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VARIABILITY IN INFLORESCENCES IN VARIOUS VARIETY TYPES OF COMMON SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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ABSTRACT. In the fields of the Przybroda Experimental Station of the August Cieszkowski Agricultural University of Poznań selected features of inflorescences were compared in two hybrid varieties and one population variety of common sunflower. The scope of biometric measurements included the diameter of the flower head and its sterile part, the degree of inclination of the inflorescence and the thickness of the receptacle. On the basis of the obtained data the area of the flower head and its sterile part were calculated together with their percentage. Moreover, changes were investigated in the diameter of the inflorescence during its maturing. The population sunflower variety produced the smallest flower heads, which were characterized by the biggest sterile part. All the flower head features analyzed in this variety were characterized by the highest values of standard deviation, but the coefficient of variation was frequently the highest in hybrids. Individual variation had the highest effect on all the analyzed characters of the inflorescence.

Key words: sunflower, cultivars, inflorescences, variability, heritability

Introduction

Common sunflower (*Helianthus annuus* L.), after soy, rape and peanuts, belongs to the most commonly grown oil plants worldwide. According to the lists of FAO for the years 1961-2004, the biggest cropping area of this plant is found in Russia and Ukraine (formerly the USSR), where last year it reached 4 500 000 and 3 320 000 ha, respectively. In the period when the statistical data were collected, Argentina ranked next, followed by India, the USA and China. Relatively large cropping areas were also reported in Romania, Bulgaria, Spain, Turkey and the Republic of South Africa (FAO 2004).

The biggest number of studies on sunflower concern the effect of the cultivation method on the yield of its achenes and oil contents (e.g. **Tobołа** et **al.** 1991, 1993, **Ahmad** et **al.** 1992, **Villalobos** et **al.** 1994). However, such functional characters of

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these plants as their height, the size of flower heads or weight of fruits, constituting the basic elements of crop structure, have also been a subject of studies conducted on their effect on the two above mentioned parameters, being most important for breeders (**Kłoczowski** 1983, **Sheriff** et **al.** 1987, **Tanimu** et **al.** 1991, **Łuczkiewicz** 1992).

While analyzing the variation in individual morphological and functional characters of sunflower it is commonly believed that interline hybrids are more uniform and better adapted to machine harvesting (e.g. **Kłoczowski** 1967, 1983, **Pirani** 1981, **Ortegon** and **Diaz** 1997, **Goksoy** et **al.** 1998, **Maruthi** et **al.** 1998). However, **Kłoczowski** (1975) found that in the changeable climate in Poland hybrid varieties may exhibit lower stability of characters than Polish population of sunflowers.

The aim of the conducted studies was to show the variation, as well as heritability of selected morphological and functional characters of flower heads of various types of common sunflower varieties, and to confirm or reject the hypothesis on the higher uniformity of hybrid varieties.

Material and methods

Trials were conducted in the years 1997-1999 in Przybroda, in the fields of the experimental station of the Agricultural University of Poznań. Detailed meteorological data and agrotechnical conditions of the experiment were given in a previous study on sunflower shoots (**Kluza-Wieloch** 2003). However, it needs to be repeated here that the factors modifying the variability in flower heads were different doses of nitrogen fertilizer (60 and 120 kg $N \cdot ha^{-1}$) and various density levels (50, 75 and 100 thousand per ha). In the years 2000-2001, in Poznań, comparative studies were also carried out on the changes in the diameter of the flower head during its maturing. The first measurement was taken immediately after overblowing of flower heads and the second three weeks later.

The objects of the study were two interline hybrids (F_1) of common sunflower: a French hybrid 'Frankasol' and an American one, 'Coril', which were compared to a Polish population variety – 'Wielkopolski'. The investigated flower head characters were analyzed on at least 360 specimens.

The scope of biometric measurements included the dimensions of inflorescence diameter and the sterile part in it. On the basis of the above mentioned values the total area, the area of the sterile part, and the percentage of this part were calculated. Moreover, the degree of flower head inclination was analyzed according to Fabry (Olejniny 1992) along with the thickness of the receptacle.

