

INFLUENCE OF ABIOTIC FACTORS ON THE VARIABILITY OF THE SEEDLING–FLOWERING PERIOD IN THE PARENTAL COMPONENTS OF MAIZE HYBRIDS

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Topicality. Maize is a monoecious cross-pollinated plant with a well-defined proterandry, however, some maize samples show persistent proterogyny. A significant manifestation of proterandry and proterogyny tends to negatively affect the pollination quality of ears and the yield of lines during reproduction. Synchronisation of flowering the ear in the female component and the tassel in the male component is essential for the reproduction of sterile analogues of self-pollinated lines and for production of F₁ hybrid seeds. Since the lack of coincidence in flowering dates can cause poor pollination and the formation of ears with incomplete kernel set and further loss of seed yield. **Purpose.** To determine the variability of the seedling – flowering period for female and male inflorescences of parental components in maize hybrids under the influence of abiotic factors. **Materials and Methods.** The research was conducted at the Institute of Grain Crops of NAAS of Ukraine during 2018–2021. In the experiment, 15 parental components of maize hybrids were used: DK216M sterile, DK216SVZM, DK273MV, DK777M, DK777ZMSV, DK680MVZS, DK315M sterile, DK315SVZM, DK239MV, NT 004 sterile, NT 004 fastener, TT005, DK2064M, DK2064SVZM, DK633/325 MV. The flowering date for inflorescences of parental components was recorded at flowering of 50 % of plants on the plot. **Results.** The agrometeorological conditions were quite contrasting over the years of research, which allowed us to comprehensively assess the variability of the seedling-flowering period of female and male inflorescences in the parental components of maize hybrids. We found that the parental components were differently sensitive to environmental changes; the dichogamy of flowering of male and female inflorescences in most maize genotypes has traits of proterandry. Proterogyny was observed in some samples under cool weather conditions with high precipitation. **Conclusions.** We found that abiotic factors affect the variability of the seedling-flowering period for female and male inflorescences in the parental components of maize hybrids, however, in our experiments; the variability of the seedling-flowering period in maize was very low. The obtained results indicate the possibility for reliable seed production of maize hybrids DN Synevyr, DN Svitiaz, DN Halateia, Monika 350 MV, DN Vesta in the Steppe of Ukraine.

Key words: maize, parental components, seedling-flowering period, proterandry, proterogyny, range of variation, coefficient of variation

Introduction. Timing of the main phenological stages of maize growth and development is of great scientific and production importance. The duration of the interstage periods depends on abiotic factors, such as climatic and other growing conditions, plant genotype and its response to these factors. All factors interact with each other, acting in a complex manner on plants [1–3].

According to some researchers, maize is a monoecious cross-pollinated plant with a well-developed proterandry, i.e. the tasseling occurs on average 5–8 days earlier than the silking. However, some maize samples show persistent proterogyny, when the female inflorescence blooms before the tassel [4–6]. This type of flowering occurs under cool weather conditions and short daylight hours. Maize is an anemophilous (wind-pollinated) plant. The duration of

flowering of the male inflorescence (tassel) depends largely on the genotype and weather conditions and is generally about 7 days, with fluctuations from 5 to 15 days. Female inflorescences (ears) are capable of effective pollination only for 6–10 (rarely 12–15) days. In cool weather, the duration of tasseling and the ability of female inflorescences to effectively pollination increases, and in hot weather, it decreases.

Excessive proterandry and proterogyny can negatively affect the quality of pollination of ears and the yield of lines during the propagation. The synchronous flowering of female and male components is important for the propagation of sterile analogues of self-pollinated lines and in obtaining hybrid F₁ seeds.

Mismatching of flowering dates can lead to poor pollination, and the formation of incomplete kernel set and, consequently, a decrease in

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seed yield [3, 7]. It has been established that each day of delay in the appearance of the stigmas (compared to the tassels) results in a 10 % decrease in yield, and the plants will be infertile after a delay of more than ten days [4, 8]. In order to prevent the above-mentioned negative phenomena, it is necessary to examine self-pollinated maize lines at the breeding stages for their susceptibility to proterandry and proterogyny before they are transferred to seed production [9].

Research is aimed at determining the variability of the seedling – flowering period of female and male inflorescences in parental components of maize hybrids under the influence of abiotic factors.

