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Original scientific paper

VARIABILITY OF MAIZE INBRED LINES IN NITROGEN USE EFFCIENCY

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Nitrogen (N) is an important element for many physiological processes in crops, and grain yield realisation. Nitrogen loss could be significant through leaching and evaporation, and from this reason lower quantities for fertilization are required. A genotype could be an important source for improved N management in crops. Breeding for high yield and nutrient-efficient genotypes is the most important strategy to enable food security, resolve resource scarcity and environmental pollution. Variability of 36 maize lines grown in optimal and low-N (without fertilization) conditions was assessed through grain yield, 1000 kernel weight, N utilization efficiency (NUtE) and N apparent recovery fraction (nitrogen use efficiency – NUE), during seasons 2017 and 2018. The genotype and year are important sources for variation of grain yield, 1000 kernel weight and NUtE, as a factor which defines N utilization efficiency. The lines, such as L1, L6, L13, L16, L26, L27, L32 and L34 are able to achieve higher grain yield when grown on low-N. Furthermore, L16, L22, L24 and L26 have high NUtE values in both experimental years (even in 2017, season with low and unequal precipitation level), especially in low-N treatment. From that point of view, they could be characterized as efficient N users, even in low-N conditions, as well as tolerant to stressful conditions. Nevertheless, L1, L6 and L27 are the lines with negative NUE, what gives them attribute as the best N users in low-N conditions. Based on the similarity of NUtE values, the genotypes such as L2, L3, L4, L8, L11, L12, L14, L15, L16, L18, L19, L24, L26, L32, L33, L34could be considered as the primary focus for further breeding programs, due to the fact that they don’t have only improved NUE, but also high grain yield (even in unfavourable years), which indicates improved tolerance to various abiotic stressful factors.
Keywords: maize lines, low soil nitrogen, nitrogen utilization efficiency, nitrogen apparent recovery fraction, grain yield.

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INTRODUCTION

Nitrogen plays a pivotal role in crop productivity. It is an important element in many physiological processes, affecting yield performance. The problem with N fertilization is due to its high mobility and evaporation from a soil, contributing to significant losses. Approximately 15% of N from fertilizers is leached in the nitrate form worldwide, indicating that above optimal doses are required to reduce losses, together with maintenance of high yields (ZHOU and BUTTERBACH-BAHL, 2014). Irrespective to grain yield decrease, when maize was grown under the low-N conditions, MU *et al*. (2016) noticed increase of physiological N utilization efficiency (NUtE), that is based on decrease of N content in ear leaves (by 38%), without significant impact on photosynthetic rate, thus increasing photosynthetic N-use efficiency (PNUE) by 54%. They concluded that optimization of N distribution in leaves is an important adaptive mechanism to maximize photosynthetic rate and thus crop productivity under low-N conditions. It is also important to underline that nitrogen metabolism, i.e. nitrogen use efficiency is closely related to water use efficiency (WUE). WANG *et al*. (2019) ascertained that under low-N conditions maize plants exhibited lesser water consumption, with higher leaf relative water content and lesser expression of leaf rolling symptom, having higher WUE, under the presence of moderate to high water stress. They attributed this phenomenon to enhanced root growth, higher root density, with more fine roots present particularly in deeper soil layers, when compared to maize grown on high-N. From this point, it is recommendable to reduce basal N rate, to optimize root growth, morphology and distribution, along with breeding for enhanced root performances (ABDEL-GHANI *et al*., 2013; YU *et al*., 2015), to improve maize tolerance to drought and reduce N leaching from soil. N (protein) accumulation in wheat and grain in other crops is highly dependent on genotype (KNEŽEVIĆ *et al*., 2016), as well as N availability during grain filling period when it could be also responsible for protein quality, such as gluten content, and rheological flour and dough properties, as it was found for triticale (ZEČEVIĆ *et al*., 2010).

