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Formation of productivity of maize hybrids of different ripening groups in the Forest-Steppe region

Abstract. The relevance of the study is determined by the necessity of scientifically substantiating the rational ratio of maize hybrids of different ripening groups to ensure the realisation of the genetic potential in forming pre-harvest grain moisture at the level of 18-22%. Therefore, the purpose of the study is to identify the most adapted and plastic ripening groups considering biological features and to identify stable hybrids based on economic efficiency through the calculation of the hybrid's productivity efficiency index. The method of plot division was used to conduct field research in accordance with the requirements of the research methodology. The results revealed that maize hybrids of different ripening groups react differently to temperature conditions, especially during the interphase period – 3-5 leaves. Maize hybrids with FAO (ripening group of the hybrid) 180-250, having a flint grain subtype, are characterised by faster linear plant growth due to higher cold resistance, making them suitable for early sowing when the soil temperature is 6-80C. Hybrids with FAO 300 and above, with a dent grain subtype, exhibit slower initial plant growth and are more thermophilic. Therefore, it is advisable to plant them after the soil has been thoroughly warmed to 8-100C. Studies have established that the highest grain yield was obtained from mid-late maturity maize hybrids (FAO 401-500) – 10.04-10.17 t/ha, with a maximum level of 14.89 t/ha in 2017. However, considering the dynamics of productivity levels over the years, the most plastic hybrids, i.e., those with the smallest difference in yield between years, are phenotypes with FAO 201-300. It was determined that early and mid-early ripening group hybrids had lower pre-harvest grain moisture – 0.6-23.9% compared to 28.7-2.7% in mid-ripening and mid-late ripening groups.

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This resulted in a higher productivity efficiency index for these hybrids. The materials of the study contain results for further research on optimising the use of maize hybrids with different FAO numbers and are of practical significance for farms of various ownership forms

Keywords: growth and development phases; yield; mineral fertilisers; pre-harvest moisture; organogenesis

INTRODUCTION

The stability of maize production and the optimisation of sequential harvesting with subsequent moisture control are ensured through the selection and optimal balance of hybrids from different ripening groups. Research on maize hybrids of various ripening groups in the Forest-Steppe region is essential for optimising crop cultivation and ensuring a stable food supply in the region. The focus is on selecting the most productive and resilient hybrids (Bakhmat & Kyrylyuk, 2016). Considering the increasing costs of post-harvest grain processing, it is practical to increase the proportion of intermediate hybrids with dent kernels to 45-50%, characterised by higher moisture content (Ovcharuk *et al*., 2021). Obtaining existing and developing new elements of regional maize cultivation technology requires significant attention to optimizing production costs and studying grain market dynamics (Maslak, 2017).

S.O. Serna-Saldivar (2019) analysed the lengthening of the vegetation period for intermediate hybrids of maize in the context of applying standard mineral fertilizer rates to achieve programmed yields of 12-14 t/ha. This extension results in reduced grain moisture levels, necessitating additional production costs and, consequently, an increase in production costs. Long-term studies have shown that harvesting maize with high pre-harvest grain moisture, besides increasing production costs for post-harvest processing by 25%, also deteriorates its quality indicators (Heiniger, 2018; Shynkaruk & Lykhochvor, 2021a).

Based on the study by R.W. Gesch *et al*. (2021), it can be concluded that in regions with limited heat resources, desiccation is a suitable agritechnical measure for reducing pre-harvest grain moisture and limiting the development of disease agents, particularly Fusarium. Desiccation significantly reduces grain moisture, enabling optimal harvest timing and, consequently, reduces post-harvest processing costs.

By multi-year research conducted by R. Khanam *et al*. (2022), it has been established that 50% of corn productivity is determined by adaptive properties to specific soil-climatic conditions, 30% by the level of material-resource provision of the cultivation technology, and 20% by weather conditions. S.M. Kalenska & V.A. Taran (2018) asserted that corn hybrids from different breeders manifest differently in specific zonal cultivation conditions since the realisation of potential individual productivity occurs under certain characteristics. Hence, the correct choice of hybrid, especially considering the maturity groups according to FAO, its resistance to abiotic factors, and immunity to harmful organisms, determines the features of grain yield formation and its production cost.

