Ph.D. Thesis

THE ROLE OF THE SOWING DATE IN THE DEVELOPMENT OF HYBRID-SPECIFIC TECHNOLOGIES IN MAIZE PRODUCTION

Enikő Bene

Supervisor:
Dr. Mihály Sárvári
Professor

UNIVERSITY OF DEBRECEN
Hankóczy Jenő Doctoral School of Crop Production, Horticulture and Food Sciences

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1. INTRODUCTION, OBJECTIVES

In maize production, besides growing factors, biological bases also have outstanding importance. The productive capacity is one of the most important criteria in choosing a hybrid. Nowadays the genetic productive capacity of maize hybrids reaches even 31-32 t ha-1. Due to the current anomalies of the weather, in order to exploit a better yield potential of maize exploitation of the elements of the production technology is needed.

Competitiveness of maize production is influenced by fluctuating yields at a great extent. As a consequence of global warming, 64% of the last 30 years was draughty, and in order to reduce the unfavourable effects, it is expedient to apply a modern agrotechnique which corresponds with the needs of the plant, adjusts to the production conditions and reduces the ecological extremes. Also, the applied sowing technology should be given a key role. Due to the climate change, the early sowing of maize at the end of March and at the beginning of April, when the upper layer of the soil still has an adequate moisture content for germination, is becoming more and more important. Besides soil moisture, the main factor determining the sowing date is the soil temperature, which, due to global warming and mainly in the central and the southern part of Hungary, reaches and even exceeds 10 °C already at the beginning of April, depending on the soil type. With an earlier sowing date the physiological ripening occurs earlier as a result of which the grain moisture content at harvest decreases significantly, increasing the efficiency of production. On the contrary the later sowing date, which increases the grain moisture content, and in a draughty year, decreases the thousand grain weight and the yield. These reasons justify that among the agrotechnical factors, we have to place great emphasis on choosing the right sowing date.

Based on the aspects listed above, the objectives of my research were the following:

- To determine the optimum sowing date interval of maize hybrids with different genetic characteristics and growing season. To observe the correlations between the sowing date, the yield and yield stability.
- To reveal the effect of given abiotic factors on the yield.

- To give it in numbers, how the sowing date affects emergence, plant height, anthesis and silking.
- To determine the relationship between the sowing date and the dynamics of water release of the grain during ripening.
- To analyse how the generative parts of the plant change depending on the sowing date, to reveal interactions.
- To determine the effect of the leaf area of maize hybrids (LAI) and the photosynthesis on the yield, from the aspect of the sowing date.
- To analyse and quantify correlations between the sowing date, the yield, the efficiency of production and the yield quality.
- To demonstrate the effect of growing factors on the yield by the division of variance components.

The modern plant production technologies, choosing the appropriate hybrid, the professional application of the sowing date are all the important elements of sustainable production and are the basic conditions for reducing expenditures and for the increase of efficiency. Maize hybrids will be needed which can sustain their yield stability even in extreme weather conditions. In the future, for sustainable maize production, a great emphasis needs to be put on research and innovation.

2. MATERIAL AND METHODS

The experiment examining the response of maize hybrids to the sowing date took place in the demonstration garden of the Institute of Plant Sciences of University of Debrecen, with the supervision of professor Mihály Sárvári, in years 2012-2014, the weather data of which are shown in Figure 1. In the experiment, in the 3 tested years, uniform NPK fertilization (N 120, P_2O_5 80, K_2O 110 kg/ha active agent), plant care according to farm conditions and chemical weed control were applied. Plots of the experiment (15.2 m^2) were arranged in 3 replicates.

The two main examined factors of my experiment were the sowing date of maize and the applied biological bases. My main purpose was the assessment of their common effect on the yield, the yield stability and the efficiency of production.

