5c	40.7b	41.0d	41.4c	42.8c	40.8b	41.2d	41.6c
Alego	49.0b	47.5a	46.7b	47.7b	48.5b	47.4a	46.4b	47.4b
P 64 LE 10	58.1d	57.5c	57.2c	57.6d	58.2d	57.4c	57.5c	57.7d
P 64 LE 11	58.5d	54.1c	56.1c	56.2d	58.6d	54.0c	56.4c	56.3d
Average	51.1	49.0	49.3	49.77	51.2	49.1	49.5	49.91

	2014	*2015*	*2016*	*Average*
Average A+B	***51.2***	***49.1***	***49.4***	***49.87***
SD	*0.39*	*0.26*	*0.28*	*5.2*
SEE	*0.23*	*0.15*	*0.16*	*0.4*
Min	*42.0*	*40.4*	*40.5*	*40.4*
Max	*59.0*	*57.2*	*57.8*	*59.0*

Table 10

Correlations between the parameters of sunflower head, average for 2014-2016

Parameter	Average	SD	D_1	D_2	D_1/D_2	AH	WH	SWH
D_1	18.0	1.80	-	0.84	0.02	0.95	0.62	-0.30
D_2	15.75	1.86	0.84	-	-0.53	0.96	0.64	-0.18
D_1/D_2	1.15	0.08	0.02	-0.53	-	-0.28	-0.19	-0.14
Area of head, cm^2	224	48.72	0.95	0.96	-0.28	-	0.66	-0.24
Weight of whole head, g	214	54.75	0.62	0.64	-0.19	0.66	-	-0.48
Specific weight per head, $g.cm^{-2}$	0.90	0.16	-0.30	-0.18	-0.14	-0.24	-0.48	-

* SD - Standard deviation; D_1 - diameter 1(cm); D_2 - diameter 2(cm); AH - area of head (cm^2); WH - weight of whole head (g); SWH - specific weight per head ($g.cm^{-2}$).

CONCLUSIONS

Sunflower hybrids can be successfully grown under organic farming conditions on soil type *Pellic Vertisols* in Central South Bulgaria. When sunflower is organically grown under conditions of natural nutrient

regime, it should be considered that in favourable years a seed yield of 2.34 t.ha^{-1} can be realized, and in drought - about 1.45 t.ha^{-1}. The proven interaction Hybrid x Year showed that hybrids manifested different requirements to the conditions of the environment. Sunflower hybrids DKF2120 achieved higher seed yields without and with feeding, i.e. it was most adaptable to be used in organic production out of the seven tested sunflower hybrids. For both fertilizing systems, the P64LE10 and P64LE11 hybrids had a significantly higher weight of 1000 seeds - from 56.2 to 57.3 g, followed by the hybrid Sanay - 49.7 to 50.1 g, and the values were found to be higher in the favorable 2014 (an average of 51.2 g). The weight of whole head was 214 g, ranging from 133 to 348 g. The area of the sunflower head was very good - 224 cm^2, without fertilization being 218 cm^2 and at foliar feeding - 229.5 cm^2. There was a strong positive correlation between the diameters of the head with its area (0.95-0.96).

BIBLIOGRAPHY

AKBARI, P., GHALAVAND, A., MODARRES SANAVY, A.M. AND M. AGHA ALIKHANI, 2011. The effect of biofertilizers, nitrogen fertilizer and farmyard manure on grain yield and seed quality of sunflower (*Helianthus annus* L.). Journal of Agricultural Technology 2011 Vol. 7(1): 173-184. ISSN 1686-9141. Available online http://www.ijat-rmutto.com.

AHMAD R. AND N. JABEEN, 2009. Demonstration of Growth Improvement in Sunflower (*Helianthus Annuus* L.) by the Use of Organic Fertilizers under Saline Conditions. Pakistan Journal of Botany, 41 (3): 1373-1384.

Byuletini „Agrostatistika", MZHG, 2018. Bulgaria. http://www.mzh.government.bg/

DIVER, S., 2001. Resource guide to organic & sustainable vegetable production. http://attra.ncat.org/attra-pub/PDF/vegetable-guide.pdf.

ENTZ, M. H., R. GUILFORD, R. GULDEN, 2001. Crop yield and soil nutrient status on 14 organic farms in the eastern portion of the northern Great Plains. Canadian Journal of Plant Science, 81(2): 351-354, https://doi.org/10.4141/P00-089

EUROSTAT, 2017. http://ec.europa.eu/eurostat

JONES H., S. CLARKE, Z. HAIGH, H. PEARCE AND M. WOLFE, 2010. The effect of the year of wheat variety release on productivity and stability of performance on two organic and two non-organic farms. The Journal of Agricultural Science, Volume 148, Issue 3: 303-317. https://doi.org/10.1017/S0021859610000146.

HELMY A. M. AND MOHAMED FAWZY RAMADAN, 2009. Agronomic performance and chemical response of sunflower (Helianthus annuus L.) to some organic nitrogen sources and conventional nitrogen fertilizers under sandy soil conditions. GRASAS Y ACEITES, 60 (1), Enero-Marzo, 55-67, ISSN 0017-3495.

KANAZIRSKA, V., 2012. Soil fertility management in organic agriculture. New Knowledge, 3: 25-35, Bularia.

MANOJLOVIC, M., CABILOVSKI, R. AND BAVEC, M., 2010. Organic materials - sources of nitrogen in organic production of lettuce. Turk. J. Agric. and For, 34: 163-172.

MARRIOTT, E. AND WANDER, M., 2006. Total and labile soil organic matter in organic and conventional farming systems. Soil. Sci. Soc. Am. J. 70: 950-959.

NANDWANI D., NWOSISI, S., 2016. Global Trends in Organic Agriculture. In: Organic Farming for Sustainable Agriculture, Editors Dilip Nandwani: 1-35. Part of the Sustainable Development and Biodiversity, book series (SDEB, vol. 9).

OXOUZI, E. AND PAPANAGIOTOU, E., 2010. Comparative analysis of organic and conventional farmers and their farming systems. Where does the difference lie? Bulgarian J.of Agricultural Science, No. 16 (2): 135-142.

PANAYOTOVA G., S. KOSTADINOVA, 2018. Seed yields of organically grown sunflower hybrids. Lucrări Ştiinţifice, Agronomie şi Agroecologie, Universitatea Agrară de Stat din Moldova**,** Volumul 52 (1): 41-47, Moldova.

ŠKORIC, D. 1992. Achievements and future directions of sunflower breeding. Field Crops Res,30: 231-270.

STOILOV V., K. NEDEVA, 2018, Organic plant production in Bulgaria. New Knowledge Journal of Science, vol. 7 (2): 157-163. ISSN 2367-4598 (Online).

ZHELJAZKOV V. D., BRADY A. VICK, BRIAN S. BALDWIN, NORMIE BUEHRINGA, CHRISTINE COKER, TESS ASTATKIE, BILLY JOHNSON, 2011. Oil productivity and composition of sunflower as a function of hybrid and planting date. Industrial Crops and Products, 33: 537–543.