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Morphological and productive characteristics of hulless barley in organic farming

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Summary: Due to its positive effects on human health, hulless barley (*Hordeum vulgare* var. *nudum*) has increasingly been used as an alternative type of cereals in recent years. The main advantage of introducing hulless barley into various food products is a higher content of β-glucan than in other cereals and in particular common wheat. The aim of this paper was to examine morphological and productive characteristics, as well as the relationship and dependence between the studied characteristics of the hulless barley cultivar Goliat cultivated in an organic farming system. The mentioned characteristics were examined with regard to the weather conditions during three vegetation seasons (2009/2010-2011/2012) and with regard to fertilization. The impact of fertilization was monitored in the following treatments: T_1 - application of biofertilizer in topdressing (5.0 l ha^{-1}); T_2- fertilization using biohumus (3.0 t ha^{-1}) and biofertilizer in topdressing (5.0 l ha^{-1}); T_0 - control – without the use of fertilizer and biofertilizer. The experiment was carried out in a randomized block design with four replications, on the soil type of leached chernozem. The results showed that the year had a very significant impact on all the examined characteristics. Fertilization did not have a significant impact on stem length and grain weight per spike. However, other observed characteristics showed significant changes depending on fertilization. The strongest correlation was found between harvest index and grain weight per spike (0.898**), as well as between spike length and number of fertile spikelets (0.877**). On the basis of the regression analysis equation, it was determined that with the unit increase in the number of fertile spikelets grain number per spike increased by 0.573.

Key words: hulless barley, fertilization, fertilizers, organic agriculture

Introduction

Barley (*Hordeum vulgare* L.) is an ancient crop and a very important cereal. It is one of the first domesticated crops and today is ranked fifth according to the dry matter production in the world, following maize, wheat, rice and soybean (Baik & Ullrich, 2008). Barley has both winter and spring, hulled and hulless, and two-row and six-row varieties. Barley grain contains starch (65-68%), proteins (10-17%), β-glucan (4-9%), fats (2-3%) and minerals (1.5-2.5%) (Wang et al., 2015). The content of β-glucan in barley grain significantly depends on the genotype and less on the environmental factors during the grain filling stage (Powell et al., 1985). However, in the hulless barley forms, the genotype and environmental factors have an almost equal impact on the content of β-glucan (Yalçın et al., 2007). It was determined that hulless barley forms had a higher content of β-glucan, as well as a higher content of soluble dietary fibres than hulled forms (Fastnaught et al., 1996).

A high genetic diversity allows barley to be cultivated in various climatic conditions, as well as for diverse utilization. Barley is mainly used as the feed of domestic animals and in beer production, but also in the production of alcohol, food, pharmaceuticals and textile. In the food industry, it is suitable for the production of malt, muffins, biscuits, tortillas, etc. The pearled barley grain is used for producing semolina, barley flakes and a coffee substitute (*divka*) (Mehandžić Stanišić, 2013). However, although it is widely applied, only around 2% of the produced barley is used as human food (Baik & Ullrich, 2008). The reason is the fact that barley has a very low content of gluten, which means that its dough

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has unfavourable texture. Consequently, barley bread loaves have smaller volume, unattractive appearance and reduced organoleptic characteristics in comparison to wheat products. Moreover, when it comes to hulled barley, the grain has to be peeled before using, which leads to the loss of part of the aleurone layer and a significant part of proteins (Bhatty, 1986). On the other hand, some authors believe that the baking quality of white flour made of hulless barley can be independently used in bread production, without the admixture of wheat flour (Kinner et al., 2011). This means that hulless barley can be an alternative for the most used cereals in human nutrition and that this might contribute to the variety of food products which people consume on a daily basis.

Due to its positive effects on human health, in recent years hulless barley (*Hordeum vulgare* var. *nudum*) has increasingly been used as an alternative type of cereals, in direct nutrition and industrial processing (Dodig et al., 2007a; Oljača et al., 2009; Sullivan et al., 2010). Barley-based products can be classified as functional food due to the content of β-glucan, since this polysaccharide helps the regulation of blood glucose and cholesterol levels (Behall et al., 2004), reduces the risk of heart disease, prevents type 2 diabetes, eliminates gastrointestinal disorders, and regulates body weight by causing the feeling of satiety (Dodig et al., 2007b; Sullivan et al., 2010).

