



Biological and economic traits of Yasmina – a new variety of six-row spring barley with high productive potential

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Abstract. *The Yasmina variety is a new, highly productive spring fodder barley. It was created at the Institute of Agriculture in Karnobat by means of a combinatorial selection method. The biological and economic traits of the variety were tested in the Institute's competitive variety trials and the IASAS system during 2019-2020. The aim of this study was to present the biological and economic traits of the new recognized spring six-row barley variety Yasmina. In the ecological network regions, it demonstrated high productivity. The mean yield from the new variety obtained in 4 Bulgarian regions was proven higher than the one from the standard variety Venera by 22.0%. During the testing period, the variety realized a yield of up to 6500 kg/a. With high protein content of 13.51%, it is ideally suited for fodder. The variety has good lodging resistance. Yasmina was recognized as an original cultivar with Order No RD-12-4/10 Mar 2021 by the Minister of Agriculture, Food and Forestry and was approved for entry in List A of the Official Variety List of the Republic of Bulgaria.*

Keywords: new variety; spring fodder barley; trait; productivity

Introduction

Barley is one of the oldest crops cultivated worldwide. It is believed that at the dawn of human history it was essential for feeding the population. The ancient peoples used barley for food and as fodder for domestic animals.

Genus *Hordeum* includes all the various forms of cultivated barley (Breshkov, 1986). It exhibits significant plasticity and, unlike other cereals, has broad distribution. In Europe, its distribution extends up to 70° north latitude and 2,000 meters in altitude.

Barley has a greater advantage, especially in regions with established summer drought making it a strong competitor among cereal crops. Its

good drought resistance and shorter growing period allow for its early ripening, harvesting and obtaining higher and more stable yield. These traits of its as a cereal crop make it possible to avoid the summer heat and severe droughts, as well as to free up earlier areas for growing second crops.

It has a wide biodiversity of varieties adaptable to different soil and climatic conditions Globally, barley is cultivated as both a winter and spring crop (Kudla and Bilinski, 1998). In most countries, located in northern and wet regions, it is spring barley that is predominantly grown. It occupies larger areas in the Scandinavian countries, Germany, Canada, etc. Due to the continental climate in Bulgaria, the barley varietal composition primarily consists of winter and winter-spring biotypes. They are less

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dependent on the climatic factors, which are of great importance for the yield and quality of spring barley. In recent years, climatic changes have been perceptibly felt, which has been expressed in disturbed precipitation rhythmicity in the autumn-winter season, lack of snow cover, etc. (Gocheva, 2019). Consequently, it is a sound reason for the farmers to carefully consider the cultivation of spring barley.

Spring barley requires a far more moderate temperature for its development and wetter climate with greater and more evenly distributed rainfall. As a result, in the relatively drier continental Bulgarian climate, it cannot be grown in just any country region. The critical climatic factor responsible for the successful cultivation of spring barley is moisture, which depends on the amount of rainfall and its even distribution throughout the growing period. The spring barley biotype has shorter vernalization and has unsatisfactory cold resistance.

The breeding work at the Institute of Agriculture is mainly directed at creating winter and winter-spring varieties of fodder and malting barley (Vulchev and Dyulgerova, 2011; Dyulgerova and Vulchev, 2012; Vulcheva and Vulchev, 2013; Gocheva et al., 2016; Dimova and Vulchev, 2019). But in the last ten years, the attention of the breeders has also been directed to creating spring varieties (Lekes and Roskosna, 1975), which are a very good alternative to the above-mentioned. The first spring variety is Venera recognized in 2018. It is a highly productive two-row barley, which has been approved by the Executive Agency of Variety Testing, Field Inspection and Seed Control (IASAS) as a national standard. Denis and Savelia are also two-row varieties which were recognized in 2020.

Six-row spring variety Yasmina was recognized as original and entered in List A of the Official Variety List of Bulgaria with Order No RD-12-4/10 Mar 2021.

