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Original article

Assessment of the Transition from Conventional Soil Tillage to Minimum Tillage Technology in A Maize Crop with Three Hybrids – A Three-Year Case Study in Lanurile, Constanța County

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Abstract

The present study aims to evaluate the impact of transitioning from conventional soil tillage to minimum tillage technology in a maize crop, cultivated over a three-year period (2022–2024) in the village of Lanurile, Constanța County, Romania. The experiment was conducted under real farm conditions and involved three late-maturing maize hybrids: DKC 5810, P0900, and P0216. The crop was grown on partially irrigated land. Soil preparation consisted of a single pass with a cultivator, followed by precision sowing, while all other technological inputs (fertilization, crop protection, and irrigation management) were kept constant across the hybrids and over the years. The agromorphological and biometric determinations revealed superior performance for the DKC 5810 hybrid, followed by P0900. Differences in productivity parameters, such as grain weight per ear and thousand-kernel weight (TKW), were statistically validated using one-way ANOVA tests, confirming significant distinctions between hybrids ($p < 0.05$). The DKC 5810 hybrid recorded the highest average kernel weight and TKW, while also achieving the greatest yield per hectare. P0900 also demonstrated high adaptability and yield potential, particularly under irrigation. In contrast, P0216, although showing vigorous vegetative development, accumulated lower grain mass and yielded less compared to the other two.

Climatic analysis over the study period showed a consistent increase in mean annual temperatures and a significant decrease in rainfall, especially during critical phenological stages such as flowering and grain filling. These climatic trends emphasized the importance of water management. The irrigation applied in four key growth stages successfully offset part of the rainfall deficit and supported optimal crop development. The results demonstrate that minimum tillage, when properly implemented under the specific pedoclimatic conditions of Dobrogea and combined with efficient irrigation and hybrid selection, can ensure competitive yields. This conservation practice reduces soil disturbance, minimizes erosion and compaction, and preserves soil moisture critical factors in semi-arid regions. Therefore, minimum tillage represents a viable and sustainable alternative to conventional tillage in areas facing water scarcity and climate variability. These findings highlight the importance of hybrid selection aligned with specific tillage practices and climate adaptability. DKC 5810 is recommended for high-input, irrigated systems, while P0900 proves stable and productive in moderately intensive conditions. Further research is encouraged across other regions to validate these results and guide sustainable maize production strategies in Romania.

Keywords: Minimum Tillage, Maize Hybrids, Sustainable Agriculture, Irrigation, Climate Change.

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INTRODUCTION

Cereals represent the crop group with the widest distribution and the greatest importance for human nutrition, providing approximately 60% of total proteins, 15% of lipids, and around 70% of carbohydrates, contributing 50–60% to the global caloric intake (Roman et al., 2015; Dobre, 2019). The success of cereal crops is explained by a combination of favorable factors: high ecological plasticity, complete mechanization, easy storage, and multiple utilization possibilities – human food, animal feed, industry, biofuels (Messegue, 2000).

Maize (Zea mays L.) holds a central place among cereals, both in terms of cultivated area and versatility of uses. In Romania, maize is extensively cultivated due to its nutritional value and high production capacity, being used for human consumption, animal feed, and industrial purposes (Cristea et al., 2004; Ion, 2010). In human nutrition, maize appears in various forms: flour (polenta), flakes, sweet corn, or popcorn (Paukert, 2021). Industrially, maize kernels are a raw material for obtaining starch, glucose, oil, as well as products such as bioethanol, spirits, and starch-based cosmetics (Petcu and Martura, 2018). However, the largest part of global production (over 60%) is destined for animal feed, being considered an essential forage, especially for ruminants (Sin, 2000).

Globally, maize is cultivated up to 59° northern latitude and 43° southern latitude, demonstrating great adaptability. Romania benefits from favorable soil and climatic conditions, being one of the European countries with significant maize cultivation areas (Popescu, 1995; Panaitescu and Niță, 2011). Nevertheless, achieving maximum productive potential requires the application of modern technologies that address current climatic challenges and agricultural sustainability requirements (Petcu and Martura, 2018).

In this context, in recent years there has been a growing interest in adopting conservation tillage technologies, such as minimum tillage, which limit mechanical interventions on the soil, thus reducing compaction, water loss, and erosion. Recent studies (FAO, 2023; ISTIS, 2024) confirm the effectiveness of these practices in maintaining soil structure and increasing farm sustainability. In Romania, although conventional technology remains predominant in many regions, more and more farms are exploring conservation methods, especially in drought-affected areas or where input costs must be reduced.