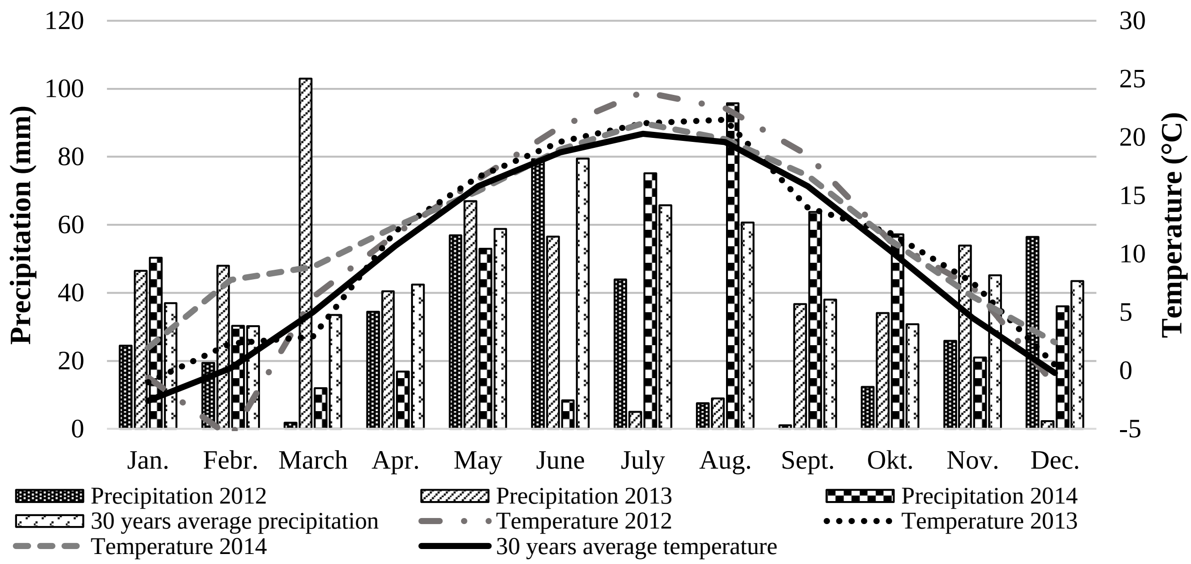

Figure 1: The change of the precipitation and temperature (Debrecen, 2012-2014)

Soil characteristics of the experimental area

In Debrecen, on the location of the experiment, the type of the soil is eluviated chernozem, the top layer of the soil does not contain lime, thickness of the mould layer is 50-70 cm, the subsoil water is in 7-9 m depth. Organic matter content of the soil is 2.6 %.

Due to lack of lime, top layer of the soil is dry, in dry crop years it tends to be parched. Considering the chemical reaction of the soil, it has a slightly acidic, nearly neutral pH, optimal for the nutrient intake of plants. Based on the soil plasticity according to Arany, which shows the physical type of the soil, it is loam soil category. The feature of the lime content of the soil is given by carbonated lime that is present in traces. The soil of the experiment has a medium AL-soluble phosphorous and potassium supply.

The test methods applied in the experiment

In years 2012-2014, 12 maize hybrids with different growing seasons and breeding (Table 1) were tested to determine the correlation between the sowing date and the productivity. We had quantified the relationship between the cold tolerance of the hybrids, sowing time, yields and grain moisture content.

Table 1: The examinated maize hybrids in the investigation

2012.		**2013.**		**2014.**	
Hybrids	**FAO number**	**Hybrids**	**FAO number**	**Hybrids**	**FAO number**
Sarolta	290	Sarolta	290	Sarolta	290
P9578	320	P9578	320	P9578	320
NK Octet	350	NK Octet	350	NK Lucius	330
DKC 4590	350	DKC 4590	350	DKC 4590	350
Kamaria	370	Kamaria	370	Kamaria	370
PR37N01	380	PR37N01	380	PR37N01	380
DA Sonka	390	DA Sonka	390	DA Sonka	390
Szegedi 386	390	Szegedi 386	390	Szegedi 386	390
P9494	390	P9494	390	P9494	390
NK Columbia	450	Miranda	460	Miranda	460
Miranda	460	DKC 4983	410	DKC 4983	410
DKC 4983	410	P0216	490	P0216	490

During those 3 years of the test, the response of biological bases to the crop year and sowing dates was monitored. That covered, on one hand, the examination of the productive capacity, the dynamics of water release, and the grain moisture content at harvest, and on the other hand, several other factors were analysed. Phenological observations were made, where the plant height and the anthesis and silking were measured. With detecting how the net photosynthetic activity, the leaf area index (LAI), the generative parts and the nutritional parameters changed with the different sowing dates, a large amount of data had become available, which made it possible to quantify the interactions between those factors mentioned.

Our aim, along with a number of other examinations, was to detect how the sowing date influences the change of the leaf area and the photosynthetic activity of maize hybrids, and how those factors affect crop formation and the yield. In the experiment, the change of the leaf area and the photosynthesis of 4 hybrids were tested, in each year uniformly those of hybrids P9578, DKC 4590, Kamaria and Da Sonka. The leaf area index was examined 4 times in each year. From the values of LAI, between two dates of measurement, based on the growth index of the leaf area duration (LAD), and the productivity index (PI) and the cumulated assimilation area (CAT) created by professor Péter Pepó were calculated.

