Biblid: 1821-4487 (2020) 24; 3-4; p 105-107
UDK: 633.15
DOI: 10.5937/jpea24-29656

Original Scientific Paper
Originalni naučni rad

EFFECTS OF SOWING DATE ON EMERGENCE AND YIELD OF MAIZE INBRED LINES

UTICAJ VREMENA SETVE NA NICANJE I PRINOS SAMOOPLODNIH LINIJA KUKURUZA

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ABSTRACT

The paper presents the seed production technologies of maize sown on three different sowing dates. Seeds of three maize inbred lines (L1, L2, L3) were used as a seed material in the location of Zemun Polje in 2018. The objectives of the present study was to determine the importance of different sowing dates as a method to overcome stressful conditions caused by unfavourable environmental factors, as well as to point out to a significance of the seed size in sowing. Effects of the following factors were observed in relation to emergence and the maize grain yield: sowing date (SD), seed fraction (LF, SF and PF) and genotype (L). The gained results indicate that the lowest percentage of emergence was determined in the variant L2/SD2/SF (34%), while the highest grain yield was determined in the variant L3/SD1/ PF 8.86 t/ha. The standard deviation of the yield is the largest for variants with the highest yield.

Key words*: sowing date, maize, yield, germination.*

REZIME

U radu je prikazana tehnologija semenske proizvodnje kukuruza sa tri različita datuma setve. Kao semenski materijal koriščeno je seme tri smooplodne linije L1, L2, L3 na lokaciji Zemun Polje u 2018 godini. Cilj rada je bio utvrđivanje značaja primene različitih datuma setve kao način prevazilaženja stresnih uslova nastalih nepovoljnim ekološkim činiocima, kao i ukazati na značaj krupnoće semena u setvi. Efekti faktora :datum setve (SD), frakcija(LF, SF, PF) i genotip(L) posmatrani su u odnosu na broj klijalih semena posle setve i prinos zrna kukuruza. Rezultati ukazuju da je najniži procenat niklih semena bio u primenjenoj varijanti L2/SD2/SF (34%) i najveći prinos za varijantu L3/SD1/PF 8.86 t/ha. Standardna devijacija prinosa najveća je za varijante sa najvećim prinosom dok je varijansa nicanja semena obrnoto proporcijonalna. Efekti faktora na nicanje u proizvodnim uslovima i prinos zrna kukuruza su različitog značaja. Rok setve kao tehnološka mera u proizvodnji semenskog kukuruza ali i u merkantilnoj proizvodnji zrna vrlo je značajna za procenat niklih semena, kao i njegova interakciji sa frakcijom i genotipom. Ukupan doprinos faktora u varijansi nicanja semena je preko 50% R=0,678. Na varijansu prinosa efekat je slabijeg intenziteta i iznosi R=0,490.

Razlike dobijene primenom različitih varijanti u proizvodnji semenskog materija ukazuju na značaj delovanja faktora i njihovo dalje istraživanje.

Ključne reči*: datum setve, kukuruz, prinos, klijavost.*

INTRODUCTION

Having information about properties of hybrid maize seed, prior to sowing, is an essential prerequisite for achieving the planned results in seed and commercial production of maize. Considering that there are different maize growing regions, the production technology should be adjusted to the specific conditions of climate, soil and other environmental factors in order to make the most of the potential of habitats and genotypes.

The sowing date is one of the adjustment measures. By the application of this measure, unfavourable conditions of climate, primarily stress caused by drought and extremely low or high temperatures, are avoided.

Variability of agroecological conditions may alter the growth and development of maize (Bergamaschi et al., 2007; Asare et al., 2011; Chen et al., 2011; Rattalino Edreira et al., 2011; Baoyuan et al., 2016).

The temperature is the main climatic factor affecting physiological processes during the grain filling period and therefore the yield itself (Holzkämper and Fuhrer, 2013). Agroecological conditions depend not only on edaphic factors in a certain region, but also on the application of cropping practices in the production of seed crops and on the existing climatic changes that bring restrictions in the established cropping practices (Cicchino et al., 2010; Lobell et al., 2013; Mayer et al., 2014).

The application of the same seed production technologies does not give the same results in different genotypes, therefore the importance of the adjustment of these technologies to the production of a particular genotype is important for the expresson of its genetic potential under the given agroecological conditions.

MATERIAL AND METHODS

The three maize inbred lines developed at the Maize Research Institute, Zemun Polje, were used as the seed material in the trial that was set up in the location of Zemun Polje in 2018.

Sowing was performed on three dates: April 1 (SD1), April 10 (SD2) and April 20 (SD3). The seed was divided into three fractions according to its size: small 6.5-8.4 (SF), large 8.5-11 (LF) and primary fraction 6.5-11 (PF). All inbred lines were sown in the density of 71,000 plants ha^{-1}, with the inter-row distance of 70 cm and the within-row plant distance of 20 cm. Each inbred was sown in tree rows per seed fraction and in four replications.