According to O. Hayduk (2022), the rates of moisture removal are crucial in regions with limited thermal resources, as of November 2022, the cost of drying 1 tonne of corn amounted to 150 UAH. Considering unfavourable ripening weather conditions, the cost of grain post-harvest processing for a yield of 8 tons/ha and pre-harvest moisture content of 28% was 16,800 UAH, constituting almost 75% of the expenses for the cultivation technology. Therefore, optimising the ratio of maturity groups of corn hybrids, considering climate changes, the structure of production costs, and post-harvest grain processing, acquires significant scientific and practical importance.

The purpose of the study is to substantiate the features of growth and development of corn hybrids of different maturity groups, investigate the influence of the size of FAO (Food and Agricultural Organization) on the formation of grain yield level and moisture content. Calculations of the efficiency index of hybrid productivity were planned to justify economic efficiency.

MATERIALS AND METHODS

The experimental study was conducted in the educational, scientific, and production laboratory of the Department of Plant Science, a separate unit of the "Agronomic Research Station" at the National University of Life and Environmental Sciences of Ukraine during the years 2017-2022 according to the developed scheme (Table 1).

Table 1. Experiment scheme

Factor A – corn hybrid maturity group by FAO		Factor B – corn hybrids	
Option designation	FAO	Option designation	Hybrid
A1	180-200	B1	DKC 3050(Bayer), DKC 3151(Bayer), EU Sirius (Lidea), MAS 10.A (MAS Seeds)
A2	201-300	B2	B2 Ayaks (RAGT), SI Phenomenon (Syngenta), Lipekks (RAGT), DKC3796 (Bayer)
A3	301-400	B3	B3 DKC3939 (Bayer), Dublikks (RAGT), Gekksgon (RAGT), Harmonium (Lidea)
A4	401-500	B4	B4 Lexstur (RAGT), DKC5075 (Bayer), DKC4717 (Bayer), DKC5141 (Bayer)

Source: compiled by the authors

The field study was established using the split-plot method according to the requirements of the research methodology. The efficiency index of hybrid productivity was calculated following the method of Y.M. Pashchenko *et al.* (2008). The soil was typical chernozem with low humus content, loamy in texture. The humus content in the arable layer (according to Tyurin) was 3.4% (DSTU 7855:2015...). The soil was moderately provided with easily hydrolysed nitrogen, above-average in mobile phosphorus and exchangeable potassium. The study was conducted following the requirements of the International Convention on Biological Diversity (1992).

The technology of growing hybrids of corn of different maturity groups was as follows: predecessor – winter wheat; soil cultivation – plowing to a depth of 25-27 cm; pre-sowing soil treatment included closing moisture and pre-sowing cultivation to a depth of seed placement (4-5 cm); fertilisation – $N_{90}P_{60}K_{60}$, particularly phosphorus and potassium fertilisers were applied under the main soil treatment; nitrogen fertilisers – finely, N_{60} was applied during pre-sowing cultivation and N_{10} – as top dressing in the phase of 5-7 leaves; during sowing, a complex mineral fertiliser was applied at the rate of $N_{10}P_{10}K_{10}$ per row; sowing time – the soil temperature at the depth of seed placement was 8-10°C; the seed sowing rate was determined by the maturity group, specifically for hybrids FAO 180-200, it was 80,000 seeds/ha, FAO 201-300 – 70,000 seeds/ha, FAO 301-400 – 60,000 seeds/ha, and FAO 401-500 – 55,000 seeds/ha; crop care included applying a Titus herbicide (Corteva, USA) at the rate of 50 g/ha) with the addition of Trend 90 as insurance; the crops were treated with Coragen insecticide (Food Machinery and Chemical Corporation, USA) at the rate of 120 mg/ha with a working solution volume of 250 l/ha at the beginning of high ear flowering using a high-clearance sprayer; harvesting was done at the stage of full grain ripeness.

RESULTS AND DISCUSSION

The entire range of corn hybrids based on FAO values is divided into 5 maturity groups: early maturing – FAO up to 200, intermediate-early – FAO 201-300, intermediate – FAO 301-400, intermediate-late – FAO 401-500, and late maturing – FAO above 501 (Table 2).

