
## GREEN ROOM SESSIONS 2018

# Book of Proceedings

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**GREEN ROOM SESSIONS 2018**
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# FOREWORD

Green Room Sessions International Conference aims to be platform for international scientific discussion on agriculture in general as well as agriculture in conjunction with economics and ecology, food and nutrition science and technology, rural development, environment and forestry. Green Room Sessions brings together and is connecting research, industry, social concepts and practices. The scientific core is based on applying Eco-Eco (ecological-economical) concepts and principles to optimize interactions between natural, social and built components of the rural environments: plants, animals, soil, water, air, humans and man-made structures. In addition, Green Room Sessions placed social issues at the centre of solutions for a sustainable and fair food system. Green Room Sessions are targeting to multiple benefits to society and the environment, by bringing people together and providing them the opportunity to sit together and exchange ideas and connect the business.

In November 2018, the 1st Green Room Sessions International Conference provided an opportunity for sharing experiences and builds the evidence base on agriculture, forestry, human interactions and built environment, as well as reaching a consensus on the priorities for achieving more sustainable food systems. It also endorsed Institutional roles of National services, Regional and International organisations in supporting further implementation and promotion of Eco-Eco (ecological-economical) concepts and principles.

Dialogue between the participants targeted:

- Enhancing smallholder and family farmers' adaptation and resilience to the impacts of climate change;
- Improving nutrition including through more diversified diets;
- Protecting and enhancing agro-biodiversity in support of ecosystem services;
- Improving livelihoods in rural areas;
- National Food Wealth, the holy trinity: agriculture, economics and ecology (a x $e^2$);
- Mutual interconnections and how to deal with them and how this mix influence National Food Wealth and National Health.

achieving a transformative change in agricultural practices towards sustainable development.

The Green Room Sessions International Conference synthesized and build on the outcomes of the regional meetings, and provided an opportunity to share and discussed policies that can help scale-up and scale-out agriculture, rural development, agroecology, nutrition in order to achieve the Sustainable Development Goals.

The Symposium also moved the topic of agriculture and rural development from dialogue to activities at the regional and country level by complementing on-going initiatives to integrate biodiversity and ecosystem services in agriculture, identifying opportunities for synergies with National Strategic Programmes and Regional Initiatives, and facilitating regional and International cooperation between the scientists and business.

Green Room Sessions International Conference as a final goal is looking forward to assist people from the rural areas, related business, agriculture and allied sectors to take the advantage of:

- Natural resources, secure access to land and water, and improved natural resource management and conservation practices;
- Improved agricultural technologies and effective production services;
- Linking the interested parties with financial services;
- Transparent and competitive markets for agricultural inputs;
- Opportunities for rural off-farm employment and enterprise development;
- Local and national policy and programming.

We launch this with the aim of unlocking innovative, integrated, multidisciplinary science and technology with activation of all dimensions of sustainable development goals for all the participants.

In this Book of Proceedings we published part of the original scientific full papers presented at the Conference. The other part is provided for publication at the journal Agriculture and Forestry (ISSN 0554-5579, Printed; ISSN 1800-9492, Online), all based on the requests of the authors who participated at the Conference.

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# PREDGOVOR

Međunarodna konferencija Green Room Sessions imala je za cilj da bude platforma međunarodne naučne diskusije o poljoprivredi uopšte, poljoprivredi vezano sa pitanjima ekonomije i ekologije, nauci o tehnologiji hrane i prehrane, ruralnim razvojem, životnom sredinom i šumarstvom. Green Room Sessions okupila je i povezivala nauku, istraživanje, industriju, društvene koncepte i prakse.

Naučni principi zasnovani su na primjeni Eko-Eko (ekološko-ekonomskih) koncepata za optimizaciju interakcije između prirodnih, socijalnih i komponenti ruralnih sredina: biljka, životinja, zemljište, voda, vazduh, kao i strukture koje su nastale kao plod rada ljudi. Pored toga, Green Room Sessions je težila da postavi društvena pitanja u centar rješenja održivog i fer sistema proizvodnje hrane. Brojni sastanci održani su tokom Konferencije sa ciljem da imaju višestruke koristi za društvo i sredinu koja nas okružuje, približavajući tokom ovih komunikacija ljude jedne drugima, pružajući im priliku da međusobno komuniciraju na jednom mjestu, razmenjuju ideje i povezuju poslovanja.

U novembru 2018. godine, Green Room Sessions International Conference pružila je mogućnost razmjene iskustava potvrđenih praksi u poljoprivredi, šumarstvu, interakcijama čovjeka i njegovog okruženja, struktura koje su nastale kao plod rada ljudi. Ovo je postignuto organizovanjem susreta naučnika i stručnjaka iz ove oblasti, te razmjenom iskustava, doprinoseći unapređenju održivijeg sistema proizvodnje i prerade. Iskustva drugih koji su gostovali istakli su značaj institucionalne uloge nacionalnih službi, regionalnih i međunarodnih organizacija u podršci i daljoj promociji eko-eko (ekološko-ekonomskih) koncepata i principa.