This study analyzes the technological transition from conventional soil tillage to minimum tillage in a maize crop on a farm located in Lanurile, Constanța County, over a three-year period, using three hybrids and maintaining the other technological elements constant. The purpose of the study is to evaluate the impact of this transition on yield, crop economics, and the adaptability of the hybrids to the new soil working conditions.

In the context of climate change and increasing pressures on natural resources, adopting conservation technologies such as minimum tillage represents a strategic direction for sustainable agriculture, with reduced impact on soil structure and soil biodiversity. Recent studies highlight that these technologies can contribute to reducing fuel consumption, conserving soil moisture, and maintaining fertility in semi-arid areas such as Dobrogea (Popa et al., 2023).

Furthermore, the selection of maize hybrids with high potential and enhanced adaptability to variable pedoclimatic conditions is essential in the current context. Recent results emphasize the need for field testing of biological material in correlation with cultivation technology in order to efficiently capitalize on productive potential (Ioniță et al., 2022).

MATERIAL AND METHOD

The aim of this study was the comparative evaluation of the performance of three late-maturing maize hybrids cultivated under minimum tillage system in a representative area of Constanța County, over a period of three consecutive years. The study focused on analyzing the agro-biological and economic performances of the three hybrids under the region's specific soil and climatic conditions, in the context of transitioning from conventional soil tillage technologies.

The experiment was carried out on the farm of I.I. Iancu Ionuț, located in Lanurile, Constanța County, in the center of the Medgidia Plateau. The locality is situated approximately 50 km from the city of Constanța. The total area of the commune is 421 hectares of intravilan (built-up area) and 18,071 hectares of extravilan (non-built-up area). According to climatic data, the area belongs to the temperate-continental steppe climate type, characterized by an average annual temperature of 11.12°C, with January minimums of 0.2°C and July maximums of 22.1°C. The average annual precipitation is around 428 mm. The dominant soils are fertile chernozems, typical of steppe regions, favorable for agriculture.

The main agrotechnical characteristics of the experimental area: the preceding crop was wheat, and maize crops were established on 60 ha, 57 ha, and 85 ha in the years 2022, 2023, and 2024, respectively. Sowing was carried out after a shallow tillage operation using a combinator, uniformly applied in all three springs (characterized by cool and wet conditions, with persistent rainfall in April 2022 and 2023), aimed at accelerating soil warming and fragmenting remaining plant residues. This was the only soil intervention prior to sowing, specific to the minimum tillage system.

All care operations and phytosanitary treatments were identical across the three growing seasons, to allow for an objective evaluation of the hybrids' response exclusively to soil technology and annual pedoclimatic conditions.

Regarding biological material, three late-maturing maize hybrids registered in the Official Catalogue of Plant Varieties of Romania for 2022 and 2023 were used: DKC 5810 (Bayer): FAO 450–490 hybrid, RM 108, medium plant height, high seedling vigor, deep rooting system, without tillering; P0216 (Pioneer – Corteva): FAO 450 hybrid, high yield potential, suitable for early and optimal sowing, excellent performance under various growing conditions; P0900 (Pioneer – Corteva): FAO 450 hybrid, late-maturing, designed for intensive technologies (under irrigation or abundant rainfall), with good drought tolerance.

The experiment was conducted in open field conditions, under real farm conditions. Throughout the vegetation period, the main developmental phenophases of the hybrids were monitored (emergence, tillering, flowering, physiological maturity), tracking: vegetative growth dynamics, adaptability to climatic conditions, uniformity of emergence and development, behavior towards diseases and pests, and final yield per hectare.

Measurements were performed directly in the field, at the Iancu Ionuț Individual Enterprise farm, as well as in the laboratory, for detailed analyses regarding grain weight, thousand kernel weight (TKW), and other relevant qualitative characteristics.

RESULTS AND DISCUSSION

In the conducted experiment, the preceding crop was winter wheat, chosen in accordance with the predominant crop structure of the farm and the crop rotation system applied at the farm level. The distribution of crops and the average yields per hectare are presented in the tables below, providing an overview of the implemented crop rotation system.