All these facts emphasize the genotype as an important source for improved N management in crops. MIROSAVLJEVIĆ *et al*. (2019) signified necessity to adjust N fertilization to each winter wheat cultivar, and similarly NOOR (2017) proposed usage of different molecular breeding techniques in combination with agronomic options to optimize N uptake and its utilization by maize crop. From this point, it is important to define mechanisms responsible for N uptake, such as finding of transcripts for NO^{-}_{3} and NH^{+}_{4} transporter genes in the root (GARNETT *et al*., 2015), as well as distribution and sequestration mechanisms (MU *et al*., 2016) that have impact on grain yield, ear kernel number, kernel weight, plant height, chlorophyll content and N accumulation in grain (WU *et al*., 2011). From this viewpoint, CHEN *et al*. (2013) divided maize genotypes into four groups: efficient-efficient (EE) having high yield under low- and high-N inputs; high-N efficient (HNE) have high yield only under high-N input; low-N efficient (LNE) that maintain high yield only under low-N input, and nonefficient-nonefficient (NNE) with low yield under low- and high-N inputs. They also accentuated that breeding for high-yielding and nutrient-efficient genotypes is the most important strategy to enable food security, resolve resource scarcity and environmental pollution.

From that reason, variability of 36 maize lines to optimal (fertilization with urea) and low-N (without fertilization) conditions was assessed through grain yield, 1000 kernel weight, N utilization efficiency (NUtE) and N apparent recovery fraction.

MATERIAL AND METHODS

The experiment was set in Zemun Polje, during the vegetative seasons of 2017 and 2018, in rain-fed conditions. Sowing of the maize lines (L1 – L36, Table 1) was performed during the second half of April, using the randomized complete block design (RCBD) in three replications, with elementary plot of 1.75 m^2, including two rows of 2.5 length with 70 cm inter row distance and 25 cm between plants in row. According to previous soil analysis, soil contained 154 kg N ha^{-1} in 2017 and 166 kg N ha^{-1} in 2018. Prior to sowing, on the treatment with nitrogen fertilization (Nt), 92 kg N ha^{-1} (i.e. 200 kg of urea) was incorporated as a start fertilization, while the control (NØ) treatment remained without fertilization. All other growing measures were standardly applied, including fertilization with other mineral elements, on the whole experimental plot.

Table 1. Description of inbred lines used in experiment

No	Inbred line	Heterotic group	FAO maturity group	No	Inbred line	Heterotic group	FAO maturity group
1	L217	ID	400	19	L77B037	BSSS	700
2	L255/75-5	LSC	450	20	L-23/884	OH-7/BSSS	650
3	L155/18-4/1	LSC	550	21	K-27	ID/BSSS	400
4	L73B002	BSSS/ID	400	22	L96NO22	IS	600
5	L73B003	BSSS/ID	400	23	L95BO17	BSSS	500
6	L73BO13	ID/BSSS	350	24	L96B027	BSSS	600
7	ZPPL301	ID/BSSS	350	25	L04L058	LSC	500
8	L335/99	BSSS/AMARGO	550	26	L76B036	BSSS	600
9	L76B004	BSSS	700	27	L73024	LSC	350
10	L04BA031	BSSS/ID	450	28	L74B040	BSSS	400
11	L884/234	BSSS	650	29	L04L011	LSC	400
12	PE25-10-1	LSC	600	30	L2/1	popcorn	600
13	Mo17	LSC	650	31	MCH6	popcorn	500
14	L92Bb	BSSS	650	32	EP631	popcorn	600
15	B97	BSSS	650	33	P322	popcorn	600
16	R802-B-37-7	LSC	600	34	PP-2/1	popcorn	600
17	L76BOO6	BSSS	600	35	L620121	sweet corn	600
18	L76L007	LSC	700	36	K8/1-131	sweet corn	400

After the harvesting of whole plot, grain yield was measured and calculated to 14 % of moisture, together with determination of 1000 kernel weight. N concentration in grain samples was determined by micro-Kjeldahl procedure (AOAC, 1984) after wet digestion with H_2SO_4 + H_2O_2.

