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PHENOLOGY AND YIELD COMPONENTS OF DUO SYSTEM MAIZE HYBRIDS GROWN IN CROP ROTATION AND AS A MONOCULTURE

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Abstract

Maize (*Zea mays* L.) is one of the most widely cultivated crops globally. The growing demand for grain and silage requires the intensification of the production process. Maize's cultivation as a monoculture ensures higher income per unit area and is therefore a preferred practice. An increasing share of the market is occupied by hybrids developed using the Duo System technology. Through an introduced gene for tolerance to cycloxydim an effective control of both annual and perennial grass weeds in maize crops is ensured. During the period of 2024-2025 a field trial for evaluating the effect of mono-cropping and crop rotation on phenology and yield components of three Duo System maize hybrids - Zanetixx DUO, Hexxagone DUO and Elaraxx DUO, was conducted. The research was conducted in the experimental base of the department of "Agriculture and Herbology" of the Agricultural University of Plovdiv, Bulgaria under irrigation. The phenological development of the hybrids was monitored under conditions of two cropping systems: monoculture and crop rotation with winter wheat. Twenty representative plants from each variant were marked and observed throughout the growing season in order to determine the maize hybrids phenological stages and their duration as following: emergence; 3-5 leaf stage; 9-10 leaf stage; tasseling; milk, dough and full maturity stages. For the purposes of the trial a structural analysis of the harvested yield was conducted. While in the first year the yields did not differ significantly, in the second year a negative effect was found as a result of the monoculture cultivation.

Keywords: cycloxydim, hybrids, maize, preceding crop, yield

INTRODUCTION

Maize (*Zea mays* L.) ranks third in global cultivation, following rice and wheat (Hanway & Ritchie, 2019; Tang et al., 2025). Global maize production for the 2024–2025 period is estimated at 1.21 billion metric tons (USDA FAS, 2025). According to the latest data from the Ministry of Agriculture and Food of Bulgaria (2025), domestic production of maize for silage, green fodder, and energy

purposes amounts to 1,597,935 tons, ranking it as the second most produced crop in the country after wheat. It is a preferred crop in agronomic practices due to its wide range of uses. Its extensive cultivation provides a variety of food products (flour, sugar, etc.), and it is used for the production of oil, glue, soft and alcoholic drinks, as well as biofuel (Ranum et al., 2014). Maize is also used as grain, green fodder, and silage for livestock. Its production is of great benefit in solving the food problem on a global scale (Tomov et al., 1984).

Nowadays, maize cultivation is supported by numerous technologies that have become established in practice in order to obtain higher yields at minimal expense and rational use of land. The need for quality production, meeting the needs of the population, requires intensification of agricultural processes, implementation of integrated plant protection, as well as the introduction of improved methods of crop care.

Fundamental in the cultivation of agricultural crops is the maintenance of good phytosanitary condition – fields free from diseases, pests and weeds. Weeds cause serious biotic stress, negatively affect in both direct and indirect ways and have a serious negative impact on crops such as maize, which can reduce yields by 77 to 91% (Tonev et al., 2019). These days, the development of herbicide-tolerant crops which successfully suppress weeds in crops without causing damage to the cultivar, is a widely adopted way of weed management (Korres et al., 2019; Bao et al., 2022). Over the years, the number of herbicide-tolerant crops have increased, which significantly reduces the cost of soil cultivation, allows for full mechanization of processes and ensures high yields from production areas.

Under BASF's ownership, the Duo System® technology utilizes Stratos Ultra herbicide (100g/l cycloxydim) in combination with hybrids developed for cycloxydim tolerance (Vančetović et al., 2014). This technology can be successfully applied to intense weed infestation with monocotyledon weeds in maize fields. The active ingredient cycloxydim is an inhibitor of the enzyme Acetyl-CoA carboxylase, which regulates the biosynthesis of fatty acids in plants. The herbicide inhibits the action of the enzyme in the chloroplasts of the monocotyledon weeds without causing harm to the tolerant maize hybrids. In their study, Kukorelli et al. (2013) point out cycloxydim-tolerant maize as a good alternative to transgenic herbicide-resistant crops, since the plants are not genetically modified and have been successfully grown in Europe. However, Malidza et al. (2023) recommend integrated weed management due to the risk of herbicide resistance emerging.

