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INTERPRETATION OF GENOTYPE × ENVIRONMENT INTERACTION IN PERENNIAL RYEGRASS (*Lolium perenne* L.)

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The aim of this field study was to evaluate genotype × year interaction for spike length, 1000 seed weight, seed number per g and hectoliter mass in perennial ryegrass, using eight divergent genotypes across two growing seasons. Interaction was evaluated using AMMI (Additive Main Effects and Multiplicative Interaction) model. All traits schowed additive (genotype, year) and non additive (genotype × year interaction) variation. On the basis od AMMI1 biplot genotype G4 showed most stability for all examined traits, so it can be recommended for sowing in different environmental conditions. Also, the genotype G4 could be used in the creation of new local varieties of perennial ryegrass.

Key words: AMMI model, interaction, hectoliter mass, perennial ryegrass, spike length, 1000 seed weight

INTRODUCTION

Perennial ryegrass (*Lolium perenne* L.) is one of the most widely sown perennial forage grass in temperate regions of the world, mainly in northwest Europe, New Zealand, Australia, South Africa and South America (YAMADA, 2013). According to the written traces perennial ryegrass is a first perennial grass that was grown in Europe. In our agroecological conditions perennial ryegrass grows on the most soil types and at different altitudes. Perennial ryegrass is particularly adapted to dry to moderately fertile soil moist, with different pH values, although in the local agro-ecological conditions of Republic of Srpska or Bosnia and Herzegovina, it is prevalent on poor acid soils where there is a free ecological niche (LAKIC *et al*., 2013). It is characterized by high tolerance to trampling, regeneration rate, and it is suitable for different ways of utilization and storage of animal feed. Also, perennial ryegrass is classified in the group of high-yielding forage crops, suitable for simple and quickly founding of sown lawns. It is characterized by ability for cultivation and production of biomass in the extensive cultivation

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conditions, such as heavy soil texture and increased humidity. The most important pasture species is perennial ryegrass, suitable for the grazing of all kinds and categories of domestic animals. It is convenient for the founding of lawns for special purposes, such as sports grounds, including infield lawns, and for other purposes. For the successful establishment of meadows and pastures a good seed germination is important, so it is preferable to do planting two to three months after the harvest (STANISAVLJEVIĆ *et al.*, 2012).

Tests with the growing amount of nitrogen have shown that it significantly affects the morphological characteristics of the tillering intensity, the number of formed leaves, and the share of leaf mass in the total overground leaf biomass (IKANOVIĆ *et al.*, 2013). Very good results of perennial ryegrass biomass yields were achieved after establishment of lawns at the mine tailings, primarily by using the method of hydroseeding.

A large number of perennial ryegrass varieties were created worldwide, that differ in suitability for different ways of cultivation and exploitation, and the time of ripening (GROGAN and GILLILAND, 2008). According to data from the Organization for Economic Co-operation and Development (OECD) in 1999 worldwide 720 varieties of perennial ryegrass were on the list of registered varieties (FOSTER *et al.*, 2001).

In the genus *Lolium* there is a great genetic variability, and significant differences are manifesting in adaptability to different agroecological conditions, reflected in: the length of life, regeneration capacity and rate, early and late maturity and other characters. Perennial ryegrass is a widespread species in Republic of Srpska, i.e. Bosnia and Herzegovina. There are a large number of genetically divergent populations of indigenous perennial ryegrass, which can be used as material for the creation of varieties suitable for different conditions of growth, cultivation and exploitation.

For successful breeding work and creation of field plant varieties, including perennial ryegrass, one of the conditions is that there is a description and characterization of the starting material.

The features of perennial ryegrass such as heading date, spike length, number of spikelets per spike and leaf width have high heritability and therefore are appropriate for the selection. However, in order to use listed features for the selection despite high heritability, they must be in the desirable correlation with seed yield in high plant density. For the selection and breeding of perennial ryegrass, natural and indigenous populations were commonly used as a starting material.