The following N-efficiency parameters were calculated according to LÓPEZ-BELLIDO *et al*., 2005; ROCHESTER, 2011 and AMANULLAH, 2016:

- N utilization efficiency (NUtE; kg kg^{-1}) – ratio of grain yield to grain N uptake;

- N apparent recovery fraction (NUE; %) – (N uptake at Nt - N uptake at NØ) / N applied by fertilizer.

The experimental data were statistically processed by analysis of the variance (ANOVA) and differences between means were tested by the least significant difference test ($LSD_{0.05}$). Results of N utilization efficiency are presented with standard deviation (SD) and similarity between tested lines was presented in a form of dendrogram. Statistical analysis was processed by SPSS 15.0 (IBM Corporation, Armonk, New York, USA) for Windows Evaluation version.

Meteorological conditions: Vegetative season of 2017 was drier, with 222.3 mm of total precipitation amount, compared to 2018 (Table 2). In 2018 temperature was higher during April and May (germination and starting growth period), while precipitation amount was higher in June, July and August (with 150.1, 61.9 and 44 mm), in comparison to 2017.

Table 2. Average monthly air temperatures and precipitation sums for vegetative period (April-September) in 2017 and 2018 at Zemun Polje

Month		IV	V	VI	VII	VIII	IX	Aver./Sum
Temperature	2017	12.4	18.6	24.4	25.5	25.8	18.4	20.9
(°C)	2018	18	21.7	22.7	23.6	25.7	19.8	21.9
Precipitation	2017	47.1	49.2	39	26.7	23.7	36.6	222.3
(mm)	2018	24.6	39	150.1	61.9	44	16.9	336.5

RESULTS AND DISCUSSION

Among the tested factors (genotype, year and fertilization level), the genotype, year and interactions between all examined factors expressed significant influence on variation of grain yield and 1000 kernel weight, while only fertilization didn't express significant influence on variation of both parameters (Table 3). It is important to underline the high variability among the genotypes in grain yield and 1000 kernels weight mainly occurred in NØ, similarly to results of AL-NAGGAR *et al*. (2011) who also ascertained that a genotype presents the main source of variation of yield potential, and that its trait is closely related to nitrogen use efficiency. It is also noticeable that almost double higher average grain yield and 1000 kernels weight was achieved in 2018 in comparison to 2017, which is probably due to the unequal distribution and smaller precipitation amount. Present conditions, ie. low precipitation amount could affect maize N partitioning across plant organs and the expression of genes (such as glutamine synthetase and asparagine synthetase) that may contribute to the higher leaf N removal into the grain (LI *et al*., 2016). MANSOURI-FAR *et al*. (2010) and KRESOVIC *et al*. (2013) obtained better maize performance in years with higher precipitation amount as it was in 2018, as well as under irrigation, underlining that grain weight is particularly sensitive to water shortage. They also stated that higher water amounts positively reflects on improved N uptake. Furthermore, BELETE *et al*. (2018) underlined the importance of growing season (mainly precipitation level) and its interaction with a genotype for N accumulation in grain and straw of durum wheat.

Moreover higher average values of grain yield and 1000 kernels weight were obtained in Nt treatment when compared to NØ (11.7% and 4.4%, respectively). It is interesting that minimal values of grain yield and 1000 kernels weight were mainly greater in NØ than in Nt treatment, which could be classified to LNE group, as it was declared further (Table 4) (CHEN *et al*., 2013). Data about average yields (for both years), present in Figure 1, demonstrates that majority of tested lines achieved higher values in Nt, but this difference was slight. Nevertheless, L1, L6, L13, L16, L26, L27, L32 and L34 achieved higher grain yield in NØ, in comparison to Nt treatment, which indicates their ability to grow under the conditions with limited N supply. WANG *et al*. (2019) stated that optimal growth, morphology and distribution of maize root at the seedling stage is dependent on N rate, thus reduced basal N rates are favourable to promote root growth, increasing WUE and NUE. This means that maize genotypes with large and deep root have higher stress tolerance to drought and N deficiency, as well as high NUE values (YU *et al*., 2015).

