



A STUDY ON CAPITULUM FLOWERING RATES ON EXPERIMENTAL PLOTS AND FLOWERING RATES OF FLORETS IN FLOWER HEADS OF DIFFERENT CULTIVARS OF COMMON SUNFLOWER (*HELIANTHUS ANNUUS* L.)

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**ABSTRACT.** In the years 1997-1999 studies on capitulum flowering rates were conducted on experimental plots at the Experimental Station of the Poznań University of Life Sciences at Przybroda, while in the years 1999-2003 studies on the development rate and the number of florets per capitulum were carried out at the Garden of the Department of Botany, PULS. The objects of the investigations included a Polish open pollinated cultivar and two interline hybrids ( $F_1$ ) of common sunflower. Flowering and overblowing in flower heads on individual plots were progressing fastest in 1998. The lower the plant density and fertilization levels, the earlier the flower heads bloomed. Capitula of hybrids were on average 1-3 cm bigger in diameter in comparison to the open pollinated cultivar, thus they were also characterised by a bigger number of tubular flowers. The most uniform flowering process was observed in hybrid 'Coril'. Sunflower cv. 'Wielkopolski' typically had the lowest number of ligulate and tubular flowers. It bloomed earliest, but this process lasted the longest in this cultivar. Tubular flowers were most numerous in 1998 and the number of ligulate flowers was highest in 2001. In that season single capitula bloomed the earliest, but this process lasted longest. Most frequently cv. 'Wielkopolski' was least uniform in terms of both these statistical characteristics. The biggest uniformity was found for hybrid 'Coril'. The numbers of ligulate and tubular flowers were not very uniform and their heritability was low.

**KEY WORDS:** sunflower, cultivars, flowers, flower heads, flowering rate

INTRODUCTION

In terms of their utilization common sunflower (*Helianthus annuus* L.) is divided into ornamental, silage, confection and oil-bearing forms. These include older open pollinated cultivars and interline hybrids, generated in the last 50 years as a result of crossing selected inbred lines. Among the above mentioned forms the biggest role is played by oil-bearing sunflower. It is one of the four most commonly grown oil crops worldwide (MUŚNICKI 1999).

It is generally assumed that  $F_1$  hybrids exhibit a lower variability of plant habit characters than open pollinated hybrids (KŁOCZOWSKI 1967, FICK and SWALLERS 1972, PIRANI 1980, VRANCEANU et AL. 1987, ŁUCZKIEWICZ 1993, MUŚNICKI and TOBOŁA 1996, MARUTHI et AL. 1998). However, KŁOCZOWSKI (1975) stated that in case of a variable Polish climate hybrids, usually grown in a warmer and dry climate of southern Europe, may be less uniform and persistent in yielding than open pollinated cultivars.

Oil-bearing sunflower has been an object of hundreds of experiments. However, most of them investigated the effect of cultivation system on the yield of its achenes and their oil content (e.g. TOBOŁA et AL. 1991, 1993, AHMAD et AL. 1992, VILLALOBOS et AL. 1994). In

contrast, there is a very limited number of typically botanical studies concerning the rate and uniformity of capitulum flowering on plots or flowering rate and the number of florets in individual capitula (HERNANDEZ and PALMER 1988, PALMER and HERNANDEZ 1988, MARIN 1992, KHAN et AL. 1999). Practically there are no comparative studies analysing these characters between open pollinated cultivars and interline hybrids.

The aim of this study was either to confirm or refute the hypothesis on a bigger uniformity of  $F_1$  hybrids based on the analysis of flowering rates of capitula and individual florets, as well as their number. Moreover, the effect of environmental and cultivation factors on these processes was followed and their variability and heritability were shown.

METHODS

Capitulum flowering rates were investigated on plots in the years 1997-1999 at the Przybroda Experimental Station of the Poznań University of Life Sciences. Factors modifying the variation in the development rate of flower heads were different doses of nitrogen fertilizer (60 and 120 kg N/ha) and different plant density rates (50, 75 and 100 thousand/ha). In the years of observations

agricultural conditions of the experiment changed, first of all in terms of weather conditions. They were described in the previous paper (KLUZA-WIELOCH and MUŚNICKI 2003). In the years 1999-2003, at the Garden of the Department of Botany, the Poznań University of Life Sciences, investigations were conducted on the development rate and the number of florets in capitula. In this case the only variable factor comprised weather conditions. Respective data were collected from the meteorological station at Ławica.