Among the methods of multivariate analysis one of the most important and mostly used method for evaluation of genotype × environment (G×E) interaction in recent years is the AMMI (Additive Main Effects and Multiplicative Interaction) model proposed by GAUCH and ZOBEL (1996). This analysis revealed a highly significant component of the interaction that has appropriate agronomic significance. The level of interaction shows the influence of environmental factors on the stability and adaptability, which is a desirable character but only if it is in relation with average or above average yield (YAN and HUNT, 2003). AMMI model is a hybrid analysis that incorporates both additive and multiplicative components of the two-way data structure. It is the model that clearly separates main and interaction effects that present agricultural researchers with different kinds of opportunities and the model often provides an agronomically meaningful interpretation of the data which is usually desirable in order to make reliable yield estimations. The biplots allows easy visualization of differences in interaction effects. AMMI biplot analysis is considered to be an effective tool to diagnose G×E interaction patterns graphically. The AMMI model describes G×E interaction in more than one dimension and it offers better opportunities for interpreting G×E interaction than analysis of variance (ANOVA) and regression of the mean (VARGAS *et al*., 2001). Integrating biplot display and genotypic stability statistics enables genotypes to be grouped based on similarity of performance across diverse environments (THILLAINATHAN and FERNANDEZ, 2001). G×E interaction occurs when genotypes respond differently to changes in the environment (BALALIĆ *et al*., 2012). Presence of the G×E interaction indicates that the phenotypic expression of one genotype might be superior to another genotype in one environment but inferior in a different environment (BONDARI, 2003). G×E interactions are a frequent occurrence in herbage yield evaluations of perennial ryegrass sward plots (JAFARI *et al*., 2003). As reported by CONAGHAN *et al*. (2008) the three-factor genotype × location × year interaction is found to be the largest source of G×E interaction for herbage yield. SOKOLOVIC *et al*. (2011) used multivariate analysis to evaluate morphological traits and yield components in ryegrass in autochthonous populations from Serbia. The traits which showed high correlation coefficients with first principal component (IPC1) were plant height in first cut, leaf length and width, dry matter of generative tillers, spike and spikelet length and 1000 seed weight

The aim of this field study was to evaluate genotype × year interaction for spike lenght, 1000 seed weight, seed number per g and hectoliter mass in perennial ryegrass, and to identify genotypes which have high and stable performace in different environments using AMMI biplot model.

MATERIALS AND METHODS

Plant material and field experiment

The research of progeny quantitative traits of perennial ryegrass (*Lolium perenne* L.) genetically divergent genotypes was conducted at the experimental field and testing laboratories of the Agriculture Institute of RS in Banja Luka, during the years 2007 and 2008.

Eight genetically divergent genotypes of perennial ryegrass were used for this research, which is involved in the breeding program of the Agricultural Institute of RS in Banja Luka.

The material used for research are progenies of indigenous and other populations of perennial ryegrass created after collecting and clone growing in nursery. After the multiplication of selected clones seed, in the year 2006, micro experiment was conducted with the following materials:

G-1 (BL–D/2004 – indigenous population originating from the vicinity of Banja Luka, Dragočaj village, was transferred in the collection by vegetative propagation, year 2004).

G-2 (BLN–K/03 – indigenous population originating from municipality Laktaši, Kosijerovo village, was transferred in the collection by vegetative propagation, year 2003).

G-3 (BL–L/2 – indigenous population originating from the vicinity of Gradiška, Laminci village, was transferred in the collection by vegetative propagation, year 2002).

G-4 (BLN–KB1/20 – indigenous population originating from municipality Laktaši, Kobatovci village, was transferred in the collection by vegetative propagation, year 2000).

G-5 (BLN–KB/4 – indigenous population originating from municipality Srbac, Kobaš village, was transferred in the collection by vegetative propagation, year 2004).

G-6 (BL–TAS/22 – introduced populations, northern Italy, from collection of the Agricultural Institute of RS, maintained vegetative, progeny of clone 22 was used for testing).

G-7 (BL–SR/1 – indigenous population originating from the vicinity of East Sarajevo, was transferred in the collection by vegetative propagation, year 2001).
G-8 (BLN–KB/11 – introduced population from Denmark, from collections of the Agricultural Institute of RS, maintained vegetatively, progeny of clone 11 was used for testing).

Founding of the experiment was carried out in the regular sowing term in spring 2007 on the brown-valley soil, where preceding crop was vegetables.

The experiment was set up by randomized block system with four replications, the plot surface of 5 m^2 (5m x 1m), spacing between plots 40 cm and 20 cm between rows. The distance between the blocks was 1 m.