Although hulless barley has not traditionally been produced in Serbia, some genotypes of satisfactory agronomic traits and profitable yield can be selected (Pržulj, 2009). Previous research has shown that hulless barley provides 15-20% lower yields than the regular barley forms (Bhatty, 1979). However, in recent years plant breeding has produced higher-yielding cultivars. The research on the organic farming of barley is of great significance in Serbia, particularly in highland areas (Oljača et al., 2009). The grain yield obtained in these studies was on the same level as the yield in the conventional production. The yield was most significantly affected by agrotechnical measures, particularly by the selection and types of the applied fertilizers.

The aim of this research is to examine morphological and productive characteristics of the cultivar of hulless barley, cv. Goliat, in order to determine its suitability for cultivating in organic farming. In addition, the analysis of the relationship between the examined characteristics can contribute to the production of higher-yielding cultivars of hulless barley in Serbia.

Material and Methods

The research on the impact of different fertilization variants on morphological and productive characteristics of hulless barley in organic farming was conducted at the research and study field "Radmilovac" during three seasons (2009/2010-2011/2012). The applied method was a randomized block design with four replications, with the area of the elementary plot amounting to 6 m^2. The soil type was leached chernozem, while the chemical properties were as follow: pH (in H_2O) 8.04, the total nitrogen content was 0.13 %, P_2O_5 22.18 mg 100 g^{-1} soil, K_2O 19.10 mg 100 g^{-1} soil, the humus content in the ploughing layer amounted to 2.45 %.

Previous crop was maize (*Zea mays* L.) in all three seasons. Tillage method with the plough was carried

Table 1. Average monthly mean air temperature (°C) and precipitation sum (mm) in Belgrade during the studied period

Years	Months									Average
	X	XI	XII	I	II	III	IV	V	VI	
	Average temperatures (°C)									
2009/10	14	10.4	4.9	1.0	3.9	8.7	13.9	18.3	21.4	10.7
2010/11	10.5	12.2	2.5	2.0	1.4	8.2	14.6	17.3	22.4	10.1
2011/12	12.9	5.0	5.8	2.7	-2.5	10.1	14.4	17.9	24.6	10.1
Average 2009/2012	12.5	9.2	4.4	1.7	0.8	9.0	14.3	17.8	22.8	10.3
Average 1991/2009	13.4	7.4	2.4	1.8	3.8	7.6	13.2	18.2	21.6	9.9
	Precipitation (mm)									Sum
2009/10	101	62	122	89	111	46	41	85	180	837
2010/11	49	45	61	40	53	26	11	63	40	388
2011/12	35	6	49	82	62	3	67	128	14	446
Average 2009/2012	61.7	37.7	77.3	70.3	75.3	25	39.7	92	78	557
Average 1991/2009	53.3	57.5	56	45.2	40.9	42.8	55.2	51.2	96.4	498.5

Source: RHMS of Serbia services

out at a depth of 25 cm, from 15 - 20 October during all three years. Pre-sowing preparation was carried out by disc harrow and harrow. The sowing was done manually, from 20-25 October.

The cultivar of hulless barley (*Hordeum vulgare* var. *nudum*), cv. Goliat, was used in the research. Goliat is a cultivar of late maturity, medium lodging resistance and good resistance to *Erysiphe graminis*, *Puccinia recondite* and *Pyrenophora teres*. Thousand grain weight amounts to 37g, its hectolitre mass is around 81 kg, while the protein content is 12-13%. It requires early sowing and soil of moderate fertility, as well as the production technology adapted to the grain without glumes.

Table 1 contains the average monthly air temperatures and monthly precipitation during the research period obtained from the meteorological station located near the experimental field. The data show considerable variations of meteorological conditions depending on the year, particularly regarding precipitation. During the vegetation season of the first year (2009/2010), the average air temperatures were higher than in the second and third year of the research by 0.6°C and 0.3°C, respectively, as well as over a long term period by 0.8°C. The air temperatures recorded in October, February and May were higher than the temperatures in the same months in the second and third year. The temperature conditions during the vegetation season of the second year (2010/2011) were within the average values. However, extremely low air temperatures in the third year (2011/2012) were registered in February, while very high temperatures were recorded in the month of June.