Table 3.Analysis of variance for the effect of genotype, year and fertilization treatment on grain yield and 1000 kernel weight of 36 maize inbred lines

	Genotype	Year	Fert.	G X Y	G X F	Y X F	G x Y x F
d.f.[1]	35	1	1	71	71	3	143
			Grain yield (t ha-1)				
LSD 0.05	1.226*	1.477*	1.61	0.851*	1.262*	1.475*	0.854*
F	9.99	83.92	2.4	16.74	4.84	28.98	8.72
p	0	0	0.122	0	0	0	0
	Genotype	2017	2018	Nt	NØ		
Min.	0.26	0.25	0.27	0.21	0.31		
Max.	4.68	3.81	5.56	4.85	4.52		
Aver.	1.85	1.21	2.48	1.96	1.73		
			1000 kernel weight (g)				
LSD 0.05	89.54*	104.60*	111.1	75.37*	91.28*	104.80*	78.22
F	7.64	55.62	0.6	8.11	3.92	18.74	4.06
p	0.000	0	0.437	0	0	0	0
	Genotype	2017	2018	Nt	NØ		
Min.	38.40	32.02	44.78	30.92	45.88		
Max.	320.18	316.05	324.3	328.53	311.82		
Aver.	142.07	142.07	207.94	178.97	171.05		

*: significant at 5% probability; [1]df: degrees of freedom.

NUtE, as a factor that gives information about yield potential based on N availability, varied greatly among seasons and maize lines. It has higher average values in 2018, than in 2017 (Table 4), as well as in NØ, than in N treatment. It is also noticeable that some lines had higher NUtE values in both seasons: >10 kg kg^{-1} in 2017 and mainly >25 kg kg^{-1} in 2018, such as L16, L22, L24 and L26. They also had apparently grater NUtE in NØ treatment. Based on average yields and nitrogen use efficiency - when maize hybrids were grown on high or moderate to low soil N, CHEN *et al*. (2013) classified maize genotypes into four types: efficient under both, low and high N inputs (EE), genotypes that are efficient under only high N input (HNE), efficient only under low-N input (LNE), and nonefficient under neither low nor high N inputs (NN).

Table 4. N utilization efficiency (NUtE) (kg kg^{-1}) of 36 maize inbred lines grown with N fertilization (N) and without it (NØ) during 2017 and 2018 (results are present as mean ± standard deviation)