Materials and Methods. In 2018–2021, the research was conducted in the fields of the SE Institute of Grain Crops of NAAS of Ukraine. In the experiment, 15 parental components of maize hybrids were used: DK216M sterile, DK216SVZM, DK273MV, DK777M, DK777ZMSV, DK680MVZS, DK315M sterile, DK315SVZM, DK239MV, NT004 sterile, NT004 maintainer, TT005, DK2064M, DK2064SVZM, DK633/325MV. Statistical processing of the results was carried out according to the method of G. F. Lakin [10].

In 2018, the agrometeorological conditions of the growing season were unstable and unfavourable for maize cultivation: the average daily air temperature was constantly above normal, and the precipitation in the first half of the growing season was significantly below normal. In 2019, at the beginning of the growing season, the average daily air temperature was also higher than the long-term average, but the amount of precipitation exceeded the norm. The first half of the 2020 growing season was cool with sufficient precipitation. The year 2021 was characterised by a cool spring and significant precipitation in the first half of the growing season of maize plants (Table 1).

Therefore, during the research, the agrometeorological conditions were quite contrasting by year, which allows us to comprehensively assess the variability in the interstage period from seedling to flowering of female and male inflorescences in the parental components of maize hybrids. The flowering date of the inflorescences of the parental components of maize was recorded when 50 % of the plants on the plot were in flowering.

Results and Discussion. The duration of the period from seedling to flowering of female

Table 1. Hydrothermal coefficient, 2018–2021

Months / Years	2018	2019	2020	2021
May	0.57	0.87	1.84	1.04
June	0.80	0.43	0.75	2.89

and male inflorescences in self-pollinated lines of fertility restorers during 2018–2021 is given in Table 2. The range of variation in the duration of the period for female and male inflorescences in the parental components is from 4 to 7 days, the coefficients of variation are 3.3–5.9 %, which confirms the influence of weather conditions on this trait.

Different traits are characterised by different coefficients of variation. However, for the same trait, the value of the coefficient of variation (Cv) remains more or less stable and usually does not exceed 50 % in symmetrical distributions. It is considered that the variation is weak if Cv does not exceed 10 %, medium if Cv is 11–25 %, and significant if Cv > 25 % [6, 11]. Thus, a weak variation of this trait in maize was observed in our experiments.

For maize seed production, an essential indicator is the synchronous flowering of female

and male inflorescences. In the self-pollinated lines DK273MV and TT005, there were no deviations in the duration of the periods from seedling to silking and the period from seedling to tasseling, except in 2021 in the TT005 line (-1 day). In 2018–2020, a slight proterandry (-1 day) was observed in the lines DK680MVZS, DK239MV, DK633/325MV. At the same time, in 2021, under the influence of cool and wet weather, these lines showed proterogyny (1–2 days). Our research has established that in 2018–2020, the prevailing part of the studied lines flowered according to the proterandry type, i.e. male inflorescences flower first, followed by female inflorescences with a gap of 1–2 days.

In general, no significant differences in flowering of female and male inflorescences were observed.

Variability in the duration of the period

Table 2. Duration of the period from seedling to flowering of female and male inflorescences in self-pollinated restorer lines, 2018–2021

Self-pollinated line	Inflorescence	Duration of the seedling – flowering period, days				R**	Cv***, %
		2018	2019	2020	2021		
DK273MV	ear	54.0	55.0	52.0	48.0	7.0	5.9
	tassel	54.0	55.0	52.0	48.0	7.0	5.9
	Deviation*	0.0	0.0	0.0	0.0		
DK680MVZS	ear	56.0	57.0	54.0	50.0	7.0	5.7
	tassel	55.0	56.0	53.0	51.0	5.0	4.1
	Deviation *	-1.0	-1.0	-1.0	+1.0		
DK239MV	ear	56.0	57.0	54.0	50.0	7.0	5.7
	tassel	55.0	56.0	53.0	52.0	4.0	3.4
	Deviation *	-1.0	-1.0	-1.0	+2.0		
TT005	ear	57.0	58.0	55.0	52.0	6.0	4.8
	tassel	57.0	58.0	55.0	51.0	7.0	5.6
	Deviation *	0.0	0.0	0.0	-1.0		
DK633/325MV	ear	58.0	59.0	56.0	52.0	7.0	5.5
	tassel	57.0	58.0	55.0	54.0	4.0	3.3
	Deviation *	-1.0	-1.0	-1.0	+2.0		

Notes: Deviation* – deviation of the duration of the seedlings – silking period from the seedlings – tasseling period; R** – range of variation, Cv*** – coefficient of variation.

from seedling to flowering of female and male inflorescences in self-pollinated maintainer lines and their sterile analogues was revealed. The range of variation of the duration of the period from seedling to flowering was within 4–7 days, the coefficient of variation was 3.1–6.0 % (Table 3), which indicates the effect of weather conditions and weak variation of the trait.

