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INFLUENCE OF SOWING TIME ON MORPHOLOGICAL CHARACTERISTICS OF SUNFLOWER PLANTS

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Abstract

Morphological characteristics of six sunflower hybrids with different precocity were assessed to notice the effect of sowing time (ST). ST was set taking into account the Celsius degrees at the soil depth of 7 cm at 7 a.m.: ST1 at 5°C, ST2 at 7°C and ST3 at 9°C. The research was performed in the field experiments in Tulcea County in 2021 under rainfed conditions. The number of leaves per plant increased upon the sowing delay from 27.7 at ST1 to 30.9 at ST3, while the number of days from sowing to flowering decreased from 62.7 at ST1 to 48.5 at ST3. Stem diameter had the highest value at ST2. The average plant height for the five hybrids increased from ST1 to ST3. ST2 provide the highest head diameter (19.8 cm) followed by ST1 (19.3 cm) and ST3 (18.5 cm).

Key words*: sowing time, morphological characteristics, sunflower plants.*

INTRODUCTION

Sunflower (*Helianthus annuus* L.) is the main oil crop in Romania being cultivated on 1.11 million ha in 2021 (retrieved from: https://www.https://insse.ro/cms/sites/default/files/com_presa/com_pdf/prod_veg_r21.pdf).
In European Union, Romania it is the largest sunflower producer followed by Bulgaria and France (FAOSTAT database).
One of the most important factors that influence morphological characteristics and yield for many crops is sowing time.
For sunflower an early sowing can avoid the dry atmosphere and water deficiency during flowering and seed filling stages but on the other hand the emergence can be extended and different weeds (such as *Poygonum convolvulus* L., *Sinapis arvenis* L., *Chenopodium album*) can cause problems (Vranceanu, 1974).
When planting is delayed soil moisture gained during winter season can be inefficient valued due to evapotranspiration, the crop did not have enough time to fill achenes (Killi & Altunbay, 2005) and the yield decreased owing to high temperature during flowering (Ahmed et al., 2020).
It was found that stem diameter, plant height and number of days from sowing to flowering increased when the sowing was performed earlier (Ozturk et al., 2017; Demir, 2019) or later (Birck et al., 2016; Mijic et al., 2020). Balalic et al. (2016) turned out that head diameter at maturity is influenced mostly by sowing date and less by the year and hybrid. It is expected that the number of leaves will be higher at an early sowing because their development stage is completed in long-day conditions (Vranceanu, 1974). In the last years there were studies which confirm this fact (Aliloo, 2018; Morsy et al., 2022).
Morphological characteristics of sunflower can also be influenced by the plant density, hybrid (Kalenska et al., 2020), drought tolerance indices (Ghaffari et al., 2012), irrigation (Shahin et al., 2018) or fertilization (Labao et al., 2017; Coelho et al., 2022).
The importance of these studies comes from providing farmers with up-to-date information specific for their area.
In the past we could have considered a proper period for sowing by looking at the calendar but then the temperatures did not vary like nowadays. This study aims to find determine the influence of sowing time consider the

temperature factor and not calendar day on the main morphological characteristics of six sunflower hybrids in the climatic conditions specific for Dobrogea area in South-East Romania.

MATERIALS AND METHODS

Plant material and field trials. The experiment was carried out in the field experiments in the South of Tulcea county (Beidaud - 44º42' N latitude and 28º34' E longitude) during 2021 on a chernozem argiloiluvial soil under rainfed conditions. Two hybrids included in the study were certified (P64LE99 and FD15E27) and four were in the process of certification (DS001, DS002, DS003 and HS7083). They were sown at three different sowing time (ST) taking into account the Celsius degrees at the soil depth of 7 cm at 7 a.m.: ST1 at 5ºC (1st April), ST2 at 7ºC (17th April) and ST3 at 9ºC (23rd April). Sowing density was 55,000 germinable seeds ha-[1]. The space between rows was 70 cm. The plot size was 210 m2 (4.2 m x 50 m). The previous crop was winter barley. The weeds were controlled with herbicide Pantera 40 EC (40 g/l quizalofop-P-tefuryl) 0.8 L/ha applied at 2-4 leaves stage and a hoeing before the emergence of inflorescence.

Determinations. The number of days from sowing to flowering was determined when 75% of the plot was flowered. The number of leaves per plant was determined at the flowering stage. Height of plants, stem diameter (at 1 m above the ground) and head diameter were assessed at maturity. All observations were performed for 10 plants in four replications.