When it comes to weather factors, precipitation has a special significance for plant production, particularly during the vegetation period of the crops. In the first research year, the precipitation in the barley vegetation period (878 mm) was higher than in the second (495 mm) and third year (485 mm), as well as over a long term period (568 mm). In the first year the greatest quantity of water deposits occurred in June, but October, December and February also witnessed heavy precipitation. In the second year, the precipitations in Jan and Feb were close to long term date, bur in March (26 mm) and April (11 mm) had less precipitation than long term date. In the third year, the dry months were November (6 mm) and March (3 mm), while there was more rainfall in May (128 mm) than the long term average. The total rainfall in the third year was within the long term average, with significantly lower rainfall in March (3 mm) and November (6 mm) but higher in May (128 mm).

The second factor included in the research was fertilization, i.e. its different treatments: T_1 - application of biofertilizer in topdressing (5.0 l ha^{-1}); T_2- fertilization using biohumus (3.0 t ha^{-1}) and application of biofertilizer in topdressing (5.0 l ha^{-1}); T_0 - control – without the use of fertilizers and biofertilizer. Biohumus (the organic fertilizer) (pH of 8.63 and the minimum content: 2.2% N; 4.8% P_2O_5 and 2.8% K_2O) was ploughed down in the quantity of 3.0 t ha^{-1} with the basic tillage. For the spring nutrition, a microbiological preparation – biofertilizer (*Bacillus megaterium* 10^{-6} cm^3, *Bacillus licheniformis* 10^{-6} cm^3, *Bacillus suptilis* 10^{-6} cm^3, *Azotobacter chtoococcum* 10^{-6} cm^3, Azotobacter vinelandi 10^{-6} cm^3, *Derxia* sp. 10^{-6} cm^3) was applied at the dose of 5.0 l ha^{-1} in the stem elongation phenophase.

Sowing was conducted manually after mid-October, with the crop density of 550 of germinating seeds m^{-2}. In each of the three research years, seven to ten days prior to harvest, 10 plants were selected by random sampling in order to determine morphological and productive characteristics of the cultivar Goliat in all fertilization variants by laboratory testing.

The examined morphological characteristics were stem height and spike length, while the observed productive characteristics were: stem and spike weight, grain weight per spike, number of fertile spikelets, grain number per spike, and harvest index.

The crops were harvested using a combine harvester at full crop maturity. Grain yield was calculated from the whole elementary plot. The grain moisture content of 14% was applied to calculate the yield which was expressed in kg ha^{-1}.

The obtained data were processed using the statistical packages SPSS Statistics 19.0. The method of two-factor analysis of variance (F test) was applied, and the significance of differences was tested by the LSD test at the significance level of p-0.01 and p-0.05. The methods of simple linear correlation and regression analysis were used for examining the degree and form of dependence between the observed characteristics.

Results and Discussion

Climatic conditions significantly affect the productivity of crops cultivated in open fields. Stem height, as well as the total plant height, is an important characteristic of cereal crops, which significantly affects the harvest index and grain yield. What is more, some studies have indicated the importance of stem height in the competition for resources (Roljević Nikolić et al., 2017). The average stem height of the studied cultivar of hulless barley (cv. Goliat) amounted 55.59-62.06 cm depending on the treatment, whereby the value obtained in the third year at all treatments was significantly higher than the first and second year. The differences, within the same treatment, obtained between the first and second years were not significant. On the other hand, the results of the statistical analysis showed no significant effect of fertilization on stem height. Similarly, the interaction of year × fertilization (Y × T) did not show a significant impact.

Spike length is an important yielding indicator, which has a direct impact on the grain yield by means of the number of spikelets, grain number per spikelet and grain number per spike. A spike of greater length is most commonly related to a larger number of spikelets, and a greater grain number per spike (Ibrahim et al., 2018). Stojanović (1993) states that a spike of greater length, due to its more active photosynthesis, can serve as a better source of assimilates and as their acceptor. The average spike length during the observed three-year period ranged from 8.47 to 9.62 cm depending on the treatment. On the control variant (T_0), the spike length in the third year (9.64 cm) was significantly higher compared to the first (12.4%) and second years (34.1%) (Tables 2 and 3). The differences obtained between the years at T_1 and T_2 were not significant. Spike length was significantly affected by the fertilization treatment, since the control value was lower by 11% and 12% in comparison with the T_1 and T_2 treatments. Observing the interaction of the studied factors, it can be concluded that during the experiment, the spike length in the control (T_0) was shorter than in the fertilization treatments (T_1 and T_2), which particularly pronounced in the second year when the obtained differences were very significant. The smallest differences between the treatments were recorded in the third year.