Dijalog između učesnika bio je usmjeren na:

- Prilagođavanje malih proizvođača i porodičnih farmera i jačanje njihove otpornosti na uticaj klimatskih promjena;
- Zaštitu i unapređenje agro-biodiverziteta, podrške održivosti ekosistema;
- Poboljšanje životnih uslova, životnog standarda u ruralnim područjima;
- „Sveto trojstvo": poljoprivreda, ekonomija i ekologija ($a \times e^2$), njihove međusobne veze i kako se baviti njima, te kako ovaj miks međusobnih relacija utiče na proizvodnju domaće hrane i zdravlje nacije;

- Postizanje tranzicionih promjena u poljoprivrednim praksama u skladu sa principima održivog razvoja.

Konferencija je dijelom uradila sintezu i nadograđivala rezultate regionalnih sastanaka i pružiti priliku da podijeli svoja iskustva sa učesnicima, diskutuje o politikama koje mogu pomoći u povećanju poljoprivredne proizvodnje, ruralnog razvoja, agroekologije, ishrane kako bi se postigli ciljevi održivog razvoja.

Konferencija je takođe inicirala pomjeranje teme poljoprivrede i ruralnog razvoja od dijaloga ka konkretnim aktivnostima na lokalnom i regionalnom nivou, tražeći rješenja očuvanja biodiverziteta u poljoprivredi, identifikujući mogućnosti za sinergiju sa nacionalnim strateškim programima i regionalnim inicijativama, pospješujući regionalnu i međunarodnu saradnju između naučnika i biznisa.

Učesnici na Konferenciji tražili su načine da se pruži pomoć ljudima iz ruralnih područja, njihovim malim biznisima, poljoprivredi i srodnim sektorima da iskoriste prednosti:

- Prirodnih resursa, bezbjednog pristupa zemljištu i vodama, poboljšavajući prakse upravljanja prirodnim resursima i pristupe konzervacije;
- Poboljšane poljoprivredne tehnologije i efikasnijih proizvodnih usluga;
- Povezivanje zainteresovanih strana sa finansijskim servisima;
- Mogućnosti za zapošljavanje i razvoj preduzeća u ruralnim područjima;
- Lokalnih i nacionalnih politika i programiranja.

Ovo inicijativa je pokrenuta sa ciljem otvaranja i susreta sa inovativnom, integrisanom, multidisciplinarnom naukom i tehnologijom uz aktiviranje svih dimenzija ciljeva održivog razvoja za sve učesnike.

U ovom Zborniku radova objavili smo dio originalnih naučnih radova (*Full papers*) predstavljenih na Konferenciji. Drugi dio je proslijeđen za objavljivanje časopisu Poljoprivreda i šumarstvo (ISSN 0554-5579, print; ISSN 1800-9492, online), sve na osnovu zahtjeva autora koji su učestvovali na Konferenciji.

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**CONTENT**

## Plant production, Plant protection and food safety, Genetic resources

## Environment protection, natural resources management, Rural development and Forestry

*Original Scientific paper*

# Yield components and genetic potential of two-rowed barley

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**Abstract**

The aim of this study was to determine the significance of the source of the yield variability and components of the two-rowed barley, as well as the varieties and lines based on the investigated properties and the extraction of superior genotypes that exhibit high and stable yields. The average plant height for all examined genotypes of two-rowed barley ranged from 75.70 cm (2009/10) to 77.87 cm (2008/09), while the average plant height was 76.79 cm. The length of spike of the studied genotypes of two-rowed barley ranged from 8.32 cm (2008/09) to 8.50 cm (2009/10), while the average was 8.41 cm. The number of grains per spike of the studied genotypes of two-rowed barley ranged from 22.50 (2009/10) to 22.69 (2008/09), while the average was 22.59. The grain weight per spike of the barley in the area of Zaječar ranged from 1.066 g (2009/10) to 1.122 g (2008/09), while the average was 1.094 g. Correlations between the length of spike and number of grains per spike and grain weight per spike in the examined genotypes of two-rowed barley at the location Zaječar showed a positive value both in the vegetations 2008/09 and 2009/10 of the study.

**Keywords:** *quality, productivity, barley*

**Introduction**

Barley is one of the oldest plant species used by human population. It underwent significant genetic changes during the domestication process, which allowed it to be widespread, before the formal beginning of plant breeding in order to create varieties for different purposes. Over the course of thousands of years of barley cultivation as a field crop, there has been a change in its basic purpose, from grain essential to human nutrition to a very important raw material in animal nutrition. Even today, in the northern parts and at high altitudes, barley is the only bread grain (Baik and Ullrich, 2008).