The synchronous flowering of the ear of the sterile analogue and the tassel of the sterility maintainer is of great importance in the propagation of sterile analogues of self-pollinated lines. Among the self-pollinated lines, the deviation in the duration of the period from seedling to silking and the period from seedling to tasseling ranged from 0 to 3 days. In the lines DK216M sterile, DK216SVZM, DK777M, DK777ZMSV, NT004 sterile, NT004 maintainer, the deviation was 1–2 days. The smallest difference in the duration of the period of silking the sterile analogue and tasseling the sterility maintainer was observed in DK315M sterile and DK315SVZM, and the largest was in DK2064M and DK2064SVZM. It should be

noted that the deviation in the above-mentioned trait of self-pollinated lines DK2064M and DK2064SVZM was stable during all years of research and amounted 3 days.

During 2018–2021, the duration of the period from seedling to flowering of female and male inflorescences in the parental components of maize hybrids DN Synevyr, DN Svitiaz, DN Halateia, Monika 350 MV and DN Vesta was recorded (Table 4).

During the years of research, the difference in flowering of female and male components of the hybrid DN Synevyr was 1 day, DN Svitiaz – 2 days, DN Halateia – 0–3 days, Monika 350 MV – 0–1 day, DN Vesta – 1 day.

The tassel of male components flowered later than the ears of female components in case of differences in flowering of the parental components of hybrids.

Conclusions. So, we have established that abiotic factors affect the duration of the period from seedling to flowering of female and male inflorescences of parental components of maize hybrids, but the variation of this trait in our expe-

Table 3. Duration of the period from seedling to flowering of female and male inflorescences in self-pollinated maintainer lines and their sterile analogues, 2018–2021

Parental component	Inflorescence	Duration of the seedling – flowering period, days				R**	Cv***, %
		2018	2019	2020	2021		
DK216M (St.)	ear	53.0	54.0	51.0	47.0	7.0	6.0
DK216SVZM	tassel	51.0	52.0	49.0	46.0	6.0	5.3
Deviation *		-2.0	-2.0	-2.0	-1.0		
DK777 M	ear	53.0	54.0	51.0	49.0	5.0	4.3
DK777 ZMSV	tassel	54.0	55.0	52.0	49.0	6.0	5.0
Deviation *		+1.0	+1.0	+1.0	0.0		
DK315M (St.)	ear	55.0	56.0	53.0	49.0	7.0	5.8
DK315SVZM	tassel	55.0	56.0	53.0	51.0	5.0	4.1
Deviation *		0.0	0.0	0.0	+2.0		
NT004 (St.)	ear	56.0	57.0	54.0	51.0	6.0	4.9
NT004 (Mn.)	tassel	55.0	56.0	53.0	49.0	7.0	5.8
Deviation *		-1.0	-1.0	-1.0	-2.0		
DK2064M	ear	56.0	57.0	54.0	53.0	4.0	3.3
DK2064SVZM	tassel	59.0	60.0	57.0	56.0	4.0	3.1
Deviation *		+3.0	+3.0	+3.0	+3.0		

Notes: Deviation* – deviation of the duration of the seedlings – silking period from the seedlings – tasseling period; R** – range of variation, Cv*** – coefficient of variation.

Table 4. Duration of the period from seedling to flowering of female and male inflorescences in parental components of maize hybrids, 2018–2021

Parental component	Inflorescence	Duration of the seedling – flowering period, days				R**	Cv***, %
		2018	2019	2020	2021		
DN Synevyr							
♀ DK216M (St.)	ear	53.0	54.0	51.0	47.0	7.0	6.0
♂ DK273MV	tassel	54.0	55.0	52.0	48.0	7.0	5.9
Deviation *		+1.0	+1.0	+1.0	+1.0		
DN Svitiaz							
♀ DK777M	ear	53.0	54.0	51.0	49.0	5.0	4.3
♂ DK680MVZS	tassel	55.0	56.0	53.0	51.0	5.0	4.1
Deviation *		+2.0	+2.0	+2.0	+2.0		
DN Halateia							
♀ DK315M (St.)	ear	55.0	56.0	53.0	49.0	7.0	5.8
♂ DK239MV	tassel	55.0	56.0	53.0	52.0	4.0	3.4
Deviation *		0.0	0.0	0.0	+3.0		
Monika 350 MV							
♀ NT004 (St.)	ear	56.0	57.0	54.0	51.0	6.0	4.9
♂ TT005	tassel	57.0	58.0	55.0	51.0	7.0	5.6
Deviation *		+1.0	+1.0	+1.0	0.0		
DN Vesta							
♀ DK2064 M	ear	56.0	57.0	54.0	53.0	4.0	3.3
♂ DK633/325MV	tassel	57.0	58.0	55.0	54.0	4.0	3.3
Deviation *		+1.0	+1.0	+1.0	+1.0		