Table 2. Distribution of corn hybrids by maturity groups

Hybrid requirements	Maturity group				
	early-ripe	mid-early	intermediate-ripe	mid-late	late-ripe
Active temperature sum, °C	2200	2400	2600	2800	3000
Effective temperature sum, °C:	900-1000	1100	1150	1200	1300
n specifically, from emergence to tassel emergence	400	450	500	550	600
n from tassel emergence to wax ripeness	400	450	500	550	600
Vegetation period, days	90-105	106-115	116-120	121-130	More than 131
Number of leaves, pcs.	12-14	14-16	16-18	18-20	More than 20
FAO value	100-200	201-300	301-400	401-500	More than 501

Source: developed based on research by V.M. Kabanets *et al.* (2022)

FAO (conditional index of rapidity) is a comprehensive indicator that considers the hybrid's relation to the sum of active and effective temperatures, mineral nutrition level, moisture supply, etc. A difference of 10 points in FAO indicates that the hybrid will have an extended vegetative period by 1-2 days, or it will form 1-2% more dry matter at the beginning (Kalenska & Taran, 2018). One of the criteria for determining the FAO value is the number of leaves. However, this property is determined not only by genetic characteristics but also depends on the growing conditions. Thus, based on long-term studies of corn morphogenesis by D.F. Tomashevsky (1970), it is stated that the first and second stages of organogenesis occur at the stage of vernalisation. The longer this interphase period, the more nodes and leaves are formed at the second stage of organogenesis. This explains that when moving hybrids that are regionally adapted for southern regions to northern latitudes, they form more leaves because these hybrids undergo the stage of vernalisation slowly due to low spring temperatures.

To ensure sustainable corn production in the Forest-Steppe region, a well-founded ratio of corn maturity groups should be followed (Lavrynenko *et al.*, 2016). According to V.S. Tsykov (2003), the recommended ratio of maturity groups in the Forest-Steppe is as follows: early maturing hybrids – 35%, intermediate-early – 55%, intermediate – 10%. However, climate change in recent years has influenced the distribution of hybrids by FAO, and according to scientific and production recommendations, the share of early maturing hybrids is 20%, intermediate-early – 40%, intermediate – 30%, and intermediate-late – 10% (Mokrienko *et al.*, 2017; Khanam *et al.*, 2022; Kabanets *et al.*, 2022).

Hybrids of different maturity groups differ in both biological characteristics and economic traits. Specifically, early and intermediate-early corn hybrids with a flint grain subtype are more cold-resistant and characterized by faster initial growth, indicating their suitability for early sowing when the soil temperature at a depth of 10 cm is 6-8°C. The middle-ripening and late-ripening hybrids with dent grain are more thermophilic plants and require soil warming up to 10-12%°C. Accordingly, hybrids with flint grain during ripening will be characterized by slower rates of moisture loss – 0.2-0.4% per day, whereas dent hybrids have the ability to reduce moisture content from 0.5 to 0.8% (Pashchenko *et al.*, 2008). Field studies have shown that hybrids of maize of different maturity groups reacted differently to changes in temperature regime at the initial stages of organogenesis, particularly until the formation of 5-7 leaves (Fig. 1).

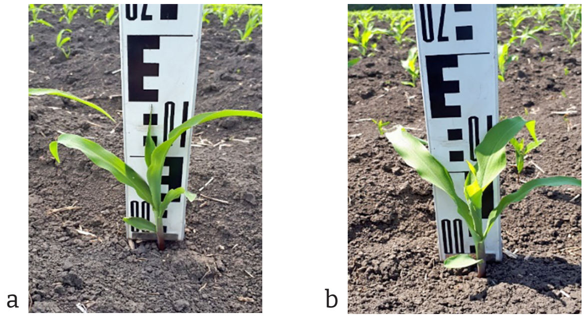

Figure 1. Initial growth rates of maize hybrids of different maturity groups, 2022
Note: a – mid-early hybrids with FAO 201-300; b – intermediate ripening hybrids with FAO 301-400
Source: photographed by the authors

Hybrids with FAO 301-400 and FAO 401-500 were found to be more sensitive to temperature fluctuations, exhibiting lower cold resistance. Genotype and grain subspecies influenced cold resistance, especially early and mid-early maturity group hybrids, thanks to the flint grain subspecies, proved to be more resistant to rapid fluctuations in daily and nighttime temperatures. Particularly noteworthy are the years 2017 and 2021 when, after a sharp increase in active temperatures in the second and third decades of April, a significant drop in air temperature was observed at the beginning of May. As a result, partial damage to the growth point was noted, leading to a 10% decrease in yield. This phenomenon in agronomy is called "temperature paralysis" (Fig. 2).