The aim of this study was to present the biological and economic traits of the newly recognized spring six-row barley variety Yasmina.

Material and methods

The Yasmina variety was developed at

the Karnobat Institute of Agriculture using a combinatorial selection method, led by Assoc. Prof. Dr. Darina Dimova. It originated from a cross between the Stander and Greel varieties in 2009. The F1 hybrid generation was cultivated in 2010. In 2011, selected class progeny from the F2 population were sown in a breeding nursery. Following a study in the Breeding Nursery, the source line No 122 was selected in 2011 and included for testing in the Control Nursery in 2012. From 2014 to 2021, it underwent testing in Competitive Variety Trials as line K-122-14, where it demonstrated the highest yield, strongest lodging resistance, and superior fodder grain traits among all tested lines. In 2019 and 2020, its biological and economic traits were evaluated by the Executive Agency for Variety Testing, Field Inspection, and Seed Control (IASAS). The national barley variety testing was conducted in 4 regions in the country: Selanovtsi, Brashlen, Radnevo and Chepintsi. The article included and discussed data from the Executive Agency of Variety Testing, Field Inspection and Seed Control (IASAS) on raw protein content, disease resistance, and yield. The morphological description was conducted according to CPVOUPOV HORDE_VUL 2019. The newly recognized variety Yasmina was submitted for testing as a breeding line with code KT 2204. At the time of testing, the national standard against which the candidate variety was compared was spring two-row barley variety Venera. The study on the new spring multi-row barley variety Yasmina in the experimental field of the Institute of Agriculture in Karnobat was conducted over a three-year period (2019-2022) on a leached vertisols soil type, following a predecessor of pea-sunflower mixture. The experiment was conducted according to the IASAS Methodology for conducting competitive variety trials with barley for biological and economic qualities from 2004 and updated in 2010, using the standard method in four replications with a plot size of 10 square meters. Biometric measurements were taken for several yield-related indicators, including plant height (cm), total tillering (number of tillers), productive tillering (number of tillers), spike length (cm), grain number per spike, number of sterile spikelets, and grain weight per spike (g). The coefficient of variation (VC%) and standard deviation for the indicators

were determined. The mathematical processing of grain yield data was performed using analysis of variance. The experimental data were processed using the Microsoft Excel^{XP} software package.

The variety Venera served as the national standard for comparison with Yasmina. With a decision of the Expert Cereal Committee at IASAS and order by the Minister of Agriculture, Food and Forestry No RD 12-4/10 Mar 2021, and under Art.14 para.2 of the Seeds and Planting Material Act the recognition and entry of variety Yasmina into the official list of the Republic of Bulgaria was affirmed.

Results and discussion

Morphological description

The new variety is systematically classified under *Hordeum sativum* ssp. *vulgare* L. *pallidum*. The variety successfully passed testing for distinctness, homogeneity and stability.

Yasmina is a typical spring variety. The stem is over 80 cm tall, medium in thickness, elastic, erect, and exhibits good lodging resistance. The leaf rosette is semierect. Leaves are medium-sized, lanceolate, with normally developed auricles and ligule. The leaf sheath and lower leaves are devoid of trichomes. The flag leaf is semierect and has slight epicuticular wax. It has average anthocyanin colouring on the awn tops. The spike is multi-row, semierect (rating 3), its shape is parallel (rating 5), with medium density (rating 5), its length is 6-8 cm (rating 6). The awns are short (rating 3), the grain is straw yellow, covered, without trichomes on the midrib (rating 1). The 1000-grain weight is 35.62 g, and the hectoliter mass – 64.10 kg/hl.

Biological features

For the Yasmina variety, ear emergence occurs

between 10 May and 22 May, and for the mean standard, it occurs between 12 and 26 May.

According to the data obtained from the testing conducted by IASAS, the duration of the growing period of variety Yasmina equals the mean standard of 109 days.