While conducting the experiment with clone progenies of perennial ryegrass, common agrotechnical measurement were applied: basic processing, soil preparation prior to sowing, basic fertilization, sowing, weed control and second fertilization. Sowing was done by hand (five rows / plot) with 27 kg ha^{-1} of seeds. During the establishment of experiment 400 kg ha^{-1} NPK (8:26:26) was utilized, afterwards 150 kg ha^{-1} KAN (27% N) in the first up growth for fertilization on two occasions, in the interval of 10 days.

The following traits were analyzed:
1. Spike length (cm) was determined by measurement of 20 spikes from each replication, separately for each genotype at the stage of full maturity.
2. 1000 seed weight (g) was determined based on 1000 seed samples, from fraction of "pure seeds". Seed number was set by counter device, and measured on the analytical scale.
3. Number of perennial ryegrass seeds (in mass of 1 g) was determined by using a fraction of "pure seed", measuring 1 gram, and counting by seed counter device.
4. Hectoliter mass (kg) is a mass of seeds in 100 liters, or one hectoliter, set by hectoliter scale. Hectoliter mass was determined on samples taken from the sealed bag. For greater accuracy, two samples of each repetition were tested, and the differences between the samples were less than 0.5 kg.

Agroecological conditions

Testing of quantitative traits of perennial ryegrass genotypes was carried out on a well prepared brown-valley soil. According to the results of arable soil layer chemical analyzes, at a depth of 0-30 cm the soil was alkaline (pH in H_2O 7.03; in KCl 6.40), with medium humus content (3.25%), medium provided in easily accessible phosphorus (15.52 mg/100 g of soil) and very well secured in potassium (35.56 mg/100 g of soil).

The average rainfall in the vegetation period (April-October) for the period of 1961-2004 was 650.0 l/m^2. In the same period, in the year 2007, there were 580.3 l/m^2, and 538.9 l/m^2 in 2008. In the period of 1961-2004 the average monthly air temperature during the vegetation period (IV-X) was 16.40^{0}C. During the vegetation period air temperatures were higher than multiannual average in 2007 by 1.6 ^{0}C, and by 1.5 ^{0}C in 2008.

By analyzing weather conditions throughout the research, it can be noted that the weather conditions during the conduction of experiments were not most favorable because the amount of rainfall in the vegetation period was lower compared to the multiannual average, while the average temperature was higher for the same period.

Statistical analysis

Genotype × year interaction was evaluated according to GAUCH and ZOBEL (1996). AMMI analysis of variance was done by the programme GenStat 8.0 (trial version). Interaction was analyzed using AMMI1 biplot. The main effects (genotype, year) were ploted on the abcissa, and the values of the interaction effects (IPC1) genotype × year on the ordinate. For ploting the biplot, excel (macro) according to LIPKOVICH and SMITH (2002) was used.

RESULTS AND DISCUSSION

The test results on spike length of perennial ryegrass genotypes are presented tabular by the years of research in Table 1. Based on the two-year research, perennial ryegrass genotypes showed significant differences in spike length, respectively the average spike length of 22.3 cm was achieved.

Table 1. Spike length (cm) of perennial ryegrass genotypes (2007, 2008)

Genotype (A)	Spike length (cm)		X 2007/08 (A)
	2007 (B_1)	2008 (B_2)	
G-1	25,9	26,2	26,1
G-2	19,2	24,1	21,7
G-3	16,1	25,1	20,6
G-4	18,6	25,8	22,2
G-5	18,9	24,4	21,7
G-6	18,5	23,4	21,0
G-7	16,9	24,9	20,9
G-8	23,8	25,6	24,7
$\bar{Y}$ **(B)**	**19,7**	**24,9**	**22,3**

In the year 2007 the average spike length was 19.7 cm, and 24.9 cm in 2008. During the two-year research, genotype G-1 (26.1 cm) stands out by the spike length. The genotype G-1 (25.9 cm) achieved the maximum spike length in 2007. In contrast, genotype G-3 (16.1 cm) achieved the minimum spike length, similar as the genotype G-7 (16.9 cm). In comparison to year 2007, in 2008 perennial ryegrass genotypes exhibited a significantly higher spike length of 23.4 cm (G-6) to 26.2 cm (G-1). The genotypes G-4 (25.8 cm), G-8 (25.6 cm) and G-3 (25.1 cm) achieved the maximum spike length in 2008.