In two years (2012 and 2013), on 4 occasions in each year, we measured the photosynthetic activity, and in one year (in 2014) the relative chlorophyll content was measured. We measured the photosynthesis of the leaf above the cob on two leaves, making 6 measurements on each leaf.

In 2014, the relative chlorophyll concentration of the leaves was determined, which was also recalculated based on the photosynthetic capacity index (Ph.C.) created by professor Péter Pepó.

After the physiological ripening the dynamics of the water release of the hybrids were tested weekly. The dynamics of ripening was tested with hybrids P9578, DKC 4590, Kamaria, DA Sonka, Szegedi 386, and DKC 4983.

Among quality parameters, the crude protein, crude oil and starch content was analysed with 3 sowing dates. Also, after harvest, we detected how the crop forming elements like cob length, the number of grain rows, the number of grains per row, the thousand grain weight and the shelling rate changed.

The evaluation of the data gained from the sowing date experiment were processed by Sváb's two-factor analysis of variance (1981), linear and parabolic regression analysis, and Pearson’s correlation analysis, Microsoft Office Excel (2013) and SPSS 22.0 programmes.

3. RESULTS AND DISCUSSION

3.1. The effect of the sowing date on the phenological characteristics of maize

Time of emergence, flowering time

During the examination the sowing date and the meteorological conditions determined the number of the days to emergence from sowing, but it is important that primarily it is not the sowing is what the time of emergence depends on. The sowing technique, the circumstances of production and the crop year together have a determinative effect on the time of emergence of maize. The interaction between the sowing date and the time of emergence can be crucial for the crop of maize hybrids, thus one of the possibilities to exploit the genetic yield potential lies in the quality of emergence.

According to the test results, importance of the sowing date was shown also in the process of flowering. With March sowing dates the anthesis and the silking fell into the second half of June, while with later sowing dates the time of flowering shifted to 3-4 weeks later.

Plant height

The height of maize hybrids was significantly determined by both the crop year and the sowing dates as well. Due to the stalk strength of modern hybrids, even the nearly 300 cm height did not cause lodging for the hybrids tested in the experiment. Breeding for this quality still remains determining in the future.

In years 2012 and 2013, the correlation between plant height and the yield was positive and of r=0.578** and r=0.407** value, i.e. on significance level $SD_{1\%}$, there is a medium close stochastic dependence. According to the significance of the correlation coefficient, the correlation between the two variables can be owed to the effect of the treatments, in both cases. The effect of the sowing date was determinative only in 2014, where the value of the correlation between the plant height and the sowing date is r=0.539**. The most outstanding year was 2012 when, except hybrids Sarolta, DKC 4590 and PR37N01, plants were the highest. Test year 2013 was similar, but in 2014 the plants were considerably shorter. The biggest difference was detected with DKC 4590, where plants were shorter than they were in 2012 by 57.2 cm and by 65.0 cm compared to 2013.

3.2. The effect of the sowing date and the crop year on the physiological indicators of maize

Leaf area index (LAI)

Based on the examination results it can be concluded that the leaf area had a determinative role with the different sowing dates. In 2012 and 2013 the maximum leaf area value was reached by the hybrids mostly with the 1st sowing date. In 2012, in each case, the highest leaf area values occurred with the highest yield results. However, in 2013, hybrid DKC 4590 produced the highest average yield with the lowest leaf area index, and hybrid DA Sonka, produced the lowest yield with its maximum leaf area measured with the 2nd sowing date. In 2014, most of the tested hybrids had the smallest leaf area with the 3rd sowing date when they produced the highest yield results. On the other hand, the maximum leaf area index resulted in significantly lower yield (Figure 2).

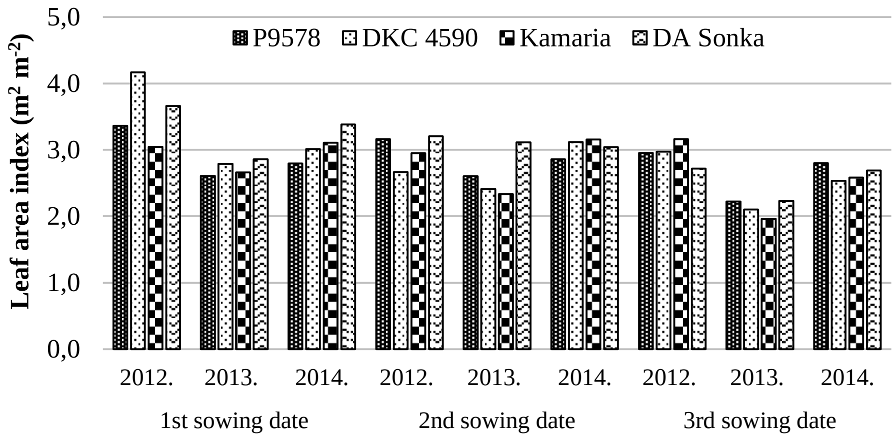

Figure 2: The leaf area index (LAI) of maize hybrids in the different sowing dates (Debrecen, 2012-2014)

