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Biometric parameters and yield of maize hybrids in dependence on agricultural technology elements

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Abstract. Modern innovative corn hybrids of the intensive type have a significant individual response of morphometric and photosynthetic indicators to the density of the coenosis. Establishing correlations of these indicators with the level of grain yield of different genotypes of corn hybrids and determining the optimal parameters for the manifestation of these characteristics allows technological measures to ensure the realization of productive potential. The purpose of the research was to establish the peculiarities of the formation of biometric and photosynthetic indicators of innovative

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corn hybrids depending on the genotype, and the density of the coenosis, and to determine the correlation-regression dependence of these characteristics. Field experiments were conducted during 2019-2021 in the agroecological zone of the Central Forest Steppe. The soil of the experimental site is typical chernozem, the precursor is soybean. With the help of field, morphometric, laboratory, and statistical (dispersion and correlation analysis) it was established that the height of the plant, the height of attachment of the upper (productive) cob, the area of the assimilation surface of one plant, and the photosynthetic potential depended on the studied factors – the genotype of the hybrid and the density of the coenosis. A medium and strong positive correlation was established between productivity and these characteristics, which indicates the need to technologically ensure optimal plant growth and development at various stages of the development of corn plants of all hybrids. The mid-ripe hybrid Zedan 32 (FAO 320) showed maximum productivity at a density of 80,000 plants/ha and sharply reduced productivity at a density of up to 100,000 plants/ha. Mid-early hybrids showed maximum yield at a density of 90,000 plants/ha, while an increase or decrease in plant density from the optimum led to a decrease in grain yield. Therefore, each hybrid has its optimal coenosis density for obtaining the maximum grain yield, and increasing the photosynthetic potential of crops by agrotechnical measures does not always guarantee a parallel increase in the grain yield of corn hybrids

Keywords: corn; plant height; height of the upper (productive) cob; assimilation surface area; photosynthetic potential; grain yield

INTRODUCTION

Experts of the United States Department of Agriculture (USDA, n.d.) significantly increased the projections for global corn production in 2023-2024 to 1224.47 million tonnes, i.e. by 1.7 million tonnes, and in Ukraine - to 25 million tonnes, i.e. by 0.25 million tonnes. Along with the production, the level of its use will also increase by 0.3 million tonnes (to 1206.65 million tonnes), as well as the volume of grain exports and global ending stocks. Experts believe that this trend will be manifested against the background of increased imports caused by the decline in world prices. These data show the importance of corn as an agricultural crop and the expediency of intensifying its production through the introduction of new competitive hybrids and elements of their cultivation technologies.

J. Cairns & B. Prasanna (2018) proved the difficulty of accurate and timely identification of adapted maize forms for different ecogradients of cultivation. At the same time, long-term ecological studies are a proven method of assessing such adaptive forms, because the contrast in environmental conditions over the years is so enormous that in many cases the impact of weather conditions on yield is stronger than the effect of zonal climatic differences. However, long-term studies by J. Zhao *et al.* (2018) show that the way of testing the environmental gradient formed by agrotechnical measures is more reliable. Thus, testing of the material under non-irrigated growing conditions, under different irrigation regimes and types, and in different plant densities provides very diverse environmental backgrounds, which makes it possible to determine the range of possible impact of the agroclimatic conditions of the region on plant growth and development.

N. Shevchenko & L. Yakovets (2021) believe that the correct selection of hybrids, as an effective factor in the use of their genetic potential, plays an important role in increasing the gross grain yield of this crop. The maximum result can be achieved by considering the biological requirements of the hybrid to the proposed cultivation technology, including sowing seeds of high reproductions, placement according to the best predecessors, sowing dates, plant density, plant nutrition system and protection against diseases and pests.