Crop density reaches 551 spike-bearing stems per square meter, with 604 plants per sq. m. for the mean standard.

The variety has high content of raw protein -13.51%.

When tested against natural infections, Yasmina exhibits high susceptibility to powdery mildew and leaf rust. It has medium resistance to leaf blotch.

Tested against an artificial infection background, the variety manifests high susceptibility to leaf rust and powdery mildew. It has medium resistance to fusarium head blight.

Economic traits

Yasmina's productivity was evaluated over several consecutive years at Competitive Variety Trials under the soil-climatic conditions at the Institute of Agriculture in Karnobat. Its testing continues in the conditions of an ecological network in the IASAS system. During these years of testing it showed high and stable productive potential.

Yasmina's productivity was evaluated over several consecutive years, and the results obtained refer to a three-year period, which included the years 2019, 2021 and 2022. Year 2020 was excluded from the testing due to its exceptionally dry climate conditions (Tables 1 and 2), since availability of moisture is a limiting factor for realizing high yield of spring barley. The lack of moisture did not allow the variety to manifest its productive potential and as a result of this the obtained yields were very low and did not show the real capabilities of the genotype.

Table 1. Average monthly temperatures in °C during barley vegetation for the period 2019-2022

Month	Year				Average monthly temperature (°C)	Multi-year values (°C)	Deviation ±
	2019	2020	2021	2022			
III	8.6	8.2	4.9	3.5	6.3	5.3	+ 1.0
IV	10.3	10.4	9.5	11.2	10.4	10.5	- 0.1
V	17.1	16.2	16.6	15.9	16.5	15.6	+ 0.9
VI	22.6	20.7	19.3	21.0	20.9	19.6	+ 1.3

Table 2. Amount of rainfall in mm per month during barley vegetation for the period 2019-2022

Month	Year				Sum III-VI	Amount of rainfall per month for a multi-year period, mm	Deviation ±
	2019	2020	2021	2022			
III	8.9	29.6	47.7	12.3	24.63	34.1	-9.47
IV	52.9	19.5	86.0	48.2	51.65	45.3	+6.35
V	44.9	54.3	15.6	36.3	37.77	58.5	-20.73
VI	95.6	71.9	117.4	86.8	92.93	65.2	+27.73

The data on yield obtained from testing variety Yasmina at the Competitive Variety Trials at the Institute of Agriculture in Karnobat (Table 3) showed that over the three years of testing, the variety was well proven compared to variety Venera. Variety Yasmina realized the highest yield in 2022 - 5580

kg/ha and exceeded the standard variety Venera by 38.8%. On average for the testing period, variety Yasmina realized 5150 kg/ha, and standard variety Venera - 3710 kg/ha, whereby variety Yasmina exceeded Venera by 39.0%.

Table 3. Yield from variety Yasmina at Competitive Variety Trials (2019-2022)

Variety	Yield, kg/ha						Mean	St %
	2019	%	2021	%	2022	%		
Venera-st	2770	100.0	4140	100.0	4210	100.0	3710	100.0
Yasmina	4550 ⁺⁺⁺	164.3	5320 ⁺⁺⁺	128.5	5580 ⁺⁺⁺	138.8	5150	139.0
GD 5%	18.38		13.64		23.91			
GD 1%	33.24		25.04		43.90			
GD 0.1%	73.59		55.49		97.28			

* significant at $p < 0.01$

Testing also continued within an ecological network under IASAS conditions. The study was conducted for two years (2019 - 2020) and included regions: Selanovtsi, Brashlen, Radnevo and Chepintsi. (Table 4). The average yield in the two-year testing was 6503 kg/ha or 22.9% above the standard. The highest yield from the variety was obtained in 2020. In all regions, the yield of

Yasmina was higher than the standard by 17.10% to 38.28%. The highest yield was obtained in region Radnevo – 7608 kg/ha.