Photosynthesis activity

During the testing of the net photosynthetic activity in 2012, the reducing effect of the later sowing dates on organic matter production became obvious (Figure 3). With later sowing dates the photosynthesis of the hybrids decreased. Hybrid P9578 showed the highest photosynthetic activity with the 1st sowing date, when it produced the highest yield result. The photosynthesis of hybrid DKC 4590 was the most intensive with the 2nd sowing date, but it produced the highest yield with the 1st sowing date. The postponed sowing dates reduced the photosynthesis and the yield of hybrid DA Sonka as well, thus it reached both the highest photosynthetic activity and the highest yield with the 1st sowing date. In 2013, the organic matter production of plants was also decreased by the delayed sowing dates. With hybrids Kamaria and DA Sonka, with the most intensive photosynthesis the highest yield occurred only with the 1st sowing date. Hybrid P9578 had the highest CO_2 production with the 2nd sowing date, when, however, it produced the lowest yield. Hybrid DKC 4590 with the 3rd sowing date had the maximum yield with the lowest photosynthesis.

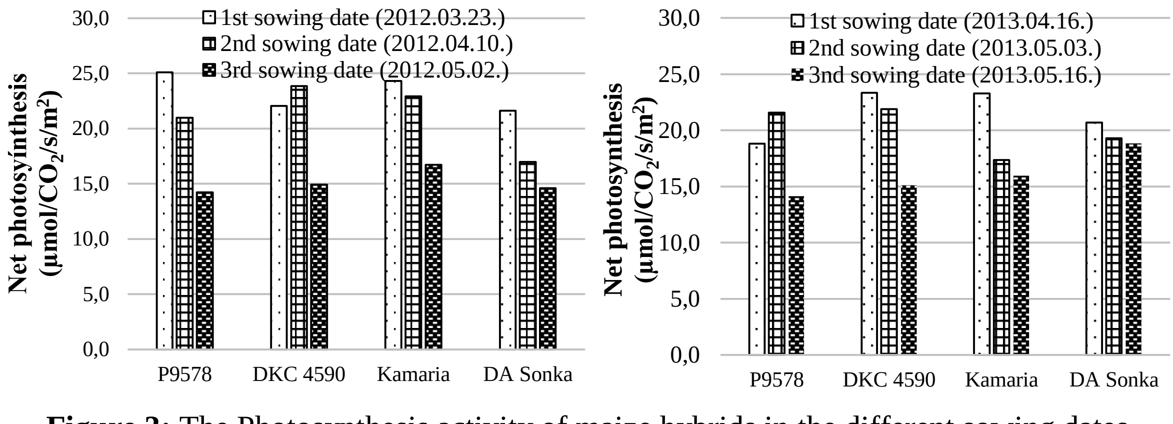

Figure 3: The Photosynthesis activity of maize hybrids in the different sowing dates (Debrecen, 2012-2013)

Photosynthetic capacity

In 2014, during the analysis of the photosynthetic capacity, the prominently high performance of the youngest plants with the 3rd sowing date was conspicuous (Figure

4), which can be explained by the different ripening periods. Ripening of the plants sown earlier started earlier than that of the late sown stands. With a delayed sowing date the ripening period is also longer, thus the carbon capture is also more intensive in the same period compared to the earlier sowing dates. DKC 4590 was the hybrid that had the best sowing date tolerance, since with each sowing date it produced the highest yield with the highest Ph.C. values.

The photosynthetic capacity showed a similar tendency to that of the yields, which proves also that in 2014 the photosynthesis had a significant role in crop formation through the organic matter accumulation. The correlation between the photosynthetic capacity and the yield was examined by linear regression analysis as well. The correlation between those two factors was very close (R^2=0.8593).