It is known that the inclusion of crops in an appropriate crop rotation contributes to their better development and higher yields, as a result of the optimization of many factors (Bullock, 1992; Riedell et al., 1998; Berzsenyi et al., 2000). Karlen et al. (1994) point out the improved water supply, structure and biological activity of the soil as factors having an additional positive influence. Crop rotation is an approach, the effect of which cannot be fully compensated by modern plant protection products in the weed management, pests and pathogens (Berzsenyi et al., 2000). For instance, in maize cultivation in Africa, crop rotation is a key agronomic practice for controlling some parasitic weeds (Oswald & Ransom, 2001). Extensive research by various authors indicates that crop rotation is a key mechanism for restoring and maintaining soil fertility under current adverse global

climate conditions (Stanev, 1995; Slavov & Alexandrov, 1997; Slavov and Alexandrov, 1998; Atanasova et al., 2013). In severe lack of moisture, providing a good preceding crop for plants is essential (Vasilev, 1974; Dzhumalieva, 1980; Vasilev, 1986; Zarkov, 1996; Atanasova et al., 2013).

The need for maize mono-cropping arises in connection with the cultivation of plants in areas most favorable for their growth and development, as well as with the constant increase in the share of these areas worldwide (Ignatov, 1985). Admittedly, maize monoculture system can provide high yields for a certain period of time and maximize profits, which makes it a widely used practice among farmers (Chikowo et al., 2009; Gałazka & Grządziel, 2018; Woźniak, 2019; Wachowska et al., 2023). Nevertheless, this inevitably leads to a higher density of some weed species, an increase in pest populations and a gradual reduction in soil fertility and structure (Simic et al., 2013).

The objective of this study is to observe the phenological development and yield potential of three DUO System hybrids under two different cropping systems: monoculture and a crop rotation system involving winter wheat.

MATERIALS AND METHODS

The study was carried out during two consecutive growing seasons of the maize (2024 and 2025) in the research field of the department of "Agriculture and Herbiology" at the Agricultural University of Plovdiv, Bulgaria (Latitude 42°7'58"N, Longitude 24°48'19"E). The experiment was conducted by the long plots method with a trial area size of 20 m². All studies were carried out in 3 replications for each maize hybrid. Cultivation was carried out both as a monoculture following a sorghum as the preceding crop, and within a crop rotation system including winter wheat, variety Enola.

Three hybrids of the DUO System technology were evaluated in the study – Zanetixx DUO - FAO 360 group, dent type; Hexxagone DUO - FAO 410 group, dent type, and Elaraxx DUO - FAO 530 group.

The hybrids were seeded in the second half of April, with a planting depth of 7 cm and a density of 60,000 seeds ha⁻¹. The field was ploughed before sowing, followed by one-time disc harrowing. Combined fertilization with 500 kg ha⁻¹ N:P:K (15%:15%:15%) + 7% SO₃ + Zn (Borealis – L.A.T Company, Austria) was performed. Manual fertilization of the plots with 250 kg ha⁻¹ NH₄NO₃ was applied during the vegetation season. During the maize growth seasons, irrigation was ensured. Background treatment with Stratos Ultra (cycloxydim 100g/l) was carried out in the phenophase 3rd-5th leaf of the maize hybrids. For the control of broadleaf weeds in the experimental plots, the herbicide Casper (dicamba 500g/kg + prosulfuron 50g/kg) was applied during the 5th leaf growth stage. Pest and disease management was not necessary. Harvesting was done manually by collecting all maize ears from each parcel.

Phenological development was monitored by using standardized system scale - BBCH, recording main growth stages, including emergence, 3–5 leaf stage, 9–10 leaf stage, tasseling and milk, dough, and full maturity stages. Twenty plants were marked in each replicate to assess growth rate and the duration of the recorded phenological stages. To support the study objectives throughout the milk

maturity stage, several parameters such as plant height, final leaf number and height of the main ear were evaluated. After the harvest of the maize hybrids several yield parameters were measured:

- Length of Ear;
- Weight of Ear;
- Ear diameter;
- Number of seeds per Ear;
- Grain weight per Ear;
- Cob weight;
- Maize seed yield ($t\ ha^{-1}$)

To determine whether there is a statistically significant difference between the results obtained from growing DUO System maize hybrids as a monoculture and in crop rotation with wheat, an independent-samples Student's t-test was conducted.

