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INFLUENCE OF SOWING DATES ON SEED YIELD AND HARVEST MOISTURE OF MAIZE HYBRID PARENTAL LINES

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Abstract

This study presents the findings of research aimed at determining the seed yield and harvesting moisture of inbred lines, parental components of maize hybrids of various FAO groups, depending on sowing dates in the agroecological conditions of the Forest-Steppe region of Ukraine. The research is based on the evaluation of different FAO group lines-parental components of Ukrainian breeding: early-maturing - OR26A (FAO 240), AV20B (FAO 260), OR28A (FAO 260); mid-maturing - OR32A (FAO 320), AV30B (FAO 320). The seed moisture content before harvest for the lines-parental components of hybrids varied within the FAO group and sowing dates. Yield calculation demonstrated that the realization of seed yield potential for each inbred line depends on the genotype and sowing dates. Improving the elements of variety agrotechnics for lines - parental components of maize hybrids of different FAO groups provides an opportunity to increase seed productivity of lines for timely seed provision of hybridization areas and the accelerated introduction of innovative hybrids into production.

***Key words**: maize, lines - parental components, sowing time, collecting seed moisture, seed yield.*

INTRODUCTION

Due to global climate changes, characterized by rising air temperatures, decreasing relative humidity, fluctuating and irregular precipitation, and an increase in the deficit of quality irrigation water, there is an urgent need to develop new innovative lines, parental components, and hybrids of maize. Additionally, the development of agrotechnological elements for their cultivation is essential. To cultivate maize without irrigation, it is crucial to maximize the use of soil moisture reserves during the autumn-winter period. Hence, an early start to sowing becomes necessary, requiring the creation of maize lines, parental components, and hybrids with enhanced cold resistance for early planting.
On the other hand, organic grain production without herbicide use favors late maize sowing, enabling weed control through mechanical means. Late planting allows for additional cultivation, contributing to better weed control (Гадзало et al., 2020).
Thus, the development of technology for early, optimal, and late planting of maize lines, parental components, and hybrids in the conditions of the Central Steppe of Ukraine is pertinent.
An essential aspect of maize cultivation technology is the application of different sowing dates, impacting plant growth, development, productivity, and the immunological state of crops. Ongoing discussions regarding the sowing dates of maize lines, parental components, recommend both earlier and later sowing compared to optimal timing. Researchers highlight the close connection between sowing dates and weather conditions during seed germination and early

plant development. Early sowing may be more effective than later sowing, but sowing in cold and unheated soil, followed by a return of cold weather, may be detrimental (Cantarero et al., 2000; Otegui et al., 1995; Shumway et al., 1992).

Considering the individual plant reactions, breeders create mid-early and early-maturing lines, parental components of maize hybrids belonging to the flint group, known for their increased cold resistance. This enables early planting since cold-resistant maize hybrids can germinate at a soil temperature of +6°C (Dang et al., 2016; Кирпа & Стюрко, 2014).

Delaying maize planting results in flowering occurring long after the summer solstice, and grain filling occurs closer to the end of the harvest season. As the sowing date is critical for grain setting and grain filling, any delay may negatively affect seed yield. It leads to a reduction in the number, size, and activity of germinating seeds, as well as a decrease in assimilation production through photosynthesis during the grain-filling period (Cirilo & Andrade, 1996; Tsimba et al., 2013).

Determining optimal planting dates is crucial for identifying critical processes in crop breeding modeling and developing strategies for creating new genetic material. Early-maturing lines often fail to fully utilize available solar radiation during favorable growth temperatures, thereby not realizing their full yield potential (Porter et al., 1998). Conversely, late-maturing lines may not ripen before the onset of the first frost. Late planting of early-maturing hybrids can sometimes equal or surpass late-maturing lines. Early-maturing lines may also be more profitable, as later hybrids may require additional artificial drying for safe storage (Saggenborg et al., 1999).

Analyzing literature review data leads to the conclusion that planting dates are a significant agronomic factor influencing seed yield in maize lines. There is no unanimous agreement among scientists regarding the optimal temperature to start planting maize. Therefore, studying the impact of planting dates on yield and harvesting moisture for new lines – parental components in Ukrainian breeding under the conditions of the Central Steppe of Ukraine is relevant.

The objective of this article is to determine the influence of planting dates on the yield and harvesting moisture of seed lines – parental components of maize hybrids from different FAO groups.