Line	2017		2018		Aver.	
	N	NØ	N	NØ	N	NØ
L1	5.05 ± 0.12	9.48 ± 0.15	3.72 ± 0.10	11.23 ± 0.19	4.39	10.35
L2	3.64 ± 0.09	5.96 ± 0.09	20.67 ± 0.53	31.55 ± 0.52	12.15	18.76
L3	1.49 ± 0.04	1.90 ± 0.03	13.04 ± 0.34	20.22 ± 0.34	7.27	11.06
L4	7.33 ± 0.18	10.09 ± 0.16	7.94 ± 0.20	11.25 ± 0.19	7.64	10.67
L5	3.14 ± 0.08	4.06 ± 0.06	11.53 ± 0.30	9.82 ± 0.16	7.34	6.94
L6	3.30 ± 0.08	5.75 ± 0.09	4.63 ± 0.12	9.92 ± 0.16	3.96	7.84
L7	3.58 ± 0.09	3.66 ± 0.06	5.37 ± 0.14	8.22 ± 0.14	4.47	5.94
L8	3.83 ± 0.09	1.76 ± 0.03	16.46 ± 0.42	24.12 ± 0.40	10.15	12.94
L9	9.67 ± 0.24	9.47 ± 0.15	3.78 ± 0.10	7.00 ± 0.12	6.73	8.24
L10	1.35 ± 0.03	1.96 ± 0.03	6.66 ± 0.17	9.91 ± 0.16	4.00	5.94
L11	10.24 ± 0.25	8.11 ± 0.12	20.31 ± 0.52	35.49 ± 0.59	15.28	21.80
L12	7.56 ± 0.19	7.60 ± 0.12	22.19 ± 0.57	32.69 ± 0.54	14.87	20.15
L13	1.62 ± 0.04	3.13 ± 0.05	8.44 ± 0.22	14.78 ± 0.25	5.03	8.96
L14	8.53 ± 0.21	5.57 ± 0.09	13.18 ± 0.34	17.04 ± 0.28	10.86	11.31
L15	5.26 ± 0.13	10.87 ± 0.17	16.60 ± 0.43	14.89 ± 0.25	10.93	12.88
L16	6.18 ± 0.15	13.52 ± 0.21	19.69 ± 0.51	29.01 ± 0.48	12.93	21.26
L17	4.22 ± 0.10	5.54 ± 0.09	5.83 ± 0.15	8.29 ± 0.14	5.02	6.92
L18	2.61 ± 0.06	3.85 ± 0.06	12.61 ± 0.33	18.70 ± 0.31	7.61	11.27
L19	4.54 ± 0.11	10.13 ± 0.16	12.61 ± 0.33	14.74 ± 0.24	8.57	12.43
L20	15.50 ± 0.38	20.89 ± 0.32	0.63 ± 0.02	4.18 ± 0.07	8.06	12.54
L21	6.62 ± 0.16	10.13 ± 0.16	8.36 ± 0.22	11.06 ± 0.18	7.49	10.59
L22	11.62 ± 0.29	15.48 ± 0.24	8.12 ± 0.21	14.51 ± 0.24	9.87	15.00
L23	3.73 ± 0.09	4.51 ± 0.07	8.00 ± 0.21	12.64 ± 0.21	5.87	8.57
L24	17.59 ± 0.43	23.09 ± 0.36	21.88 ± 0.56	33.10 ± 0.55	19.73	28.09
L25	16.50 ± 0.41	25.21 ± 0.39	10.89 ± 0.28	11.36 ± 0.19	13.70	18.29
L26	8.88 ± 0.22	11.92 ± 0.18	16.78 ± 0.43	29.30 ± 0.49	12.83	20.61
L27	4.67 ± 0.11	8.67 ± 0.13	2.71 ± 0.07	6.60 ± 0.11	3.69	7.63
L28	5.81 ± 0.14	2.93 ± 0.05	4.17 ± 0.11	7.30 ± 0.12	4.99	5.11
L29	1.75 ± 0.04	1.58 ± 0.02	1.92 ± 0.05	3.09 ± 0.05	1.84	2.34
L30	3.97 ± 0.10	1.77 ± 0.03	5.19 ± 0.13	5.23 ± 0.09	4.58	3.50
L31	3.37 ± 0.08	5.08 ± 0.08	16.53 ± 0.43	10.30 ± 0.17	9.95	7.69
L32	3.12 ± 0.08	5.65 ± 0.09	15.55 ± 0.40	23.64 ± 0.39	9.34	14.65
L33	7.83 ± 0.19	10.86 ± 0.17	13.82 ± 0.36	16.21 ± 0.27	10.82	13.54
L34	3.19 ± 0.08	4.49 ± 0.07	10.01 ± 0.26	21.41 ± 0.36	6.60	12.95
L35	3.36 ± 0.08	3.44 ± 0.05	2.19 ± 0.06	3.29 ± 0.05	2.77	3.36
L36	1.03 ± 0.03	1.77 ± 0.03	9.94 ± 0.26	15.31 ± 0.25	5.48	8.54
Aver.	5.88	7.77	10.61	15.48	8.25	11.63

Based on the data, presented in Table 3 (NUtE) and Figure 1 (average grain yields), lines L2, L11, L12, L16, L24, L25 and L26 would belong to EE group, lines L3, L4, L8, L14, L15, L18, L19, L20, L21, L22, L32, L33 and L34 would belong to LNE group, lines L1, L6, L7, L9, L10, L13, L17, L23, L27 and L36, would belong to HNE group and L5, L28, L29, L30, L31 and L35, would belong to NN group.