Genotypes with high IPC1 values (positive or negative, since it is a relative value) have large interaction effects. If the IPC1 values are closer to zero (line of stability), the interaction effect is small, i.e. these genotypes are stable in the studied years. From the agronomic point of view desirable genotypes are those with IPC1 values which are close to zero, and with average or above average yield.

Table 2. AMMI analysis of variance for spike lenght of perennial ryegrass

Source of variation	**df**	**SS (%)**	**MS**	***P***
Rep.[1]	6	0,78	1,02	0,85299
Genotype (G)	7	28,20	31,58	0,00000
Year (Go)	1	55,17	432,64	0,00000
G × Go	7	15,85	17,75	0,00001
IPC1	7	100	17,75	0,00001
IPC2	5	ns	0,00	1,00000
Error	42		2,36	

[1] tested with respective mean square error term

*$P < 0,05$; **$P < 0,01$

On the basis of AMMI analysis of variance for spike length it can be seen that all sources of variance were highly significant, main effects (genotype, year) and interaction (genotype × year). Year effect (55,17 %) accounted for most of the sum of squares indicating the substantial effect of year on spike length performance of the genotypes of perennial ryegrass evaluated in this study. The influence of genotype on spike length amounted 28,20%, and interaction 15,85 %. Significant genotype × year interaction demonstrated that the genotypes responded differently to variation in year conditions. The genotype × year interaction was further partitioned into IPC1 and IPC2, of which only IPC1 component was highly significant and accounted for 100 % of the total G×E interaction sum of squares (Table 2).

The 1000 seed weight is an important feature, especially for determination of seed amount for sowing. Very often, 1000 seed weight of perennial ryegrass is different, and it is significantly affected by genotype, environmental influences and interaction of genotype × environment. As for the genotype, the 1000 seed weight considerably variate, thus for diploid varieties (*2n*) value is 2 g, and for tetraploid (*4n*) about 3 g. Based on the results of two-year research, eight genotypes of perennial ryegrass achieved an average 1000 seed weight of 2.1 g, respectively from 1.8 g (genotype G-7) and 1.9 g (genotype G-6) to 2.5 g (genotypes G-1 and G-8), table 3.

Table 3. 1000 seed weight (g) of perennial ryegrass (2007, 2008)

Genotype (A)	1000 seed weight (g)		X
	2007 (B_1)	2008 (B_2)	2007/08 (A)
G-1	2,2	2,8	2,5
G-2	2,1	2,2	2,2
G-3	1,8	2,1	2,0
G-4	1,9	2,2	2,1
G-5	1,9	2,0	2,0
G-6	1,8	1,9	1,9
G-7	1,6	2,0	1,8
G-8	2,2	2,7	2,5
Y **(B)**	**1,9**	**2,2**	**2,1**

In the first year of testing (2007) the average of 1000 seed weight was 1.9 g. The largest grain was in genotypes G-1, G-8 (average 2.2 g) and G-2 (2.1 g), while five genotypes achieved values from 1.6 to 1.9 g/1.000 seeds. During the second year of testing (2008), the average 1000 seed weight was 2.2 g, respectively from 1.9 g (genotype G-6) to 2.8 g (genotype G-1).

Table 4. AMMI analysis of variance for 1000 seed weight of perennial ryegrass

Source of variation	**df**	**SS (%)**	**MS**	***P***
Rep.[1]	6	0,53	0.006	0,702
Genotype (G)	7	66,66	0.597	0,000
Year (Go)	1	23,40	1.470	0,000
G × Go	7	9,41	0.084	0,000
IPC1	7	100	0,084	0,000
IPC2	5	ns	0,000	1,000
Error	42		0,009	

[1] tested with respective mean square error term
$^{*}P < 0,05$; $^{**}P < 0,01$

On the contrary to spike length, for 1000 seed weight most of the variation was caused by genotype (66,66 %), although all other sources of variation showed highly significant differences on the basis of AMMI analysis of variance. Only IPC1 component of interaction was highly significant and accounted for 100 % of the total G×E interaction sum of squares (Table 4).

Grain size is an important biological property that can vary depending on environmental conditions, especially temperature and humidity even more. Also, seed size is an important feature from the point of drying, processing and storage of seeds. Based on the results of two-year research (2007-2008) the mass of 1 gram showed an average of 508 seeds/g, respectively from 420 (genotype G-8) to 598 seeds/g (genotype G-7), table 5.