To obtain sustainable and high yields of any crop, according to H. Hussain *et al.* (2019), a detailed study of the agroclimatic conditions of its cultivation in a certain area is required for more rational use and optimal placement of crops, and this issue is of particular importance in connection with global and local climate change. R. Vozhehova *et al.* (2022) demonstrated that the maximum seed yield of early maturing lines was obtained at a density of 90 thousand plants/ha, medium-early inbred lines showed the highest seed yield at a sowing density of 80 thousand plants/ha, and the mid-season group – at a coenosis density of 70 thousand plants/ha. K. Djaman *et al.* (2018) conducted experiments to study the results of the effect of plant density of hybrids on the growth and development of maize of different maturity groups and proved that early maturing hybrids with an increase in the density of coenosis from 60 to 100 thousand plants/ha increased plant height by 11-17 cm. At the same time, the diameter of the stem decreased by 0.20 cm, and the leaf surface area also decreased.

A. Mastrodomenico *et al.* (2018), on the contrary, insist that when coenosis is thickened, especially in favourable years of rainfall, although the productivity of one plant decreases, the number of productive plants per unit area increases significantly, which leads to an increase in yield for hybrids of all FAO groups. In sparse crops, despite the possibility of obtaining the high productivity of one plant, without sufficient coenosis density, there is

no increase in total yield. Analysis of the results obtained by V. Bahatchenko *et al.* (2018) shows a close relationship between the density of coenosis and grain moisture. It was proved that with an increase in plant density, the moisture content of maize grain predictably increases. The driest grain was found at a planting density of 75 thousand plants/ha in simple hybrids, in self-pollinated lines at a density of 85 thousand plants/ha, and the wettest at planting densities of 95 and 105 thousand plants/ha, respectively. Among the lines – parental components, the maximum grain yield per cob was obtained by early maturing lines with a planting density of 85 thousand plants/ha (82.8%). In the medium-early and mid-season lines, the maximum grain yield was obtained with a sowing density of 105 thousand plants/ha, the grain yield was 82.8 and 76.6%, respectively.

According to the yield data obtained by H. Zhemela *et al.* (2021), the optimal plant density of maize hybrids for early maturing hybrids is 75 thousand plants/ha, medium early hybrids – 70 thousand plants/ha, and mid-season hybrids – 65 thousand plants/ha. Research institutions in Canada, Mexico, China, Germany, and other countries recommend sowing corn hybrids with a planting density of 70-100 thousand plants/ha under optimal moisture conditions and increased rates of basic nutrients (NPK), which provides a leaf area index of 5.5 and the highest increase in dry matter (García-Martínez *et al.*, 2020; Li *et al.*, 2022; Veenstra *et al.*, 2023).

Due to climate change and the introduction of new hybrids, it is becoming important to determine the optimal sowing density for a sustainable harvest and increased production profitability. That is why the study aimed to determine the specific characteristics of the formation of biometric and photosynthetic parameters of innovative maize hybrids, depending on their genetic characteristics and sowing density, as well as to establish the relationship between these traits using correlation and regression analysis.

MATERIALS AND METHODS

The field experiments were conducted during 2019-2021 in the agricultural production cooperative "Peremoha" (Klepachi village, Khorol district, Poltava region) in the Central Forest-Steppe climate zone. When planning the experiment scheme, the principle of "single difference" was observed, as well as the range of gradations of the experiment factors, which allows to establish the optimal parameters of the influence of each factor. A two-factor experiment was set up: factor A – Ukrainian hybrids: Zedan 26 (FAO 240), Zedan 28 (FAO 260) and Zedan 32 (FAO 320). Factor B: corn plant density of 70, 80, 90, 100 thousand plants/ha. The experiment was replicated four times with variants placed in space using the randomised block design. The area of the sown plots was 70 m^2, and the accounting area was 50 m^2.

Biometric measurements were carried out during the growing season. The height of hybrid plants, the height of attachment of the upper (productive) cob, the growth of leaf surface area, and the photosynthetic potential of maize hybrids were determined. The plant density in the crop was measured at the 3-5 leaf stage separately in each variant of the experimental plot. After that, the artificial formation of plant density was carried out according to the scheme of the experiment. Before harvesting, plants were counted again in all variants (in 4 replications).