Figure 2. Determination of maize plant viability of hybrids with FAO 301-400 after 24 hours, 2017
Source: photographed by the authors

Maize cold resistance is also associated with the plant's need for a sum of effective temperatures required at the initial stages of growth and development. Hybrids with FAO 201-300 have greater tolerance to fluctuations in daily and nighttime temperatures (Mokrienko *et al.*, 2017). Starting from the 11-13 leaf stage (tassel emergence), changes in the intensity of linear growth occur – more intensive plant growth is observed in mid-ripening hybrids. These differences in growth and development throughout the vegetative period are due to both genetic and morphobiological characteristics. Analysing the initial growth rates of maize plants, it was noted that early and mid-early hybrids are less responsive to deviations from the optimal temperature regime, being more cold-resistant. Therefore, it is advisable to sow them in optimal-early sowing dates.

Observations of the growth and development of maize plants of different maturity groups confirmed that the duration of the interphase period between emergence and tasseling has a significant impact on pollination efficiency. It was established that a duration of more than 60 days negatively affects pollination efficiency, increasing the likelihood of "poor kernel filling". This is because plants are exposed to critically high temperatures (pollination burn) during the formation of generative organs, resulting in a delay in tassel flowering and initiation. Studies have shown that in maize hybrids with FAO 301-400 and FAO 401-500, the delay in tassel flowering and initiation averaged 7 and 9 days, respectively. In early and mid-early hybrids, tassel emergence occurs on the 55th day after emergence, resulting in nearly simultaneous flowering, differing by 2-3 days, ensuring full pollination (Mokrienko, 2014).

The ultimate indicator of maize production efficiency is grain yield. Studies have shown that the realisation of genetic potential and natural resources is determined by the complex influence of all cultivation factors, especially temperature and water regimes (Table 3).

Table 3. Grain yield of maize hybrids from different maturity groups, t/ha 2017-2022

FAO	Hybrid	Year						Average for 2017-2022
		2017	2018	2019	2020	2021	2022	
180-200	DKC 3050	8.25	7.71	5.67	5.17	8.74	8.22	7.29
	MAC 10.A	7.64	6.54	5.01	5.00	8.04	7.88	6.69
	ES Sirius,	8.01	7.94	4.18	4.35	8.24	8.06	6.80
	DKC 3151	8.76	8.13	6.08	5.75	9.02	8.71	7.74
	Average	8.17	7.58	5.24	5.07	8.51	8.22	7.13
201-300	Ayax	10.15	9.23	7.02	7.54	10.78	11.25	9.33
	SI Phenomenon	10.78	9.15	6.42	6.12	11.02	11.86	9.23
	Lipekks	11.6	9.61	7	6.97	11.78	12.12	9.85
	DKC3796	11.4	9.46	6.52	6.14	11.97	11.97	9.58
	Average	10.98	9.36	6.74	6.69	11.39	11.80	9.49
301-400	DKC3939	10.45	9.22	6.04	5.74	10.97	8.98	8.57
	Dublikks	11.22	9.47	5.01	4.32	11.74	9.03	8.47
	Hexagon	12.87	12.21	4.78	4.12	13.12	10.78	9.65
	Harmonium	13.23	12.45	4.62	4.47	13.45	11.12	9.89
	Average	11.94	10.84	5.11	4.66	12.32	9.98	9.14
401-500	Lekstur	12.54	10.42	4.06	4.00	11.23	9.25	8.58
	DKC5075	13.74	11.03	3.98	3.74	12.57	10.06	9.19
	DKC4717	14.51	13.97	4.15	3.78	13.02	10.78	10.04
	DKC5141	14.89	14.02	3.75	3.56	13.74	11.03	10.17
	Average	13.92	12.36	3.98	3.77	12.64	10.28	9.49

Source: compiled by the authors

Studies have shown that in dry years, especially in 2019 and 2020, when Growing Degree Days (GDD) for June-July were 0.64 and 0.52, respectively, mid-early and mid-late hybrids, being exposed to heat stress, yield lower compared to mid-early and early maturity groups. For instance, in 2019, the average grain yield of mid-late hybrids was 3.98 t/ha, while in early maturity groups, it was 5.74 t/ha. This is also associated with the higher drought resistance of hybrids belonging to the flint grain subspecies. For example, the test weight of flint hybrids was 620 g/l, whereas dent hybrids had only 497 g/l.