The object of the analysis comprised a Polish open pollinated cultivar 'Wielkopolski', with which two interline hybrids ( $F_1$ ) of common sunflower were compared, i.e. a French one, 'Frankasol', and an American cv. 'Coril'. Capitulum flowering rates on plots were analysed on 50 specimens of each of the 36 combinations of replicates. These analyses were performed twice a week. The number of florets and their development rates in flower heads were investigated on 30 specimens of each cultivar, apart from the first year of the study, when a smaller sample was analysed. In the last years of the experiment it was performed on two cultivars, since an interline hybrid 'Frankasol' was removed from the National Register of Varieties COBORU and it was not possible to obtain its seeds in the  $F_1$  generation.

The analysis of flowering and overblowing rates of capitula consisted in the first stage in counting of flowering specimens on the plot, while in the second stage - in counting those still flowering and overblown. These investigations were conducted from the day when the first tubular flowers opened in a single flower head, to the moment when all these organs developed in the last capitulum. Each time the ratio of flowering flower heads to budding flower heads and then that of flowering to overblown ones were calculated. The collected data were used to calculate regression equations, based on which curves of blooming and overblowing were plotted for examined sunflowers.

Flowering rate of a single flower head was observed on the daily basis. This consisted in the recording of dates and calculation of days of the flowering phase, registering its beginning, full bloom and completion. Moreover, blooming rates of ligulate and tubular flowers were also observed every day. The aim of this procedure was to determine the actual number of days of development for these organs in a given capitulum. The moment, when the biggest percentage of these flowers burst into blossom, was also determined. Moreover, developing ligulate and tubular flowers in the capitulum were also counted, by removing them from flower heads.

The analysis of variation in the number of florets was characterised, following the recommendation by KALA (1996), using the standard deviation and the coefficient of variation. Varietal variation was the basis for the determination of heritability ( $h^2$ ) in the general sense according to the method proposed by PŁOCHIŃSKI (1968) as well as BOS and CALIGARI (1995).

## RESULTS

Flowering and overblowing rates of flower heads on plots were dependent on environmental conditions, plant density and different types of cultivars. Only fertilization had no significant effect on these processes. The course of flowering was characterised using graphs based on equations of regression curves (Fig. 1).

In 1997 the first capitula of cv. 'Wielkopolski' burst into blossom the fastest (9.07), while flower heads of hybrid 'Coril' started to develop the latest (14.07). However, this was this cultivar in which the flowering phase lasted the shortest. In the following season also this cultivar bloomed the earliest (1.07) and both hybrids started to develop only 10 days later. This phase in hybrid 'Frankasol' ended the latest. In the last year of the study this process was similar. Hybrids started to flower 5-6