The grain yield was measured at the stage of full grain ripeness (manually from each plot of the experiment). The harvesting moisture content of maize grain, grain yield from the cob harvest and the yield of conditioned grain (at 14% grain) were determined in samples of cobs (30 pieces), which were taken separately at harvesting on each replication of the experiment. The grain yield of maize hybrids was converted to 14% moisture content. The research was conducted on soils typical for the climatic zone (typical chernozem). Agronomic practices for growing maize hybrids in the research were used by the recommendations for the Central Forest-Steppe zone of Ukraine, except for the variants under study. The predecessor under maize was soybean, and ammonium nitrate was applied at 500 kg/ha for spring cultivation. Weather conditions were typical for the Central Forest-Steppe zone of Ukraine. The research was conducted according to the field experiment methodology, and the statistical processing of the research results was carried out based on the results of biometric and weight measurements by the method of analysis of variance and correlation using the Agrostat software (Ushkarenko *et al.*, 2009; Ushkarenko *et al.*, 2014).

The following hybrids of Ukrainian breeding, listed in the State Register of Plant Varieties Suitable for Distribution in Ukraine, were used in the study: Zedan 26, Zedan 28, Zedan 32. (Bulletin, 2022; State register of plant varieties suitable for distribution in Ukraine, 2023).

Table 1. *Hybrids used in the research*

Hybrid	State registration certificate	Holder of property rights
Zedan 26	State Registration Certificate No. 221030, Application No. 21009008 dated 14.01.2021.	Skakun V.M., Skakun O.O., Vozhehova L.S., Vlashchuk O.A.
Zedan 28	State Registration Certificate No. 221029, Application No. 21009007 dated 14.01.2021.	Skakun V.M., Skakun O.O., Vozhehova L.S., Vlashchuk O.A.
Zedan 32	State Registration Certificate No. 221028, Application No. 21009006 dated 14.01.2021.	Skakun V.M., Skakun O.O., Vozhehova L.S., Vlashchuk O.A.

Experimental studies of plants, including the collection of plant material, complied with institutional, national, or international guidelines. The authors adhered to the standards of the Convention on Biological Diversity (1992) and the Convention on Trade in Endangered Species of Wild Fauna and Flora (1979).

RESULTS AND DISCUSSION

Plant height is one of the most important biometric indicators of maize growth and development. Depending on agronomic practices and weather and climatic conditions, this indicator can vary significantly. In the studies conducted, it largely depended on both the hybrid genotype and the plant density in the crop (Table 2).

Table 2. *Plant height of maize hybrids of different FAO groups in the flowering phase depending on the factors of the experiment, cm (average for 2019-2021)*

Corn hybrid (Factor A)	Plant density of corn hybrids, thousands of plants per hectare (Factor B)				On average by factor A
	70	80	90	100	
Zedan 26 (FAO 240)	245.1	251.8	253.6	254.9	251.4
Zedan 28 (FAO 260)	266.3	267.5	272.7	273.9	270.1
Zedan 32 (FAO 320)	276.9	279.6	287.6	288.4	283.1
On average per factor B	256.1	259.6	264.6	265.7	
Assessing the materiality of partial differences					
HIP_{05}, cm	A = 12.9; B = 8.8				

Source: *compiled by the authors*

The genotype of the hybrid influenced the height of the plants, the highest values of which averaged 283.1 cm in the mid-season hybrid Zedan 32 (FAO 320). The lowest height was in the mid-early hybrid Zedan 26 (FAO 240) and was 245.4 cm. This is due to both the duration of the growing season and the morphological features of the hybrids' habitus. The increase in plant height from thickening the coenosis from 70 to 100 thousand plants/ha was 11.5 cm or 4.2%. The maximum plant height of 288.4 cm was observed in the maize hybrid Zedan 32 (FAO 320) at a density of 100 thousand plants/ha.