Table 5. Grain size (number of seeds/g) of perennial ryegrass (2007, 2008)

Genotype (A)	Number of seeds/g		X
	2007 (B_1)	2008 (B_2)	2007/08 (A)
G-1	464	381	423
G-2	502	453	478
G-3	558	485	522
G-4	538	470	504
G-5	521	529	525
G-6	590	597	594
G-7	662	533	598
G-8	470	369	420
Y (B)	**538**	**477**	**508**

During the first year of testing (2007) an average of 538 seeds/g was achieved. From the eight genotypes of perennial ryegrass, those with the largest grains were genotypes G-1 (464 seeds/g) and the G-8 (470 seeds/g), while genotype G-7 (662 seeds/g) had the most seeds per gram. In 2008 an average of 477 seeds/g was achieved, or for 11.3% less than the previous year.

In this year, highest number of seeds/g was recorded for genotypes G-5, G-6, G-7 (529-597 seeds/g), and the lowest number for genotypes G-8 (369 seeds/g) and G-1 (381 seeds/g). Number of seeds/g, and seed size, has a special significance in the determination of sowing depth and seed quantity per unit area, which affects the initial growth and development of plants (Table 5).

Table 6. AMMI analysis of variance for seed number per g of perennial ryegrass

Source of variation	**df**	**SS (%)**	**MS**	***P***
Rep.[1]	6	0,12	68	0,748
Genotype (G)	7	71,56	33694	0,000
Year (Go)	1	20,33	67016	0,000
G × Go	7	7,99	3760	0,000
IPC1	7	100	3760	0,000
IPC2	5	ns	0,000	1,000
Error	42		118	

[1] tested with respective mean square error term
$^{*}P < 0,05$; $^{**}P < 0,01$

For seed number per g ANOVA showed highly significance for all sources of variation, with the preponderance of genotype. The influence of genotype on seed number per g amounted 71,56 %, and genotype × year interaction 7,99 %. The genotype × year interaction was partitioned into IPC1 and IPC2, of which only IPCA1 component was highly significant and accounted for 100 % of the total G×E interaction sum of squares for seed number per g (Table 6).

Hectoliter mass or seed volume (kg) is a significant physical property, primarily due to the design of facilities and equipment for seed packaging. Based on the results of two-year research (2007-2008), eight genotypes of perennial ryegrass achieved hectoliter mass of 21.5 to 27.1 kg, or an average of 25.3 kg (Table 7).

Table 7. Hectoliter mass (kg) of perennial ryegrass (2007, 2008)

Genotype (A)	Hectoliter mass (kg)		X
	2007 (B_1)	2008 (B_2)	2007/08 (A)
G-1	20,9	22,1	21,5
G-2	28,4	25,7	27,1
G-3	29,5	24,4	27,0
G-4	27,8	25,3	26,6
G-5	25,8	25,6	25,7
G-6	25,5	27,2	26,4
G-7	26,7	25,4	26,1
G-8	20,9	23,5	22,2
$\bar{Y}$ **(B)**	**25,7**	**24,9**	**25,3**

In 2007 the average hectoliter weight of 25.7 kg was achieved, respectively from 20.9 kg (genotypes G-1 and G-8) to 29.5 kg (genotype G-3). During the second year of research (2008) hectoliter mass was slightly lower, average of 24.9 kg. In this year, the highest hectoliter mass was achieved in genotype G-6 (27.2 kg), and lowest in genotype G-1 (22.1 kg), while the other genotypes had quite uniform hectoliter mass from 23,5 to 25,7 kg.