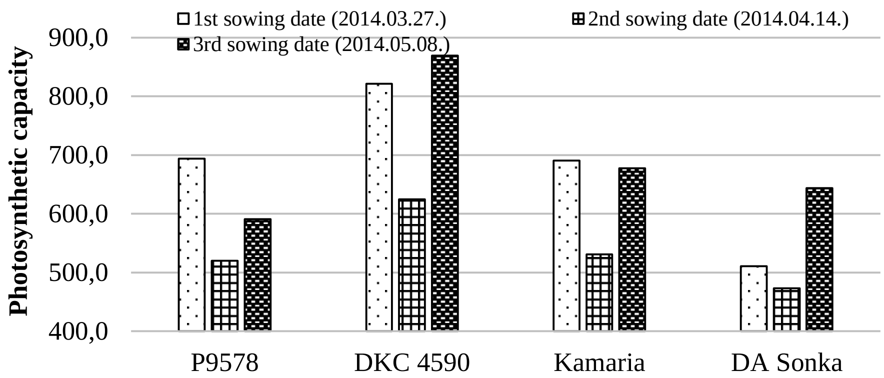

Figure 4: The photosynthetic capacity (Ph.C.) of maize hybrids in the different sowing dates (Debrecen, 2014)

The cumulated assimilation area (CAT), the leaf area duration (LAD), the productivity index (PI)

I gained the results of the cumulated assimilation area (CAT) by multiplying the LAI values measured in different points of time with each other. The accumulated anabolic area was significantly larger in 2012 than in the test year of 2014. According to Pearson's correlation analysis, in 2012 there was a close, positive, significant correlation (r=0.721**) between CAT and the yield.

During the examination of the leaf area duration (LAD) the plants maintained the active photosynthetic area for the longest time in 2012. In that year the LAD closely correlated (r=0.673*) to the yield, as the foliage maintained longer can produce more dry matter.

During the analysis of the productivity index (PI) a strong correlation (r=0.763**; r=0.918**) was observed between the PI and the yield in 2013 and 2014.

In each year a very close correlation could be detected between the cumulated assimilation area (CAT) and the leaf area duration (LAD) (r=0.982** in 2012; r=0.972** in 2013; r=0.917** in 2014). Also, in 2013 and 2014 during the correlation analysis a medium and a close stochastic dependence could be observed between the accumulated anabolic area and the productivity index (r=-0.601*), and between the leaf area duration and the productivity index (r=-0.727**). In 2014, there was also a negative, but close correlation between the CAT and the PI (r=-0.830**), and between the LAD and the PI (r=-0.880**).

3.3. The effect of the sowing date and the crop year on the yield of maize

Assessing the results of analysis examining the correlation between the sowing date and the yield, and between the sowing date and the grain moisture content at harvest in 3 test years, it can be concluded that the weather conditions in the different years were diverse .

In 2012 and 2013 the weak, negative statistical relationship between the sowing date and the yield (r=-0.394** and r=-0.298**) proves that with the delay of the sowing dates the yield decreased. On the other hand, in 2014, due to the favourable amount of rain the sowing dates did not cause considerable difference between the yield results.

However, the very close correlation between the grain moisture content at harvest and the sowing date had proven to be true. With the delay of the sowing date a significant, even more than 10% discrepancy can occur compared to a grain moisture content with an earlier sowing date. There was a medium stochastic dependence in 2012 and a close stochastic dependence in 2013 and 2014 between the analysed factors.

The correlation between the sowing date and the maize hybrids was considerably influenced by the amount of rain fallen during the growing season and its distribution in the 3 test years. In 2012 discrepancies between both the yields and the grain moisture contents with the different sowing dates were significant. Besides that, the difference between the performances of the hybrids was also remarkable.

In 2013, due to the rainy and cold weather in March, sowing could not be accomplished in time. The lack of rain in the period following that was determining during the growing season.

The year of 2014 was also extreme, which occurred not with the draughty months in summer, but the unfavourable distribution of rainfall. Harvest was postponed with 2-3 weeks because of the lower total heat in the growing season and the rainy months of August and September.

The effect of the crop year on the yield is clearly shown by the maximum yields and the grain moisture contents at harvest (Table 2). Both in 2012 and 2013, the hybrids reached the highest yield mostly with the 1st sowing date, while in 2014, 6 hybrids produced maximum yield with the 1st and 3-3 hybrids reached it with the 2nd and the 3rd sowing dates.

Table 2: The correlation between the sowing date, the maximum yield of the maize hybrids and the grain moisture content (Debrecen, 2012-2014)

Maturity group	Maximum yield ($t\ ha^{-1}$)	Sowing date for the maximum yield	Grain moisture content (%)
2012.			
FAO 290-350	12,4	23 March	11,0
FAO 370-390	12,7	23 March	11,1
FAO 410-460	11,6	23 March	12,7
$SD_{5\%}$ Hybrid	*0,5*		*0,6*
2013.			
FAO 290-350	11,5	16 May	29,5
FAO 370-390	12,7	16 April	13,9
FAO 410-490	12,2	3 May	17,7
$SD_{5\%}$ Hybrid	*0,6*		*1,3*
2014.			
FAO 290-350	13,2	8 May	26,2
FAO 370-390	12,0	8 May	23,8
FAO 410-490	13,0	27 March	17,1
$SD_{5\%}$ Hybrid	*0,7*		*1,3*

With the earlier sowing dates the grain moisture content at harvest is remarkably lower, where, compared to the later sowing dates, our results show that the water content of grains at harvest can be reduced even by 10-15%.