The minimum height of cob attachment was characterised by the mid-early maize hybrid Zedan 26 (FAO 240). On average, over three years, the height of earing in the mid-early maize hybrids Zedan 26 and Zedan 28 was 97.6 and 108.8 cm, respectively, and in the mid-season hybrid Zedan 32 – 113.6 cm, i.e., an increase in the length of the growing season is accompanied by a higher level of earing (Table 3).

Table 3*. The height of attachment of the upper (developed) ear of maize hybrids depending on the factors of the experiment, cm (average for 2019-2021)*

Corn hybrid (factor A)	Corn density, thousand plants/ha (factor B)				On average by factor A
	70	80	90	100	
Zedan 26 (FAO 240)	96.1	96.5	98.1	99.6	97.6
Zedan 28 (FAO 260)	107.3	108.6	109.2	110.1	108.8
Zedan 32 (FAO 320)	111.2	113.5	114.7	114.9	113.6
On average per factor B	107.5	108.5	109.7	110.5	
Assessing the materiality of partial differences					
HIP_{05}, cm	A = 4.8; B = 3.5				

Source: *compiled by the authors*

Having analysed the influence of plant density on the height of heading in hybrids, it is necessary to point out the tendency to increase the height during the thickening of the sowing. Thus, the height of the cobs at a density of 70 thousand plants/ha was in the range of 96.1-111.2 cm, at a density of 80 thousand plants/ha – 96.5-113.5 cm, at a density of 90 thousand plants/ha – 98.1-114.7 cm, at a density of 100 thousand plants/ha – 99.6-114.9 cm. The mid-season maize hybrid Zedan 32 showed the highest value of the height of the cobs per plant at a density of 100 thousand plants/ha – 114.9 cm.

When optimising production processes and maximising crop yields, the size of the plant's assimilation apparatus plays a key role, as it accumulates solar radiation during the photosynthetic process and converts it into organic matter. The productivity of photosynthesis is strongly related to the area of plant leaves, which can be regulated by the crop sowing structure, so one of the effective opportunities for more complete use of photosynthetically active solar radiation is to create conditions by agrotechnical measures for accelerated development of the leaf apparatus at the beginning of

the growing season by using factors of photosynthesis intensification, in particular, establishing the optimal density of coenosis (Polyakov & Karpuk, 2020; Asanashvili, 2020).

Based on the modern theoretical vision of the mechanism of functioning and interrelationships of the donor-acceptor system in a plant, it is possible to ensure an enhanced production process by changing the morphological and physiological parameters of the crop, namely by creating a powerful photosynthetic surface of the plant and prolonging the duration of the photosynthetic apparatus. Over the years of research and comparative evaluation of hybrids, it turned out that the hybrid Zedan 32 showed consistently higher performance, with the area of the assimilation surface of one plant ranging on average from 0.461 m^2/plant at a density of 100 thousand plants/ha to 0.498 m^2/plant at a density of 70 thousand plants/ha (Table 4).

Table 4. *Effect of coenosis density on the assimilation area of one maize plant in the flowering phase depending on the factors of the experiment, m^2/plant (average for 2019-2021)*

Corn hybrid (factor A)	Corn density, thousand plants/ha (factor B)				On average by factor A
	70	80	90	100	
Zedan 26 (FAO 240)	0.413	0.402	0.388	0.375	0.3945
Zedan 28 (FAO 260)	0.426	0.421	0.415	0.395	0.4143
Zedan 32 (FAO 320)	0.498	0.481	0.472	0.461	0.4780
On average per factor B	0.446	0.435	0.425	0.410	
Assessing the materiality of partial differences					
HIP_{05}, m^2/plant	A = 0.021; B = 0.018				