Grain quality is a qualitative property influenced by the genetic factors and environmental factors, as well as their interaction, so the variety can behave in some years as beer or forage crop, which can be determined by the testing and directed for a particular purpose (Bratković *et al*., 2014; Đekić *et al*., 2012; Popović *et al*., 2011). The yield per unit area is the result of the action of factors of variety fertility in interaction with environmental factors. The main goal in breeding barley is to create varieties with high yield potential and good grain quality suitable for animal feed or brewing industry (Pržulj and Momčilović, 2002). Improved production technology has contributed to the increase in yields in recent decades, because improved production technologies enable better realization of the potential for yield (Đekić *et al*., 2017). High and stable yield of barley is the main goal of breeding, especially in institutions where it is not possible to adequately test the breeding

material on quality traits (Bratković *et al*., 2014). The need for a variety of short or long growing season depends on the environmental conditions of a particular area. In winter barley often variations in yield can be detected, also between the years and between locations (Madić *et al*., 2018; Mirosavljević *et al*., 2015; Pržulj *et al*., 2014).

Global climate changes cause ever warmer summers and milder winters, which in the future will shift the dates of sowing and heading as well as the barley farming areas. In Serbia, drought is present almost every year. In some years (1990 and 1992) the lack of precipitation was so pronounced that yields of some cultures were reduced by 70% in comparison to the average. In cases with normal winter precipitation, winter barley mainly ends vegetation before the first spring moisture deficit or, for the end of vegetation it successfully uses moisture accumulated during the winter months (Mladenov and Pržulj, 1999).

Bearing in mind the significance and consequences of the interaction between genotype and the environment in barley breeding, the aim of this paper was to determine superior genotypes based on the yields components, which show minimal interaction, i.e. high stability, and as such can be recommended for expansion in production or as parental components in crossing/breeding.

## Materials and Methods

*Experimental design, soil conditions and statistical analysis*

As a test material, 12 recognized varieties and 8 homozygous lines (F7 and F8 generations) of the two-rowed barley were used in this study. Varieties and lines were originally from the Centre of small Grains in Kragujevac (Jagodinac, Maksa and Rekord) and the Institute of Field and Vegetable Crops Novi Sad (NS-587, NS-293, NS-595, NS-519, NS-565, NS-183, NS-525, NS-589, NS-593, J-110, J-90, J-96, J-82, J-103, J-176, J-81 and J-104). On the basis of the average duration of the vegetation period, early and late genotypes were identified. Early genotypes belong are NS-519, J-96, Maksa, NS-565, NS-525, J-110, and late J-176, Jagodinac, NS-183, J-103 and Rekord.

Field trials were conducted in the two-year period (2008/2009 and 2009/2010) at the Zaječar location (Center for Agricultural Research) under conditions of dry cropping. The trials were set by the random design method in four repetitions. The surface of the basic plot was 5 m² (5m × 1m). The sowing was conducted with the use of a machine with a 12.5 cm intermittent distance. The soil on which the trial was conducted was uniform and well prepared. The quantity of seeds per m² was 400-500 germinating kernels, depending on the characteristics of varieties and lines. During the barley vegetation standard agro-technical measures were applied.

The following characters: stem height, length of spike, number of grains per spike and grain weight per spike were analyzed. The sample for analysis of the height of the stem consisted of 80 plants (20 plants x 4 repetitions) taken directly before harvesting.

The main type of soil on which the trial in Zaječar was carried out was carbonate-free vertisol. The physical properties of this soil are very unfavourable and it belongs to the type of heavy clay soil. According to the analysis, this soil was of a slightly acid reaction ($pH_{KCl}$ = 5.67) and medium level of provided humus (2.52). This soil has the medium level of provided phosphorus (15 mg / 100g of soil), and well-provided of potassium (30.1 mg / 100g of soil).

On the basis of the achieved research results, mean variables were calculated. Statistical analysis was made in the module Analyst Program SAS/STAT (SAS Institute, 2000).

*Agroecologial conditions*

Zaječar its surroundings belong to a moderate continental climate. The latitude of the meteorological station in Zaječar is 43º 53 ', longitude 22º 17', and the altitude is 144 m. The period from November to February, March and June, the temperatures in the vegetation seasons 2008/2009 and

2009/2010 was below the multiannual average, except from April and May in the 2008/2009 year. Temperature variations on average were higher in the first in relation to the second vegetation season.

The period from November to February, March and June in 2008/2009 and 2009/2010 is characterized by rainfall above average (Table 1). In April, precipitation in the vegetation season 2008/2009 was significantly lower and higher in the vegetation season 2009/2010. In May, the precipitation in the vegetation season 2008/2009 was below the multiannual average. During the ripening phase in June, the precipitations in the vegetation seasons 2008/2009 and 2009/2010 significantly exceeded multiannual values.

**Table 1.** Values of climate variables in 2008-2010 and long-term data for the location (Zaječar)

| Months | Nov-Feb | March | April | May | June |
|---|---|---|---|---|---|
| | Temperature variations (°C) | | | | |
| 2008/2009 | 8.0 | 10.4 | 14.0 | 15.8 | 13.7 |
| 2009/2010 | 8.0 | 10.9 | 11.6 | 12.3 | 13.1 |
| 1981/2010 | 9.2 | 11.8 | 13.4 | 14.1 | 14.6 |
| | Precipitation (mm) | | | | |
| 2008/2009 | 286.4 | 58.3 | 14.4 | 18.0 | 76.4 |
| 2009/2010 | 391.5 | 64.3 | 73.5 | 58.9 | 95.1 |
| 1981/2010 | 184.5 | 40.6 | 53.2 | 52.4 | 58.1 |