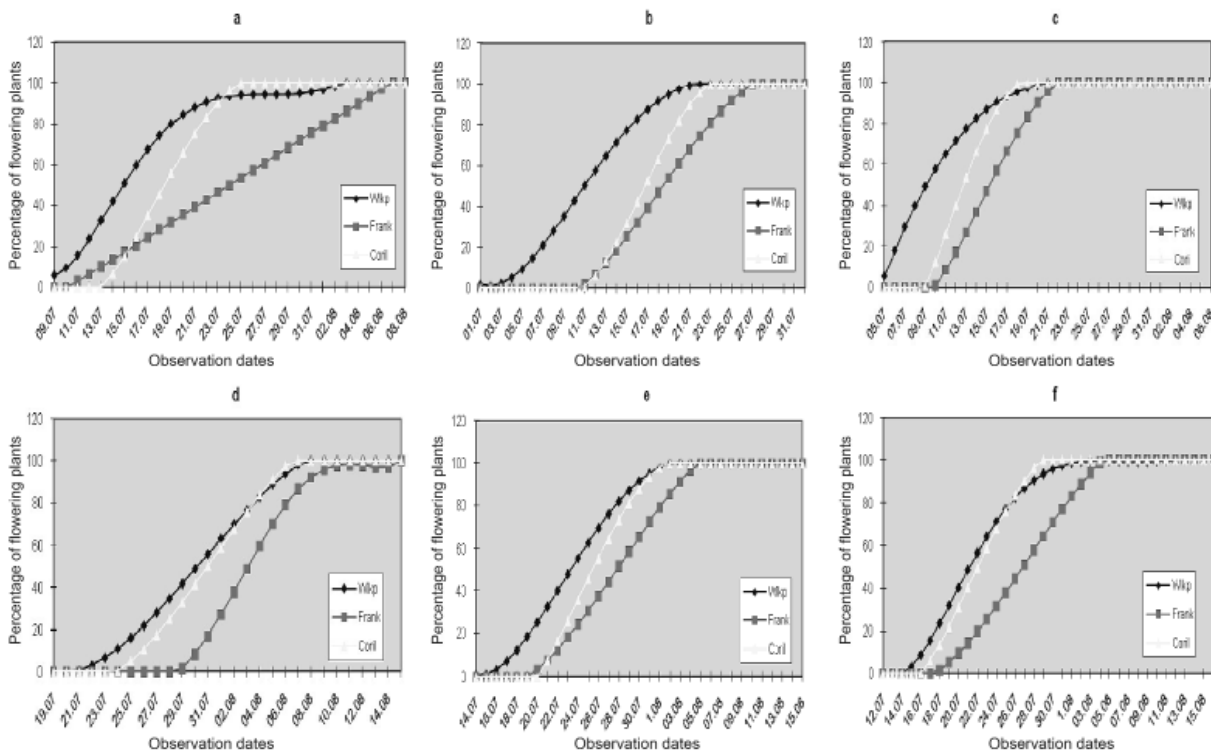


FIG. 1. Blooming and overblowing rates in observed cultivars in the years: a, d - 1997, b, e - 1998, c, f - 1999

days after cv. 'Wielkopolski', which started to open its capitula on 5.07. Again all flower heads bloomed in the shortest time in hybrid 'Coril'. During the three years of observations this hybrid was characterised by the most uniform development of capitula in all specimens. Flower heads of sunflower cv. 'Wielkopolski' always burst into blossom as the first. This was irrespective of the level of nitrogen fertilization and also to a certain degree on plant density, since flowering specimens appeared simultaneously on all plots sown with this cultivar; however, the biggest number of capitula developed at the minimum plant density. Every year flower heads of hybrid 'Frankasol' on plots with the highest plant density burst into blossom the latest.

The first overblown capitula in 1997 were observed in the open pollinated cultivar (21.07), while in hybrid 'Coril' they appeared only three days later. All flower heads ended their development the fastest in this hybrid (7.08). This phase lasted the longest in the other hybrid. In the following season of the study also sunflower cv. 'Wielkopolski' as the first entered the overblowing process (14.07). In both hybrids such capitula appeared only a week later. However, the end of flowering in the open pollinated cultivar occurred at the same time as in hybrid 'Coril'. Again overblowing of flower heads in hybrid 'Frankasol' took the longest. In the last year of the observations, similarly as in the previous years, also this cultivar initiated the overblowing process (15.07), but the first capitula of hybrid 'Coril' which reached this phase of development appeared already one day later. This hybrid ended its overblowing process the earliest and in this season it lasted the longest in the open pollinated cultivar.