RESULTS AND DISCUSSION

The maximum and minimum air temperatures (Figure 1), as well as the amount of precipitation for the vegetation period in which maize plants were grown (Figure 2), were of fundamental importance for their development.

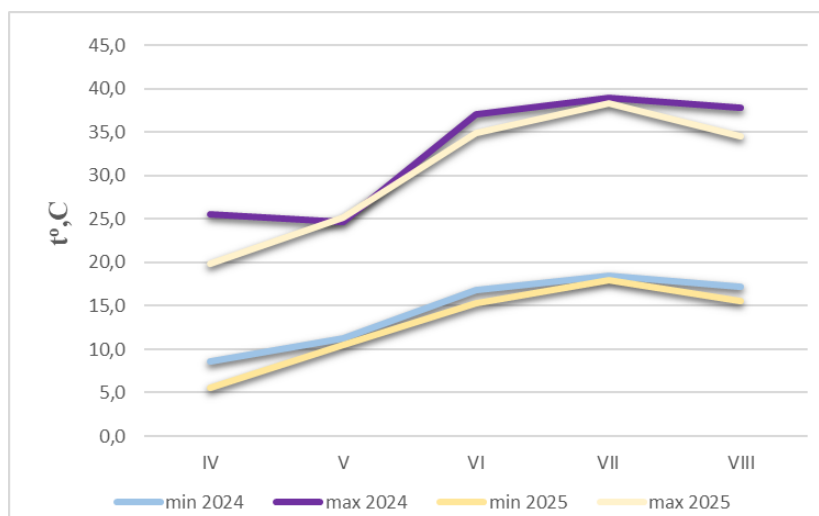


Figure 1. Average monthly minimum and maximum air temperatures for the vegetation period of maize

During the summer months, a permanent increase in temperature values above the optimal ones for the development of the crop alongside with low levels of atmospheric humidity were observed. The most critical month for both years is July with an average of 13 days in which the maximum air temperatures exceed 40 °C.

The precipitation is one of the main factors influencing grain yield in maize (Traykov et al., 2017). According to Popov and Koedzhikov (1966), the amount of precipitation for its vegetation should not be reduced below 300 mm. However, it is extremely insufficient in both 2024 and 2025 experimental years.

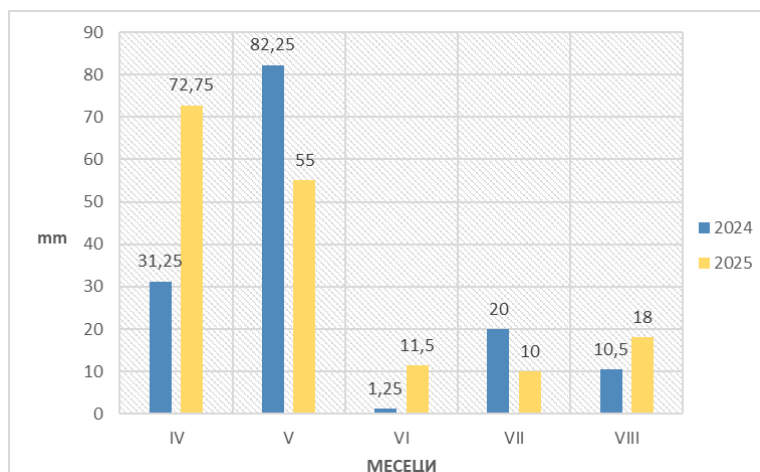


Figure 2. Average monthly precipitation for the vegetation period of maize, mm

Based on the analysis of agrometeorological conditions in the region, it can be stated that the trial years 2024 and 2025 were relatively unfavorable for maize cultivation, especially with regard to temperature during the vegetation period.

Throughout its life cycle, maize goes through the following general phases of development: germination, leaves development, stem elongation, tasseling, flowering, milk, dough and full maturity stages. The expression and duration of these phases depends not only on the growing conditions of the crop (Popov and Koedzhikov, 1966), but it also vary among the different hybrids. Monitoring on the phenological development of maize hybrids can provide information about unfavorable conditions occurring at a given stage, which can ultimately lead to a reduction in yield. If disturbances in the growth processes of plants were detected, the necessary corrective measures can be taken in a timely manner.