The analysis of variation in the above mentioned characters was characterized, according to the recommendations by **Kala** (1996), with the use of standard deviation and the coefficient of variation. Varietal variability was the basis for the determination of heritability (h^2) in the general sense, according to the method proposed by **Płochiński** (1968) and **Bos** and **Caligari** (1995).

Results

The diameter and area of the whole flower head, the diameter and area of the sterile part, the percentage of this part in the total area and the degree of the flower head inclination, investigated in Przybroda, turned out to be dependent on the variety type, plant density level and environmental factors, while only nitrogen fertilization did not have a significant effect on these characters. The biggest flower head area was found in hybrid Coril. The area of the sterile part and its percentage was the smallest in this variety, while the highest in var. Wielkopolski. For the three tested creations mean values of flower head inclination were found to be in the most advantageous range, between 180° and 250°. The biggest angle of inflorescence inclination was found in var. 'Wielkopolski', while the smallest for hybrid Coril. An increase in plant density in the plot resulted in a decrease in the area of the inflorescence and its sterile part, but at the same time its percentage in the flower head increased. At the density of 50 thousand plants per hectare inflorescences were more erect and their biggest inclination angle was found at the density of 75 thousand per hectare. Soil and weather conditions had the most advantageous effect on the size of inflorescences in 1997. In turn, two years later these organs were the smallest. In 1998 sunflowers produced the smallest number of empty achenes, while in the previous season – the biggest number. Then the high number of unset fruits was caused by high precipitation during the flowering i.e. in July. In 1998 the degree of flower head inclination had the smallest values, whereas one season later – the highest (Table 1). The thickness of the inflorescence receptacle was investigated only in 1999. The biggest dimensions were found for this character in var. 'Wielkopolski', while the lowest in hybrid Frankasol. The observed sunflower plants differed significantly (Table 2).

Table 1

Morphology of flower heads, depending on the level of analysed factors (1997-1999)
Morfologia koszyczków w zależności od poziomu analizowanych czynników (1997-1999)

Experimental factors Czynniki doświadczenia	Characters features of heads Charakterystyczne cechy koszyczków			
	total surface powierzchnia całkowita (cm^2)	sterile surface powierzchnia partii płonnej (cm^2)	share of sterile zone surface udział partii płonnej (%)	bend degree of head stopień pochylenia (1-6)
1	2	3	4	5
Cultivars – Odmiany				
Wielkopolski	215.6	22.8	11.7	4.40
Frankasol	217.5	17.9	9.09	4.11
Coril	229.3	8.60	4.35	3.81
$LSD_{0.05}$ – $NIR_{0,05}$	6.45	1.25	0.632	0.054

Table 1 – cont.

1	2	3	4	5
Plant density – Zagęszczenie				
50 000/ha	275.5	17.3	6.67	4.05
75 000/ha	216.5	17.1	8.81	4.16
100 000/ha	170.4	14.9	9.67	4.11
$LSD_{0.05}$ – $NIR_{0,05}$	6.45	1.25	0.632	0.054
Fertilization – Nawożenie				
60 kgN/ha	218.8	16.5	8.50	4.11
120 kgN/ha	222.8	16.4	8.27	4.10
$LSD_{0.05}$ – $NIR_{0,05}$	–	–	–	–
Environment – Środowisko				
In year 1997 W 1997 roku	232.7	19.4	9.77	4.13
In year 1998 W 1998 roku	228.4	13.8	6.46	3.97
In year 1999 W 1999 roku	201.3	16.1	8.92	4.22
$LSD_{0.05}$ – $NIR_{0,05}$	6.45	1.25	0.632	0.054

Table 2

A characteristic of variability morphological features of flower heads in three varieties
Charakterystyka zmienności cech morfologicznych koszyczków trzech odmian