Weather conditions. At Beidaud area during the sunflower growing period (April-August), the mean temperature has increased continuous from 9ºC (April) to 24.4ºC (June) and decreased slightly to 23.6ºC in August. The sum of rainfall for the same period was 400.8 mm sufficient for covering the sunflower water requirements for a good development which is over 400 mm (Pejic et al., 2009). Rainfall was irregular during the months of sunflower vegetative period, the rainiest month was June (147.7 mm) and the driest was August (32.2 mm) (Figure 1).

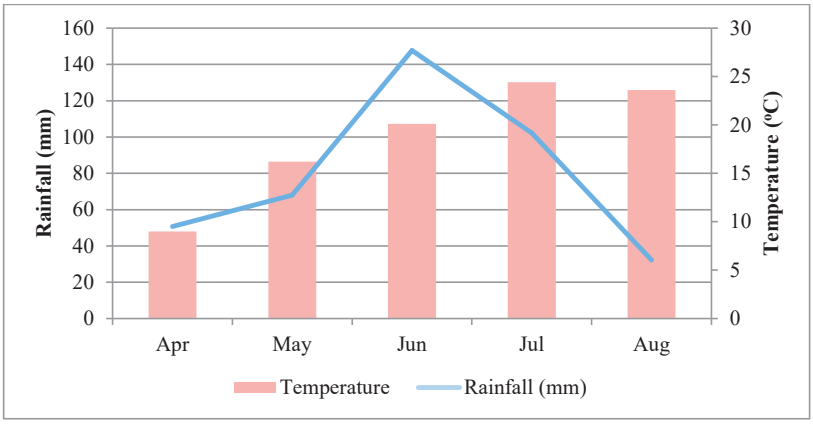

Figure 1. Average temperature (°C) and monthly distribution of rainfall (mm) during the sunflower growing season

Statistical analysis. Collected data were statistically analysed by ARM-9 software using Tukey's HSD (Honestly Significant Difference) test ($P< 0.05$).

RESULTS AND DISCUSSIONS

In the present study it is clearly presented that sunflower plants need more days to reach flowering stage when they are sowing at 5ºC compared to those sowed at 7ºC and 9ºC (Table 1). This fact it is attributed to lower temperature that extend the growth period for plants sowed at ST1. With all this, plants from ST1 flowered first. These results are in accordance with those obtained by Ahmed et al. (2020) and Morsy et al. (2022).

Table 1. Number of days from sowing to flowering stage of six sunflower hybrids sowed in three sowing times

Sowing time	Hybrid						Average
	P64LE99	DS001	DS002	DS003	FD15E27	HS7083	
ST1	61	63	64	66	61	61	62.7
ST2	50	51	53	55	51	50	51.7
ST3	49	49	49	51	46	47	48.5
Average	53.3	54.3	55.3	57.3	52.7	52.7	

The lowest value was for DS001 at ST1 (194.08 cm) and the highest value was for DS002 at ST3 (226.37 cm). Between hybrids at ST1 there were no significant differences. With one exception (P64LE99) all hybrids followed the same trendline: the height continued to raise upon sowing delay (Table 2). This is in contrast with observations made by Demir (2019) and Ozturk et al (2017). Mean rates of ST were higher than those reported by Birck et al. (2016) - 170.2 cm, Capone et al. (2011) - 98.9 cm or by Allam et al. (2003) - 140.8 cm. The plant height varies depending of the ability of hybrids to adapt to environmental conditions. Even if the plant height was great there were no lodging symptoms.

Table 2. Plant height (cm) of six sunflower hybrids sowed in three sowing times

Hybrid	ST1	ST2	ST3
P64LE99	211.58-	209.92bc	215.03bc
DS001	194.08-	203.94cd	211.98bc
DS002	212.03-	226.37a	226.78a
DS003	208.4-	216.7b	218.13ab
FD15E27	202.13-	205.67cd	207.58c
HS7083	197.55-	198.02d	204.85c
Tukey's HSD P< 0.05	21.21	7.76	10.27

Different letters in columns differ at significant difference according to Tukey's HSD test; P< 0.05; "-": no significant difference.

Number of leaves/plant was influenced by both hybrid and ST. All hybrids generate the most leaves when were sowed at 9°C and generate less when were sowed at 5°C. Hybrid FD15E27 had the most leaves/plant at all ST while DS002 had the less (Table 3).