Notes: Deviation* – deviation of the duration of the seedlings – silking period from the seedlings – tasseling period; R** – range of variation, Cv*** – coefficient of variation.

riments can be considered as weak.

The dichogamy of flowering of male and female inflorescences in most maize genotypes has signs of proterandry. In the cool weather

with abundant rainfall in 2021, some samples of maize showed proterogyny. No significant differences in flowering of the ear of the sterile analogue and the tassel of the sterility maintainer were found in the self-pollinated lines studied.

The synchronous flowering of female and male components of maize hybrids DN Synevyr,

DN Svitiaz, DN Halateia, Monika 350 MV and DN Vesta was kept during all years of research.

The results obtained indicate the possibility of sustainable seed production of these maize hybrids in the Steppe zone of Ukraine and prevent such negative phenomena as the incomplete kernel set with a further loss of seed yield.

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Свініцький Л. М. Вплив абіотичних факторів на мінливість періоду “сходи – цвітіння” у батьківських компонентів гібридів кукурудзи. *Зернові культури.* 2023. 7 (1). 60–65.

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Актуальність. Кукурудза – однодомна перехреснозапильна рослина з добре вираженою протерандрією, але, у деяких зразків кукурудзи відмічається стійка протерогінія. Суттєво виражені протерандрія і протерогінія можуть негативно впливати на якість запилення качанів і урожайність ліній при розмноженні. Синхронність цвітіння качана у жіночого і волоті – у чоловічого компонента має важливе значення при розмноженні стерильних аналогів самозапилених ліній та при отриманні насіння гібридів F1. Оскільки не співпадіння цвітіння може призвести до неякісного запилення, та

утворення череззерниці з подальшою втратою урожайності насіння. **Мета дослідження.** Визначити мінливість періоду “сходи – цвітіння” жіночих і чоловічих суцвіть у батьківських компонентів гібридів кукурудзи під впливом абіотичних факторів. **Матеріали і методи дослідження.** Дослідження проводилися в ДУ Інститут зернових культур НААН України протягом 2018–2021 рр. У досліді використовували 15 батьківських компонентів гібридів кукурудзи: ДК216М стерильна, ДК216СВЗМ, ДК273МВ, ДК777М, ДК777МСВ, ДК680МВЗС, ДК315М стерильна, ДК315СВЗМ, ДК239МВ, НТ 004 стерильна, НТ 004 закріплювач, ТТ005, ДК2064М, ДК2064СВЗМ, ДК633/325 МВ. Дата цвітіння суцвіть батьківських компонентів кукурудзи фіксувалась при цвітінні 50 % рослин на ділянці. **Результати.** Під час проведення досліджень агрометеорологічні умови за роками були досить контрастними, що дозволяє всебічно оцінити тривалість міжфазного періоду “сходи – цвітіння” жіночих і чоловічих суцвіть у батьківських компонентів гібридів кукурудзи. Виявлено, що батьківські компоненти мають різну чутливість до змін середовища; дихогамія цвітіння чоловічих та жіночих суцвіть у більшості генотипів кукурудзи носить ознаки протерандрії. В умовах прохолодної погоди з високою кількістю опадів у деяких зразків проявляється протерогінія. **Висновки.** Встановлено, що абіотичні фактори впливають на тривалість періоду “сходи – цвітіння” жіночих і чоловічих суцвіть батьківських компонентів гібридів кукурудзи, але варіювання ознаки “сходи – цвітіння” у кукурудзи в наших дослідках можна вважати слабким. Результати вказують на можливість ведення надійного насінництва в Степовій зоні України наступних гібридів кукурудзи: ДН Синевир, ДН Світязь, ДН Галатея, Моніка 350 МВ, ДН Веста.

Ключові слова: кукурудза, батьківські компоненти, період “сходи – цвітіння”, протерандрія, протерогінія