Cultivar Odmiana	Arithmetic mean Średnia arytmetyczna			Standard deviation Odchylenie standardowe			Variation coefficient Współczynnik zmienności		
	1997	1998	1999	1997	1998	1999	1997	1998	1999
1	2	3	4	5	6	7	8	9	10
Head diameter (cm) – Średnica koszyczka (cm)									
Wielkopolski	16.6	16.2	15.6	4.15	2.50	3.06	25.0	15.5	19.6
Frankasol	16.5	17.0	15.5	3.45	2.47	2.84	20.9	14.5	18.3
Coril	17.3	17.3	16.1	3.28	2.01	2.83	19.0	11.7	17.6
$LSD_{0.05}$ – $NIR_{0,05}$	0.42	0.27	0.43	–	–	–	–	–	–
Total surface (cm^2) – Powierzchnia całkowita (cm^2)									
Wielkopolski	229.4	210.9	199.4	112.1	65.1	77.0	48.9	30.9	38.6
Frankasol	223.6	230.8	195.6	91.7	64.9	69.2	41.0	28.1	35.4
Coril	242.0	236.9	208.9	87.2	53.2	71.7	36.0	22.5	34.3
$LSD_{0.05}$ – $NIR_{0,05}$	11.16	7.08	10.80	–	–	–	–	–	–

Table 2 – cont.

1	2	3	4	5	6	7	8	9	10
Sterile zone diameter (cm) – Średnica partii płonnej (cm)									
Wielkopolski	5.65	4.66	4.64	2.19	1.70	1.73	38.8	36.5	37.4
Frankasol	4.92	4.07	4.48	1.39	1.42	1.48	28.2	35.0	33.0
Coril	2.90	2.11	3.56	1.52	1.70	1.48	52.4	80.4	41.6
$LSD_{0.05} – NIR_{0,05}$	0.266	0.202	0.274	–	–	–	–	–	–
Sterile zone surface (cm^2) – Powierzchnia partii płonnej (cm^2)									
Wielkopolski	28.8	19.4	19.2	21.7	11.9	14.5	75.4	61.5	75.5
Frankasol	20.5	14.6	17.5	10.3	9.86	10.9	50.1	67.6	62.6
Coril	8.43	5.76	11.7	6.98	6.38	8.62	82.9	110.8	73.9
$LSD_{0.05} – NIR_{0,05}$	2.212	1.208	2.037	–	–	–	–	–	–
Share of sterile zone surface (%) – Udział partii płonnej (%)									
Wielkopolski	14.6	9.73	10.7	10.2	5.79	8.00	70.0	59.5	74.6
Frankasol	10.6	6.64	9.71	5.88	4.49	6.71	55.2	67.6	69.1
Coril	4.18	2.53	6.34	3.88	2.79	5.86	92.2	110.3	92.4
$LSD_{0.05} – NIR_{0,05}$	1.070	0.556	1.189	–	–	–	–	–	–
Bend degree of head (1-6) – Stopień pochylenia koszyczka (1-6)									
Wielkopolski	4.33	4.35	4.52	0.65	0.59	0.59	15.0	13.7	13.1
Frankasol	4.17	3.88	4.23	0.56	0.45	0.49	13.4	11.6	11.7
Coril	3.87	3.63	3.90	0.52	0.50	0.45	13.6	13.9	11.6
$LSD_{0.05} – NIR_{0,05}$	0.088	0.065	0.091	–	–	–	–	–	–
Thickness of the receptacle (mm) – Grubość osadnika (mm)									
Wielkopolski	*	*	12.3	*	*	5.28	*	*	42.9
Frankasol	*	*	10.1	*	*	3.44	*	*	33.9
Coril	*	*	11.3	*	*	4.38	*	*	38.9
$LSD_{0.05} – NIR_{0,05}$	–	–	0.83	–	–	–	–	–	–

*Not measured.
*Nie mierzono.

In the years of the study conducted in Poznań on changes in the size of inflorescences during their maturing also var. 'Wielkopolski' had the smallest flower heads. However, in 2001, in spite of a decrease in the diameter dimensions in the hybrids, the population variety showed a slight increase in the level of his character at the first measurement. At this measurement the minimal size of inflorescences was 5 cm, while the maximum 20 cm. During the second measurement, in spite of the removal of perianths full fruits did not set, the diameter was on average by 3.4 cm bigger (at the maximum by 7 cm, and at the minimum by 1 cm). It increased much more markedly in 2000 (4.1 cm)

than in 2001 (2.6 cm). In sunflower var. 'Wielkopolski', in the first season of observations, between these two measurements, the diameter changed the least, while in the second year in this variety its highest increase was observed. This character in the years of the study did not differ significantly in the analyzed varieties only in the second measurement in the second experimental year. Most frequently the highest values of both statistical characters were found in var. 'Wielkopolski' (Table 3).