Seed emergence in the field and grain yield of maize were observed.

Harvest was done manually and then the material was dried and shelled. Drying was done to 14% grain moisture at the temperature of 40 ^{o}C. The yield determination was done by harvest of the middle row.

The number of germinated seeds was established after the maize plant emergence in the 1-leaf stage by caunting plants in the middle row.

Gained experimental data were processed by mathematical and statistical methods by the application of the statistical package IBM SPSS 19.0 (version free of charge).

Each of obtained parameters was processed by the statistical analysis using descriptive statistics for all parameters at the annual level. Differences between analysed parameters, as well as their interactions were determined by the analysis of variance (ANOVA) for the factorial trial set up according to randomised design as well as by the LSD test at 5% and 1% risk levels.

Table 1. Means for emergence and grain yield of observed variances of factors

			Mean		sd	
SD	F	L	Emerg.	Grain yield	Emerg.	Grain yield
SD1	LF	L1	86.8350	6.4625	6.86559	0.85484
		L2	62.5000	6.0475	9.66916	0.29193
		L3	87.5025	5.0700	4.40896	1.52999
	SF	L1	78.7500	7.4075	9.56256	0.62297
		L2	47.0850	6.7650	21.83032	0.46630
		L3	84.1650	5.7250	7.51640	0.76757
	PF	L1	84.1650	5.3325	7.99514	1.41427
		L2	73.7500	5.4750	9.56082	0.90850
		L3	90.0025	8.8650	3.33500	1.23853
SD2	LF	L1	69.8325	6.3425	2.93567	0.58420
		L2	69.2500	5.3650	8.67041	1.30896
		L3	70.0000	5.4350	7.57799	1.24848
	SF	L1	74.1675	6.9650	2.15209	1.25797
		L2	34.1675	6.3400	9.07918	0.91349
		L3	72.9175	6.7975	12.35070	1.02168
	PF	L1	65.0000	5.4025	9.90884	1.02034
		L2	57.9175	6.1975	5.50513	0.88017
		L3	66.2500	7.3425	14.42368	1.17916
SD3	LF	L1	68.3350	5.4750	8.81791	0.55848
		L2	59.5000	5.8725	6.87454	1.82198
		L3	60.9175	6.8300	2.92116	0.62209
	SF	L1	69.4175	5.1925	19.08954	0.95206
		L2	73.5000	5.3000	7.73041	0.41028
		L3	67.2500	7.0375	2.87228	1.51562
	PF	L1	76.7500	5.5775	3.75623	1.08758
		L2	46.2525	5.1950	20.42949	0.75124
		L3	47.1675	5.6950	19.60439	1.05683

	N	Rank	Min.	Max.	Mean	sd	LSD
E	108	70.00	21.67	91.67	68.27	16.30	3.039
GY	108	6.65	3.14	9.79	6.13	1.26	0.3478

SD-sowing date; F-fraction LF-large fraction, SF-small fraction; PF- primary fractionE-emergence; GY-grain yield; LF-large fraction, SF-small fraction; PF-primary fraction

RESULTS AND DISCUSSION

The lowest (34%), i.e. highest (90%) emergence in the trial was determined in the genotype L2 for the variant SD2/LF, i.e. genotype L3 for the variant SD1/SF, respectively (Table 1.). The highest (8.86t/ha), i.e. lowest (5.07 t/ha) grain yields were established in the genotype L3 for the variant SD1/PF, and SD1/LF, respectively. The greatest variability in emergence (sd 21.8) was recorded in the variant SD1/SF/L2. The yield, in relation to the given parameters, was the highest (8.86 t/ha) in the variant SD1/PF/L3, while it was the lowest (5.07 t/ha) in the variant SD1/LF/L3. The differences in emergence and yields among variants SD/F/L were a consequence of high temperatures and unfavorable precipitation distribution. In 2018, the highest air temperature since the beginning of meteorological data measurements recorded in April was on average higher by 2^{o}C than the warmest April ever (18.20^{o}C) (RHMZ Bulletin). High temperatures were recorded during the entire growing season, which mostly affected stages of emergence and emergence, and even later stages of pollination and grain filling. Regarding precipitation in the growing season, there was only 336.6 mm, which was lower by 130mm than precipitation during the reference period (1981-2010) and the water requirements of the crop. The greatest water deficiency was in April, May and July (Table 1).

By applying technology of seed processing according to physical properties a grater quantity of a high-quality seed material for sowing is obtained (Đokić et al., 2020). The rank of emergence of all variants was 70 % and the grain yield was 6.65 t/ha. The total variation in the degree of plant emergence was 16.3 and of the yield was 1.2%.