Recording the phenological growth phases of maize using the BBCH scale (Lancashire et al., 1991) allows for a more precise comparison of the development of the observed hybrids and helps to take into account the differences between the two cropping systems.

Tables 1 and 2 present the dates of occurrence of the main and some intermediate developmental phases of the hybrids grown as a monoculture and in crop rotation during the two experimental years – 2024 and 2025.

The sowing of the three hybrids was carried out in the second half of April, both for 2024 (16.04.2024) and for 2025 (23.04.2025), upon establishing a permanent rising of the soil temperature above 8-10 °C (Yanchev, 2019). In both crop years, the period from sowing to plant emergence occurred under average daily air temperatures of approximately 15.3 °C. In a moderate climate, the optimal temperature for germination of maize is between 21 and 26°C, but should always be above 10 °C (Ortega & Carril, 2014).

The seeds of the Zanetixx DUO hybrid germinate in 11 days in both cropping systems in the first year. In 2025, the initial growth of the hybrid occurred in significantly lower period of time – 6 and 7 days when grown as a monoculture and in crop rotation, respectively. The emergence of the Hexxagone DUO hybrid for the

two experimental years occurs on average in 10 days in both cultivation systems. There was a considerable difference in the number of days from sowing to germination of the Elaraxx DUO hybrid in 2024 and 2025. In the first year, the seeds germinated in 16 and 15 days in monoculture and crop rotation, in that order, which was an average of 7.5 days longer than the germination period in the second year. The extended emergence in 2024 was explained by the fact that maize seeds germinate at a slower rate with lower stored soil moisture in the period before and after sowing. The amount of precipitation for the month of April in 2024 was 31.25 mm - 2.3 times less than the moisture measured for the same period in 2025 - 72.75 mm.

Table 1. Phenological growth stages of three maize hybrids recorded in 2024

BBCH code	Phenological growth stages	Zanettix DUO		Hexxagone DUO		Elaraxx DUO		Year
		M	CR	M	CR	M	CR	
00	Dry seed (caryopsis)	16.4.2024	16.4.2024	16.4.2024	16.4.2024	16.4.2024	16.4.2024	2024
09	Emergence: coleoptile penetrates soil surface	26.4.2024	26.4.2024	28.4.2024	28.4.2024	1.5.2024	30.4.2024	
13	Three leaves unfolded	3.5.2024	3.5.2024	3.5.2024	3.5.2024	7.5.2024	6.5.2024	
15	Five leaves unfolded	14.5.2024	14.5.2024	17.5.2024	17.5.2024	19.5.2024	17.5.2024	
19	Nine leaves unfolded	30.5.2024	1.6.2024	31.5.2024	31.5.2024	3.6.2024	6.6.2024	
51	Tasseling	18.6.2024	19.6.2024	25.6.2024	23.6.2024	30.6.2024	29.6.2024	
73	Milk maturity stage	9.7.2024	8.7.2024	11.7.2024	9.7.2024	26.7.2024	24.7.2024	
83	Dough maturity stage	18.7.2024	18.7.2024	21.7.2024	20.7.2024	9.8.2024	7.8.2024	
89	Full maturity stage	16.8.2024	16.8.2024	25.8.2024	25.8.2024	2.9.2024	1.9.2024	
Vegetation period, days		122	122	131	131	139	138	

Reaching the third leaf phenophase occurs in a shorter period in 2024 for all three hybrids – an average of 7 days, with no differences in the date being recorded, depending on the preceding crop. It takes 2.5 more days for the third leaf to unfold for all three hybrids in the second experimental year. During the development of the plant leaves (May), the highest amount of precipitation was recorded – 82.3 mm and 55 mm in 2024 and 2025, respectively. The water requirements of plants increase after germination and the beginning of active growth of plants (Zhalnov, 2004), although such precipitation is not essential for yield formation, since it is beyond the critical water phases of maize (Gospodinov, 2013).