In wetter years, a reverse pattern was observed, where hybrids with higher FAO numbers produced higher grain yields. For example, in 2017, the grain yield of mid-late hybrids was 13.92 t/ha, while for early maturity groups, it was 8.17 t/ha. On average over the years of the study, hybrids with FAO 201-300 and FAO 401-500 were the most stable maturity groups. However, it is noteworthy that in critical years regarding moisture supply, mid-late hybrids show a more significant reduction in productivity compared to mid-early hybrids.

Research aimed at determining the optimal maturity group was also conducted by V. Cherchel *et al.* (2021). They noted that in favourable conditions, the difference in grain yield of maize hybrids from different maturity groups was 0.42 t/ha between early and mid-early forms, 0.17 t/ha between mid-early and mid-late forms, and 0.07 t/ha between mid-late and late forms. In stressful conditions, the differences were 0.33 t/ha, 0.25 t/ha, and 0.21 t/ha, respectively. It should be noted that the largest difference in grain yield was observed between early and mid-early maturity groups. In these studies, the biggest difference in grain yield was recorded between hybrids with FAO 180-200 and 401-500, amounting to 2.36 t/ha.

High grain yield does not always correspond to a corresponding level of maize production profitability. When choosing maize hybrids, it is also important to consider the rate of moisture loss (Mokrienko, 2014). Table 4 shows the calculations of the productivity efficiency index, which takes a comprehensive approach to selecting the maturity group into account. The higher the index, the higher the level of profitability. Research has shown that the lowest pre-harvest moisture content was recorded in early and mid-early maize hybrids, respectively 20.6% and 23.9%, while in mid-early and mid-late hybrids, it was 28.7% and 32.7%. The efficiency index was calculated by dividing grain yield by pre-harvest moisture content. The highest efficiency index was observed in mid-early maturity group hybrids – 0.49, whereas in mid-late group, it was only 0.31.

Table 4. Productivity efficiency index of hybrids in 2022

FAO	Hybrid	2022	Pre-harvest moisture, %	Productivity efficiency index of hybrid
180-200	DKC 3050	8.22	22,0	0.37
	MAC 10.A	7.88	21.6	0.36
	ES Sirius	8.06	20.2	0.40
	DKC 3151	8.71	18.7	0.47
	Average	8.22	20.6	0.40
201-300	Ayax	11.25	25.4	0.44
	SI Phenomenon	11.86	24.1	0.49
	Lipekks	12.12	23.1	0.52
	DKC3796	11.97	23.2	0.52
	Average	11.80	23.9	0.49
301-400	DKC3939	8.98	26.8	0.34
	Dublikks	9.03	27.9	0.32
	Hexagon	10.78	30.5	0.35
	Harmonium	11.12	29.8	0.37
	Average	9.98	28.7	0.35
401-500	Lekstur	9.25	32.8	0.28
	DKC5075	10.06	31.5	0.32
	DKC4717	10.78	32.6	0.33
	DKC5141	11.03	34.1	0.32
	Average	10.28	32.7	0.31

Source: compiled by the authors

In Table 5, calculations of grain drying costs and economic efficiency associated with drying it to the base moisture level of 14% are provided. The calculations consider the cost of 1 tonne of maize grain, which is 4500 UAH, and drying cost of 1 tonne percent is 150 UAH.

Table 5. Calculation of grain drying costs and economic efficiency of maize production in 2022

FAO	Moisture difference to base, %	Drying costs, UAH/ha	Harvest value, UAH/ha	Harvest value with drying, UAH/ha
180-200	6.6	8137.8	36978.8	28841.0
201-300	9.9	17523	53100.0	35577.0
301-400	14.7	22005.9	44898.8	22892.9
401-500	18.7	28835.4	46260.0	17424.6

Source: compiled by the authors

The highest harvest value was obtained when growing mid-early and mid-late maturity group hybrids, amounting to 44898.8 UAH/ha and 46260 UAH/ha, respectively. However, due to the high pre-harvest moisture content of the grain, additional costs for drying the grain to the base level significantly increase, resulting in a harvest value of 22892.9 UAH/ha and 17424.6 UAH/ha for these maturity groups, respectively. The highest figures were recorded when growing mid-early hybrids, amounting to 35577 UAH/ha.