Table 3. Number of leaves/plant of six sunflower hybrids sowed in three sowing times

Hybrid	ST1	ST2	ST3
P64LE99	28.63b	27.73c	30.40b
DS001	25.75c	29.85ab	32.15a
DS002	25.88c	26.45d	28.80c
DS003	26.60c	27.13cd	29.83bc
FD15E27	31.55a	30.78a	32.20a
HS7083	29.10b	29.05b	32.20a
Tukey's HSD P< 0.05	1.767	1.160	1.514

Different letters in columns differ at significant difference according to Tukey's HSD test; P< 0.05; "-": no significant difference.

The hybrid with the highest head diameter correlated with ST was DS003 at ST2 - 20.88 cm and the smallest head diameter was for DS002 at ST1 (Table 4). Mijic et al. (2020) tested 22 sunflower hybrids and concluded that head diameter ranged greatly from 19.2 cm to 30 cm.

Head diameter as well as plant height and 100-seed weight at phenotypic and genotypic levels indicated that selection for any of them is effective for improving the other ones especially seed weight plant^{-1} (Ahmed et al., 2020).

Table 4. Head diameter (cm) of six sunflower hybrids sowed in three sowing times

Hybrid	ST1	ST2	ST3
P64LE99	16.8bc	19.07ab	18.01ab
DS001	18.67ab	19.29ab	19a
DS002	15.75c	17.58b	16.47b
DS003	18.25ab	20.88a	19.76a
FD15E27	18.ab	19.55ab	18.58ab
HS7083	19.31a	22.16a	18.45ab
Tukey's HSD P< 0.05	2.41	3.21	2.22

Different letters in columns differ at significant difference according to Tukey's HSD test; P< 0.05; "-": no significant difference.

For stem diameter there were no statistically differences. With the exception of FD15E27, all hybrids had the highest value at ST2. In this experiment stem diameter was influenced by the ST but not by hybrid. The results varied from 1.73 cm for DS001 at ST1 and 2.33 for HS7083 at ST2 (Table 5).

Table 5. Stem diameter (cm) of six sunflower hybrids sowed in three sowing times

Hybrid	ST1	ST2	ST3
P64LE99	1.91-	2.14-	2.09-
DS001	1.73-	2.1-	2.07-
DS002	1.80-	2.21-	1.98-
DS003	2.05-	2.18-	1.99-
FD15E27	2.2-	2.04-	2.17-
HS7083	1.98-	2.33-	2.26-
Tukey's HSD P< 0.05	0.7	0.29	0.34

Different letters in columns differ at significant difference according to Tukey's HSD test; P< 0.05; "-": no significant difference.

Number of leaves/plant increased continuous from ST1 to ST2 and to ST3 as with plant height which makes us believe that there is direct relation between these two morphological characters. The results are opposite with those obtained by Morsy et al. (2022) where the number of leaves were highest in the first sowing dates. Ahmed et al. (2015) obtained the highest number of leaves/plant at the middle sowing date.

At ST2, the average head diameter was 19.75 cm and was statistically higher than the first ST (17.91 cm) and the last ST (18.38 cm). It was demonstrated that head diameter is strongly influenced by irrigation level from 11.1 cm at $ET_{75\%}$ to 17.6 $ET_{100\%}$ (Shanin et al., 2018). Balalić et al. (2016) point out that head diameter affects the number of flowers and grains per head, which directly affects the grain yield per plant. In the study carry out by Demir et al. (2019) when five sowing dates were evaluated head diameter decreased continuous from the first sowing date to the last one.

Stem diameter had the highest value at ST2 fallowed by ST3 and ST1 as in the case of head dimeter (Table 6). This is in accordance with the results obtained by Allam et al. (2003). The ST average was 2.06 cm which is bigger than that reported by Birck et al. (2016) which was 2.39 cm.

Table 6. Differences between ST for number of leaves/plant, stem diameter (cm) and head diameter (cm)

Sowing time	Plant height (cm)	Number of leaves/plant	Head diameter (cm)	Stem diameter (cm)
ST1	204.29b	27.68b	17.91b	1.94b
ST2	210.1a	28.5ab	19.75a	2.17a
ST3	214.05a	30.92a	18.38b	2.09ab
Tukey's HSD P< 0.05	5.7	2.76	1.12	0.19

Different letters in columns differ at significant difference according to Tukey's HSD test; P< 0.05; "-": no significant difference.

CONCLUSIONS

Morphological characteristics are influenced by hybrid but mostly by sowing time.
Sunflower plants sowed early need more days to reach the flowering stage but even so they flowered first before those sowed later. Plant height and number of leaves/plant increased their value upon sowing delay while head and stem diameter had the highest value in the middle sowing time.
Similar researches have to be repeated at specific periods due climate change in all climatic regions.

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