Grain weight per spike varied significantly depending on the studied year (Tables 2 and 3). On all treatments, the grain weight per spike obtained in the third year was significantly higher than the first and second year of testing, with the largest differences obtained at T_2. Fertilization did not have a significant impact on this property, but it was noticed that the T_2 treatment provided somewhat higher values (by about 4.5%) than T_1 and T_0. Although the effect of the interaction of the studied factors was not significant, the data in Table 2 show that obtained values at control were lower than in the fertilization treatments, particularly in the T_2 treatment, and that the application of fertilizers in the organic farming of this cultivar can affect its productivity.

Likewise, heat stress in the phases of cereal development, sterility of spikelets can also occur due to the competition for nutrients inside the spike and between the spike and other plant organs (Pržulj & Momčilović, 2011). This indicates different mechanisms for developing the genetic yield potential and a very significant impact of the genotype on the number of fertile spikelets. In all three treatments, the highest average number of fertile spikelets was recorded in the third research year. The biggest differences were found on control (T_0), while the differences obtained on T_2 treatment were not significant.

The stem elongation phase is very significant in the formation of yield elements. During this phase, the 4th, 5th, 6th and 7th stages of organogenesis occur, and they are crucial for the number of spikelets, florets and their fertility (Pržulj & Momčilović, 2011). Sufficient phosphorus quantity during the spike formation ensures a better development of the stamen and ovary, which decreases the sterility to the lowest degree possible. On the other hand, the lack of phosphorus in this phase results in sterility. The number of fertile spikelets in this research was significantly increased by fertilization. Namely, in the T_1 and T_2 treatments, the number of fertile spikelets was higher by 14.4% and 16.9% than in the control (Tables 2 and 3). The analysis of the results obtained in the research shows that the application of fertilizers in organic farming has a positive impact on the number of fertile spikelets, and that their number varied significantly more in the control than in the fertilization treatments, particularly in the T_2 (organic fertilizer and biofertilizer).

Table 2. Morphological and productive characteristics naked barley in the three-year study period (2009/2010-2011/2012)

Year	Treatment			Average
	T_0	T_1	T_2	
	Stem height (cm)			
2009/2010	51.21	53.63	52.89	52.58
2010/2011	46.30	54.91	58.15	53.12
2011/2012	69.25	69.36	75.13	71.25
Average	55.59	59.30	62.06	
	Spike length (cm)			
2009/2010	8.58	9.38	9.58	9.18
2010/2011	7.19	9.39	9.45	8.68
2011/2012	9.64	9.79	9.82	9.75
Average	8.47	9.52	9.62	
	Grain weight per spike (g)			
2009/2010	0.70	0.72	0.72	0.71
2010/2011	0.89	0.84	0.90	0.88
2011/2012	1.07	1.09	1.15	1.10
Average	0.89	0.88	0.92	
	Number of fertile spikelets			
2009/2010	23.60	24.47	26.37	24.81
2010/2011	19.20	27.07	27.57	24.61
2011/2012	26.40	27.60	26.97	26.99
Average	23.07	26.38	26.97	
	Number of grains per spike			
2009/2010	16.70	21.27	18.88	18.95
2010/2011	16.13	18.70	19.33	18.05
2011/2012	21.40	22.20	23.10	22.23
Average	18.08	20.72	20.44	
	Harvest index			
2009/2010	0.37	0.35	0.33	0.35
2010/2011	0.41	0.37	0.37	0.38
2011/2012	0.45	0.43	0.48	0.45
Average	0.41	0.38	0.39	
	Yield (kg ha^{-1})			
2009/10	1,938.30	2,239.83	2,267.58	2,148.57
2010/11	2,003.00	2,443.83	2,551.33	2,332.72
2011/12	3,025.00	4,708.33	5,375.00	4,369.44
Average	2,322.10	3,130.66	3,397.97	

Treatment: T_0- control, T_1- biofertilizer, T_2-organic fertiliser + biofertilizer

Grain number of the primary spike results from spike length, spikelet number in the primary spike and floret number per spikelet, and depends on the fertilization of florets and grain set (Perišić et al., 2011; Jaćimović et al., 2012). All these parameters are significantly affected by meteorological conditions during the year and the applied cultural practices, which makes the grain number per spike a very variable productive property. A significantly higher grain number per spike was recorded in the third year compared to the first (4.4 – 28.1%) and second research year (18.7 – 32.7%) depending on the treatment. Fertilization, as the observed factor, also had a significant impact on this hulless barley property. Namely, the grain number per spike in the treatments T_1 and T_2 was higher by 14.4% and 16.9% than in the control, which represents a very significant difference.