Table 8. AMMI analysis of variance for hectoliter mass of perennial ryegrass

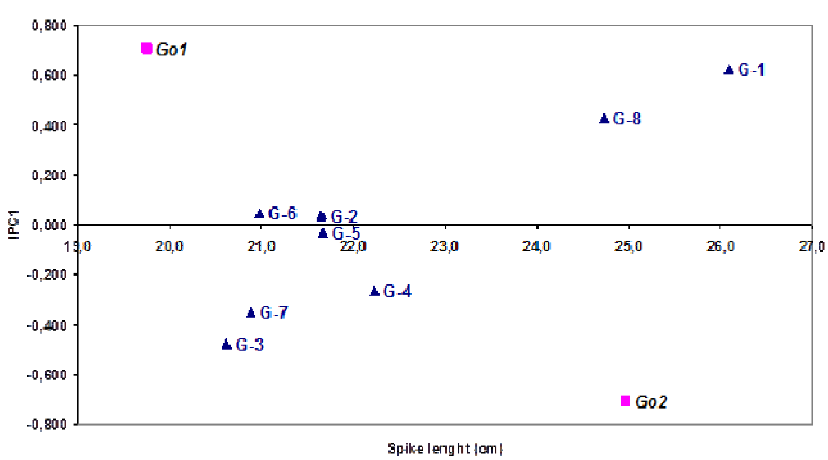
Source of variation	df	SS (%)	MS	*P*
Rep.[1]	6	0,30	0,19	0,917
Genotype (G)	7	71,44	37,81	0,000
Year (Go)	1	2,73	10,08	0,000
G × Go	7	25,53	13,52	0,000
IPC1	7	100	13,52	0,000
IPC2	5	ns	0,00	1,000
Error	42		0,58	

[1] tested with respective mean square error term
**P* < 0,05; ***P* < 0,01

Also, for hectoliter mass all sources of variation were highly significant. The highest contribution to hectoliter mass was performed by the genotype (71,44 %). Interaction genotype × year contributed with 25, 53 % to hectoliter mass of perennial ryegrass. IPC1 was highly significant (Table 8).

For all examined traits interaction genotype × year was highly significant, so it was divided on PCA components. Only IPC1 was highly significant, so AMMI1 biplot was performed for them.

Figure 1. AMMI1 biplot for spike lenght in ryegrass

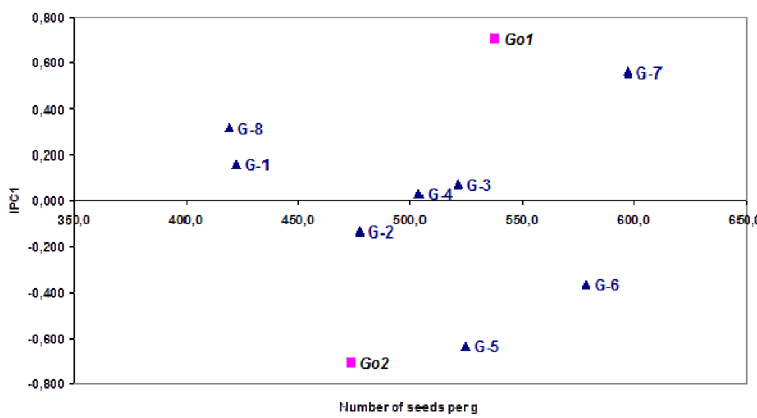


Genotype G1 had the highest mean value for spike length, and highest interaction score, i.e. was unstable with maximum distance from the line of stability. The genotypes G2, G5 and G6 were stable in the years of investigation, but had mean values below the general average. Genotype G4 had a relatively good stability, with the mean value about the general average (Figure 1).

Figure 2. AMMI1 biplot for 1000 seed weight in ryegrass

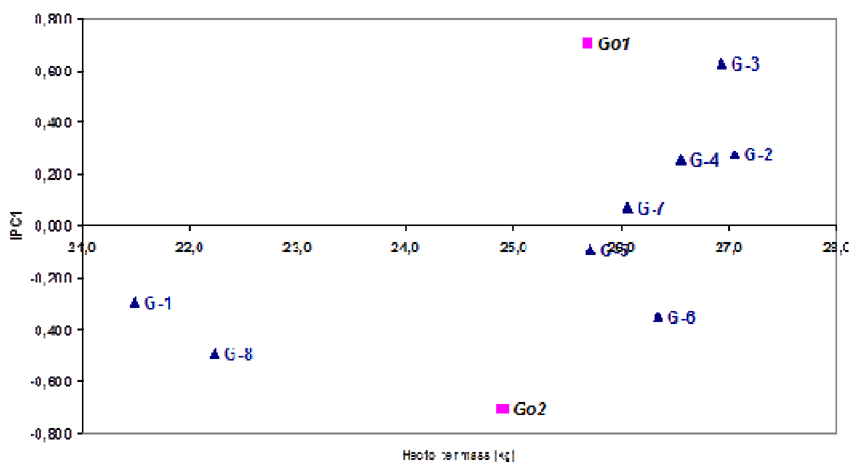
Genotypes G1 i G8 with highest mean values for 1000 seed weight were most unstable (with IPC1 values which were furthest from zero). Genotype G4 was stable and with mean value about the general average. Stability for this trait showed also G3, but with mean value below the general average (Figure 2).