MATERIALS AND METHODS

Field experiments were conducted from 2019 to 2021 in the agricultural production cooperative "PEREMOHA" (Klepachi village, Khorol district, Poltava region) in the agro-ecological zone of the Central Forest-Steppe. The climate in the Central Forest-Steppe is moderately continental, with relatively mild, low-snow winters and warm, moderately humid summers. The soil of the research plot is typical chernozem. The cultivation practices for maize varieties in the experiments were generally accepted for the Forest-Steppe zone of Ukraine. The predecessor crop was soybean. The research was conducted following the field experiment methodology, and statistical analysis was carried out using variance analysis (Ушкаренко et al., 2009; Ушкаренко et al., 2014).

A two-factor study was set up using the method of randomized split blocks, with four repetitions. The planting area of the plots was 50.0 m², and the accounting area was 30.0 m². Factor A – planting date, with the following dates: 15.04, 25.04, 05.05, 15.05. Factor B – different FAO group lines, parental components of Ukrainian breeding: mid-early: OR–26A (FAO 240), AB–20B (FAO 260), OR–28A (FAO 260); mid-maturing: OR–32A (FAO 320), AB–30B (FAO 320).

RESULTS AND DISCUSSIONS

The conducted experimental studies revealed a significant impact of planting dates on the development of plants and the yield formation of seed lines – parental components of maize hybrids from different FAO groups. Depending on the experimental factors, the crops are subjected to varying agrometeorological conditions, resulting in diverse growth patterns and development, ultimately leading to variable productivity.

During the investigations from 2019 to 2021, the indicator "seed yield" for hybrids from different FAO groups varied depending on planting dates, ranging from 2.43 to 4.44 tons per hectare (Figure 1).

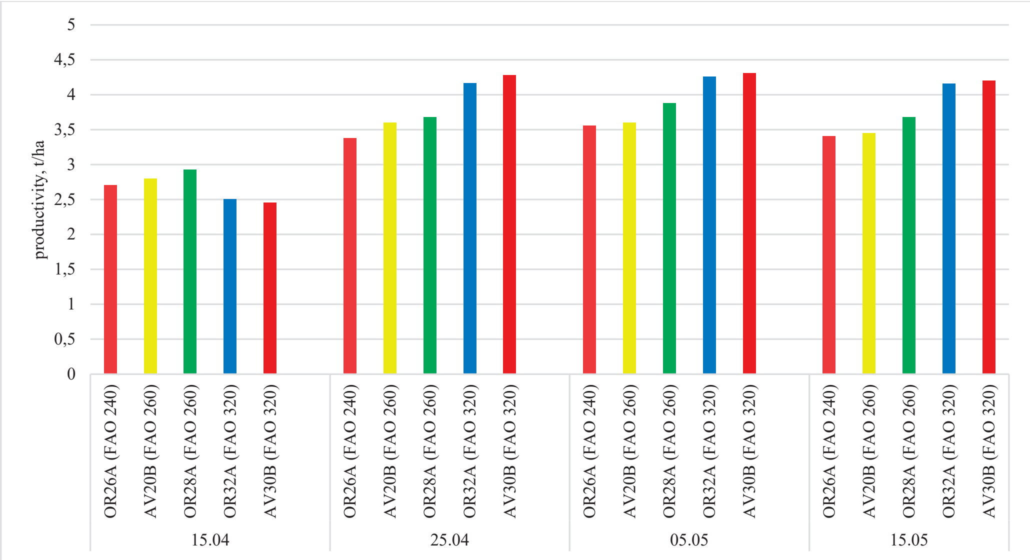

Figure 1. Seed Yield of Parental Lines of Maize Hybrids at 14% Moisture Content, Depending on Planting Dates, t/ha

According to the results of the conducted research, it has been determined that the parental lines of maize hybrids from different FAO groups demonstrated maximum yield for later planting dates.

Mid-early line OR–26A (FAO 240) showed maximum seed yield in 2019 and 2021 for planting on 05.05, with 3.61 and 3.65 t/ha, respectively. In 2020, for planting on 15.05, it recorded a seed yield of 3.59 t/ha. The minimum yield of 2.66 t/ha was observed for planting on 15.04, resulting in a yield reduction of 0.99 t/ha, or 26.4%.

Mid-early line AB–20B (FAO 260) demonstrated maximum seed yield in 2019 and 2021 for planting on 05.05, with 3.71 and 3.72 t/ha, respectively. In 2020, for planting on 15.05, it recorded a seed yield of 3.70 t/ha. The minimum yield of 2.77 t/ha was observed for planting on 15.04, resulting in a yield reduction of 0.95 t/ha, or 25.5%.