Source: *calculated by the authors*

Zedan 28 hybrid had the lowest assimilative surface area – from 0.395 to 0.426 m^2/plant, and with increasing plant density, the assimilative surface area became even lower. The minimum leaf area per plant in the experiment was formed by the hybrid Zedan 26 – from 0.375 (at a density of 100 thousand plants/ha) to 0.413 m^2/plant (at a density of 70 thousand plants/ha). It should also be noted that the maximum area of the assimilation surface of one plant was recorded for all maize hybrids at a plant density of 70 thousand plants. At the same time, researchers H.M. Kaletnyk *et al.* (2021) observed that increasing the leaf surface area of plants is not always beneficial, because, in the case of thickening of the coenosis, the lower tier of plant leaves is shaded by the upper one, which leads to a deterioration in the illumination of the array and a decrease in the intensity of photosynthesis in general.

One of the most pressing issues in agricultural science is to increase the productivity of plant photosynthesis, which is the basis for crop yields. Corn grain yields, like those of other crops, are entirely determined by the active work of the photosynthetic apparatus. Photosynthesis is a source of organic matter formation and accumulation by plants, which indicates the great importance of photosynthesis in the formation of yield and accumulation of dry matter in the plant (Tan *et al.*, 2021). The photosynthetic potential of maize hybrids increased with the lengthening of the growing season and showed the maximum performance in the mid-season hybrid Zedan 32 – an average of 2111.6 thousand m^2*day (Table 5).

Table 5. *The photosynthetic potential of maize hybrids depending on the factors of the experiment, thousand m^2*day (average for 2019-2021)*

Corn hybrid (factor A)	Corn plant density thousand plants/ha (factor B)				On average by factor A
	70	80	90	100	
Zedan 26 (FAO 240)	1589.1	1606.2	1747.2	1873.9	1704.1
Zedan 28 (FAO 260)	1713.4	1682.3	1866.3	1974.7	1809.2
Zedan 32 (FAO 320)	2092.5	1925.4	2123.7	2304.9	2111.6
On average per factor B	1798.3	1738.0	1912.4	2051.2	
Assessing the materiality of partial differences					
HIP_{05}, thousand m^2*days	A = 90.4; B = 122.9				

Source: *compiled by the authors*

The highest photosynthetic potential of maize hybrids of all FAO groups was found at coenosis thickening up to 100 thousand plants/ha – from 1873.9 thousand m^2*day in Zedan 26 hybrid to 2304.9 thousand m^2*day in Zedan 32 hybrid. The analysis of the influence of traits on grain yield of maize hybrids

showed that there is a medium and strong positive correlation between yield and all studied traits (Table 6). This indicates that at different stages of maize plant development of all hybrids, it is necessary to ensure optimal growth and development of plants technologically.

Table 6. *Correlation between traits and yield of maize hybrids of different FAO groups (r)*

Corn hybrid	Characteristics			
	Plant height	Attachment height of the upper (productive) head	Assimilation surface area	Photosynthetic potential
Zedan 26	0.651*	0.460*	0.778*	0.756*
Zedan 28	0.714*	0.531*	0.841*	0.836*
Zedan 32	0.727*	0.645*	0.945*	0.977*

Note. ** - statistical significance at 0.05*
Source: *calculated by the authors*

A positive correlation coefficient indicates the influence of photosynthetic potential on yield, but there was a decrease in yield with an increase in photosynthetic potential from 2100.0 thousand m^2*day, i.e., an increase in the photosynthetic potential of maize crops utilizing agricultural technology does not always lead to a parallel increase in yield in hybrids, so for each maize hybrid, depending on genotypic characteristics, there should be an optimum plant density that ensures maximum efficiency of photosynthetic potential productivity. It has been determined that hybrids of different FAO groups have their optimal plant density to achieve the highest yield of maize grain (Fig. 1).