The main reason for the improvement of the cereal production is the increase of harvest index (Calderini et al., 1995). Harvest index usually changes depending on the weather conditions in the season and it is considerably higher in more fertile years than in the less favourable ones. The best grain/straw ratio in this research was registered in the third research year on all treatments. The largest and statistically significant differences in the research years were recorded at T_2, and at least at the T_1 treatment. The harvest index value in the control (0.41) was higher than in the treatment T_1 (0.38), while the other differences recorded between the treatments were not statistically significant (Tables 2 and 3).

The average grain yield of hulless barley obtained on various treatments, during the three-year study amounted 2,322.10 to 3,397.97 kg ha^{-1} (Table 2). Grain yield in the third year was significantly higher compared to the first and second year, with the largest differences on treatment T_2. On the other hand, the differences between the first and second years on the T_0 and T_1 treatments were not significant.

The application of biofertilizer (3,130.66 kg ha^{-1}) increased the grain yield of hulless barley by 35%, while the combined application of fertilizers (3,397.97 kg ha^{-1}) increased the yield by 46% in comparison with the control (2,322.10 kg ha^{-1}). Jarak et al. (2006) examined the effects of fertilizer application on the soil microbiological activity and barley yield in compacted and uncompacted soils. The application of biofertilizer had an impact on the better barley yield which was higher on the headland (14.5 %) and the central section (6.5 %) of the inoculated plot than in the control plot. The analysis of the interaction between the studied factors indicates that the differences in grain yield between the treatments were not significant in the first year. On the other hand, in the third year, the differences between the observed treatments were significant.

The results of the correlation analysis (Table 4) showed that between the studied morphological and productive characteristics of the examined hulless barley cultivar there were positive correlations which were mostly statistically very significant (Table 4). The strongest correlation was determined between harvest index and grain weight per spike (0.898**), then between spike length and number of fertile spikelets (0.877**), as well as between stem height and grain weight per spike (0.803**). Furthermore, there was a very

Table 3. Analysis of variance of the examined characteristics

Tested parameters		2009/2010-2011/2012			
		a level	Y	T	Y × T
Stem height	F test		**	ns	ns
	LSD	0.05	8.272		
		0.01	11.345		
Spike length	F test		**	**	*
	LSD	0.05	0.555	0.555	0.962
		0.01	0.761	0.761	1.320
Grain weigh per spike	F test		**	ns	ns
	LSD	0.05	0.065		
		0.01	0.090		
Number of fertile spikelets	F test		**	**	**
	LSD	0.05	1.372	1.372	2.377
		0.01	1.882	1.882	3.260
Number of grains per spike	F test		**	*	ns
	LSD	0.05	1.697	1.697	
		0.01	2.327	2.327	
Harvest index	F test		**	*	*
	LSD	0.05	0.016	0.016	0.027
		0.01	0.022	0.022	0.037
Yield	F test		**	**	**
	LSD	0.05	262.5	262.5	454.6
		0.01	360.0	360.0	623.5

Y – year, T – treatment, ns = $P>0.05$ * = $P<0.05$ ** = $P<0.01$.

Table 4. Results of correlation analysis

	Stem height	Spike length	Grain weight per spike	Number of fertile spikelets	Number of grains per spike	Harvest index	Yield
Stem height	1	.718**	.803**	.672**	.778**	.726**	.756**
Spike length	.718**	1	.382*	.877**	.720**	0.175	.479*
Grain weight per spike	.803**	.382*	1	.390*	.573**	.898**	.798**
Number of fertile spikelets	.672**	.877**	.390*	1	.601**	0.145	.433*
Number of grains per spike	.778**	.720**	.573**	.601**	1	.467*	.663**
Harvest index	.726**	0.175	.898**	0.145	.467*	1	.731**
Yield	.756**	.479*	.607**	.433*	.663**	.731**	1

** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level.

significant correlation between grain number per spike and stem height (0.778**), spike length (0.720**), and number of fertile spikelets (0.601**). Grain yield had the strongest correlation with grain weight per spike (0.798**) and stem height (0.756**).

The results of the regression analysis showed that the harvest index of the studied cultivar significantly depended on grain weight per spike. On the other hand, grain weight per spike had a significant positive dependence on the change of stem height, where the increase of the stem height by 1 cm led to the rise of the grain weight by 0.013 g ($\hat{y}_i = 0,145 + 0,013*x_i$). Pržulj and Momčilović (2003) determined that the nitrogen quantity which was translocated from vegetative parts in the spring barley represented 41-85% and 37-153% of the total nitrogen in the grain at the low and high levels of this macronutrient absorption, respectively.