Temperature, precipitation and a sufficient amount of water in the soil are the three most important reasons for the instability of yield in our area. In ecological conditions of Serbia, high temperatures and water deficit in June lead to reduced yields and deterioration of technological properties of grains and malt, which is why the extension of the total vegetation cannot influence the prolongation of the grain filling period to increase the yield (Pržulj *et al*., 1997). Varieties of shorter vegetation, especially winter beer barley, finish the synthesis of most of the dry matter before the onset of the dry period, but have a lower genetic potential for yield due to the positive correlation between these properties (Pržulj, 2001; Pržulj and Momčilović, 2008; Madić *et al*., 2009; Popović *et al*., 2011; Al-Tabbal, 2012; Carpici and Celim, 2012).

**Results and Discussion**

The barley with the lowest plant height value in the two-rowed barley was determined in the line J-81 (68.71 cm) and the highest in the variety NS-293 (88.90 cm). More favourable conditions in 2008/2009 resulted in a higher average stem length value (77.87 cm) compared to 2009/2010 (75.70 cm). The line J-96 with the highest average plant height in first year (83.39 cm) and line J-176 in second year (86.08 cm). The highest average stem in all year height in the variety NS-293 (88.63 cm and 89.17 cm). More favourable conditions in the second year resulted in a higher average length of spike value (8.50 cm) compared to the first year (8.32 cm). The average length of spike for all genotypes of two-rowed barley in the area of Zaječar in the all years was 8.41 cm (Table 3). The tested lines were the lowest plant height value respect to the varieties and statistically highly significant differences were determined between the years and varieties of barley ($P<0.01$).

**Table 2.** Mean values for plant height for genotypes of two-rowed barley in the 2008-2010 years

| Genotype | | 2008/09 | | | 2009/10 | | | Average | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | x | Sd | Sx | x | Sd | Sx | x | Sd | Sx |
| 1 | Jagodinac | 80.00 | 1.910 | 0.955 | 80.17 | 1.331 | 0.665 | 80.08 | 1.527 | 0.540 |
| 2 | Maksa | 80.00 | 1.039 | 0.520 | 75.63 | 0.652 | 0.326 | 76.81 | 1.500 | 0.530 |
| 3 | Rekord | 71.71 | 1.876 | 0.938 | 70.01 | 0.857 | 0.428 | 70.86 | 1.625 | 0.575 |
| 4 | NS-587 | 73.50 | 1.943 | 0.971 | 71.14 | 1.837 | 0.919 | 72.32 | 2.157 | 0.763 |
| 5 | NS-293 | 88.63 | 1.498 | 0.749 | 89.17 | 1.925 | 0.962 | 88.90 | 1.623 | 0.574 |
| 6 | NS-595 | 76.02 | 0.984 | 0.492 | 75.08 | 1.124 | 0.562 | 75.55 | 1.100 | 0.389 |
| 7 | NS-519 | 79.86 | 0.689 | 0.345 | 71.73 | 1.249 | 0.625 | 75.80 | 4.449 | 1.573 |
| 8 | NS-565 | 75.81 | 1.559 | 0.779 | 67.88 | 0.484 | 0.242 | 71.84 | 4.373 | 1.546 |
| 9 | NS-183 | 79.64 | 1.668 | 0.834 | 81.98 | 1.294 | 0.647 | 80.81 | 1.866 | 0.660 |
| 10 | NS-525 | 80.46 | 0.948 | 0.474 | 75.04 | 1.599 | 0.799 | 77.75 | 3.142 | 1.111 |
| 11 | NS-589 | 80.98 | 1.724 | 0.862 | 74.50 | 1.161 | 0.580 | 77.74 | 3.721 | 1.316 |
| 12 | NS-593 | 74.99 | 1.678 | 0.839 | 72.02 | 2.071 | 1.035 | 73.50 | 2.359 | 0.834 |
| 13 | J-110 | 75.34 | 1.609 | 0.804 | 71.01 | 0.797 | 0.399 | 73.17 | 2.597 | 0.918 |
| 14 | J-90 | 75.11 | 1.329 | 0.665 | 74.22 | 1.514 | 0.757 | 74.66 | 1.402 | 0.496 |
| 15 | J-96 | 83.39 | 0.729 | 0.364 | 80.66 | 0.873 | 0.437 | 82.02 | 1.637 | 0.579 |
| 16 | J-82 | 81.11 | 1.021 | 0.510 | 79.20 | 1.162 | 0.581 | 80.15 | 1.438 | 0.508 |
| 17 | J-103 | 76.07 | 1.201 | 0.600 | 72.39 | 1.325 | 0.662 | 74.23 | 2.287 | 0.808 |
| 18 | J-176 | 80.66 | 1.404 | 0.702 | 86.08 | 0.920 | 0.460 | 83.37 | 3.097 | 1.095 |
| 19 | J-81 | 69.26 | 0.446 | 0.223 | 68.16 | 0.815 | 0.408 | 68.71 | 0.849 | 0.300 |
| 20 | J-104 | 76.84 | 0.674 | 0.337 | 78.01 | 0.148 | 0.074 | 77.42 | 0.770 | 0.272 |
| Prosek | | 77.87 | 4.421 | 0.494 | 75.70 | 5.746 | 0.642 | 76.79 | 5.225 | 0.413 |