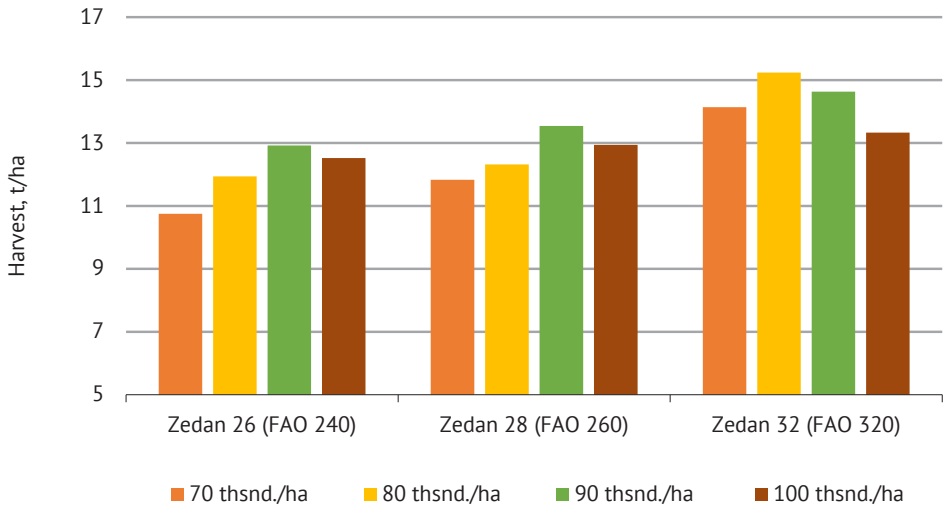

Figure 1. *Dependence of maize grain yield of hybrids of different FAO groups on plant density*
Source: *compiled by the authors*

The mid-early hybrid Zedan 26 (FAO 240) showed a maximum grain yield of 12.92 t/ha at a coenosis density of 90 thousand plants/ha. Reducing the plant density to 80 thousand plants/ha led to a drop in grain yield by 0.98 t/ha, or 7.8%, further thinning of the crop to 70 thousand plants/ha led to a decrease in grain yield by 2.17 t/ha, or 17.1%, Thickening of the crop to 100 thousand plants/ha caused a decrease in yield by 0.40 t/ha or 3.2%. The hybrid of the mid-early group Zedan 28 (FAO 260) showed the highest grain yield of 13.54 t/ha at a plant density of 90 thousand plants/ha. Reducing the density of coenosis to 80 thousand plants/ha led to a decrease in yield by 1.22 t/ha, or 8.9%, and thinning of coenosis to 70 thousand plants/ha caused a drop in grain yield by 1.71 t/ha, or 12.6% while thickening of coenosis to 100 thousand plants/ha led to a decrease in yield by 0.60 t/ha, or 4.5%.

The hybrid of the medium-ripening group Zedan 32 (FAO 320) showed the maximum grain yield of 15.24 t/ha (the highest indicator in the experiment among other genotypes) at a density of 80 thousand plants/ha. A further decrease in plant density to 70 thousand plants/ha caused a drop in yield by 1.10 t/ha, or 7.3%, and an increase in coenosis density to 90 thousand plants/ha affected the reduction of corn grain yield by 0.61 t/ha or 3.9%, and a thickening of the crop to 100 thousand plants/ha caused a sharp decrease in yield by 1.91 t/ha or 12.5%.

It is worth noting that the established patterns of influence of coenosis density on the yield of new Ukrainian maize hybrids are not sufficient, and this issue requires further scientific research. According to the results of our research, a significant increase in corn grain yield depends on the FAO group and plant density. This is consistent with the findings of other researchers, in particular, S. Kalenska and V. Taran (2018) showed that intensive maize hybrids are capable of producing high grain yields at plant densities of 90 thousand plants/ha by increasing the survival of individuals during the growing season, and moisture supply is the main limiting factor for obtaining high grain yields in the Right-Bank Forest-Steppe of Ukraine.