Table 1. Crop structure within I.I. Iancu Enterprise during the years 2022–2024

Year	Crop plant				
	Wheat	**Maize**	**Barley**	**Sunflower**	**Rapessed**
2022	85	60	50	35	20
2023	83	57	40	40	30
2024	90	85	20	30	25

Table 2. Average crop yields within I.I. Iancu Enterprise during the years 2022–2024

Year	Crop plant				
	Wheat	**Maize**	**Barley**	**Sunflower**	**Rapessed**
2022	4830	6320	5070	2265	2145
2023	5000	6800	5150	2500	2500
2024	5500	7700	5050	2720	2300

Chemical fertilization within the study was carefully structured into three distinct stages, each corresponding to key developmental phases of the maize crop. The first stage, basic fertilization, took place in the autumn, prior to sowing. Here, 200 kg/ha of complex NPK fertilizer (20:20:20) was applied pre-emergence, aiming to provide the essential nutrients needed to support vigorous early growth. As the crop progressed, foliar fertilization was carried out at the 4-leaf stage, using Plonvit foliar fertilizer (produced by Intermag) at a rate of 2 L/ha, diluted in 300 liters of solution per hectare. This application was intended to stimulate physiological processes and enhance vegetative development. Later, at the 10-

leaf stage, nitrogen fertilization was performed by administering 100 kg/ha of solid nitrogen, supporting the formation of inflorescences and the accumulation of dry matter within the grains.

Due to the nature of the minimum tillage system, where soil disturbance is minimized to conserve water resources and preserve soil structure, climatic conditions during the growing season played a pivotal role in influencing maize performance.

Soil preparation consisted of a single combinator pass, carried out two days before sowing: on April 24 in 2022, and April 25 in both 2023 and 2024. This light soil work enabled sufficient fragmentation, leveling, and aeration to create an optimal seedbed. Precision sowing was performed during the optimal window for the Dobrogea region: on April 25 in 2022, and on April 27 for the following two years. Favorable rainfall levels in April supported good seed germination and uniform seedling emergence across the experimental plots.

Climate analysis for Lanurile village over the agricultural period 2022–2024 (Table 3) revealed a consistent rise in monthly average temperatures compared to multiannual norms. The average annual temperature during the study period was recorded at 13.78°C, exceeding the historical mean of 11.12°C by 2.66°C—an increase of approximately 24%. This upward trend persisted throughout the entire agricultural cycle, affecting not only the colder months, when soil water reserves are usually replenished, but also the critical vegetation stages, thereby intensifying plant metabolism and increasing their water demands.

Meanwhile, rainfall patterns showed a downward trend, with an annual average of 357.3 mm, marking a deficit of 70.8 mm relative to the multiannual average of 428.1 mm. This reduction, representing 16.55%, was especially evident during May, July, and August—months critical for maize development, as these periods coincide with the crop's highest water needs during pollination and grain formation. The resulting imbalance between water availability and plant demand likely posed a significant limiting factor for hybrid performance, particularly under conservation tillage systems where soil water reserves are crucial for crop success.

Table 3. Temperature and precipitation regime in Lanurile Locality during the agricultural years 2022–2024

Month	Average monthly temperature ⁰C		Precipitation mm	
	Normală	**2022-2024**	**Normală**	**2022-2024**
XI	6.9	8,8	37,5	35,1
XII	2,1	3,6	32,2	28,5
I	0,2	4,8	31,6	40,6
II	1,1	2,9	32,8	22,1
III	3,9	6,8	22,1	24,5
IV	10,1	10,1	33,1	51,2
V	15,8	16,6	48,7	10,8
VI	19,9	21,8	52,6	44,6
VII	22,1	25,8	34,7	21,1
VIII	22,7	26,1	31,1	20,8
IX	17,2	21,2	40,8	30,1
X	11,5	16,9	30,9	27,9
Average	11,12	13,78	428,1	357,3

To objectively assess the statistical significance of the climatic differences between the normal multiannual values and those recorded during the study period, a descriptive statistical analysis was conducted, supplemented by a simplified one-way ANOVA test. The statistical results indicated p-values greater than 0.05 for both temperature ($p = 0.45$) and precipitation ($p = 0.16$), suggesting that, within this limited sample, the observed differences were not statistically significant. Nevertheless, the identified climatic trends—progressive warming and reduced precipitation—have clear agronomic relevance and can decisively influence crop performance, especially under minimum tillage systems.

Thus, it can be concluded that, although the statistical analysis did not confirm rigorous mathematical significance, the recorded climatic values (Figure 1) support field observations and may contribute to a better understanding of the yield variability of the analyzed hybrids under this technological system.