The costs of maize production per hectare are very high (220-260 thousand HUF ha^{-1}), which is mainly caused by the increasing prices of chemicals and fossil energy. Therefore it is important that the grain moisture content at harvest should be as low as possible, and thus the cost of drying should be as low as possible, too, since in an unfavourable situation it can reach or even exceed 30-35% of the production costs.

In 2012, due to the draughty conditions, it was favourable that ripening fell in a dry period, which helped the natural water release of maize. This was there was no need for drying with any of the sowing dates, which saved an appreciable part of the costs.

The results of the analysis of the costs occurred with the maize hybrids in 2013 and 2014 confirms that the postponed sowing dates increase the cost of drying. The higher grain moisture content at harvest caused by the sowing date later than the optimum generated 143-148 thousand HUF ha^{-1} extra cost with some hybrids compared to the earlier sowing date.

The effect of the applied agrotechnical factors like the hybrid and the sowing date on the yield could be assessed by the division of variance components. Based on that it could be determined at what extent the given factors in the given years contributed to the increase of the yield. In the calculation the minimum yield was taken as a base, and then the yield increase reached by the tested factors together was divided between the factors.

During analysing the 3 years together beside the effect of the hybrid and the sowing date, the effect of the crop year could also be taken into account. According to the results it can be assessed that the especially extreme weather of those 3 years had a determinative effect on the yield of maize. In the average of the years the part of the crop year was 44.4%-ban (3.9 t ha^{-1}), that of the sowing date was 31.4%-ban (2.7 t ha^{-1}) and that of the hybrid was 24.2% (2.1 t ha^{-1}) in the modification of the yield results of maize (Figure 5).

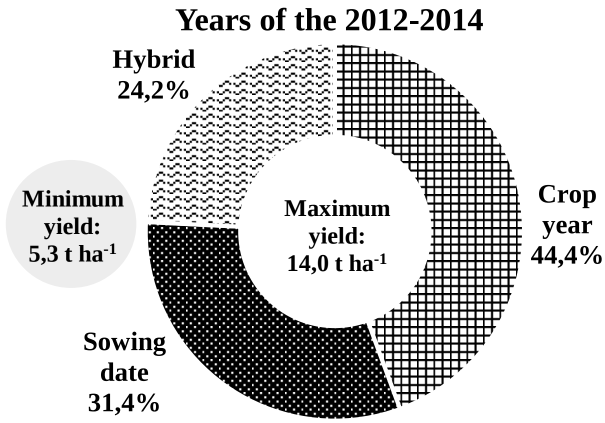

Figure 5: The effect of the sowing date, hybrid and the crop year in yield formation (Debrecen, 2012-2014)

3.5. The effect of the sowing date and the crop year on the crop formation factors of the tested maize hybrids

Among the hybrids, P9578, DA Sonka and Kamaria had an outstanding shelling rate. For hybrid P9578 every year was favourable. Both in 2012 (88.9%) and 2014 (89.8%) it proved its excellent grain-cob ratio. Even in the unfavourable year of 2013, beside hybrid DA Sonka (87.2%), P9578 had the highest measured value (86.9%). The weakest performance was observed with hybrid Sarolta (82.6-83.7%), and in 2014 the shelling rate of hybrid PR37N01 was only 81.3% (Figure 6).

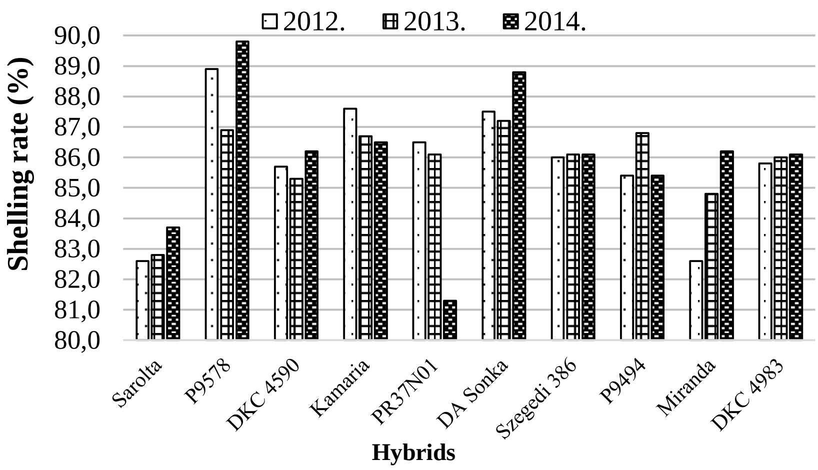

Figure 6: The change of the shelling rate in the average of the sowing date (Debrecen, 2012-2014)