Mid-early line OR–28A (FAO 260) exhibited maximum seed yield in 2019 and 2021 for planting on 05.05, with 3.96 and 4.11 t/ha, respectively. In 2020, for planting on 15.05, it recorded a seed yield of 3.87 t/ha. The minimum yield of 2.89 t/ha was observed for planting on 15.04, resulting in a yield reduction of 1.22 t/ha, or 29.6%.

Mid-early line OR–32A (FAO 320) showed maximum seed yield in 2019 and 2021 for planting on 05.05, with 4.37 and 4.35 t/ha, respectively. In 2020, for planting on 15.05, it recorded a seed yield of 4.40 t/ha. The minimum yield of 2.47 t/ha was observed for planting on 15.04, resulting in a yield reduction of 1.93 t/ha, or 43.9%.

Mid-early line AB–30B (FAO 320) demonstrated maximum seed yield in 2019 and 2021 for planting on 05.05, with 4.40 and 4.42 t/ha, respectively. In 2020, for planting on 15.05, it recorded a seed yield of 4.44 t/ha. The minimum yield of 2.43 t/ha was observed for planting on 15.04, resulting in a yield reduction of 2.01 t/ha, or 45.3%.

In recent years, there has been an increased demand for simple maize hybrids in the Ukrainian market. Production practices indicate that these hybrids are characterized by high yields, technological efficiency, disease resistance, and uniformity in key morphological indicators. However, it is challenging to combine a complex of valuable economic traits with a high degree of stability in performance.

The low harvest moisture content of maize seeds is primarily determined by the duration of the vegetation period, with early maturity being the dominant factor.

Figure 2 presents data on seed moisture content before harvest. During the 2019–2021 research period, this indicator for the seeds of parent lines – components of hybrids from different FAO groups – varied within the FAO groups and planting dates.

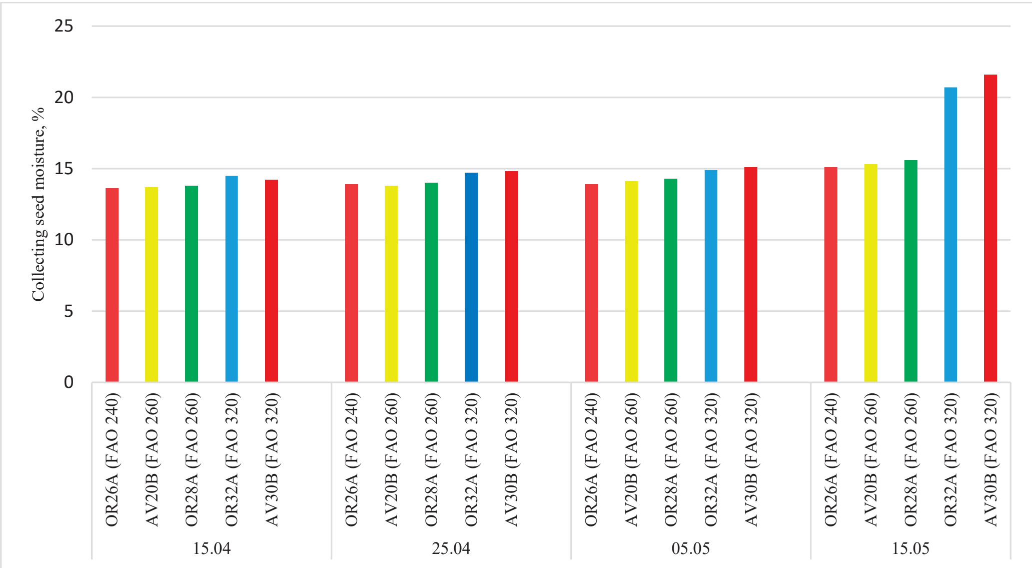

Figure 2. Harvest moisture content of parent lines - components depending on sowing dates, % (average for 2019-2021)

In addition to the main additional costs for grain drying, grain quality losses from *Fusarium rots* also directly depend on the moisture content of cobs. Therefore, production is extremely interested in low harvest moisture. Low harvest moisture also depends on harvesting dates, and delaying harvesting and postponing it to late autumn does not bring the expected natural grain drying due to low moisture release rates at low temperatures and secondary moisture absorption during autumn rains.