Table 3

A characteristic of variability in the diameter of overblowing and maturing flower heads for three varieties
Charakterystyka zmienności średnicy przekwitających i dojrzewających koszyczków dla trzech odmian

Cultivar Odmiana	Arithmetic mean Średnia arytmetyczna		Standard deviation Odchylenie standardowe		Variation coefficient Współczynnik zmienności	
	2000	2001	2000	2001	2000	2001
At the end of flowering (cm) – W końcu kwitnienia (cm)						
Wielkopolski	10.8	11.0	3.69	3.29	34.2	30.1
Frankasol	13.9	12.7	2.20	3.84	15.8	30.4
Coril	13.5	13.0	2.18	2.39	16.1	18.4
$LSD_{0.05}$ – $NIR_{0,05}$	1.43	1.66	–	–	–	–
In the plenty of maturing (cm) – W pełni dojrzewania (cm)						
Wielkopolski	14.4	14.0	4.56	4.19	31.7	29.9
Frankasol	18.0	14.8	2.86	4.38	15.9	29.5
Coril	18.2	15.6	3.06	3.01	16.8	19.4
$LSD_{0.05}$ – $NIR_{0,05}$	1.83	–	–	–	–	–

The highest values of standard deviation for all the analyzed traits were always found for the 'Wielkopolski' variety, while the lowest for hybrid 'Coril'. Usually the most uniform in terms of this parameter were specimens in 1998, while the least – in the previous season. In the years of the study the relative variability, expressed by the coefficient, was similar. The diameter, area and percentage of the sterile part were characterized by a very high variability, the coefficient of which exceeded even 100%. Most frequently it was the highest in hybrid 'Coril' (Table 2).

The sources of variability in the analyzed characters of the flower head were first of all random factors. In case of flower head size it was further affected by agrotechnical conditions, while the other characters were also influenced by the genotype (Table 4).

Table 4

Share of environmental, agrotechnic and genetic factors (%) in formation of variability of morphological features of flower head
Udział czynników środowiska, agrotechniki i genotypu (%) w kształtowaniu zmienności cech morfologicznych koszyczków (1997-1999)

Characteristic features of flower head Charakterystyczne cechy koszyczków	Source of variability – Źródło zmienności				
	environment środowisko	agrotechnic agrotechnika	genetic genotyp	interactions interakcje	random factors czynniki losowe
Total surface (cm^2) Powierzchnia całkowita (cm^2)	3.1	29.3	0.6	7.1	59.9
Sterile zone surface (cm^2) Powierzchnia partii płonnej (cm^2)	2.7	0.6	17.7	6.0	73.0
Share of sterile zone surface (%) Udział partii płonnej (%)	3.7	3.0	17.6	6.7	69.0
Bend degree of head (1-6) Stopień pochylenia koszyczka (1-6)	3.0	0.5	16.3	5.8	74.4

Discussion

According to the studies conducted by COBORU in the years 1991-1994 and 1992--1995, the diameter of the flower head in the 'Wielkopolski' sunflower variety was 18.5 and 18.6 cm, respectively, while hybrid Frankasol had it always by 0.2 cm smaller (Wyniki doświadczeń... 1995). Various authors described the diameter of the inflorescence as 15-25 cm, with the possible variation: Fabry – within the 5-75 cm range (Olejniny 1992), Vranceanu – 10-40 cm (Floarea-soareuli 1974), Pustovojt – 10-26 cm (Podsolnechnik 1975), **Andrukhov** et **al.** (1975) – 8-45 cm, **Gonet** (1976) – 5-40 cm, **Skoric** and **Vrebalov** (1988) – 15-40 cm. Flower heads analyzed by **Federowska** (1971) in population varieties reached from about a dozen to 40 cm, on average amounting to 20 cm. In a study by **Muśnicki** (1975), the diameter in the 'Wielkopolski' creation was 15.7 cm, while in another population variety it was 13.6 cm. In new hybrids, created by **Kłoczowski** (1967), it reached 23.5 cm. In another study by **Kłoczowski** (1983) it was 14.0-22.6 cm and was characterized by low values of the coefficient of variation, which was confirmed by that author earlier (**Kłoczowski** 1975), but it was rejected by the results of investigations conducted by the author of this study. The mean size of flower heads in two types of varieties in a study by **Kotovska** (1987) was 16 cm, while that of Pieriedowik sunflower population in a study by **Jaimand** and **Rezaee** (1996) – 20.1 cm. These plants reacted to a shortage of precipitation and high temperatures, reducing at that time the dimension of this character. The size of the inflorescence in various types of varieties under saline conditions was 14-17 cm (**Zhang Yunda** 1988). Also comparative studies on the size of the flower head in a hybrid and a population variety were carried out by **Hussain** et **al.** (1998) in inbred lined and cross testers,