The average plant height for all genotypes was 76.79 cm (Table 2). The height of the stem in new varieties of barley has been significantly reduced, especially in the case of the two-rowed varieties, and ranges from 60-80 cm (Dodig, 2000). Pržulj (2001) considers that in the further breeding of winter barley the height of the stem should be shortened by about 10-20 cm, and further changes should be directed towards the thickness of the stem and finding the anatomical structure that will provide sufficient strength. With barley, the losses in yield caused by lodging in some years can reach more than 65% (Jezovski *et al*., 2003).

The average length of spike for genotypes of two-rowed barley in the area of Zaječar in the growing period from 2008-2010 years was 8.41 cm. The variety with the lowest average length of spike in all years of testing was Jagodinac (7.91 cm) and the highest in the line J-176 (9.65 cm). More favourable conditions in the second year resulted in a higher average length of spike value (8.50 cm) compared to the first year (8.32 cm). The average length of spike for all genotypes of two-rowed barley in the area of Zaječar in the all years was 8.41 cm (Table 3). The variety NS-593 had the higher average length of spike value in the first year (9.34 cm), and the highest length of spike the variety J-176 (9.12 cm). In 2010 year the variety NS-589 (8.99 cm) had the higher average length of spike value in the first year and the length of spike the variety J-176 (10.18 cm). The tested varieties (8.38 cm) were the lowest length of spike value respect to the lines (8.45) and statistically highly significant differences were determined between the varieties of barley ($P<0.01$) and significant differences were determined between the years ($P<0.05$).

**Table 3.** Mean values for length of spike for genotypes of two-rowed barley in the 2008-2010 years

| Genotype | | 2008/09 | | | 2009/10 | | | Average | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | x | Sd | Sx | x | Sd | Sx | x | Sd | Sx |
| 1 | Jagodinac | 7.67 | 0.071 | 0.035 | 8.16 | 0.071 | 0.035 | 7.91 | 0.270 | 0.095 |
| 2 | Maksa | 8.33 | 0.037 | 0.019 | 8.38 | 0.036 | 0.018 | 8.35 | 0.043 | 0.015 |
| 3 | Rekord | 8.13 | 0.043 | 0.022 | 8.53 | 0.085 | 0.043 | 8.33 | 0.223 | 0.079 |
| 4 | NS-587 | 8.70 | 0.036 | 0.018 | 8.65 | 0.086 | 0.043 | 8.67 | 0.066 | 0.024 |
| 5 | NS-293 | 8.22 | 0.088 | 0.044 | 8.44 | 0.085 | 0.043 | 8.33 | 0.142 | 0.050 |
| 6 | NS-595 | 8.44 | 0.064 | 0.032 | 8.68 | 0.099 | 0.050 | 8.56 | 0.150 | 0.053 |
| 7 | NS-519 | 8.08 | 0.088 | 0.044 | 8.31 | 0.088 | 0.044 | 8.19 | 0.147 | 0.052 |
| 8 | NS-565 | 8.70 | 0.085 | 0.043 | 7.56 | 0.072 | 0.036 | 8.13 | 0.614 | 0.217 |
| 9 | NS-183 | 7.50 | 0.044 | 0.022 | 8.64 | 0.086 | 0.043 | 8.07 | 0.613 | 0.217 |
| 10 | NS-525 | 8.20 | 0.056 | 0.028 | 8.12 | 0.095 | 0.048 | 8.16 | 0.083 | 0.029 |
| 11 | NS-589 | 8.92 | 0.053 | 0.027 | 8.99 | 0.071 | 0.036 | 8.95 | 0.069 | 0.024 |
| 12 | NS-593 | 9.34 | 0.029 | 0.015 | 8.40 | 0.091 | 0.045 | 8.87 | 0.506 | 0.179 |
| 13 | J-110 | 8.77 | 0.071 | 0.036 | 8.52 | 0.073 | 0.036 | 8.64 | 0.149 | 0.053 |
| 14 | J-90 | 7.26 | 0.091 | 0.045 | 7.78 | 0.043 | 0.022 | 7.52 | 0.286 | 0.101 |
| 15 | J-96 | 7.82 | 0.043 | 0.022 | 8.02 | 0.088 | 0.044 | 7.92 | 0.125 | 0.044 |
| 16 | J-82 | 8.07 | 0.036 | 0.018 | 8.50 | 0.085 | 0.043 | 8.28 | 0.238 | 0.084 |
| 17 | J-103 | 8.50 | 0.085 | 0.043 | 8.78 | 0.044 | 0.022 | 8.64 | 0.162 | 0.057 |
| 18 | J-176 | 9.12 | 0.044 | 0.022 | 10.18 | 0.096 | 0.048 | 9.65 | 0.571 | 0.202 |
| 19 | J-81 | 8.20 | 0.056 | 0.028 | 8.90 | 0.071 | 0.035 | 8.55 | 0.379 | 0.134 |
| 20 | J-104 | 8.37 | 0.077 | 0.038 | 8.47 | 0.074 | 0.037 | 8.42 | 0.088 | 0.031 |
| | Prosek | 8.32 | 0.518 | 0.058 | 8.50 | 0.524 | 0.059 | 8.41 | 0.528 | 0.042 |