The seed moisture of all parent lines – components of maize hybrids from different FAO groups at the time of harvesting ranged from 12.9% to 22.9%, indicating the extraordinary importance of studying this indicator as a primary indicator of maize cultivation technology, high efficiency, and profitability. The variation in this indicator is explained by different sowing dates and FAO groups of lines.

The maximum data for the "grain moisture" indicator, 14.9–22.9%, for all maize lines were observed for sowing on 15.05, and the minimum moisture content of the grain, 12.9-15.1%, was observed for sowing on 15.04. Regarding the dependence of harvest moisture on the FAO groups of lines, a pattern was observed: minimal grain moisture was characteristic of the OR–26A line, 12.9-15.4%, while the maximum was observed for the OR–32A (FAO 320) and AV–30B (FAO 320) lines, 13.9–22.9%.

Thus, practically all lines, except for the FAO 320 hybrids, had baseline grain moisture at the time of harvesting, allowing for post-harvest drying. This is important in the process of forming energy-efficient technologies for growing agricultural crops.

Production is interested in maize harvesting dates that fall in the early third decade of September when the forecasted moisture is less dependent on weather fluctuations.

The difference in grain moisture depending on sowing dates was more clearly defined in lines with an extended vegetation period. These lines, such as OR–32A (FAO 320) and AV–

30B (FAO 320), had variations in seed moisture ranging from 6.6% to 7.9%, comparing early with late sowing dates. The difference in seed moisture between early and optimal dates in the OR–32A (FAO 320) and AV–30B (FAO 320) lines was significantly smaller (from 0.5 to 1.3%). This can be explained by the fact that the "sowing – emergence" period for the early sowing date was more extended, and the difference in calendar time for emergence was significantly less compared to calendar sowing dates.

The harvest moisture of lines FAO 240–260 for early, optimal, and late dates was almost at the same level. This indicates that the ripening period of these genotypes fell in August, when there is low relative air humidity, high day and night temperatures, promoting accelerated moisture release and a reduction in moisture to minimum levels, below which natural seed moisture practically does not decrease.

Improving the elements of variety agronomy for parent lines of maize hybrids from different FAO groups provides an opportunity to increase the seed productivity of the crop.

CONCLUSIONS

Each FAO group of parent lines of maize hybrids in the conditions of the Central Steppe of Ukraine has its optimal sowing date. The mid-ripening line OR–26A (FAO 240) showed the maximum seed yield in 2019 and 2021 for sowing on 05.05-3.61 and 3.65 t/ha, respectively, in 2020 for sowing on 15.05-3.59 t/ha. The minimum yield of 2.66 t/ha was recorded for sowing on 15.04, resulting in a yield decrease of 0.99 t/ha or 26.4%. The mid-ripening line AB–20B (FAO 260) showed the maximum seed yield in 2019 and 2021 for sowing on 05.05-3.71 and 3.72 t/ha, in 2020 for sowing on 15.05-3.70 t/ha. The minimum yield of 2.77 t/ha was recorded for sowing on 15.04, resulting in a yield decrease of 0.95 t/ha or 25.5%. The mid-ripening line OR–28A (FAO 260) showed the maximum seed yield in 2019 and 2021 for sowing on 05.05-3.96 and 4.11 t/ha, in 2020 for sowing on 15.05-3.87 t/ha. The minimum yield of 2.89 t/ha was recorded for sowing on 15.04, resulting in a yield decrease of 1.22 t/ha or 29.6%. The mid-ripening line OR–32A (FAO 320) showed the maximum seed yield in 2019 and 2021 for sowing on 05.05-4.37 and 4.35 t/ha, in 2020 for sowing on 15.05-4.40 t/ha. The minimum yield of 2.47 t/ha was recorded for sowing on 15.04, resulting in a yield decrease of 1.93 t/ha or 43.9%. The mid-ripening line AB–30B (FAO 320) showed the maximum seed yield in 2019 and 2021 for sowing on 05.05-4.40 and 4.42 t/ha, in 2020 for sowing on 15.05-4.44 t/ha. The minimum yield of 2.43 t/ha was recorded for sowing on 15.04, resulting in a yield decrease of 2.01 t/ha or 45.3%. Minimum grain moisture values of 12.9-15.1% were observed for sowing on 15.04, and the minimum seed moisture of 12.9-15.4% was charcteristic of the OR–26A line.

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MISCELLANEOUS