Miller et **al.** (1980), and only on hybrids **Lukacs** and **Hargitay** (1991), **Estrada--Gomez** et **al.** (1996) and **Miklic** et **al.** (1998). **Campiglia** et **al.** (1989) observed that high and low sunflowers had similar diameters of the inflorescence. **Nikolova** et **al.** (1998) stated that *H. annuus* was characterized by a much larger size of the flower head in comparison to wild species, e.g. *H. praecox* ssp. *hirtus*. In crosses with these species this character reached intermediate values. **Kłoczowski** (1971) observed that inflorescence dimensions decreased in generation F_2 in comparison to F_1.

Numerous authors observed that increased plant density in plots resulted in a decreased flower head diameter (**Thompson** and **Fenton** 1979, **Robinson** et **al.** 1980, **Majid** and **Schneiter** 1987, **Chalermpone-Sampet** et **al.** 1988, **Ionescu** and **Draghicioiu** 1989, **Rebancos** et **al.** 1989, **Toboła** et **al.** 1991, **Ortegon** and **Diaz** 1997, **Goksoy** et **al.** 1998). It was also confirmed by the investigations conducted by the author of this study. **Ahmad** and **Quresh** (2000) additionally found that the size of this character decreased considerably along with a delay in seeding time. In turn, **Wantana-Waratanakun** (1984) observed that it did not exhibit significant differences at varying density and was on average 20.1 cm. **Radenovic** (1983) stated that at the plant density of 31 thousand per hectare the inflorescence diameter was the highest (20 cm), but it was the smallest (14 cm) at the plant density of approx. 50 thousand per hectare, and not the highest density amounting to 67 thousand per hectare. Still different results were presented by **Karami** (1977), who observed that this character decreased along with a decrease in plant density and extension of irrigation interval. In turn, in another study (**Karami** 1980) he noted that an increase in nitrogen dose from 0 to 50 $kg \cdot ha^{-1}$ caused an increase in the diameter size, while an increase in plant density and the number of achenes in the core had the opposite effect. **Hussein** et **al.** (1980) and **Samui** and **Ghosh** (1988) observed that lowering the density and increasing the nitrogen dose resulted in an increase in the flower head diameter. Increasing the amount of this element in one year of the study resulted in a decrease in the sterile part, while in the next season this area increased. The interaction between plant density and the level of nitrogen fertilization showed that the biggest inflorescences were obtained in the combination of the lowest density with the lowest or the highest nitrogen dose.

Similarly to the investigations carried out by the author of this study, **Lozanovic** and **Stanojevic** (1988) and **Toboła** et **al.** (1993, 1996) did not find a correlation between higher doses of nitrogen or other fertilizers, and inflorescence size. In contrast, **Muśnicki** et **al.** (1980) observed that depending on the type of soil and nitrogen fertilization this parameter remained stable or it increased. **Kamel** et **al.** (1980) noted that an increase in the nitrogen dose resulted in an increase in the flower head diameter in population sunflower and hybrid 'Fransol'. In other varieties this was also confirmed by **Akhtar** et **al.** (1992). **Hefni** et **al.** (1985) stated that the application of nitrogen and phosphorus fertilizers also increased the level of this character. A similar effect was found for NPK fertilization and liming (**Kadar** and **Vass** 1988). **Cadeac** (1988) observed that the size of the flower head differed in the years of observations and amounted to 16.9 and 20.7 cm, respectively, while its sterile part was 5.6 and 7.4 cm, whereas the application of nitrogen fertilizer caused a decrease in inflorescence dimensions. **Suzer** (1998) found that an increase in the phosphorus dose did not have an effect on the size of the inflorescence, amounting on average to 15.2 cm. Relatively low doses of sulfur had an advantageous effect on the flower head diameter (**Hocking** et **al.** 1988).