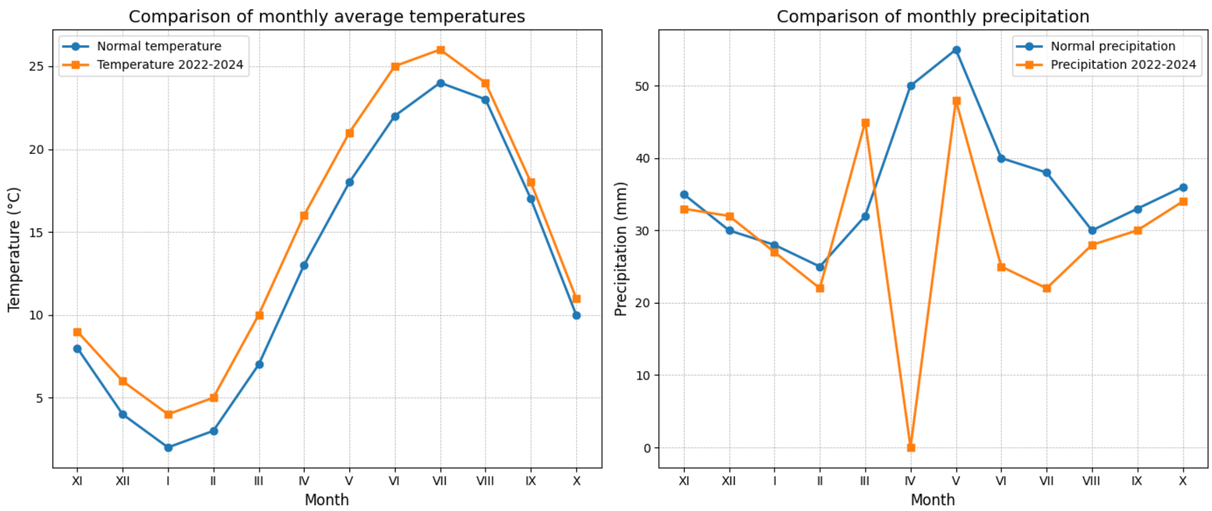


Figure 1. Comparative graphs of monthly average temperatures, monthly average precipitation, and multiannual normals

In the experiment, maize sowing was carried out at a depth of 6 cm using precision planters, maintaining a row spacing of 70 cm. The sowing density was set at 78,000 harvestable plants per hectare, adapted to the potential of the hybrids used and the availability of irrigation over 60 hectares out of the total 85 hectares cultivated with the three hybrids. The seeding rate was 27 kg/ha.

Weed control was performed both mechanically and chemically, following an integrated plant protection program. Three days after sowing, a pre-emergent herbicide treatment was applied using Callisto 480 SC (Syngenta) at a rate of 330 ml/ha to control broadleaf weeds and grasses. At the same time, the insecticide Decis Expert (Bayer) was applied at a rate of 125 ml/ha, targeting key pests during early vegetative stages, such as *Diabrotica virgifera virgifera* (Western corn rootworm) and *Helicoverpa armigera* (corn earworm). The solution was prepared at a volume of 250 L/ha.

Upon entry into the active vegetative growth phase, a post-emergent treatment with Equip (Bayer) herbicide was applied at a rate of 1.5 L/ha to combat invasive species such as *Setaria viridis* (green foxtail) and *Sorghum halepense* (Johnsongrass). This treatment was combined with the foliar fertilizer Plonvit (2 L/ha in 300 L solution/ha) and a preventive fungicide, as part of an integrated technological package.