Excepting hybrid Sarolta, all of the hybrids reached its highest thousand grain weight in 2014. Maximum values were produced by hybrids DKC 4590 (347.2 g), PR37N01 (374.6 g) and P9494 (357.1 g). Figure 7 shows that, in many cases the thousand grain weight increased at the same extent as the yield results, which confirms the correlation between the two factors (r=0.4269** in 2012; r=0.383** in 2013; r=0.493** in 2014).

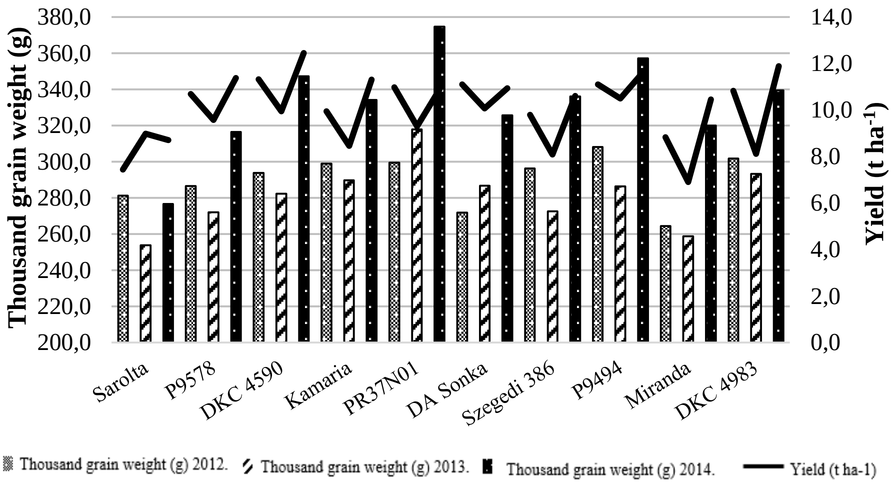

Figure 7: The change of the thousand grain weight in the average of the sowing date in the three examinated years (Debrecen, 2012-2014.)

3.6. The effect of the sowing date and the crop year on the nutritional parameters

Considering its starch content, hybrid DKC 4590 had stable results in the 3 years (73.4-73.6%). For the other hybrids 2013 was the most favourable year, when hybrids Kamaria (74.2%), PR37N01 (73.8%), Sarolta and DA Sonka (73.7%) were outstanding. Starch content of the grains was the lowest with hybrid P 9494 (73.2%). In the draughty year of 2012 hybrid DKC 4590 (73.6%), while in the year of 2014 with more favourable conditions hybrid Kamaria (73.5%) had the best performance.

In the oil yield the differences were smaller between the tested 2012-2014 years. The data gained from 2013 and 2014 were similar, but the data from 2012 had higher discrepancies. During the examination in each year hybrid Szegedi 386 had the best parameters, and with it in 2012 3.7%, in 2013 and 2014 approx. 4.6% oil contents were realized.

Analysing the 3 years with regard to the protein content, in 2012 hybrids Sarolta (10.2%), Miranda (9.8%) and Kamaria (9.7%), in 2014 hybrids Szegedi 386 (10.1%) and again Sarolta (9.7%) proved to be excellent among the tested hybrids. In 2013 the hybrids reached significantly lower values, and the crop year affected considerably only the protein content of hybrid DKC 4590 (9.0%).

In case of so minimal nutritional differences the yield dependent starch, protein and oil yield per hectare is also expedient to be taken into consideration. In case of the tested hybrids with the given sowing dates the bigger discrepancies occurred only in the starch content values of the yield.

In 2012 and 2013 the sowing dates caused significant differences in yield results, thus the starch yield changed according to the quantity of the crop. The starch content of the grain crop with the 1st sowing date significantly exceeded that with the other two sowing dates. In 2014 there were no considerable differences between the yields, thus the starch yields were not so different with the different sowing dates either. Among the hybrids the starch yield of DKC 4590 (9.2 and 8.4 t ha^{-1}), P9494 (9.2 t ha^{-1} and 9.3 t ha^{-1}), and also in 2014 that of DKC 4590 (9.7 t ha^{-1}) proved to be remarkable.