When investigating in the year 2000 the development rate of individual capitula it was observed that the first flower head (in hybrid 'Coril') burst into blossom on 16.07, while the last (in cv. 'Wielkopolski') developed to 29.08. This process was most uniform in hybrid 'Frankasol', in which it lasted 24 days, with its peak (when this phase was reached by over 50% specimens) occurring between 1.08 and 13.08. The biggest time span was found for blooming of cv. 'Wielkopolski'. It lasted for 38 days, while flowers of an interline hybrid 'Coril' developed for 34 days. In that year the turn of July and August was very wet, which considerably extended flowering. In the next year this process began earlier, although it was even more extended in time and lasted from 5.07 (sunflower cv. 'Wielkopolski') to 21.08 (hybrid 'Frankasol'). This time each of analysed cultivars was characterised by a similar length of the flowering phase. It was longest in hybrid 'Frankasol', i.e. 39 days. Flowers of cv. 'Wielkopolski' developed, analogously as in the previous year, for 38 days, while hybrid 'Coril' bloomed the shortest (35 days). In that year rainfall was even more frequent than in the previous year, with intervals of only 3-4 days. In 2002 specimens of cv. 'Wielkopolski' started flowering as the first (8.07), while in hybrid 'Coril' it occurred one day later. The last specimen of the Polish sunflower cultivar ended flowering on 17.08. In that year this process lasted as long as 41 days. This could have been caused by high total precipitation in the first half of August. In turn, in the hybrid flowering lasted for only 27 days, but it began at the beginning of August. In the last year of the study the beginning of flowering in cv. 'Wielkopolski' was as early as 28.06, while in the  $F_1$  hybrid sunflower it was a day later, since

June of that month was exceptionally dry and warm. The last capitula of the Polish cultivar ended flowering on 22.07, while those of the hybrid – the next day. In both sunflowers it lasted short, for only 25 days (Table 1).

Such as extended time span in flowering time, together with the fact that every year different cultivars initiated and ended this process as the first, may be explained only by the course of weather conditions, since in each year of observations a spring drought was recorded at the turn of April and May. Thus, at the expected emergence date for sunflowers only approx. 2% seedlings emerged. Their development preceded that of the other specimens.

In 2000 full blooming lasted from the last days of July to the beginning of the second decade of August. In the analysed cultivars it occurred at an almost identical time, on average being 13.3 days. However, in the following season it occurred earlier and it was shorter in all sunflowers, since it lasted for 11.7 days. It took place much earlier, i.e. in the third decade of July, in the Polish sunflower, while it occurred similarly in hybrids, at the end of July and the beginning of August. In the third year of observations it lasted on average 10.5 days. In both cultivars it occurred similarly in the second and third decade of July. In the last year of the study full blooming started the earliest. It occurred in the first and second decade of July and lasted on average 12.5 days (Table 1). Irrespective of the cultivar, 1-6 whorls of tubular flowers developed every day. It was observed that their number increased in case of warm and dry weather conditions.

Bursting into blossom in case of ligulate and tubular flowers reflected the actual number of days of their development in a given flower head. The whole process consisted first of the blooming of ligulate flowers, followed by blooming of tubular flowers. The former, located on the margins, developed in the successive years of the study on average for 3.3, 3.5, 2.6 and 3.3 days, respectively. In the observed cultivars the duration of their blooming was usually the shortest in sunflower cv. 'Wielkopolski'. Their development was most variable in hybrid 'Coril'. In the years of observations blooming of these flowers lasted from one to five days (Table 2). Both these extreme values were recorded only in the last two years and solely in single specimens. The two-day cycle of their development was characteristic first of all of cv. 'Wielkopolski', while in hybrid 'Coril' it did not occur in 2001, although a year earlier it was found very often. In turn, in hybrid 'Frankasol' it was observed once among the 60 tested specimens. In the open pollinated cultivar it was found that after the whole ring of ligulate flowers developed there was a one-day interval before the development of tubular flowers, irrespective of the fact whether the blooming of the former lasted two, three or four days.

Tubular flowers frequently opened while ligulate flowers were still developing. In the years of the study it was found in approx. 6%, 12%, 43% and as many as 75% cases even as early as the second day of development of ray flowers. Such a phenomenon was observed most frequently in cv. 'Wielkopolski', while it was rarest in hybrid 'Frankasol'. In 2003 it was recorded in hybrid 'Coril' that both types of flowers opened even on the same day. It was also observed that flowering time of ligulate flowers did not concur with the development of tubular flowers. It occurred much more frequently

TABLE 1. Flowering rates of individual capitula

Cultivar	Beginning of flowering				Full blooming				End of flowering				Number of days			
	2000	2001	2002	2003	2000	2001	2002	2003	2000	2001	2002	2003	2000	2001	2002	2003
'Wielkopolski'	23.07	5.07	8.07	28.06	30.07-13.08	19-30.07	13-22.07	5-17.07	29.08	11.08	17.08	22.07	38	38	41	25
'Frankasol'	27.07	14.07	-	-	1-13.08	26.07-6.08	-	-	19.08	21.08	-	-	24	39	-	-
'Corril'	16.07	15.07	9.07	29.06	29.07-9.08	25.07-4.08	14-24.07	7-18.07	18.08	18.08	4.08	23.07	34	35	27	25