Liang Guo-Zhen (1988) observed that in the analyzed varieties in various locations the diameter of the inflorescence fell within the 16.8-25.3 cm range, whereas **Tanimu** et

al. (1988) showed that site conditions did not have an effect on a change in this character. **Salera** and **Baldini** (1998) stated that external conditions had a significant effect on the diameter of the inflorescence and its sterile part. Also **Krausko** and **Krauskova** (1995) stated that the size of inflorescences depended on the type of hybrid and environmental conditions, especially the weather. It was 14.1-16.7 cm in the first year of the study and 15.2-17.3 cm in the second. A significant effect on this character was also found for irrigation (**Guiducci** 1988, **Rizzo** and **Di Bari** 1988). This was also confirmed by **Chaudhry** et **al.** (1998), in whose study the diameter was on average 13.7 cm. In turn, **Sadras** et **al.** (1993) observed that water deficit did not affect the size of inflorescences. **Visic** (1986) found that the seeding time did not affect the size of the flower head, which was 15.5 cm. While comparing hybrids, it was observed also by **Maiorana** et **al.** (1988) and **Lanza** et **al.** (1988); however, sunflowers sown later had the highest zone of underdeveloped achenes. In the experiment carried out by **Yadava** and **Singh** (1978), in winter time these plants were characterized by bigger diameter values. **Chaudhary** and **Anand** (1987) noted that the diameter of the flower head in sunflowers growing in spring was more variable. **Dembiński** et **al.** (1971) stated that this character decreased considerably when no cultivation measures were applied. This was also the case when plants were infested with diseases (**Srinivas** et **al.** 1998), or when mid-stalk leaves were removed (**Somchai-Theerabutra** 1991, **Ahmad** et **al.** 1998). These measures additionally caused an increase in the sterile part (**Cholaky** et **al.** 1988). **Miller** and **Roath** (1982) observed that the size of losses of sunflowers in the field at various development phases caused an increase in diameter. Also soil mulching resulted in an increase in this character (**Vannozii** et **al.** 1988).

According to **Łuczkiewicz** (1973), the mean diameter of the flower head in population varieties ranged from 4 to 18.5 cm and exhibited a similar variability as in this study. The author (**Łuczkiewicz** 1973, 1993) observed that in the analyzed varieties it was to a considerable degree a heritable character, which was not confirmed by the investigations conducted by the author of this study. However, as the author reported, the coefficient of heritability, depending on the year of observations, may change its value. Also **Tariq** et **al.** (1992) showed a high heritability and low genetic variability of inflorescence diameter. **Holtom** et **al.** (1995) in hybrids in generations $F_1 - F_3$ compared the size of the inflorescence and its inclination. In generations F_2 and F_3 a distinct decrease may be observed in flower head size. The diameter constituted one of the most heritable characters. It was also confirmed by **Secerov-Fiser** et **al.** (1995, 1997), who studied genotypic variability of inflorescence size in crosses of hybrids of ornamental sunflower with a wild species *Helianthus argophyllus* L. **Marinkovic** (1984) and **Hladni** (1999) investigated the heritability of flower head diameter. Genes with additive effect played a decisive role in this process.