Table 2. Phenological growth stages of three maize hybrids recorded in 2025

BBCH code	Phenological growth stages	Zanettix DUO		Hexxagone DUO		Elaraxx DUO		Year
		M	CR	M	C	M	CR	
0	Dry seed (caryopsis)	23.4.2025	23.4.2025	23.4.2025	23.4.2025	23.4.2025	23.4.2025	2025
09	Emergence: coleoptile penetrates soil surface	28.4.2025	29.4.2025	29.4.2025	29.4.2025	30.4.2025	30.4.2025	
13	Three leaves unfolded	7.5.2025	7.5.2025	7.5.2025	8.5.2025	9.5.2025	9.5.2025	
15	Five leaves unfolded	18.5.2025	18.5.2025	18.5.2025	18.5.2025	18.5.2025	18.5.2025	
19	Nine leaves unfolded	5.6.2025	5.6.2025	5.6.2025	5.6.2025	5.6.2025	5.6.2025	
51	Tasseling	23.6.2025	23.6.2025	25.6.2025	25.6.2025	28.6.2025	28.6.2025	
73	Milk maturity stage	4.7.2025	4.7.2025	5.7.2025	5.7.2025	10.7.2025	10.7.2025	
83	Dough maturity stage	18.7.2025	18.7.2025	18.7.2025	18.7.2025	30.7.2025	30.7.2025	
89	Full maturity stage	14.08.2025	14.08.2025	18.08.2025	18.08.2025	26.08.2025	26.08.2025	
Vegetation period, days		114	114	118	118	126	126	

An important phenological indicator is the number of days from sowing to the tasseling of the plants. On average for the period 2024 – 2025, the Zanettix DUO hybrid reaches this phenophase in 60.5 days in both growing systems. The Hexxagone DUO maize hybrid reaches it in 64.5 and 63.5 days when grown as a monoculture and after a winter wheat preceding crop, in that order. The Elaraxx DUO hybrid's tassel emerges the latest – 67.5 (M) and 68 (C) days after sowing.

The appearance of the upper parts of the tassel and the presence of visible anthers from the middle part of the tassel marks the beginning of flowering in maize hybrids. During the first experimental year, it began on average 3.5 days after tasseling for all three hybrids, while in the second year, the phase started on the 4th day after tasseling, regardless of the cropping system.

The temperature during flowering is of utmost importance for the normal development of the plants, with 25-28 °C being considered optimal (Ivanov and Zhekova, 2022). Considering that during this period, the average maximum temperatures were 38 °C, the conditions for the progression of the phase were unfavorable. Nevertheless, irrigation contributed to a greater extent to reducing the negative impact of high temperatures.

Comparatively to 2025, a shorter duration of the interphase period from milk maturity to full maturity in 2024 was observed. This may primarily result from the higher air temperatures recorded in July, 2024 that have a significant impact by shortening the interphase periods.

In 2024, the length of the growing season of the Zanetixx DUO and Hexxagone DUO hybrids in both cropping systems was 122 and 131 days, respectively. Elaraxx DUO, grown after winter wheat preceding crop, was harvested 1 day earlier (138 days) than in the monoculture variant (139 days). The vegetation periods in the second experimental year were significantly shorter – 114, 118 and 126 days for the Zanetixx DUO, Hexxagone DUO and Elaraxx DUO hybrids, respectively, with no difference in the number of days between the variants. The data from the analysis show that for the experimental years 2024 and 2025, no significant differences were found between the duration of the phases and the length of the growing season of the hybrids grown as a monoculture and in crop rotation with winter wheat. Mono-cropping does not negatively affect the phenological development of plants.

The following ten tables present the results related to plant biometrics and productivity. Although genetically determined, plant height is directly influenced by environmental factors (Tahir et al., 2008). The total height of the hybrids (cm) was measured at the milk maturity phenophase, when stem elongation has already ceased because the plant has entered reproductive development (Lin et al., 1995; Peiffer et al., 2014). There are significant differences between the two cropping systems in the Hexxagone DUO hybrid in the first year and the Elaraxx DUO hybrid in the second year, both of which are in favor of crop rotation.

Table 3. Maize plant height, cm

Rotations	2024	2025
Zanetixx DUO		
Crop rotation	227.17	246.67
Monoculture	223.92	247.50
Rotation 1/ Rotation 2	Ns	ns
Hexxagone DUO		
Crop rotation	257.50	274.33
Monoculture	234.97	278.42
Rotation 1/ Rotation 2	*	ns
Elaraxx DUO		
Crop rotation	264.92	292.25
Monoculture	263.17	269.58
Rotation 1/ Rotation 2	Ns	*

Asterix (*) indicates a significant difference ($P \leq 0.05$) between cultivar means based on an independent t-test; ns = non-significant.