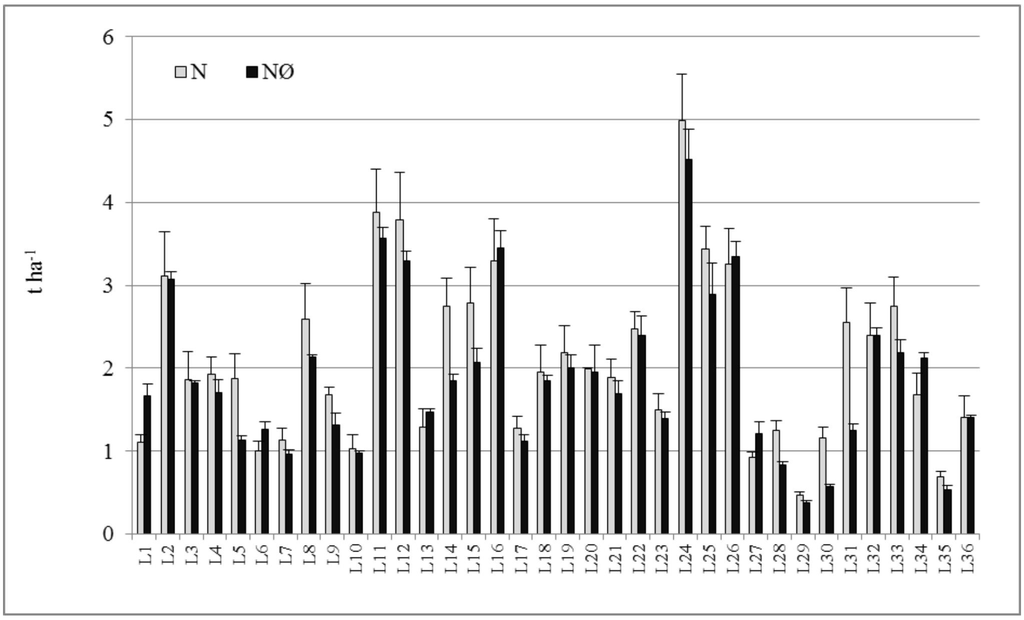

Figure 1. Average grain yield of 36 maize lines grown with N fertilization (N) and without it (NØ) (results are present as mean for 2017 and 2018 ± standard deviation)

N apparent recovery fraction (NUE) also varied in great range among maize lines. Some lines had negative values, such as L1, L6 and L27 (in both seasons) indicating that higher values of grain yield and N concentration in grains were scored in NØ treatment in comparison to N treatment. Lines, like L3, L4, L5, L7, L10, L12, L14, L17, L18, L21, L24, L25, L30 and L33 achieved positive NUE in both investigation years. However, NUE values of the other lines varied among seasons, with mainly positive values obtained in 2017, as somewhat unfavourable season, indicating connection between NUE and (WUE) (MANSOURI-FAR *et al*., 2010; YU *et al*., 2015). As lower grain yields, obtained in the same year by the same genotypes, were taken into consideration, importance of increased N requirements (higher N rates) during stressful conditions is accentuated (DRAGIČEVIĆ *et al*., 2015). It is important to underline that maize root architecture (large and deep root system), is very important trait that combat stress (particularly drought), enabling greater absorption of N and other essential minerals, thus providing improved growth of above-ground biomass, as well as grain yield potential (YU *et al*., 2015; SZCZEPANIAK, 2016; WANG *et al*., 2019).