TABLE 2. Development rate of ligulate flowers

Cultivar	Mean number of days			Range		
	2000	2001	2002	2000	2001	2002
'Wielkopolski'	3.4	3.2	2.5	2-4	2-4	1-4
'Frankasol'	3.6	3.6	-	3-4	2-4	-
'Corril'	3	3.7	2.6	2-4	3-4	1-4

TABLE 3. Development rate of tubular flowers

Cultivar	Mean number of days			Range			Day of maximum development rozwoju						Percentage			
	1999	2000	2001	2002	2003	2000	1999	2000	2001	2002	2003	1999	2000	2001	2002	2003
'Wielkopolski'	9.5	12.9	10.3	9.6	11.5	7-14	2	3	4	3	4	15.1	14.6	14.5	16.2	13.7
'Frankasol'	9.5	12	11	-	-	7-13	2	3	3	-	-	15.5	16.4	14.2	-	-
'Corril'	9.0	10.5	9.7	10.5	9.3	8-12	3	4	4	3	5	21.0	17.8	18.4	17.5	17.1

in 2000, when it was reported in 44% specimens of cv. 'Wielkopolski' and 28% in cv. 'Coril'. In hybrid 'Frankasol' every year the development of the whorls of ligulate flowers concurred with the flowering of tubular flowers.

Opening of tubular flowers in 1999 lasted on average 9.3 days. It was shortest in comparison to the following years of observations, since in that year at the turn of July and August more than 15 warm and dry days were recorded. Flowers bloomed the fastest in hybrid 'Coril'. In the successive season the course of flowering was considerably extended and it was on average 11.8 days in all sunflowers. Still these flowers developed the shortest in hybrid 'Coril', while they flowered the longest in cv. 'Wielkopolski'. The duration of this process was most extended in this cultivar (9-19 days). In 2001 the development of these organs lasted shorter than in the previous year, being on average 10.3 days. Again hybrid 'Coril' bloomed the shortest, while in that year flowers opened the longest in cv. 'Frankasol'. In the last two years of investigations tubular flowers bloomed on average 10.4 days. In 2002 it lasted shorter in the Polish cultivar, while in the next season – in the hybrid (Table 3).

In 1999 in cv. 'Wielkopolski' and 'Frankasol' the biggest number of tubular flowers burst in blossom on the second day of capitulum development. In an interline hybrid 'Coril' the biggest number of these organs in all the years of the investigations, constituting as much as 21% total number of flowers, opened on the third day. In the following season in cv. 'Wielkopolski' and 'Frankasol' the intensity of development of tubular flowers was also manifested on the third day, while in the fourth day of the process the biggest number of these organs opened in hybrid 'Coril'. It was analogous in the successive year. Then also on the fourth day the biggest number of these flowers developed in sunflower cv. 'Wielkopolski'. In contrast, the biggest number of flowers in hybrid 'Frankasol' appeared on the third day of development. In 2002 in both cultivars the biggest number of florets developed on the third day and in the last season the biggest number was recorded in the Polish sunflower cultivar on the fourth day, while in the  $F_1$  hybrid it was on the fifth day (Table 3).

The number of ligulate flowers always significantly differentiated cultivars. In 2000 their biggest number developed, amounting to a mean of 52 flowers in each observed capitulum. In turn, in the following season in all sunflowers on average only 40 these organs bloomed. In the successive year on average 44 developed, while in the last season it was only 36.5. Always the biggest number of ligulate flowers bloomed in an interline hybrid 'Frankasol' (max. 67), while the lowest number was recorded in cv. 'Wielkopolski' (17). The mean number of ligulate flowers in analysed cultivars in the years of the experiments ranged from 33 to 56 (Table 4). Every year in all sunflowers the biggest number of ligulate flowers opened on the second day of flowering.