The number of leaves per plant did not vary significantly not only between the two cropping systems, but also among the different hybrids.

The point of the plant where the main ear is set is essential for optimizing the mechanized harvesting of the crop (Stoyanova et al., 2021). The variation in total plant height largely depends on the height at which the main ear is set, as the two traits were strongly correlated (Gyenes-Hegyí et al., 2002; Valková & Petrovská, 2015). In the second experimental year, when grown as a monoculture, the main ears of the Hexxagone DUO and Elaraxx DUO hybrids were set lower than in crop rotation.

Table 4. Maize total leaves per plant

Rotations	2024	2025
Zanetixx DUO		
Crop rotation	14.55	14.13
Monoculture	14.48	14.13
Rotation 1/ Rotation 2	Ns	ns
Hexxagone DUO		
Crop rotation	14.95	14.45
Monoculture	14.68	14.15
Rotation 1/ Rotation 2	*	*
Elaraxx DUO		
Crop rotation	15.12	14.48
Monoculture	14.75	14.40
Rotation 1/ Rotation 2	*	ns

Asterix (*) indicates a significant difference ($P \leq 0.05$) between cultivar means based on an independent t-test; ns = non-significant.

Table 5. Maize height of the main ear, cm

Rotations	2024	2025
Zanetixx DUO		
Crop rotation	89.83	112.67
Monoculture	84.75	114.33
Rotation 1/ Rotation 2	*	ns
Hexxagone DUO		
Crop rotation	98.33	125.58
Monoculture	96.25	119.5
Rotation 1/ Rotation 2	Ns	*
Elaraxx DUO		
Crop rotation	91.00	121.75
Monoculture	98.67	110.33
Rotation 1/ Rotation 2	*	*

Asterix (*) indicates a significant difference ($P \leq 0.05$) between cultivar means based on an independent t-test; ns = non-significant.

Table 6. Maize length of the ear, cm

Rotations	2024	2025
Zanetixx DUO		
Crop rotation	20.12	20.56
Monoculture	20.98	19.71
Rotation 1/ Rotation 2	*	*
Hexxagone DUO		
Crop rotation	19.50	20.58
Monoculture	19.17	19.57
Rotation 1/ Rotation 2	Ns	ns
Elaraxx DUO		
Crop rotation	20.47	21.00
Monoculture	21.23	20.43
Rotation 1/ Rotation 2	*	*

Asterix (*) indicates a significant difference ($P \leq 0.05$) between cultivar means based on an independent t-test; ns = non-significant.

Statistically proven, the length of the ear in the second year of the experiment was higher in hybrids grown after a wheat as a preceding crop. In 2024, there was no such trend, and even in two of the hybrids, higher ears' length was recorded in continuous cultivation.

Crop rotation also positively affects the ear diameter trait of all the maize hybrids, as was evident from the data obtained from the second year of the experiment.

In 2025, after a several years of mono-cropping, a significant decrease of the ear weight of the hybrids Zanetixx DUO and Elaraxx DUO was observed. However, this did not hold true for the Hexxagone DUO hybrid, where there was no difference in this trait between the two cultivation systems.

Table 7. Maize ear diameter, cm

Rotations	2024	2025
Zanetixx DUO		
Crop rotation	3.80	4.56
Monoculture	4.00	4.30
Rotation 1/ Rotation 2	*	*
Hexxagone DUO		
Crop rotation	3.93	4.77
Monoculture	3.79	4.51
Rotation 1/ Rotation 2	*	*
Elaraxx DUO		
Crop rotation	4.62	4.89
Monoculture	4.21	4.57
Rotation 1/ Rotation 2	*	*

Asterix (*) indicates a significant difference ($P \leq 0.05$) between cultivar means based on an independent t-test; ns = non-significant.