The sowing dates also significantly affected the differences between SD1 and SD2 (12.8 %) and SD1 and SD3 (13.9%). There were no significant differences between SD2 and SD3. Significant differences in yields were recorded between SD1 and SD3 (0.552 t/ha).

Table2. Effect of factors on significance of differences in emergence and yield of maize seed

sowing date			Mean Difference (I-J)	Fraction			Mean Difference (I-J)	Dependent Variable genotype			Mean Difference
	I	J			I	J			I	J	(I-J)
E	SD1	SD2	12.8058*	E	LF	SF	3.6947	E	L1	L2	16.5922*
		SD3	13.9628*			PF	3.0464			L3	3.0089
	SD2	SD1	-12.8058*		SF	LF	-3.6947		L2	L1	-16.5922*
		SD3	1.1569			PF	-.6483			L3	-13.5833*
	SD3	SD1	-13.9628*		PF	LK	-3.0464		L3	L1	-3.0089
		SD2	-1.1569			SF	.6483			L2	13.5833*
GY	SD1	SD2	.1069	GY	LF	SF	-.5144*	GY	L1	L2	.1778
		SD3	.5528*			PF	-.2425			L3	-.5156*
	SD2	SD1	-.1069		SF	LF	.5144*		L2	L1	-.1778
		SD3	.4458			PF	.2719			L3	-.6933*
	SD3	SD1	-.5528*		PF	LF	.2425		L3	L1	.5156*
		SD2	-.4458			SF	-.2719			L2	.6933*

*SD-sowing date; LF-large fraction; SF-small fraction, PF-primary fraction; L- genotype; E-emergence; GY-grain yield;*Significant at -p≤0,05.*

The second observed factor, the fraction, did not significantly affect emergence. However, the differences were significant in yields when various seed fractions were used: between LF and SF: 3.6747% (for emergence) and -0.5144 t/ha (for yield) (Table 3). Regarding the genotype, emergence significantly differed between L1 and L2 (16.5%) and L1 and L3 (3%). Differences in grain yields depending on the used genotype (L) were significant if adequate growing practices (first of all sowing dates) were applied. The greatest differences of 0.5156 t/ha and 0.6933 t/ha were recorded between L3 and L1, and L3 and L2, respectively (Table 2).

The effects of factors on seed emergence under production conditions and maize grain yield were of different significance. Sowing date as a technological measure in the seed maize production, but also in commercial seed production is very important for the percentage of emergence seeds, as well as its interaction with the seed fraction and the genotype, p≤0.05 (Table 3). The seed size, as a second factor that was evaluated, was not significant in any of the observed variants. The importance of the seed size is reflected in the interaction with sowing on emergence and grain yield. The consistency of drying temperature, duration of the treatment and biological effect of the process are treatments that contribute to the relation between the seed shape and the yield (Galić et al., 2019). The number of germinating seeds per unit area and yield vary over genotypes and its interaction with other factors, which points out to a great significance of the selection of the appropriate genotype and sowing technology.

The total contribution of factors in the variance of seed emergence in the filed was over 50% R=0.678, while the effect was of lower intensity in the variance of yield (R=0.490) (Table 3).

Table 3. Effect of factors on emergence and yield (ANOVA)

Source of variation	F-test	
	Emergence	Grain yield
S	19.136**	2.857 ns
F	1.240ns	2.201 ns
L	24.902**	4.310*
S * F	5.201*	1.732 ns
S * L	5.294*	0.754
F * L	2.099 ns	4.151*
S * F * L	3.737*	4.049*

** Significant at p≤0,05;** Significant at p≤0.01; ns-non significant*

a. R Squared = .678 (Adjusted R Squared =0.575)

b. R Squared = .490 (Adjusted R Squared =0.326)

CONCLUSION

During the expression of the effects of the factor of seed properties, agroecological conditions also change, due to which they act differently. Agroecological conditions depend as much on meteorological and edaphic conditions in a certain region as on the application of agro-technological procedures in the production of seed crops. According to the stated, traits of the produced maize hybrid seed depend on the procedures completely controlled by man, on the ecological conditions that are under certain anthropogenic effects, on the properties of the parental inbreds and on all interactions among mentioned factors.

With climate change, the average daily air temperature increased with the insufficient precipitation, especially at the beginning of the growing season. The highest percentage of emergence (90%) and the highest grain yield (8.86t/h) in the variant SD1/PF/L3 confirm the importance of different sowing dates as a technological procedure in reducing poor effects of environmental factors. By earlier sowing the extreme April temperatures were avoided and soil moisture from the previous winter period was used for seed emergence and emergence and normal development in remaining pheno-phases.

Differences in yield and emergence of various genotypes with the application of different variants of seed production confirm that the same results cannot be expected with the application of the same technology.

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Received: 01. 12. 2020. Accepted: 24. 12. 2020.