On the basis of the simple linear regression equation ($\hat{y}_i = 1.920 + 0.286*x_i$), it can be concluded that the increase of spike length by 1cm leads to the rise of the fertile spikelet number by 0.286. A longer spike has a better photosynthetic ability and, along with the mineral nutrition, it has a direct effect on the intensity of organic matter production and a larger number of fertile florets in the spikelet (Miralles & Slafer, 2007). On the other hand, the unit increase in the number of fertile spikelets has an impact on the increase in grain number per spike by 0.572 ($\hat{y}_i = 5.157 + 0.573*x_i$). Other authors also stated that grain number per spike depended on spikelet fertility (Hristov et al., 2008). Although yield is a key goal, efficient breeding program requires a proper understanding of the relationships among all the properties (Mirosavljević et al., 2015). The results of this study showed that the grain yield per unit area can be most significantly influenced by the increase in grain weight per spike ($\hat{y}_i = - 2020.685 + 5535.786*x_i$).

Conclusion

The study results showed that the meteorological factors during the season had a very significant impact on the expression of the genetic potential of the Goliat cultivar, cultivated in an organic farming system. All the examined characteristics were under a strong influence of the year as the observed factor. Fertilization had no significant impact on stem length and grain weight per spike, while for other characteristics significant differences were noted between treatments. The combined application of organic fertilizer and biofertilizer had the significant impact on the examined characteristics and grain yield. The correlation analysis indicated the existence of positive and strong correlations between the studied characteristics, particularly between the harvest index and grain weight per spike, while the regression analysis determined the strong dependence of the number of fertile spikelets and grain number per spike on the spike length, as well as the grain yield per area unit on the grain weight per spike. The obtained results show that plant breeding and selecting the most suitable cultivation technologies can improve both morphological and productive characteristics of the hulless barley cultivated according to the principles of organic farming.

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Morfološke i produktivne osobine golozrnog ječma u uslovima organske proizvodnje

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Sažetak: Zbog blagotvornog uticaja na zdravlje ljudi, poslednjih godina raste interes za upotrebom golozrnog ječma (*Hordeum vulgare* var. *nudum*) kao alternativne vrste žita. Glavna prednost uključivanja golozrnog ječma u različite prehrambene proizvode proizilazi iz većeg sadržaja β-glukana u odnosu na običnu pšenicu, pa se takvi proizvodi često svrstavaju u funkcionalnu hranu. Cilj rada je proučavanje morfoloških i produktivnih osobina, kao i odnosa i zavisnosti između ispitivanih osobina ozime sorte golozrnog ječma (cv. Golijat) gajenog u organskom sistemu proizvodnje. Pomenute osobine su ispitivane u zavisnosti od vremenskih uslova tokom tri vegetacione sezone (2009/2010-2011/2012) i đubrenja. Uticaj đubrenja praćen je kroz sledeće tretmane: T_1 - primena biofetilizatora u prihranjivanju (5,0 l ha^{-1}); T_2- đubrenje biohumusom (3,0 t ha^{-1}) i biofertilizatorom u prihranjivanju (5,0 l ha^{-1}); T_0 - kontrola – bez primene đubriva i biofertilizatora. Ispitivanje je realizovano prema planu slučajnog blok sistema u četiri ponavljanja, na zemljištu tipa izluženi černozem. Rezultati su pokazali da godina, odnosno meteorološki činioci tokom vegetacione sezone ispoljavaju veoma značajan uticaj na sve ispitivane osobine. Đubrenje nije imalo značajan uticaj na dužinu stabla i masu zrna u klasu, dok su druge ispitivane osobine pokazale značajne promene u zavisnosti od delovanja ovog faktora. Značajnije efekte na proučavane osobine imala je kombinovana primena organskog đubriva i biofertilizatora u poređenju sa samostalnom primenom biofertilizatora. Najjača korelaciona povezanost ustanovljena je između žetvenog indeksa i mase zrna u klasu (0,898**), kao i između dužine klasa i broja plodnih klasića (0,877**). Na osnovu jednačine regresione analize utvrđeno je da jedinično povećanje broja plodnih klasića utiče na povećanje broja zrna u klasu za 0,573.

Ključne reči: golozrni ječam, đubrenje, đubriva, organska poljoprivreda

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