Table 8. Maize ear weight, g

Rotations	2024	2025
Zanetixx DUO		
Crop rotation	204.53	190.84
Monoculture	165.34	178.99
Rotation 1/ Rotation 2	*	*
Hexxagone DUO		
Crop rotation	205.35	232.74
Monoculture	198.82	233.71
Rotation 1/ Rotation 2	Ns	ns
Elaraxx DUO		
Crop rotation	224.56	245.36
Monoculture	224.94	190.64
Rotation 1/ Rotation 2	Ns	*

Asterix (*) indicates a significant difference ($P \leq 0.05$) between cultivar means based on an independent t-test; ns = non-significant.

A severe decrease in the values of both the number of seeds per ear and maize seeds weight was noted as a result of continuous cultivation of maize hybrids. Maize cob weight trait follows the same tendency.

Table 9. Maize number of seeds per ear

Rotations	2024	2025
Zanetixx DUO		
Crop rotation	606.88	715.67
Monoculture	608.15	629.30
Rotation 1/ Rotation 2	Ns	*
Hexxagone DUO		
Crop rotation	616.27	723.60
Monoculture	618.87	647.72
Rotation 1/ Rotation 2	Ns	*
Elaraxx DUO		
Crop rotation	686.61	722.36
Monoculture	704.46	691.03
Rotation 1/ Rotation 2	*	*

Asterix (*) indicates a significant difference ($P \leq 0.05$) between cultivar means based on an independent t-test; ns = non-significant.

Table 10. Maize seeds weight, g

Rotations	2024	2025
Zanetixx DUO		
Crop rotation	158.97	180.40
Monoculture	169.58	144.11
Rotation 1/ Rotation 2	*	*
Hexxagone DUO		
Crop rotation	179.51	209.23
Monoculture	185.87	178.99
Rotation 1/ Rotation 2	Ns	*
Elaraxx DUO		
Crop rotation	207.02	216.48
Monoculture	198.67	164.30
Rotation 1/ Rotation 2	Ns	*

Asterix (*) indicates a significant difference ($P \leq 0.05$) between cultivar means based on an independent t-test; ns = non-significant.

The cob, once separated from the ear, is considered an organic waste material, but it has successfully found applications in many industrial sectors (Pinto et al., 2012). For the purposes of the experiment, determining the cob weight was used to calculate the grain extraction rate from the ear. The value of this trait increases or decreases in direct proportion to the weight of the ear from which the cob was taken.

Although growing the hybrids as a monoculture did not have a negative impact on the size of yields in the first experimental year, the data shown in Table 12 shows that they marked a significant decline in the second year by 200 to 300 kilograms.

Table 11. Maize cob weight, g

Rotations	2024	2025
Zanetixx DUO		
Crop rotation	19.85	24.13
Monoculture	20.82	21.22
Rotation 1/ Rotation 2	Ns	*
Hexxagone DUO		
Crop rotation	19.31	23.51
Monoculture	19.45	21.39
Rotation 1/ Rotation 2	Ns	*
Elaraxx DUO		
Crop rotation	26.26	28.88
Monoculture	25.64	26.34
Rotation 1/ Rotation 2	Ns	*

Asterix (*) indicates a significant difference ($P \leq 0.05$) between cultivar means based on an independent t-test; ns = non-significant.

Table 12. Maize seed yield, kg/da

Rotations	2024	2025
Zanetixx DUO		
Crop rotation	953.81	1082.42
Monoculture	1017.46	864.69
Rotation 1/ Rotation 2	Ns	*
Hexxagone DUO		
Crop rotation	1077.07	1255.39
Monoculture	1115.20	1073.04
Rotation 1/ Rotation 2	Ns	*
Elaraxx DUO		
Crop rotation	1242.16	1298.89
Monoculture	1192.05	985.82
Rotation 1/ Rotation 2	Ns	ns

Asterix (*) indicates a significant difference ($P \leq 0.05$) between cultivar means based on an independent t-test; ns = non-significant.

CONCLUSIONS

No significant differences were found between the duration of the phases and the length of the growing season of the hybrids grown as a monoculture and in crop rotation with winter wheat. Mono-cropping does not negatively affect the phenological development of the plants for the period 2024-2025.

All evaluated parameters were positively affected by crop rotation with a preceding crop winter wheat. Statistically significant lower values of these traits were recorded during the second experimental year as a result of the continuous cultivation of maize on the same field.

Monoculture cultivation affects negatively yields of the maize hybrids. In the second year of the experiment, a considerable decrease in the yields of the maize hybrids was observed.

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