

Biblid: 1821-4487 (2015) 19; 5; p 233-235
UDK: 633.15

Original Scientific Paper
 Originalni naučni rad

INFLUENCE OF HYBRID COMBINATIONS ON THE MAIZE SEED TRAITS

UTICAJ HIBRIDNE KOMBINACIJE NA OSOBINE SEMENA KUKURUZA

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ABSTRACT

In this paper the influence of hybrid on the particular traits of maize seed was examined. Four maize hybrids were tested on four locations. Analysed traits were: yield, ratio of seed fractions and germination by fractions. Yield differed among the hybrids. Hybrid ZP 427 achieved the highest yield per area unit (5,522.4 kg/ha), and ZP 434 had the lowest, with 2,357.8 kg/ha. The ratio of seed fractions differed significantly depending on the hybrid. Based on the results we can conclude that hybrid ZP 600 had the best ratio of fractions, with 76.2 % of small fraction. In all tested hybrids large fractions had higher germination efficiency. The highest average germination was observed in large fractions of hybrid ZP 666 (97.87 %), while the lowest germination was at small fractions of ZP 600 (92.38 %). On all three examined traits there was significant effect of both genotype and location, as well as their interaction.

Key words: maize, yield, seed fractions, germination.

REZIME

U radu je ispitivan uticaj hibrida na pojedine osobine semena kukuruza. Istraživanjem su obuhvaćena četiri ZP hibrida kukuruza različite genetičke osnove, čija je proizvodnja bila na četiri lokacije. U radu je analizirana proizvodnja semena pomenutih hibrida u 2014. godini. Ispitivane su sledeće osobine: prinosa, procentualni odnos krupnih i sitnih frakcija semena i klijavost po frakcijama. Dobijeni rezultati su testirani analizom varijanse, a međusobna poređenja su vršena pomoću LSD testa. Hibridi su se razlikovali po visini prinosa. Hibrid ZP 427 ostvario je najveći prosečan prinosa po jedinici površine od 5.522,4 kg/ha, a najniži prinosa je imao hibrid ZP 434 koji je ostvario 2.357,8 kg/ha. Procentualno učešće krupnih i sitnih frakcija bilo je vrlo različito u zavisnosti od hibrida. Hibrid ZP 427 imao je 90% krupne i 10% sitne frakcije, hibrid ZP 434 ostvario je 70,8% krupne i 29,2% sitne frakcije, kod ZP 666 zabeleženo je 44,5% krupne i 55,5% sitne frakcije i na kraju ZP 600 imao je 23,8% krupne i 76,2% sitne frakcije. Na osnovu toga se može zaključiti da je kod hibrida ZP 600 zabeležen najbolji odnos frakcija, tj. sitnih frakcija ima 76,2% što daje više setvenih jedinica po hektaru. Što se klijavosti tiče, kod svih ispitivanih hibrida, krupne frakcije su imale veći procenat klijavosti. Najviša prosečna klijavost je zabeležena kod krupne frakcije hibrida ZP 666 (97,87%), dok je najniža klijavost bila kod sitne frakcije hibrida ZP 600 (92,38%). Kod ispoljavanja sve tri ispitivane osobine značajan uticaj su imali genotip i lokacija, kao i njihova interakcija.

Ključne reči: kukuruz, prinosa, frakcije semena, klijavost.

INTRODUCTION

Maize is one of the leading species in the global agricultural production ranking high in the world economy (Pavlov *et al.*, 2015). It is the first ranged crop on arable lands in Serbia. In the last decade period it was grown between 1.25 and 1.40 million hectares/year or near 40% of total arable lands (Tolimir *et al.*, 2006).

Achieving high yields per area unit while keeping maximum quality of seeds is very important in maize seed production. The hybrid maize seed production belongs to the group of advanced technologies and is much more complex, sensitive and expensive than the commercial maize production (Pavlov *et al.*, 2008, 2008a).

The production of seed of genetically pure maize inbred lines is the most important prerequisite for a high-quality production of certified seed of maize. (Pavlov *et al.*, 2008).

Seed yield per hectare is certainly one of the most important elements that directly affect profitability and efficiency of seed production. In order to achieve this, it is necessary to select yielding female components that will ensure high quality of produced seed. High quality seed means an appropriate 1000-kernel weight and high both, germination energy and total germination. This is very important, as each seed should produce new plant, which will be a bearer of yield.

The Maize Research Institute, Zemun Polje, organises its own system of seed quality control during the production, drying, processing and packing, which prevents non-compliances. There are three ISTA accredited seed testing laboratories in Serbia that test seeds during drying, processing and packing. Such a system of a maize seed production unites the use of scientific accomplishments - patents (released hybrids), natural conditions, capacities of drying, processing and packing of seeds, experts, marketing competences and transport capacities (Pavlov *et al.*, 2008; Milošević *et al.*, 2007).

This study presents the analysis of seed production of four hybrids sown in four different locations in 2014.