According to R. Vozhehova *et al.* (2021), dry matter increased with increasing coenosis density from 50 to 80 thousand plants/ha. The scientists concluded that maize hybrids with a longer growing season form more crude aboveground mass and dry matter than early maturing maize hybrids. In the studies of S. Anjum *et al.* (2017), it was also proved that for early maturing hybrids under irrigation, the optimal planting density is 90 thousand plants/ha, and it is recommended to reduce the density to 70 thousand plants/ha for mid-season maize hybrids, i.e., to apply a differentiated approach to the seeding rate of different genotypes. Z. Glupak and A. Butenko (2022) also concluded that in northern Ukraine (Chernihiv region), corn yields depended on the maturity group of the hybrid and plant density. For earlier maturing FAO 300-320 hybrids, the best density was 90-80 thousand plants/ha, with a yield of 10.7-10.4 t/ha. For hybrids FAO 360-380, the best density was 80 thousand plants/ha, which yielded a yield of 10.9-11.1 t/ha.

S. Kalenska and V. Taran (2018) noted that Ukrainian breeders have created and offered producers several new maize hybrids, but all of them have different morphological-biological features and characteristics, tolerance to favourable and unfavourable environmental factors, which requires differentiated selection of hybrids with increased yield and grain quality. current research has confirmed the multidirectional response of innovative Ukrainian hybrids to technology elements, which makes the development of varietal technologies for each genotype relevant.

V. Petrychenko *et al.* (2018) emphasise the relevance of the issue of increasing the adaptive potential of new maize hybrids, as the priorities of the morphological-biological type models themselves change, depending on the FAO group. These issues are becoming increasingly important in the context of insufficient technological support for the process of growing and harvesting corn, which is a consequence of the steady rise in energy prices, and the lack of parity in prices for agricultural products and fossil fuels. Given the above, it is difficult to overestimate the role of high-yielding corn hybrids with a wide adaptive potential to growing conditions and increasing the profitability of agricultural production. The results of these studies coincide with the conclusions of the above-mentioned scientists that the FAO maize hybrid group and its adaptive potential are important for providing effective recommendations for production when introducing innovative varietal technologies. This area of research should be implemented in each agricultural-ecological zone, which will increase the economic performance of production.

S. Meseka *et al.* (2018) show that to obtain consistently high yields of maize grain, it is necessary to grow hybrids with different types of response to changing environmental conditions, in particular, intensive type hybrids with optimised growing technologies – to obtain high yields in unlimited conditions, homeostatic – to ensure the predicted grain yield on stressful backgrounds, and finally, medium-plastic – to obtain stable yields of maize grain in fields with unstable agrophysical conditions. In the current research, maize hybrids with different rates of response to technology elements were used, which coincides with the results and conclusions of S. Meseka *et al.* (2018) regarding the need to use varieties with different responses to ecogradients in agricultural production.

Thus, according to the results of the conducted research, a significant increase in maize grain yield depends on the FAO group and elements of plant density technology, which is consistent with the data of other researchers. However, it is worth noting that the established patterns of influence of coenosis density on the yield of new Ukrainian maize hybrids are not sufficient, and this issue requires further research.

CONCLUSIONS

Phenotypic realisation of the genotypic potential of modern innovative maize hybrids of Ukrainian selection depends on the optimisation of technological measures of cultivation. The correlation of quantitative biometric traits in maize hybrids of different FAO groups with grain yield was established. A high dependence of plant height (r=0.651-0.727), height of productive cob attachment (r=0.460-0.645), area of plant assimilation surface (r=0.778-0.945), photosynthetic potential (r=0.756-0.977) with grain yield of maize hybrids of different maturity groups was established. The greatest dependence of grain yield of hybrids was recorded with the area of the assimilation surface of plants and photosynthetic potential. The coenosis density of the hybrid can regulate biometric parameters and influence the level of grain yield. The optimal plant density in corn hybrids depends on the intensity level of the hybrid and the FAO group. The intensive type of hybrid Zedan 32 sharply loses grain yields when thickened from 15 to 13 t/ha. The moderately intensive maize hybrid Zedan 28 reduces grain yields during thinning from 90,000 plants/ha to 70,000 plants/ha by 1-1.3 t/ha. The corn hybrid with the lowest yield potential, Zedan 26, reduces

grain yields when thinned from 90,000 plants/ha to 70,000 plants/ha from 13 to 10.8 t/ha.