The obtained data on the length of the classes, regardless of the year, showed that there was a significant difference between the genotypes, with the average variety NS-589 and line J-176 (Table 3) on average for all years. Kirchev *et al*. (2012) indicate that the length of spike and the number of grains per spike are largely determined by the genotype and that these characteristics are very influenced by climatic factors.

The number of grains per spike of the studied genotypes of two-rowed barley in the area of Zaječar ranged from 22.69 (2009/10) to 22.50 (2008/09). The average number of grains per spike for genotypes of two-rowed barley in the vegetation periods was 22.59 (Table 4). The variety with the lowest average number of grains per spike in all years of testing was NS-565 (20.06) and line J-96 (20.48) and the highest in the variety NS-593 (25.65) and line J-176 (25.55). The variety NS-593 (27.10) and line J-176 (24.40) had the higher average number of grains per spike in the first year. In the second year the variety NS-593 (24.20) and line J-176 (26.70) had the higher average number of grains per spike value (Table 4). The tested lines were the lowest number of grains per spike value respect to the varieties and statistically highly significant differences were determined between the varieties of barley ($P<0.01$).

**Table 4.** Mean values for number of grains per spike for genotypes of barley in the area of Zaječar in the growing period from 2008-2010

| Genotype | | 2008/09 | | | 2009/10 | | | Average | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | x | Sd | Sx | x | Sd | Sx | x | Sd | Sx |
| 1 | Jagodinac | 23.80 | 0.455 | 0.227 | 23.10 | 0.392 | 0.196 | 23.45 | 0.543 | 0.192 |
| 2 | Maksa | 22.50 | 0.469 | 0.234 | 22.10 | 0.258 | 0.130 | 22.30 | 0.411 | 0.145 |
| 3 | Rekord | 23.00 | 0.508 | 0.254 | 22.56 | 0.330 | 0.165 | 22.78 | 0.460 | 0.163 |
| 4 | NS-587 | 22.40 | 0.258 | 0.129 | 22.20 | 0.248 | 0.124 | 22.30 | 0.258 | 0.091 |
| 5 | NS-293 | 22.61 | 0.357 | 0.178 | 22.86 | 0.243 | 0.121 | 22.74 | 0.312 | 0.110 |
| 6 | NS-595 | 24.60 | 0.258 | 0.129 | 23.70 | 0.416 | 0.208 | 24.15 | 0.578 | 0.204 |
| 7 | NS-519 | 23.10 | 0.374 | 0.187 | 22.50 | 0.248 | 0.124 | 22.80 | 0.435 | 0.154 |
| 8 | NS-565 | 22.42 | 0.520 | 0.260 | 17.70 | 0.187 | 0.093 | 20.06 | 2.551 | 0.902 |
| 9 | NS-183 | 20.90 | 0.187 | 0.093 | 23.00 | 0.108 | 0.054 | 21.95 | 1.131 | 0.400 |
| 10 | NS-525 | 22.20 | 0.474 | 0.237 | 22.30 | 0.363 | 0.181 | 22.25 | 0.395 | 0.139 |
| 11 | NS-589 | 23.00 | 0.187 | 0.093 | 22.66 | 0.463 | 0.231 | 22.83 | 0.373 | 0.132 |
| 12 | NS-593 | 27.10 | 0.469 | 0.234 | 24.20 | 0.316 | 0.158 | 25.65 | 1.594 | 0.563 |
| 13 | J-110 | 22.50 | 0.389 | 0.195 | 20.39 | 0.374 | 0.187 | 21.45 | 1.181 | 0.417 |
| 14 | J-90 | 20.90 | 0.147 | 0.074 | 22.10 | 0.147 | 0.074 | 21.50 | 0.656 | 0.232 |
| 15 | J-96 | 20.00 | 0.248 | 0.124 | 20.96 | 0.461 | 0.230 | 20.48 | 0.618 | 0.218 |
| 16 | J-82 | 20.70 | 0.258 | 0.129 | 21.90 | 0.420 | 0.210 | 21.30 | 0.718 | 0.254 |
| 17 | J-103 | 23.70 | 0.303 | 0.151 | 23.30 | 0.474 | 0.237 | 23.50 | 0.426 | 0.151 |
| 18 | J-176 | 24.40 | 0.147 | 0.074 | 26.70 | 0.508 | 0.254 | 25.55 | 1.277 | 0.452 |
| 19 | J-81 | 21.30 | 0.294 | 0.147 | 23.20 | 0.294 | 0.147 | 22.25 | 1.051 | 0.372 |
| 20 | J-104 | 22.60 | 0.248 | 0.124 | 22.50 | 0.248 | 0.124 | 22.55 | 0.236 | 0.083 |
| | Prosek | 22.69 | 1.599 | 0.179 | 22.50 | 1.688 | 0.189 | 22.59 | 1.642 | 0.130 |