MATERIAL AND METHOD

Four hybrids of a diverse genetic origin (ZP 427, ZP 434, ZP 600 and ZP 666) were used in trails set for this study. These hybrids were sown in the following four locations in different maize growing regions in 2014: Sanad (Banat), Turija (Bačka), Žarkovac (Srem) and Hrastovača (Stig).

Sowing performed according to ZP maize growing practices was adapted to hybrids and agroecological conditions of growing regions (dry land farming – irrigation). The number of plants per area unit, female to male row ratio, sowing dates of parents as well as cropping practices from sowing to harvest were recommended.

Harvest was done with seed maize pickers. Drying and primary seed processing were done in processing plants according to production methods and organisation developed by the Maize Research Institute. Seed was primarily processed with 6.5-11-mm sieves, and then the 8.5-mm sieve was used to divide seeds into the large seed size fraction (8.5-11 mm) and the small seed size fraction (6.5-8.5 mm). Seed germination was analysed in the Seed Testing Laboratory of the Maize Research Institute by applying the FP standard method.

The following parameters were analysed in this study: yields over hybrids and locations, percentage share of small seed size fraction and seed germination over fractions.

Obtained results were processed by the two-factorial analysis of variance, while intercomparisons were done by using the least significant difference (LSD) test.

RESULTS AND DISCUSSION

The analysis of variance showed a significant effect of a genotype, production location and their interaction on all observed traits. The greatest effect of the genotype was recorded in the small seed size fraction.

Table 1. Yield (kg/ha) over hybrids and locations in 2014

Hybrid	Location				Average
	Banat	Srem	Sr. Bačka	Stig	
ZP 427	5130 c	6424 b	5031 c	3709 ef	5073.75 a
ZP 434	2120 h	2904 g	2250 h	2207 h	2370.25 d
ZP 600	4356 d	1960 h	3484 f	3912 e	3430.50 c
ZP 666	3721 ef	4238 d	6740 a	3495 f	4548.50 b
Average	3831.75 b	3884.25 b	4376.25 a	3330.75 c	3855.75

*Hybrid and location $LSD_{0.05} = 157.5$ Hybrid/Location
 $LSD_{0.05} = 315$

Table 1 shows that the average yield over four hybrids and four locations amounted to 3855.75 kg per hectare. Yield variation was great. The highest yield (5073.75 kg/ha) was recorded in the hybrid ZP 427 and then in hybrids ZP 666 (4548.50 kg/ha), ZP 600 (3430.50 kg/ha) and ZP 434 (2370.25 kg/ha). Yield variation over locations was less pronounced and ranged from 4376.25 kg/ha in Srednja Bačka to 3330.75 kg/ha Stig. The top yields were achieved in locations with the best soil conditions.

Variation over fractions was also low. These results are in accordance with results obtained by Čirović (1993) and Pavlov (2008, 2014). Jovin (2005) concluded that a higher crop density was a higher yield was, and that a percentage share of fractions remained almost the same.

Table 2. Percentage share of small seed size fractions over hybrids and locations in 2014

Hybrid	Location				Average
	Banat	Srem	Sr. Bačka	Stig	
ZP 427	12.17 g	8.60 g	6.48 g	8.86 g	9.03 d
ZP 434	28.92 f	29.75 f	29.42 f	26.44 f	28.63 c
ZP 600	74.80 ab	81.00 a	76.50 ab	73.90 b	76.55 a
ZP 666	51.42 d	51.21 d	40.50 e	61.73 c	51.22 b
Average	41.92 a	42.03 a	38.81 b	42.77 a	41.35

*Hybrid and location $LSD_{0.05} = 3.269$ Hybrid/Location
 $LSD_{0.05} = 6.539$

The average percentage of the small seed size fraction was 41.35 % (Table 2). Variation over hybrids was great ranging from 9.03 % in the hybrid ZP 427 to 76.55 % in the hybrid ZP 600. This percentage amounted to 28.63 % and 51.22 % in hybrids ZP 434 and ZP 666, respectively.

Variation of percentage of the small seed size fraction over particular hybrids ranged from 6.48 % to 12.17 % in the hybrid ZP 427. On the other hand, this variation was lower in the hybrid ZP 434, ranging from 26.44 % in the location of Stig to 29.75 % in the location of Srem. A similar trend was observed in the hybrid ZP 600 (73.90 %-81.00 %). The highest variation was recorded in the hybrid ZP 666 in which it ranged from 40.50 % in Bačka to 61.73 % in Stig, while this variation was smaller in Banat and Srem.