Based on the results it can be assessed that within the sowing technology the sowing date should also be applied specifically to the given hybrids. A lot depends on the choice of the genotype in terms of profitability. Because of the weather extremes of late years even more emphasis has to be laid on the choice of the biological bases. At sowing we don’t know what crop year is ahead of us, so a hybrid needs to be chosen which adjusts to the ecological conditions and gives the highest yield stability.

4. NOVEL SCIENTIFIC RESULTS

1. Results of our experiment proved that with a sowing date at the end of March the anthesis and the silking of maize occur even 3-4 weeks earlier compared with sowing dates at the end of April or in May, which is also affected by the growing season of the hybrid. The soil temperature data of the tested years confirm that in these days the soil temperature reaches the 8-10 °C good for the sowing of maize already at the end of March and the beginning of April. The earlier sowing within the interval was significant mainly in the draughty years of 2012 and 2013.
2. With the earlier sowing dates the hybrids reached the physiological ripeness earlier, the black layer occurred earlier, which resulted in a 10-15% lower grain moisture content at harvest.
3. The crop formation of maize was described by the photosynthetic capacity (Ph.C.) which had a close correlation with the yield (r=0.8593). Also, the cumulated assimilation area (CAT) and the productivity index (PI) were determined.
4. The effect of the sowing date modifying the crop forming elements (cob length, the number of grain rows, the number of grains per row) was little, as those were not modified significantly by the sowing date. A correlation was found only between the thousand grain weight and the yield, and between the factors a medium close correlation (r=0.383-0.493) was detected in each year.
5. It was observed that with the delay of the sowing date the shelling rate significantly increased, and was much more unfavourable compared to at the end of March sowing date. With the earlier sowing dates the weight ratio of grains was better by even 3-5%.
6. Based on the division of variance components annually and in the average of 3 years the effect of the factors on the yield was different. In a dry crop year the sowing date (58.1-74.2%), while in a favourable crop year the applied genotype (78.4%) modified the yield.

5. RESULTS APPLICABLE IN THE PRACTICE

1. Adjusting to the climate change the idea of the optimum interval of sowing dates needs reconsideration. Of course, hybrids with shorter growing season have a wider interval of the optimum sowing date, but also that agrotechnical factor has to be applied specifically to the given place of production and hybrid.
2. In practice, also for farms, determination of the optimum sowing date interval of hybrids by tests and the data of the close correlation between the sowing date-yield stability and the quality provide new learnings.
3. Based on our results, for the practice we recommend the application of several hybrids with different characteristics and growing seasons within a given farm, depending on the sown area, if it is possible, because growing only some hybrids that are similar to each other and have the same response to the environmental conditions can imply a high risk.
4. In case of a delayed sowing date, preferably not the drying of grains at harvest should be the chosen method.
5. Knowing the dynamics of water release of the hybrids helps to plan harvest in the ripening period.
6. The crop production was affected in average of the examined years 44.4% due to the weather extremities caused by the climate change, it can be a suitable solution to moderate the unfavorable effects to harmonize the interactions between agrotechnical factors.

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Neptun ID: JJ37DW
Doctoral School: Hankóczy Jenő Doctoral School of Crop Production, Horticulture and Food Sciences

List of publications related to the dissertation

Hungarian book chapter(s) (1)

1. **Bene E.**: A kukorica termesztéstechnológiájának fejlesztése a fenntartható növénytermesztésben. In: A fenntartható növénytermesztés fejlesztési lehetőségei : Prof. Dr. Sárvári Mihály 70 éves. Szerk.: Pepó Péter, Debreceni Egyetemi Kiadó, Debrecen, 233-239, 2014. ISBN: 9789634737414

Foreign language Hungarian book chapter(s) (1)

2. **Bene, E.**, Krivián, Á., Becze, Z.J.: Effect of agrotechnique on different genetic characteristics maize hybrids for production. In: The influence of some technological elements over the weath and corn grains quality stored in Bihor and Hajdu Bihar counties. Ed.: Csajbók József, Debreceni Egyetem ATC Mezőgazdaságtudományi Kar, Debrecen, 3-7, 2013.

Hungarian scientific article(s) in Hungarian journal(s) (3)

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Address: 1 Egyetem tér, Debrecen 4032, Hungary Postal address: Pf. 39. Debrecen 4010, Hungary
Tel.: +36 52 410 443 Fax: +36 52 512 900/63847 E-mail: publikaciok@lib.unideb.hu, ¤ Web: www.lib.unideb.hu

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