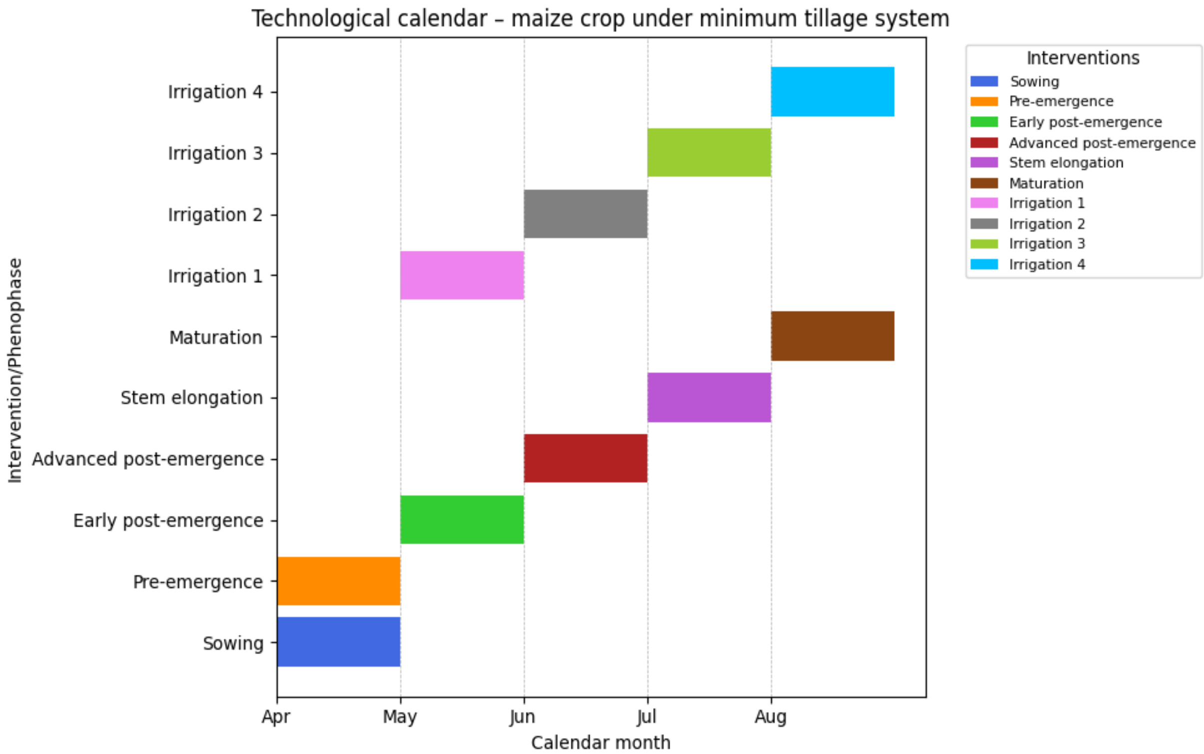
Regarding disease control, two fungicide treatments were applied using Propulse (Bayer) at a rate of 1 L/ha. The first treatment was carried out at the 6–8 leaf stage, concurrently with foliar fertilization and the second herbicide application. The second treatment was applied during the stem elongation phase to prevent infections caused by *Helminthosporium turcicum*, the pathogen responsible for northern corn leaf blight.

Mechanical weed control was performed through inter-row cultivation at a depth of 8 cm, a stage that coincided with the application of solid nitrogen fertilization, completing the nutritional plan (Tables 4 and 5).

Table 4. Overview of treatments applied throughout the study period

No.	Stage	Product	Intervention Purpose
1.	Pre-emergence – 3 days after sowing	Calisto 480SC+Decis Expert	Weed and pest control
2.	Post-emergence 4–6 leaves	Equip+Plonvit+fungicide	Control of Johnsongrass, green foxtail, nutrition, and disease prevention
3.	Post-emergence 6–8 leaves	Propulse 1L/ha+Plonvit	Preventive fungicide treatment and foliar nutrition
4.	Stem elongation	Propulse 1L/ha	Control of northern corn leaf blight
5.	Mechanical cultivation	Inter-row cultivation at 8 cm depth	Mechanical weed control
6.	Nitrogen fertilization	100kg azot/ha	In-vegetation fertilization
7.	Irigation 1	700m³/ha	Irrigation – stable emergence
8.	Irigation 2	700m³/ha	Irrigation – 10–12 leaf stage
9.	Irigation 3	700m³/ha	Irrigation – tasseling
10.	Irigation 4	700m³/ha	Irrigation – maturation

Table 5. Technological schedule of maize during the study years



Due to the deficient rainfall regime during the agricultural years under study, four sprinkler irrigations were performed using a Hipodron-type linear pivot system. The first irrigation was conducted starting on May 20, applying 700 m³/ha, followed by a second irrigation in June when the plants were at the 10–12 leaf stage, with the same irrigation rate. The third irrigation took place at tasseling, during the first ten days of July, and the fourth was performed in August, all maintaining a constant application rate of 700 m³/ha.

The controlled application of irrigation, correlated with minimum tillage practices, aimed to maintain a favorable soil moisture regime, especially during critical periods for maize development, thus supporting the physiological processes and productive potential of the analyzed hybrids.

The maize crop was harvested mechanically using a Claas Tucano 320 agricultural combine once the plants had reached full physiological maturity. This stage was determined by the stabilization of grain moisture around 17–18%, a threshold uniformly attained by all three hybrids analyzed. Harvesting operations began after October 19, with the latest harvest recorded on October 27, 2024. The entire process involved grain harvesting, after which the grains were transported to the farm headquarters for storage and conditioning. In preparation for marketing, grain moisture was reduced to below 15%, considered optimal for safe storage and trading. The production was sold during the autumn season of the respective agricultural years under study.