The genotype has the highest effect on the seed size and 1000-kernel weight, however, effects of agroecological conditions and maize growing practices are not negligible (Mirić, 2007). Maize breeders should consider the seed size, i.e. the 1000-kernel weight, in order to ensure the highest number of kernels per area unit. In the last decade, seed maize has been packed in seed units of 25,000 seeds or 75,000 seeds where intended for export, thus the seed size directly affected seed production efficiency. The task of seed growers is to recommend cropping practices that will provide the achievement of a set aim in order to ensure as a high number of seed units per hectare as possible. It is necessary to select proper seed maize regions, to select an adequate ratio of female plant rows to male plant rows; number of female and male components should be adapted in such a way that set aims are achieved. In other words, production technology has to be adapted to requirements of hybrids and seed production costs.

Seed germination represents the most important parameter used in seed quality testing laboratories worldwide. There are many different definitions of germination, but in general it can be described as the emergence and development of the seedling to a stage where the aspect of its essential structures indicates whether it is able to develop further into a satisfactory plant under favourable conditions. The international seed trade is based on the information about germination, which makes this seed quality parameter essential for seed producers (Milivojević, 2005).

Table 3. Germination (%) of large seed size fractions over hybrids and locations in 2014

Hybrid	Location				Average
	Banat	Srem	Sr. Bačka	Stig	
ZP 427	95.6 g	96.7 cdefg	96.4 efg	97.0 bcdef	96.43 b
ZP 434	95.8 fg	98.0 abc	96.0 defg	99.0 a	97.33 a
ZP 600	97.0 bcdef	97.0 bcdef	92.5 h	96.0 fg	95.63 c
ZP 666	97.8 abcd	97.9 abc	98.1 ab	97.7 abcde	97.88 a
Average	96.55 b	97.40 a	95.63 c	97.88 a	96.81

*Hybrid and location $LSD_{0.05} = 0.653$ Hybrid/Location
 $LSD_{0.05} = 1.307$

The average germination of the large seed size fraction was high and amounted to 96.81 %, while it varied from 95.63 % in the hybrid ZP 600 to 97.88 % in the hybrid ZP 666 (Table 3). When observing germination over locations it can be noticed that the average germination amounted to 96.43 % in the hybrid ZP 427, and it varied insignificantly from 95.6 % in Banat to 97.0 % in Stig. The average germination was 97.33 % in the hybrid ZP 434, but it varied more. The highest germination (99.0 %) was recorded in Stig, then in Srem (98.0 %), Srednja Bačka (96.0 %) and Banat (95.8 %).

The highest average germination (95.63 %) was recorded in the hybrid ZP 600 and it ranged from the highest value of 97 % in Banat and Srem to the lowest value of 92.5 % in Srednja Bačka.

The most uniform germination was recorded in the hybrid ZP 666, in which it ranged from 97.7 % to 93.1 %.

Table 4. Germination (%) of small seed size fractions over hybrids and locations in 2014

Hybrid	Location				Average
	Banat	Srem	Sr. Bačka	Stig	
ZP 427	93.2 d	94.0 cd	93.8 d	96.0 ab	94.25 b
ZP 434	93.5 d	97.5 a	96.0 ab	97.0 ab	96.00 a
ZP 600	93.2 d	95.6 bc	90.2 e	90.5 e	92.38 c
ZP 666	96.5 ab	96.1 ab	97.3 a	95.6 bc	96.38 a
Average	94.10 b	95.80 a	94.33 b	94.78 b	94.75

*Hybrid and location $LSD_{0.05} = 0.805$, Hybrid/Location $LSD_{0.05} = 1.609$

Average germination of small seed size fractions was 94.75 %, ranging from 92.38 % to 96.38 % (Table 4). When observing germination over hybrids and locations it can be noticed that the average germination amounted to 94.25 % in the hybrid ZP 427, while it varied from 93.2 % in Banat to 96 % in Stig. The corresponding values for the hybrid ZP 434 were 96.00 %, i.e. 93.5 % in Banat and 97.5 % in Srem. The lowest average germination in small seed size fractions was recorded in the hybrid ZP 600 and it amounted to 92.38 %. It varied from 90.2 % in Srednja Bačka to 95.6 % in Srem. On the other hand, the highest average germination in small seed size fractions was detected in the hybrid ZP 666, in which it amounted to 96.38 %, while variations over locations were not significant and ranged from 95.6 % to 97.3 %.

The average germination was higher by 2.1 % in large seed size fractions than in small seed size fractions. These results are in accordance with results gained by Čirović (1993) and Pavlov (2008 and 2014).

CONCLUSION

Based on obtained results it can be concluded that effects of genotype on expression of all observed traits were high. It was particularly pronounced in the percentage share of the small seed size fraction.

Higher yields were recorded in locations with more favourable soil conditions.

Average germination was higher by 2.1 % in large seed size fractions than in small seed size fractions.

An extremely high sum of precipitation in the 2014 season resulted in a lower percentage of the small seed size fraction in all observed hybrids, in comparison with years with the average precipitation sum.

These studies should be continued and a greater number of hybrids should be included, so that maize breeders could get more information on favourable seed production traits necessary in the process of development of new hybrids.

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Received: 10.3.2015.

Accepted: 30.11.2015.