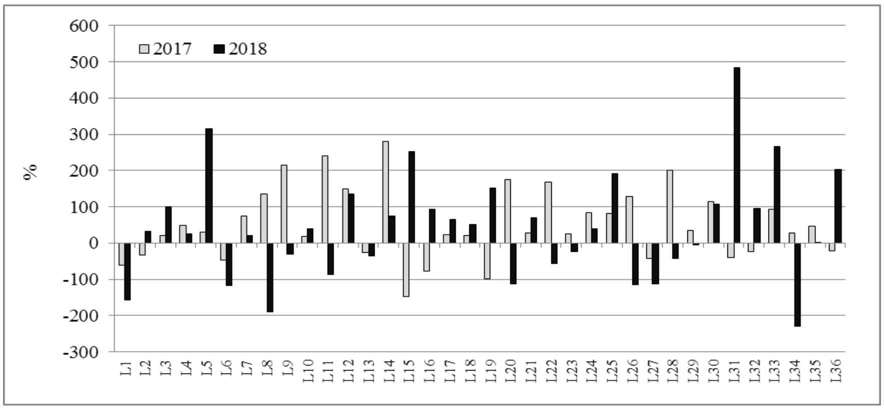

Figure 2. Percent of fertilizer recovery of 36 maize inbred lines grown during 2017 and 2018

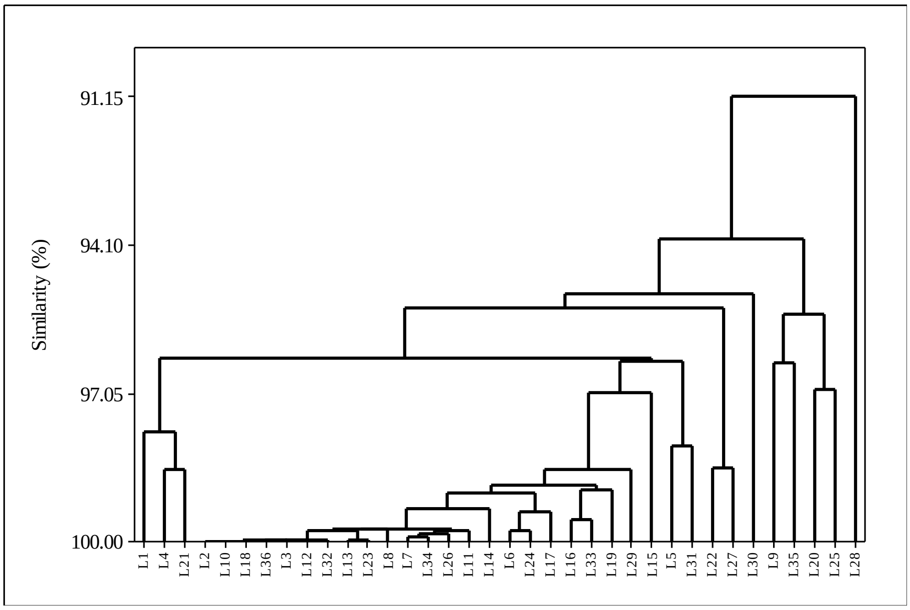

Figure 3. Similarity between 36 maize inbred lines for N utilization efficiency (NUtE) (kg kg^{-1})

According to the results of similarity between tested lines, present in Figure 3, several groups were formed. Among all genotypes, L28 doesn't belong to any group, while L9, L20, L25 and L35 formed separate subgroup in regard to L30. Other three subgroups were consisting: group 1 from L22 and L27; group 2 from L1, L4 and L21; group 3 from L2, L10, L18, L36, L3, L12, L32, L13, L23, L8, L7, L34, L26, L11, L14, L6, L24, L17, L16, L33, L19, L29, L15, L5 and L31. It is noticeable that NN genotypes are mainly independent and comprises separate subgroup (L28, L30 and L35). Nevertheless, EE genotypes mainly belong to group 3. Similarly, majority of the genotypes from LNE group belong also to group 3 (L3, L8, L14, L15, L18, L19, L32, L34 and L33) as well as to group 2 (L4 and L21). If EE and LNE genotypes are the focus, then group 2 and 3 could present greater germplasm source for improved nitrogen efficiency in breeding programs. There is no present connection between line traits (heterotic background and maturity group – Table 1) and formed groups, based on NUtE values.

Exception are three inbred lines L1, L4 and L21, with common ID germplasm all same maturity group FAO 400, which cluster together in group 2.