Within the study, several agromorphological field measurements were also carried out to highlight the development characteristics of each hybrid under the specific soil and climatic conditions and technological system applied. One such determination involved counting the number of plants and double ears over a 10-meter row length on two adjacent rows. Based on the averages recorded over the three years, it was observed that the hybrid DKC 5810 had 40 plants on the first row, 11 of which developed double ears, and 38 plants on the second row, with 9 showing this trait. For the hybrid P0216, 39 plants were recorded on the first row, with 9 double-eared, and 38 plants on the second row, 6 of which exhibited the same characteristic. Hybrid P0900 stood out with a higher plant density, having 40 plants on the first row and 41 on the second row, with 10 double-eared plants in each case. This feature suggests a strong generative branching capacity, indicating a superior production potential, especially under favorable nutrition and moisture conditions.

Further measurements involved counting the total number of ears present on the same 10-meter row sections to obtain a clearer picture of the fruiting capacity. Hybrid DKC 5810 recorded an average of 98 ears, P0216 had 92 ears, and P0900 achieved 101 ears. These data correlate with the observed presence of double ears and confirm the superior yield potential of P0900 compared to the other two hybrids.

Another parameter evaluated was the average plant height, considered an indicator of vegetative vigor and uniform development. DKC 5810 registered an average height of 2.39 m, ranging between 2.27 m and 2.51 m. P0216 showed an average of 2.31 m, with minimum and maximum values of 2.24 m and 2.42 m, respectively. P0900, although the most productive, had a slightly lower average height of 2.28 m, with a range between 2.17 m and 2.37 m. These relatively small variations indicate good uniformity of the experimental plots and specific adaptability of each hybrid to the minimum tillage system.

An additional field measurement was the determination of the ear insertion height. The results were as follows: DKC 5810 had an average ear height of 95.23 cm, ranging from 80.93 cm to 108.4 cm; P0216 recorded an average of 94.31 cm, between 82.10 cm and 103.3 cm; P0900 had an average of 93.33 cm, ranging from 80.6 cm to 105.6 cm.

The field measurements provide a detailed and rigorous overview of the phenotypic behavior of the three maize hybrids in the context of minimum tillage technology and a deficit rainfall regime supplemented by rationalized irrigation. Morphological characteristics and the total number of ears reveal differentiated but consistently high productive capacity, offering valuable insights for selecting the optimal hybrid under such technological systems.

To further evaluate hybrid performance under minimum tillage conditions, additional biometric determinations were performed at the farm's headquarters before harvest. These included analyses of plant and ear weights at different preparation stages and detailed laboratory analyses of morphoproductive ear components.

For each hybrid, over the three study years, 10 mature plants with ears were harvested from two adjacent rows within the experimental plots. The first measurement focused on the total weight of plants at full physiological maturity. The average results were: DKC 5810: average plant weight of 770.27 g, ranging from 682.6 g to 830.2 g; P0900: average plant weight of 764.55 g, ranging between 667.1 g and 813.1 g; P0216: average plant weight of 731.59 g, with a range of 651.3 g to 811.1 g.

The second measurement targeted the weight of ears with husks, conducted two days before final harvest. After weighing the whole plants, the ears were separated and weighed individually. The average ear weights with husks were: DKC 5810: 289.3 g (ranging from 171.2 g to 358.8 g), with a residual plant biomass (excluding ears) averaging 480.92 g; P0900: 296.73 g (between 216.3 g and 331.1 g), with a residual biomass of 467.82 g; P0216: 230.64 g (ranging from 198.9 g to 308.2 g), with an average dry biomass of 500.95 g.

Detailed laboratory analyses continued with the measurement of ear weights without husks. After manually removing the husks, the ears were reweighed. The average values were: DKC 5810: 264.39 g (ranging from 150.8 g to 337.8 g), with an average husk mass of 24.91 g; P0900: 261.07 g (ranging from

194.7 g to 302.0 g), with an average husk mass of 35.66 g; P0216: 205.44 g (ranging from 168.9 g to 279.4 g), with an average husk mass of 25.2 g.

These results highlight clear differences in biomass structure and dry matter accumulation capacity among the three hybrids. Although hybrid P0216 exhibited a comparable total plant mass, the ear weights, both with and without husks, were visibly lower, suggesting a higher proportion of vegetative mass relative to productive structures. Conversely, hybrids DKC 5810 and P0900 demonstrated a more favorable ratio between total plant mass and ear mass, indicating superior efficiency in resource allocation toward generative structures.