The barley with the lowest grain weight per spike value in the two-rowed barley was determined in the variety NS-565 (0.997 g) and line J-82 (1.080 g) and the highest in the variety NS-595 (1.169 g) and line J-176 (1.241 g). More favourable conditions in 2008/2009 resulted in a higher average stem length value (1.122 g) compared to 2009/2010 (1.066 g). The grain weight per spike of two-rowed barley in the area of Zaječar in the vegetation periods was 1.094 g (Table 5). The tested varieties (1.089 g) were the lowest grain weight per spike value respect to the lines (1.101 g) and statistically highly significant differences were determined between the varieties of barley and the years ($P<0.01$).

All this suggests that the selection/breeding in the direction of increasing yields is very uncertain and slow due to the very quantitative nature of yield components and the influence of the external environment factors. Pržulj (2001), states that in our production conditions higher yields are realized by varieties of shorter vegetation because they succeed in forming the largest part of the yield before the occurrence of high temperatures. In these studies, barley was not exposed to extremely high temperatures in both years, so the early ripening did not come to full expression.

**Table 5.** Mean values for grain weight per spike for genotypes of barley in the area of Zaječar in the growing period from 2008-2010

| Genotype | | 2008/09 | | | 2009/10 | | | Average | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | x | Sd | Sx | x | Sd | Sx | x | Sd | Sx |
| 1 | Jagodinac | 1.052 | 0.025 | 0.012 | 0.970 | 0.026 | 0.013 | 1.011 | 0.050 | 0.018 |
| 2 | Maksa | 1.097 | 0.022 | 0.011 | 1.035 | 0.021 | 0.010 | 1.066 | 0.039 | 0.014 |
| 3 | Rekord | 1.087 | 0.027 | 0.014 | 1.087 | 0.022 | 0.011 | 1.087 | 0.023 | 0.008 |
| 4 | NS-587 | 1.150 | 0.029 | 0.015 | 1.102 | 0.017 | 0.008 | 1.126 | 0.034 | 0.012 |
| 5 | NS-293 | 1.107 | 0.022 | 0.011 | 1.097 | 0.022 | 0.011 | 1.102 | 0.021 | 0.007 |
| 6 | NS-595 | 1.245 | 0.021 | 0.010 | 1.092 | 0.022 | 0.011 | 1.169 | 0.084 | 0.030 |
| 7 | NS-519 | 1.132 | 0.043 | 0.022 | 1.065 | 0.013 | 0.006 | 1.099 | 0.047 | 0.016 |
| 8 | NS-565 | 1.190 | 0.039 | 0.019 | 0.805 | 0.013 | 0.006 | 0.997 | 0.208 | 0.073 |
| 9 | NS-183 | 1.015 | 0.029 | 0.014 | 1.067 | 0.017 | 0.008 | 1.041 | 0.036 | 0.013 |
| 10 | NS-525 | 1.117 | 0.033 | 0.016 | 1.050 | 0.026 | 0.013 | 1.084 | 0.045 | 0.016 |
| 11 | NS-589 | 1.160 | 0.008 | 0.004 | 1.115 | 0.026 | 0.013 | 1.137 | 0.030 | 0.011 |
| 12 | NS-593 | 1.225 | 0.013 | 0.006 | 1.065 | 0.013 | 0.006 | 1.145 | 0.086 | 0.030 |
| 13 | J-110 | 1.122 | 0.026 | 0.013 | 0.960 | 0.022 | 0.011 | 1.041 | 0.090 | 0.032 |
| 14 | J-90 | 1.042 | 0.035 | 0.017 | 1.050 | 0.018 | 0.009 | 1.046 | 0.026 | 0.009 |
| 15 | J-96 | 1.042 | 0.017 | 0.008 | 1.015 | 0.035 | 0.018 | 1.029 | 0.029 | 0.010 |
| 16 | J-82 | 1.032 | 0.027 | 0.014 | 1.127 | 0.022 | 0.011 | 1.080 | 0.056 | 0.020 |
| 17 | J-103 | 1.185 | 0.031 | 0.015 | 1.167 | 0.024 | 0.012 | 1.176 | 0.027 | 0.010 |
| 18 | J-176 | 1.207 | 0.010 | 0.005 | 1.275 | 0.026 | 0.013 | 1.241 | 0.040 | 0.014 |
| 19 | J-81 | 1.090 | 0.018 | 0.009 | 1.097 | 0.017 | 0.008 | 1.093 | 0.017 | 0.006 |
| 20 | J-104 | 1.132 | 0.017 | 0.008 | 1.077 | 0.017 | 0.008 | 1.105 | 0.033 | 0.012 |
| | Prosek | 1.122 | 0.069 | 0.008 | 1.066 | 0.091 | 0.010 | 1.094 | 0.085 | 0.007 |

The analysis of plant height(cm), length of spike (cm), number of grains per spike and grain weight per spike of tested two rowed barley varieties grown at Zaječar during two growing seasons 2008/2009 and 2009/2010, are shown in Table 6.