The number of tubular flowers in capitula for all sunflowers tested during the years of the observations was on average 1360 in the flower head and ranged from 751 to 1800. This character significantly differentiated analysed cultivars. In the first year of observations the biggest number developed in cv. 'Wielkopolski', while the lowest number appeared at that time in hybrid 'Frankasol'. In turn, the situation was opposite in the next season. In 2001 a considerable reduction was recorded in terms of the number of flowers in the capitulum, with

extreme values in all cultivars also being considerably lower. This was also manifested in the much smaller diameters of capitula, since both these characters were correlated. Similarly as in the previous year, the lowest number of these organs bloomed in cv. 'Wielkopolski', while the highest number was found in hybrid 'Coril'. This trend was similar in the two successive years of observations (Table 5). The lowest and at the same time the highest extreme values for these flowers were always recorded in cv. 'Wielkopolski', amounting to 116 in the fourth year of observations and 2673 in the first year. The number of flowers which burst into blossom on the first day of flowering in the years of the study ranged from 1 to 166. The maximum number of developed flowers in the capitulum for one day was 351.

Both characteristics of variation in the number of ligulate and tubular flowers, except for the year 2001, were usually the highest in the open pollinated sunflower cultivar, while they were the lowest in hybrid 'Coril'. Only in the last year of the study the  $F_1$  hybrid was characterised by the highest value of standard deviation. In turn, in 2001 hybrid 'Frankasol' turned out to be most variable, while 'Coril' again proved to be the most uniform (Tables 4-5). For all cultivars relatively high values were recorded for the coefficient of variation. Heritability of the number of ligulate and tubular flowers was low, amounting to 8.99% and 11.7%, respectively.

## DISCUSSION

Tubular flowers in capitula of plants from family *Asteraceae* are placed alternately in whorls. However, their pattern is spiral, as it may be seen more clearly for the setting achenes devoid of the perianth. HERNANDEZ and PALMER (1988) created a mathematical model for the arrangement of these organs in the capitulum. The same authors (PALMER and HERNANDEZ 1988) studied also the variation in the number of florets and spirals on which they were placed. They stated that the number of these sinistrorse and dextrorse rows corresponded to the Fibonacci sequence, i.e. it was 21, 34, 55, 89 and 144. Most frequently they were arranged in 55 or 89 such spirals. Their number in the flower head was on average 60.6, with a maximum of 24.5 florets being developed on them (KHAN et AL. 1999). When creating his method to count florets and achenes in the capitulum based on long and short spirals, MARIN (1992) observed that their number ranged from 60 to 3080. This method was burdened with a very small error, since for comparison all fruits were counted manually. USTINOVA (1964) stated that florets developed in flower heads in 26 rings. Fabry (OLEJNINY 1992) recorded that 1-4 whorls of tubular flowers bloomed daily, while GONET (1976) mentioned 2-3 rows.

TOBOŁA and MUŚNICKI (1997) showed that open pollinated cultivars, including also a sunflower cv. 'Wielkopolski', burst into blossom by 5.5-7.5 days earlier than interline hybrids, which was also confirmed in this study. Information was found in available literature that flowering of capitula lasted for 6-10 (BRZOSTOWSKI 1950), 8-12 (ANDRIUCHOV et AL. 1975), 8-10 days, respectively (OLEJNINY 1992), while all specimens of a given cultivar developed usually for 15-20 days. In this study it was observed that this period was much longer. ŁUCZKIEWICZ (1992) observed that hybrids tested by



him bloomed on average for nine and 11 days, depending on the year of observations. In his opinion the length of this period depended on the weather and capitulum diameter, which was most frequently connected with the number of tubular flowers they contained. The same was observed in this study. This was also confirmed by GONET (1976), who stated that at advantageous weather conditions flowering lasted for 7-10, while during cool and rainy weather as long as 14 days, respectively. According to USTINOWA (1964), under advantageous conditions it took 13 days. Ligulate flowers opened for two days. The biggest number of tubular flowers burst into blossom between the fourth and eighth day, which was not confirmed in this study.