Table 6. Measurement of husk-free ear weight at physiological maturity

Plant no.	Hybrid DKC 5810 (g.)	Hybrid P0900 (g.)	Hybrid P0216 (g.)
1.	223,4	215,2	184,1
2.	337,8	281,4	216
3.	318,8	296,9	279,4
4.	298,7	267,2	219,8
5.	279,2	280	224
6.	228,5	236,1	186,4
7.	150,8	269,2	188,6
8.	268,4	194,7	201,4
9.	258,3	302	168,9
10.	280	268	185,8
Minimum	150,8	194,7	168,9
Maximum	337,8	302	279,4
Average	264,39	261,07	205,44

To provide a detailed characterization of the morpho-productive elements of the analyzed hybrids, following the previous determinations, measurements of ear length without husks were conducted, followed by the determination of cob weight. This analysis was carried out on the same ears used for the weight measurements, after complete removal of the kernels. The average results, calculated over the three years of study, highlighted the following: the hybrid DKC 5810 presented an average ear length of 21 cm and an average cob weight of 22.39 g, with values ranging between 19.42 g and 27.5 g. For hybrid P0900, the average ear length was 20 cm, and the cob weight was higher, with an average of 25.59 g, ranging from 17.1 g to 35.8 g. Hybrid P0216 also recorded an average ear length of 20 cm, with an average cob weight of 23.03 g, ranging between 17.15 g and 31.61 g.

To evaluate the real productive potential of the ears, an additional determination was made by individually counting the kernels, one by one, on a batch of ten samples for each hybrid, across the three study years. The analysis revealed that: DKC 5810 had an average of 546 kernels per ear, ranging from 412 to 612. P0900 recorded an average of 554 kernels per ear, with values between 502 and 618. P0216 showed a lower average of 490 kernels per ear, ranging between 408 and 596.

These differences indicate a higher kernel density and spikelet fertility in hybrid P0900, supporting its previously observed productive performances.

The final determinations targeted the total kernel weight per ear, thousand kernel weight (TKW), and final yield per hectare (Table 7), obtained by weighing ten distinct samples for each hybrid. The average results over the three years of study were as follows: for DKC 5810, the average kernel weight per ear was 241.37 g, with values ranging between 128.7 g and 316 g. The thousand kernel weight (TKW) recorded an average of 442.07 g, and the average yield per hectare was 11,430 kg. P0900 showed an average kernel weight of 235.64 g (ranging from 171.5 g to 280.1 g), a TKW of 425.35 g, and an average yield of 10,780 kg/ha. In the case of P0216, the average kernel weight was 180.33 g, with values between 148.1 g and 233.6 g, a TKW of 408.02 g, and an average yield of 10,300 kg/ha.

Table 7. Measurement of grain weight per ear in the three maize hybrids under study

Plant no.	Hybrid DKC 5810 (g.)	Hybrid P0900 (g.)	Hybrid P0216 (g.)
1.	203,98	198,1	163,1
2.	316	258,3	189,3
3.	298,05	270,83	233,6
4.	274,6	232,28	198,78
5.	251,43	258,6	199,56
6.	206,4	211,25	162,3
7.	128,7	243,3	161,92
8.	248,08	171,5	184,25
9.	230,8	280,1	148,1
10.	255,7	232,2	162,4
Minimum	128,7	171,5	148,1
Maximum	316	280,1	233,6
Average	241,37	235,64	180,33

The obtained data highlight that the hybrid DKC 5810 exhibited the best overall productive performance, benefiting from a favorable combination between kernel number, thousand kernel weight (TKW), and the kernel-to-cob ratio. Hybrid P0900 also proved to be highly competitive, demonstrating a high productivity level and stable agronomic behavior. In contrast, hybrid P0216, although characterized by a high vegetative biomass weight, accumulated a lower kernel mass, resulting in a lower yield compared to the other two hybrids.

To support the validity of the observed differences among the analyzed hybrids regarding kernel weight per ear, a one-way ANOVA (Analysis of Variance) was performed. The test aimed to evaluate the significance of differences between means, based on a set of simulated data corresponding to the experimental mean, minimum, and maximum values recorded for each hybrid.

The result of the analysis indicated a probability value (p) of 0.0226 ($p < 0.05$), meaning that the differences observed in kernel weights among the three hybrids are statistically significant, with a 95% confidence level. This finding experimentally validates the field and laboratory observations, where DKC 5810 consistently showed the best performance in terms of individual kernel weight, followed by P0900, while P0216 recorded lower values.