It has been established that modern innovative hybrids of maize of Ukrainian selection in the conditions of the Central Forest-Steppe agroecological zone can form grain yields in the range of 13-15 t/ha. The realisation of the genetic potential of hybrids depends on the improvement of technological measures during cultivation. The optimal coenosis density of corn depends on the intensity level and FAO group. To increase the yield level of the hybrid, the priority indicators should be the area of the assimilation surface of plants and photosynthetic potential, which are adjusted at a high level by the density of crop coenosis, but increasing the photosynthetic potential of maize hybrids by increasing plant density has certain limitations, which may not always lead to a parallel increase in grain yield in hybrids of different FAO groups.

The development of varietal technologies for growing modern maize hybrids should be a necessary component of the introduction of breeding developments into production. A promising area for further research may be to determine the response of maize hybrids of different intensity levels and FAO groups to the level of macro- and microelements and growth-regulating elements. Given the trend towards climate change, it is necessary to consider the response of maize hybrids to early sowing to ensure fuller use of the bioclimatic potential and disclosure of the phenotypic realisation of the genotypic potential.

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CONFLICT OF INTEREST

None.

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Біометричні показники та урожайність гібридів кукурудзи залежно від елементів агротехнології

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Анотація. Сучасні інноваційні гібриди кукурудзи інтенсивного типу мають істотну індивідуальну реакцію морфометричних та фотосинтетичних показників на щільність ценозу. Встановлення кореляцій цих показників з рівнем урожайності зерна різних генотипів гібридів кукурудзи та визначення оптимальних параметрів прояву цих ознак дозволяє технологічними заходами забезпечити реалізацію продуктивного потенціалу. Метою досліджень було встановити особливості формування біометричних та фотосинтетичних показників інноваційних гібридів кукурудзи залежно від генотипу, щільності ценозу та визначити кореляційно-регресійні залежності даних ознак. Польові експерименти проводили протягом 2019-2021 років в агроекологічній зоні Центральний Лісостеп. Ґрунт дослідної ділянки – чорнозем типовий, попередник – соя. За допомогою польових, морфометричних, лабораторних, статистичних (дисперсійний та кореляційний аналіз) встановлено, що висота рослини, висота прикріплення верхнього (продуктивного) качану, площа асиміляційної поверхні однієї рослини, фотосинтетичний потенціал залежать від досліджуваних факторів – генотипу гібриду та щільності ценозу. Встановлено середню та сильну позитивну кореляцію між урожайністю та даними ознаками, що свідчить про необхідність на різних етапах розвитку рослин кукурудзи усіх гібридів технологічно забезпечувати оптимальний ріст і розвиток рослин. Середньостиглий гібрид Зедан 32 (ФАО 320) показав максимальну урожайність при густоти 80 тис. рослин на гектарі та різко знижував врожайність при загущеності посівів до 100 тис. рослин/га. Середньоранні гібриди найбільшу врожайності показали за густоти стояння 90 тисяч рослин/га, збільшення ж або зменшення густоти рослин від оптимальної призводили до зменшення врожаю зерна. Встановлена індивідуальна фенотипова реакція новостворених гібридів на щільність ценозу, що дозволило розкрити генотиповий потенціал та надати рекомендації практичному агровиробництву для підвищення урожайності кукурудзи. Встановлена оптимальна щільність ценозу, що дозволяє отримувати урожайність зерна гібридів кукурудзи ФАО 240-320 в умовах Центрального Лісостепу в межах 13-15 т/га. Гібриди впроваджуються в господарствах різних форм власності Полтавської області

Ключові слова: висота рослини; висота верхнього (продуктивного) качана; площа асиміляційної поверхні; фотосинтетичний потенціал; урожайність зерна