Vranceanu (FLOAREA-SOARELUI 1974) and Fabry (OLEJNINY 1992) reported that 30-70 ligulate flowers developed in capitula, while ANDRIUCHOV et AL. (1975) observed their number to be 60-92. Within this study their lowest number was much smaller (17). Since they are sterile, their only function may be to attract insects (OLEJNINY 1992).

BRZOSTOWSKI (1950) reported that in flower heads there may be 600-1200 tubular flowers. Other sources defined their number to be 500-2000 (ANDRIUCHOV et AL. 1975), 800-2000 (HUGGER 1989), 500-3000 (OLEJNINY 1992), 1200-4000, while in extreme cases in single growing sunflowers there may be as many as 8000 (PODSOLNEČNIK 1975). The latter number was also confirmed by Skoric and Vrebalov (SUNCOKRET 1988). According to those authors, in most cases 600-1200 these organs may be found and rarely there are 3000-4000. In a study by HADISOESILO and FURGALA (1986) compared cultivars contained on average from 1386 to 2200 tubular flowers. CADEAC (1988) stated that one year 993 flowers developed in a flower head, while in another it was 1592. ŁUCZKIEWICZ (1973) defined that in open pollinated cultivars there were 508-2120 flowers. In another study ŁUCZKIEWICZ (1992) stated that capitula of cv. 'Czernianka' contained, depending on the year of observations, on average 900-1000 these organs. The presented data collected within this study showed an even smaller number of these flowers in the flower head.

In an earlier publication (KLUZA-WIELOCH 2005) the author of this study showed that capitula of hybrids had diameters on average by 1-3 cm bigger than the open pollinated cultivar. For this reason in this study it was observed that they were characterised by a bigger number of tubular flowers. SARANGA et AL. (1996) stated that the number of tubular flowers was significantly lower in smaller than it was in large flower heads, but it was not affected by manipulations on plants, i.e. removal of some leaves or flowers from the margin zone. CADEAC (1988) observed a relatively high correlation between the number of flowers and the duration of flowering, as well as the diameter of the stem and the flower head.

FEDEROWSKA (1972) stated that low temperature and precipitation extended the flowering process. The same finding was reported in this study. SADRAS et AL. (1993) observed that at water deficit the number of flowers in still closed capitula was reduced, but it did not have an effect on their size. VILLALOBOS et AL. (1994) stated that the number of flowers in some cultivars decreased with an increase in plant density, while in others it always remained constant. STEER and HOCKING (1983) observed that their number was lower at a low nitrogen supply. Application of nitrogen fertilizer resulted in

its increase, while the size of the capitulum decreased (CADEAC 1988). Moderate doses of sulfur had a positive effect on the number of florets in the flower head (HOCKING et AL. 1988).

The number of tubular flowers in cv. Czernianka was inheritable to a high degree, which was not confirmed by experiments conducted on the tested cultivars. Similarly as in this study, it also exhibited a very high variability (ŁUCZKIEWICZ 1973, 1992). SECEROV-FISER et AL. (1995, 1997) studied genotypic variation in the number of ligulate flowers in crosses of ornamental sunflower hybrids with a wild species *Helianthus argophyllus* L. Characters of the latter dominated in the inheritance of the number of flowers.

## CONCLUSIONS

1. Studies on flowering rate on plots and flowering rates of florets in individual flower heads showed that not all F1 hybrids are better adapted to conditions of Polish climate or more uniform than open pollinated cultivars. This seems to have been confirmed also by other studies conducted by COBORU, since hybrid 'Frankasol' was eliminated from the National Register of Varieties.

2. The decisive effect on a lack of uniformity of the flowering phase for all sunflower cultivars was found for the spring drought, occurring at the turn of April and May, i.e. optimal sowing time. It resulted in delays in the emergence dates expected for sunflower, with few seeds germinating at that time, while specimens grown from these seedlings later exceeded others in their development.

3. The number of developing tubular flowers was higher at warm and dry weather conditions. Rainy weather considerably extended the flowering process. Capitula of hybrids had on average diameters by 1-3 cm bigger than the open pollinated cultivar and thus they were characterised by a higher number of tubular flowers.

4. Heritability of the number of both types of flowers in the capitulum was low, as they were modified first of all by weather conditions. In turn, the coefficient of variation, particularly the number of tubular flowers, took high values.

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