Including genotyping of some other traits, such as crop growth rate and leaf area profile (AKMAL *et al*., 2010; WU *et al*., 2011), as well as root growth, morphology and distribution (YU *et al*., 2015; WANG *et al*., 2019) it could be possible to develop the maize genotypes with not only improved NUE, when they are growing on low-N, but also with improved tolerance to various abiotic stressful factors.

CONCLUSION

The genotype and year are important sources of variation for grain yield, 1000 kernel weight and NUtE, as a factor which determines efficiency of N utilization. Some of the tested lines (L1, L6, L13, L16, L26, L27, L32 and L34) are able to achieve higher grain yield on low-N. Irrespective to the present variability, L16, L22, L24 and L26 have high NUtE values in both experimental years, especially in NØ treatment. They could be characterized as good N users, even in low-N conditions, as well as tolerant to stressful conditions particularly when it is taken into account that they belong to EE and LNE groups, with high grain yield obtained in both, optimal and stressful season. Nevertheless, L1, L6 and L27 as lines with negative NUE gives them attribute as the best N users in low-N conditions.

Based on the similarity of NUtE values, the genotypes from EE and LNE groups, such as L2, L3, L4, L8, L11, L12, L14, L15, L16, L18, L19, L24, L26, L32, L33, L34 could be considered as the primary focus for further breeding programs, due to the fact that they don't have only improved NUE, but also high grain yield (even in unfavourable years), which indicates improved tolerance to various abiotic stressful factors.

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VARIJABILNOST INBRED LINIJA KUKURUZA U EFIKASNOSTI ISKORIŠĆENJA AZOTA

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Izvod

Azot je element koji je važan za brojne fiziološke procese, kao i ostvarenje prinosa useva. Veliki gubici azota se ostvaruju putem ispiranja i evaporacije i stoga se preporučuju niže doze ovog elementa za đubrenje. Genotip može predstavljati važnu bazu za efikasniji menadžment azotom kod useva. Selekcija genotipova sa visokim prinosom i efikasnošću iskorišćenja nutritiva predstavlja važnu strategiju za istovremeno obezbeđivanje sigurnosti hrane, rešavanje nedostatka resursa i zagađenja životne sredine. Varijabilnost u reakciji 36 linija kukuruza gajenih u uslovima optimalne N obezbeđenosti i niskog N (bez đubrenja) praćena je tokom 2017. i 2018. godine, preko prinosa zrna, mase 1000 zrna, efikasnosti iskorišćenja N (NUtE) i nadoknade N (NUE). Genotip i godina su predstavljali važne izvore variranja prinosa zrna, mase 1000 zrna i NutE, kao faktora koji definišu efikasnost iskorišćenja N. Linije L1, L6, L13, L16, L26, L27, L32 i L34 su imale veće vrednosti prinosa u uslovima niskog N. Osim toga, L16, L22, L24 i L26 su imale veće vrednosti NutE tokom obe eksperimentalne sezone (čak i u 2017, sezoni sa nižim nivoom i lošijim rasporedom padavina), posebno pri niskom N. Sa te tačke gledašta, navedene linije bi mogle biti okarakerisane kao efikasni N potrošači, kao i genotipovi sa većom toleratnošću na stresne uslove. Takođe, L1, L6 i L27, sa negativnim NUE vrednostima bi mogle predstavljati najekonomičnije N potrošače u uslovima niske N obezbeđenosti. Na osnovu sličnosti NutE vrednosti, genotipovi L2, L3, L4, L8, L11, L12, L14, L15, L16, L18, L19, L24, L26, L32, L33, L34 bi mogli da predstavljaju fokus, odnosno, mogli bi načelno da se uzmu u razmatranje u selekcionim programima, s obzirom da nemaju samo poboljšan NUE, već i visok prinos (čak i tokom nepovoljne sezone), u odnosu na ostale genotipove, što bi ih moglo okarakterisati kao genotipove sa poboljšanom tolerantnošću na abiotički stres.

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