In addition to the analysis of individual kernel weights, a statistical evaluation of the thousand kernel weight (TKW) was also conducted, an important indicator for estimating the biological yield potential of hybrids. Based on the mean values recorded both in the field and in the laboratory, data series were simulated for each hybrid. The ANOVA analysis applied to these series produced a highly conclusive result, with a probability value (p) of 0.0000087, significantly lower than the 0.05 threshold.

This value confirms that the differences between the TKW values of the three hybrids are not random but reflect distinct genetic and physiological characteristics. Hybrid DKC 5810 stood out with the highest TKW, followed by P0900, while P0216 recorded the lowest value—an aspect directly correlated with the total yield obtained per hectare.

Therefore, the statistical analysis supports the empirical validity of the observed morpho-productive differences and confirms that the thousand kernel weight is a relevant and differentiating indicator of genetic potential, particularly under minimum tillage technology conditions.

These comprehensive determinations contribute to shaping a detailed productive profile of the three hybrids, revealing clear differences in their efficiency in converting resources into economically important biomass. Furthermore, they emphasize the importance of selecting the appropriate hybrid based on the applied technology, climatic conditions, and farm objectives. The biometric and laboratory determinations reinforce field observations and substantiate the physiological and productive distinctions among the three hybrids under the minimum tillage system, providing a solid basis for interpreting hybrid behavior under real farm conditions.

CONCLUSIONS

Following the study conducted at the Iancu Ionuț Individual Enterprise farm, located in Lanurile, Constanța County, it was demonstrated that the application of minimum tillage technology in maize cultivation, combined with a controlled irrigation system and the selection of appropriate hybrids, can deliver competitive productive results even under challenging climatic conditions.

The three-year field experiment showed that reduced soil tillage, performed through a single combinator pass, allowed the formation of a suitable seedbed and supported uniform emergence, despite the cool springs and frequent rains recorded in April. The climatic regime analyzed during the study period revealed a consistent increase in average monthly temperatures, both during the growing season and in the cold months, accompanied by a clear downward trend in precipitation. This climatic dynamic impacted crop behavior, particularly in the absence of additional water sources. Nevertheless, the application of sprinkler irrigation during four key maize developmental stages partially compensated for the water deficit and allowed the biological potential of the tested hybrids to be properly expressed.

The analyses performed in the field, on the farm, and in the phytotechnical laboratory provided a detailed picture of each hybrid's phenotypic behavior. Hybrid DKC 5810 stood out for its overall best performance, recording the highest values in most of the analyzed parameters: average kernel weight per ear, number of kernels, thousand kernel weight (TKW), and ultimately, yield per hectare. Hybrid P0900 also demonstrated excellent adaptability under intensive technology and irrigation conditions, showing consistent results. In contrast, P0216, despite its good vegetative development, recorded lower kernel mass, resulting in a lower yield compared to the other two hybrids.

The validity of the observed productive differences was further supported by the statistical analysis of experimental data. The ANOVA tests applied to kernel weight and TKW data highlighted statistically significant differences between the three hybrids, with p-values below the 0.05 threshold. These results confirm that the recorded yield differences are not random but rather reflect the genuine biological and adaptive potential of each genetic creation.

Based on these results, the continued application of the minimum tillage system is confidently recommended in areas with a climatic regime similar to that of Dobrogea, particularly in farms equipped with irrigation facilities. Hybrid selection should be made according to available resources and the technological objectives of each farming enterprise. Thus, DKC 5810 is recommended for farms with high inputs and irrigation, while P0900 can represent a viable and stable solution for moderate-input technologies. Careful climate monitoring, adaptive fertilization, and the application of phytosanitary treatments according to phenophases and pathogen pressure remain key factors in maximizing productive efficiency.

Furthermore, it is recommended to extend this type of study over a longer period and across other agricultural regions of the country, to validate the obtained conclusions and to develop precise regional recommendations within the framework of sustainable agriculture.

The three-year field experiment demonstrates that minimum tillage technology is a viable alternative to conventional practices, ensuring a proper seedbed and uniform emergence even under challenging climatic conditions. Consistent application of this system is recommended in regions with a climate similar to Dobrogea, especially on irrigated farms. Hybrid choice and input adaptation should be based on available resources and technological objectives to maximize productive efficiency. Careful climate monitoring and the implementation of flexible technologies remain key factors for long-term success.

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