In 2019, variety Yasmina had the highest yield reported in region Chepintsi – 7862 kg/ha.

Table 5 shows data from the analysis of variance of the economic traits during the testing period.

Table 4. Results of grain yield from variety Yasmina during the period 2019-2020

N	Variety	Region Selanovtsi		Region Brashlen		Region Radnevo		Region Chepintsi		Mean for the region	
		kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%	kg/ha	%
Year 2019											
1.	Venera-st	5201	100.0	7624	100.0	2870	100.0	4972	100.0	5167	100.0
2.	Yasmina	5212	100.2	6844	89.76	4050	141.11	7862	158.12	5992	116.0
Year 2020											
1.	Venera-st	5307	100.0	5357	100.0	5880	100.0	5067	100.0	5403	100.0
2.	Yasmina	6213	117.1	7227	134.9	7608	129.38	7007	138.28	7014	129.6

Table 5. Analysis of variance of variety Yasmina traits mean over the study period (2019-2022)

Traits/Variety	Mean	CV%
	Standard deviation	
Plant height, Yasmina, cm	84.10 ±4.41	5.24
Plant height, Venera, cm	74.20 ±1.75	2.36
Number of tillers per plant, Yasmina	4.80 ±0.42	8.78
Number of tillers per plant, Venera	4.20 ±0.55	5.30
Number of productive tillers per plant, Yasmina	4.50 ±0.53	11.74
Number of productive tillers per plant, Venera	4.50 ±0.53	11.71
Spike length, Yasmina, cm	8.39 ±0.36	4.30
Spike length, Venera, cm	13.24 ±0.49	3.74
Grain number per spike, Yasmina	60.50 ±4.88	8.07
Grain number per spike, Venera	27.10 ±1.37	5.06
Sterile spikelet number per spike, Yasmina	8.80 ±3.71	42.11
Sterile spikelet number per spike, Venera	2.20 ±0.79	35.86
Grain weight per spike, Yasmina, g	2.60 ±0.45	17.18
Grain weight per spike, Venera, g	1.31 ±0.12	9.10
Grain weight per plant, Yasmina, g	7.83 ±1.24	15.80
Grain weight per plant, Venera, g	4.73 ±0.49	10.36
1000-grain weight, Yasmina, g	42.75 ±4.60	10.75
1000-grain weight, Venera, g	48.30 ±3.02	6.25
Grain yield, Yasmina, kg/ha	5580 ±0.46	7.79
Grain yield, Venera, kg/ha	4210 ±0.21	17.03

It is visible from the table that by the selection criteria of plant height, variety Yasmina had an average height of 84 cm, whereas standard variety Venera – 74 cm. From a breeding standpoint the plant height of both varieties had very good and optimal values which did not allow plant lodging. The coefficients of variation for both varieties were low, for variety Yasmina - 5.24% CV and for variety Venera – 2.36% CV, respectively, which comes to

show that the trait variation for the two varieties is insignificant and it is stable.

The total number of tillers of variety Yasmina was 4.80 on average, and the total number of tillers of variety Venera had an average number of 5.20. The coefficients of variation were 8.78% CV and 6.30% CV, respectively, which shows that the trait variation for both varieties is insignificant.

The number of productive tillers of variety Yasmina had an average value of 4.50, for variety Venera the productive tillers also had a value of 4.50, and the coefficients of variation were 11.74% CV and 11.71 % CV, respectively. The values of the coefficients of variation showed that it was average and depended on the climatic conditions.

The spike length trait is comparatively conservative. There are reports in literature that spike length is affected to a small extent by the conditions (Dimova, 2015). The observed differences regarding the mean values of the trait are subject to their systematic affiliation, where the variety with longer spike is the two-row variety Venera. The spike length of variety Yasmina had a mean value of 8.39 cm, whereas the spike length of variety Venera had a mean value of 13.24 cm. The coefficients of variation are 4.30% CV for variety Yasmina and 3.74% CV for variety Venera, respectively, and these values showed that the trait variation for both varieties was insignificant.