Figure 3. AMMI1 biplot for seed number per g in ryegrass



With the highest seed number per g was genotype G7, but it was very unstable for this trait. Most stable genotypes were G3 and G4, both with mean values about the average. Genotypes G2 and G1 were stable, but with low mean values for number of seeds per g (Figure 3).

Figure 4. AMMI 1 biplot for hectoliter mass in ryegrass



Genotypes G5, G7, G4 and G2 had man values over general average, and they were most stable for hectolitre mass in examined environments. Most unstable was G3, with highest IPC1 value (Figure 4).

A genotype showing high positive interaction in an environment obviously has the ability to exploit the agroecological or agromanagement conditions of the specific environment and is therefore best suited to that environment. G×E varies with the material tested and the sites chosen for testing. Especially complex inherited, quantitative traits are influenced by environmental effects (DARBESHWAR, 2000). If there is no G×E interaction the genotypes need to only to be evaluated in one environment and whichever genotype is the best in that environment will also be the best in any other environment. AMMI analysis permits estimation of interaction effect of a genotype in each environment and it helps to identify genotypes best suited for specific environmental conditions (MISHRA *et al*., 2009). Taking into account all studied traits in perennial ryegrass during two-year experiments, it can be seen that genotype G4 had mean value above general mean (hectolitre mass) or had mean values which were not significantly different from general average (spike length, 1000 seed weight and seed number per g). This genotype showed most stability for all examined traits, so it can be recommended for sowing in different environmental conditions. Also, it could be used in the creation of new local varieties of perennial ryegrass.

CONCLUSION

Based on the research of quantitative traits of eight divergent perennial ryegrass (*Lolium perenne* L.) genotypes in agroecological conditions of Banja Luka region on the brown-valley soil, the following can be concluded:

During the two-year research (2007-2008), weather conditions, and in particular the amount and distribution of rainfall during the vegetation period were different, and it can be considered that the year and interactions of genotype × environment significantly affected the results of the research.

Perennial ryegrass genotypes showed significant differences in the spike length. For this property genotype G-1 (26.1 cm spike length) stands out.

Seed quality of perennial ryegrass genotypes was very good, and the average 1000 seed weight was 2.1 g, respectively from 1.8 g (G-7) to 2.5 g (G-1 and G-8).

The average grain size was 508 seeds/g. The smallest grain size had the genotype G-7 (598 seeds/g), and the largest G-8 (420 seeds/g), thus the differences are highly significant. Hectoliter mass was from 21.5 kg (G-1) to 27.1 kg (G-2), or an average of 25.3 kg.

The biplots allows easy visualization of differences in interaction effects. Taking into account all studied traits in perennial ryegrass, it can be seen that genotype G4 had mean value above general mean (hectolitre mass) or had mean values which were not significantly different from general average (spike length, 1000 seed weight and seed number per g). This genotype showed most stability of all examined traits, so it can be recommended for sowing in different environmental conditions. Also, genotype G4 could be used in the creation of new local varieties of perennial ryegrass.

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INTERPRETACIJA INTERAKCIJE GENOTIP × SPOLJAŠNJA SREDINA KOD ENGLESKOG LJULJA (*Lolium perenne* L.)

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Izvod

Cilj ovog istraživanja bio je da se proceni interakcija genotip × godina za dužinu klasa, masu 1000 semena, broj semena po g i hektolitarsku masu kod engleskog ljulja, koristeći osam divergentnih genotipova gajenih tokom dve vegetacione sezone. Interakcija je ocenjena primenom AMMI (metod aditivnih glavnih efekata i višestruke interakcije) modela. Za sve osobine utvrđene su aditivne (genotip, godina) i ne aditivne (interakcija genotip × godina) varijacije. Na osnovu rezultata AMMI1 biplota genotip G4 pokazao je najveću stabilnost za sve ispitivane osobina, tako da se može preporučiti za setvu u različitim uslovima sredine. Takođe, genotip G4 može se koristiti i u stvaranju novih domaćih sorti engleskog ljulja.

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