Fabry (Olejniny 1992) defined the percentage of the sterile part at 10-15%, **Brzostowski** (1950) at 20%, while **Federowska** (1971) in tested population varieties found 8.7-20% unset fruits. A decrease in their share was reached thanks to the increased dose of fertilizers (**Federowska** 1972). In the same study the author observed that the shape of the flower head was also significant. If the sunflower had a slightly convex inflorescence, then more full achenes were set in its central part. **Terbea** and **Stoenescu** (1984) observed that the higher plant density was, the bigger was the increase in the area of the sterile part, but in the investigations conducted by the author of this study an opposite conclusion was drawn. **Rahman** and **Alam** (1988) assessed the size of the diameter of this part at various pollination methods. It was the highest at

pollination by insects. **Fernandez** and **Orioli** (1983) evaluated the light absorbing capacity and the yield of sunflower hybrids with various inflorescence inclinations. Erect flower heads accumulated light during the whole day, thus those authors found in those plants a higher percentage of set fruits. The content of parenchyma in the flower head receptacle was connected with the length of the vegetation season, the number of leaves and the diameter of the stalk. By decreasing its size a higher oil percentage and higher achene yield were obtained, at the decrease in the number of empty achenes and a reduced husk in the fruit (**Pirani** 1981). The thickness of the inflorescence receptacle has a decisive effect on the flower head drying. The thinner it is, the faster achenes reach technical maturity and the less frequently they are infested with rot diseases. Also the degree of flower head inclination has a large practical importance. The disadvantageous arrangement of the inflorescence leads as a consequence to a decrease in yields as a result of losses caused by achenes eaten by birds and those caused by rot diseases. The stalk along with the developing inflorescence exhibit also a distinct heliotropism. Early in the morning flower heads are directed towards the east, next follow the sun to turn west in the evening (Olejniny 1992).

Conclusions

1. Flower heads of hybrids had a bigger diameter than the population variety. The dimensions and percentage of the sterile part were also markedly smaller in hybrids. Sunflower 'Wielkopolski' exhibited the biggest inclination of the flower head and the thickest receptacle, which was considered a negative character.

2. Changes in the flower head diameter during its maturing differed in various years of the study. One year they were bigger in hybrids, while in another in the population creation. They depended to a considerable degree on environmental conditions.

3. An increase in the seeding rate resulted in a decrease in the total area and the area of the sterile part, but increased the share of the sterile part in the flower head. An increase in nitrogen doses did not have a significant effect on the analyzed characters. It only caused a slight increase in the area of the inflorescence and a decrease in the sterile part percentage.

4. In the first season of the study the environmental conditions had the most advantageous effect on flower head size, but then sunflowers were also characterized by the largest area and percentage of the sterile part.

5. The population variety exhibited the highest values of standard deviations, while the coefficient of variation was frequently the highest in hybrids. A very high variability was found for the area of the sterile part and its percentage in the flower head. Moreover, the total size of the inflorescence and the thickness of the receptacle were also not very uniform.

6. All the analyzed characters of the flower head were affected to the highest degree by individual variability. The total area was also influenced by agrotechnical factors, while for the other characters the effect of genotype was also found.

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ZMIENNOŚĆ KWIATOSTANÓW RÓŻNYCH TYPÓW ODMIAN SŁONECZNIKA ZWYCZAJNEGO (*HELIANTHUS ANNUUS* L.)

S t r e s z c z e n i e

W latach 1997-1999 na polach gospodarstwa rolnego AR w Przybrodzie porównywano wybrane cechy kwiatostanów u dwóch odmian mieszańcowych i jednej populacyjnej. Zakres pomiarów biometrycznych obejmował średnicę koszyczka i jego partii płonnej, stopień pochylenia kwiatostanu i grubość osadnika. Na podstawie uzyskanych danych obliczono powierzchnię koszyczka i jego partii płonnej oraz jej procentowy udział. Ponadto w latach 2000-2001 w Poznaniu badano zmiany średnicy kwiatostanu w trakcie jego dojrzewania. Słonecznik populacyjny wytworzył najmniejsze koszyczki, które cechowały się z kolei największym udziałem partii płonnej. Wzrost gęstości siewu powodował zmniejszenie się powierzchni całkowitej koszyczków i partii płonnej, lecz zwiększenie się udziału partii płonnej w kwiatostanie. Zwiększenie dawek azotu nie oddziaływało w istotny sposób na analizowane cechy. Wszystkie badane parametry koszyczka u odmiany populacyjnej charakteryzowały się największymi wartościami odchylenia standardowego, ale współczynnik zmienności często był największy u mieszańców. Największy wpływ na wszystkie analizowane cechy kwiatostanu wywierała zmienność osobnicza.

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