With the next studied trait of grain number per spike, once again the difference is great, which is again due to their different systematic affiliation. The mean value of the trait for variety Yasmina was 60.50 grains, whereas the mean value of the trait for variety Venera was 27.10 grains. The substantial difference in grain number per spike was due to the fact that variety Yasmina has a four-row whereas standard Venera has a two-row spike which is the reason for the smaller number of grains. The coefficients of variation of the trait are 8.07% CV for variety Yasmina and 5.06% CV for variety Venera, respectively. The values of the coefficients are low, which shows that the trait is poorly affected by the growing conditions and varies weakly.

Sterile spikelets is an index, which is strongly affected by the year conditions (Dimova et al., 2007; Dimova et al., 2009). The number of sterile spikelets depends on the systematic affiliation of the accessions and some researchers established that in two-row barley they are far fewer compared to the multi-row forms (Valcheva et al., 2009). With variety Yasmina the mean value of sterile spikelets is 8.80 pcs., and with variety Venera the mean value is 2.20 pcs. The coefficients of variation were 42.11% CV for variety Yasmina and 35.86% CV for

variety Venera, respectively. Out of all the studied productivity-related indexes, sterile spikelets was one of the traits with the greatest variation.

Grain weight per spike was the next studied index, where the mean value for variety Yasmina was 2.60 g, and for variety Venera - 1.31 g. The coefficient of variation for variety Yasmina was 17.18% CV, which shows that the trait variation is medium and depends on the year conditions. The value of the coefficient of variation for the standard variety Venera was 9.10% CV, which shows that the trait variation in this variety is insignificant and is not affected by the growing conditions.

With the next studied trait – grain weight per plant, the mean value for variety Yasmina was 7.83 g, and the coefficient of variation was 15.80% CV, which showed that the trait variation was medium and was not affected by the growing conditions. With standard variety Venera, grain weight per plant had a mean value of 4.73 g, and the coefficient of variation was 10.36% CV, which showed that the trait variation was medium and also did not depend to a great extent on the growing conditions.

Studies by researchers have proven that 1000-grain weight is a genetically determined trait but dependent on the environmental conditions (Marcheva et al., 2006). 1000-grain weight for barley was one of the traits least affected by the conditions, and two-row barley, like the standard variety Venera, was characterized by more stable grain size compared to multi-row ones. The data on 1000-grain weight showed that the mean value of variety Yasmina was 42.75 g, whereas the coefficient of variation was 10.75% CV, which showed that the trait variation was medium. The mean trait value for variety Venera was 48.30 g, and the coefficient of variation was 6.25% CV, which value showed that the variation was insignificant.

The last studied trait was yield. The data makes it clear that the yield from variety Yasmina had a mean value of 5580 kg/ha and a coefficient of variation of 7.79% CV. The value of the coefficient of variation showed that the trait variation was insignificant and the yield from variety Yasmina was a comparatively stable value. The mean yield value for variety Venera was 4210 kg/ha with a coefficient of variation 17.03% CV, respectively. The trait variation of yield

for the standard variety Venera was medium and the coefficient value showed that it was affected by the growing conditions.

Conclusion

The six-row spring barley variety Yasmina has been officially recognized and included in List A of Bulgaria's Official Variety List (Order No RD-12-4/10 Mar 2021), affirming its originality and value. Yasmina's exceptional blend of spring biotype characteristics and high productivity marks a significant breeding achievement in barley cultivation. Yasmina's yield exceeded that of the standard variety Venera by over 22%, demonstrating its superior productivity. Due to the very good combination of high productivity and excellent fodder grain qualities, variety Yasmina was approved by the Executive Agency of Variety Testing, Field Inspection and Seed Control (IASAS) as national standard for spring barley.

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