Analysis of variance in two-rowed barley genotypes tested showed statistically highly significant differences in plant height and grain weight per spike in relation to the growing season ($P<0.01$). Also, the impact of the genotypes on plant height, length of spike, number of grains per spike and grain weight per spike of the tested two-rowed winter barley genotypes was statistically highly significant. It was observed that the number of grains per spike showed no significant difference in the growing seasons. Statistically highly significant difference in plant height, length of spike, number of grains per spike and grain weight per spike is determined under the influence of the interaction year x location x variety.

**Table 6.** Analysis of variance of the tested parameters (ANOVA)

| Effect of year on the traits analyzed | | | | |
|---|---|---|---|---|
| *Traits* | Mean sqr Effect | Mean sqr Error | F(1. 158) | p-level |
| Plant height (cm) | 187.5323 | 26.28431 | 7.13476** | 0.008352 |
| Length of spike (cm) | 1.3487 | 0.27165 | 4.96503* | 0.027277 |
| Number of grains per spike | 1.4402 | 2.70310 | 0.53280 | 0.466514 |
| Grain weight per spike (g) | 0.1238 | 0.00656 | 18.87812** | 0.000025 |
| Effect of cultivar on the traits analyzed | | | | |
| Traits | Mean sqr Effect | Mean sqr Error | F(19. 140) | p-level |
| Plant height (cm) | 185.3408 | 5.849849 | 31.68300** | 0.000000 |
| Length of spike (cm) | 1.6326 | 0.094632 | 17.25252** | 0.000000 |
| Number of grains per spike | 16.0392 | 0.884181 | 18.14018** | 0.000000 |
| Grain weight per spike (g) | 0.0291 | 0.004331 | 6.72367** | 0.000000 |
| Effect of the year x cultivar interaction | | | | |
| Traits | Mean sqr Effect | Mean sqr Error | F(19. 120) | p-level |
| Plant height (cm) | 22.35860 | 1.721944 | 12.9845** | 0.000000 |
| Length of spike (cm) | 0.59402 | 0.005112 | 116.1935** | 0.000000 |
| Number of grains per spike | 5.68224 | 0.119855 | 47.4095** | 0.000000 |
| Grain weight per spike (g) | 0.02172 | 0.000582 | 37.3024** | 0.000000 |

*Statisticaly significant difference ($P<0.05$) **Statisticaly high significant difference ($P<0.01$)

The average values of the Pearson coefficient of correlation (*r*) of examined properties in two-rowed barley are shown in Table 7. Correlations between plant height and length of spike (r=-0.12), number of grains per spike (r=-0.12) and grain weight per spike (r=–0.15) in the examined genotypes of two-rowed barley at the location Zaječar showed a negative value both in the vegetation 2008/09. This shows that the plant height in the two-rowed genotypes has a negative effect on the yield components, which can be explained as a result of the lower resistance to lodging of higher genotypes. The weaker negative correlation between the yield and the height of the stem in the two-rowed and multiple-rowed barley was obtained by Jui *et al*. (1997).

**Table 7.** Correlation coefficients of the examined properties in two-rowed barley

| 2008/09 / 2009/10 | Plant height | Length of spike | Number of grains per spike | Grain weight per spike |
|---|---|---|---|---|
| Plant height | - | -0,12 | -0,12 | -0,15 |
| Length of spike | 0.31* | - | 0.67* | 0.79* |
| Number of grains per spike | 0.42* | 0.76* | - | 0.77* |
| Grain weight per spike | 0.37* | 0.80** | 0.85** | - |

Positive correlations in the second year of the study between plant height and length of spike, number of grains per spike and grain weight per spike. Most authors point out the weak to very positive effect of grain yield on both types of barley (Akdeniz *et al*., 2004; Bhuta *et al*., 2005). Pržulj *et al*. (1996) state that even if there is no direct dependence between the height of the plant and the yield, the decrease in height influences the yield increase indirectly, by increasing the weight of 1000 grains and increasing resistance to lodging.

**Conclusions**

The investigated genotypes of two-rowed barley had significantly lower plant height value in the second year of research (75.70 cm) compared to the first year (77.87 cm). The average height of the stem for all examined genotypes of two-rowed barley was 76.79 cm. The length of spike of the studied genotypes of two-rowed barley while the average was 8.41 cm, number of grains per spike 22.59 and grain weight per spike 1.094 g.

Statistically highly significantly different between of year on the plant height and grain weight per spike and highly significantly different between of genotypes on the all tested parameters. Significantly positively and strong correlated with grain weight per spike and length of spike and number of grains per spike in 2009/10 (0.80** and 0.85**, respectively) and positively and strong correlated in 2008/09 (0.79* and 0.77*, respectively).

Based on these results, it can be concluded that several traits have a decisive role in the formation of grain yield. The contribution of each individual feature can be different for different genotypes and the various environmental conditions so that this results from the interaction between the features within each genotype and genotype interactions with environmental factors.

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