The calculation of the harvest value, considering the drying costs, confirmed the reliability of the productivity efficiency index. Therefore, when choosing a hybrid, it is necessary to consider not only the potential yield but also the moisture loss characteristics, which depend on the maturity group, grain subspecies, number of envelope leaves, and peculiarities of tassel formation. Long-term research has established that optimising maize hybrid maturity groups will enhance their productivity by realising their genetic potential and effectively utilising resources, especially heat and moisture. The hybrids of the mid-early maturity group are the most stable in forming high yields due to the reduced risk of plant exposure to high temperatures during flowering and grain formation, thus avoiding firing and "tip-back".

The conducted study has established that to achieve high grain yield, the duration of the interphase period from emergence to tassel flowering should also be considered. The importance of the duration of this vegetative growth period is highlighted by the findings of M.F. Danilevicz *et al.* (2021). An increase in this period raises the risk of flowering occurring under higher, suboptimal temperature conditions of 23-25°C, adversely affecting silk pollination. The current study revealed that in early and mid-early maturity group hybrids, this period was 54-58 days, whereas in mid-early and mid-late hybrids, it extended to 62-66 days. This negatively affected silk pollination and consequently reduced grain yield, especially in years with high-temperature regimes, resulting in a decrease ranging from 10% to 17%.

The highest grain yields from 2017 to 2021 were achieved by mid-early and mid-late maturity group maize hybrids, indicating their high ecological plasticity. However, the study by L. Shynkaruk & V. Lykhochvor (2021b) showed that hybrids with a long vegetative period, having FAO 400 and above, are characterised by increased pre-harvest grain moisture content. Consequently, their efficiency index was 0.31 compared to 0.49 in mid-early hybrids, indicating increased production costs. Economic efficiency calculations for maize production demonstrated that drying costs for mid-early maturity group hybrids amounted to 17.5 thousand UAH/ha, mid-early and mid-late hybrids incurred 22.0 thousand UAH/ha and 28.8 thousand UAH/ha, respectively.

Similar studies by R.W. Gesch *et al.* (2021) and R.L. Nielsen (2020) noted that the use of mid-early and mid-late maturity group maize hybrids, especially under restricted temperature conditions, requires desiccation to achieve grain with optimal pre-harvest moisture content. This, in turn, increases the cost of grain. Pashchenko conducted similar studies determining the productivity efficiency index of hybrids in the Steppe zone, and their production verification confirmed the effectiveness of calculating this indicator, leading to an 8-10% increase in maize grain yield due to the correct choice of maturity group (Pashchenko, 2008).

This study established that the rate of moisture loss is influenced by morphological characteristics of plants, including the number of husk leaves, the diameter of the tassel, grain subspecies – dent subspecies capable of losing 0.5-0.7% moisture, whereas flint subspecies lose 0.2-0.3%, corresponding to the quality composition of the grain. The shape of the tassel also significantly influences the rate of moisture loss – barrel-shaped maize tassels exhibit uniform moisture loss along the tassel. Similar results regarding moisture loss dynamics in maize hybrids were obtained by M.V. Kapustian *et al.* (2021). L. Shynkaruk & V. Lykhochvor (2021a) also note that the formation of the number of tassels on the plant significantly influences the pre-harvest moisture content of maize grain. Thus, the formation of the second (lower) tassel leads to an increase in the pre-harvest moisture content of the grain by 2-4%. In the conditions of the Forest-Steppe, studies on determining the stability of maize hybrids of different maturity groups with high and medium yield values and high agronomic stability have also confirmed the effectiveness of maize hybrids with FAO 240-270. Accordingly, their share should constitute 55-60% (Grabovsky *et al.*, 2014).

Therefore, the correct selection of maize hybrids based on the intensity of cultivation technology and optimising their ratio, with a preference for mid-early hybrids up to 60%, will stabilise grain production, especially in extreme years.

CONCLUSIONS

Hybrids of maize with different vegetative periods differ in their growth and development rates at the initial stages of organogenesis, have varying resistance to temperature regimes, and therefore respond differently to sowing dates. Early and mid-early maize hybrids, belonging to the flint grain subspecies, exhibit higher cold resistance and are advisable to be sown at a soil temperature of 6-8°C. These hybrids also demonstrate higher drought tolerance, leading to the formation of superior grain yield as a key element of crop structure.

Under extreme weather conditions, when there is a deficit of soil moisture during the vegetative period and the negative impact of aerial dryness on plants, early and mid-early maturity group maize hybrids are more adapted and flexible. For instance, in the dry years of 2019 and 2020, the grain yield of early maturity group hybrids was 5.24 and 5.07 t/ha, respectively, while for mid-late maturity group, it was 3.98 and 3.77 t/ha, respectively. In years with sufficient soil moisture, hybrids with FAO 301-401 and FAO 401-500 are more productive, yielding 12.32 and 12.64 t/ha, respectively, compared to 8.51 t/ha in early maturity group. However, it should be noted that maize hybrids with FAO 301-400 have a lower pre-harvest grain moisture content of 28.7% compared to 32.7% in hybrids with FAO 401-500, resulting in lower costs for drying.

Utilising the productivity efficiency index of a hybrid as a comprehensive parameter allows optimising hybrid selection across maturity groups. Based on years of research, hybrids with FAO 201-300 are the most stable maturity group considering economic efficiency. The research findings will be promising for further studies aiming to optimise the hybrid composition for specific soil-climatic conditions, enhancing maize production efficiency. In the future, research on the productivity formation of maize hybrids of different maturity groups can explore more aspects, such as molecular mechanisms of maturity, interaction with different soil types, and the impact of climate change on maize cultivation. This can help develop new hybrids that are more productive, stress-resistant, and contribute to increased maize yield, which is crucial for ensuring food security.

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CONFLICT OF INTEREST

None.

INTRODUCTION

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Формування продуктивності гібридів кукурудзи різних груп стиглості в Лісостепу

Анотація. Актуальність досліджень зумовлена необхідністю наукового обґрунтування раціонального співвідношення гібридів кукурудзи різних груп стиглості, що забезпечить реалізацію генетичного потенціалу з формуванням передзбиральної вологості зерна на рівні 18-22 %. Тому метою досліджень передбачалося виявити найбільш адаптовані та пластичні групи стиглості з урахуванням біологічних особливостей, а також виявити стабільні гібриди з урахуванням економічної ефективності через розрахунок індексу ефективності продуктивності гібриду. Метод розщеплення ділянок був використаний для проведення польового досліду згідно з вимогами методики дослідної справи. Результатами досліджень встановлено, що гібриди кукурудзи різних груп стиглості неоднаково реагують на температурний режим, особливо, у міжфазний період сходи – 3-5 листок. Гібриди кукурудзи з ФАО (група стиглості гібриду) 180-250, які мають кременистий підвид зерна, характеризуються більш швидким лінійним ростом, що обумовлено вищою холодостійкістю рослин, а відповідно, і придатні для ранніх строків сівби, коли температура ґрунту становить 6-80°С. Гібриди з ФАО 300 і вище, з зубовидним підвидом зерна, мають повільніше темпи початкового росту рослин і є більш теплолюбними, а тому їх доцільно висівати за стійкого прогрівання ґрунту 8-100°С. Дослідженнями встановлено, що найвищу врожайність зерна формували середньопізні гібриди кукурудзи (ФАО 401-500) – 10,04-10,17 т/га, з максимальним рівнем 14,89 т/га у 2017 році. Проте, якщо врахувати динаміку рівня продуктивності по рокам, то найбільш пластичними гібридами, тобто ті, які мають найменшу різницю по врожайності по рокам, є фенотипи з ФАО 201-300. З'ясовано, що гібриди ранньостиглої і середньоранньої груп стиглості характеризувалися нижчою передзбиральною вологістю зерна – в 0,6–23,9 % проти 28,7–2,7 % відповідно у середньостиглих і середньопізніх, що і обумовило вищий індекс ефективності продуктивності гібридів. Матеріали статті містять результати для подальших досліджень з оптимізації використання гібридів кукурудзи з різним ФАО, а також мають практичне значення для господарств різних форм власності

Ключові слова: фази росту й розвитку; урожайність; мінеральні добрива; передзбиральна вологість; органогенез