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Genetics and Breeding

Yield and coefficient of ecological valence of spring barley in the regions of Sadovo and Karnobat, Bulgaria

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Abstract. *The aim of the study was to examine the yield and the coefficient of ecological valence of spring barley in the regions of Sadovo and Karnobat. Seven spring barley cultivars were planted in the first and second ten days of March, in comparative cultivars trials on the block method in four repetitions of an area of 10 m^2, with sowing rate of 450 germinating seeds per m^2. They were assessed on the standard for the French cultivar Josefin used of the Executive Agency of Varietal Testing, Field Inspection and Seed Control. The statistical processing of the results was carried out by ANOVA. The coefficient of ecological valence (W) is calculated. Cultivars grown in the region of Sadovo showed better ecological plasticity, but gave lower yields, in the region of Karnobat were more productive but difficult to adapt to environmental conditions. Suitable cultivars for growing spring barley in the regions of Sadovo and Karnobat are Barke, Scarlett and Bodega. They exceed the standard variety Josefin in yield with proven differences at both test sites.*

Keywords: spring barley, yield, coefficient of ecological valence

Introduction

Starting material is well known as a source material for enhancing the effectiveness of improvement works in all crops (Ganusheva et al., 2005; Valcheva et al., 2013; Gocheva and Vulchev, 2014; Dimova, 2015). High performance and success in breeding is based on the use of rich genetic diversity of sources with various valuable qualities. They serve as donors in crossing and recombination factors. Most often, the limited starting material and its genetic uniformity delay the breeding process and lead to unsatisfactory results (Condon et al., 2008). The problem of the source material is general and applies to other countries with well-developed breeding work. This requires the establishment of broad international cooperation in the exchange of materials and information on the results achieved. The success of any breeding program to the greatest extent depends on the availability of a rich and well-studied source material.

The task of breeding is to create cultivars that reveal their productive capacity under certain external conditions (Slinkard et al., 2000). New cultivars must be highly productive, with good quality characteristics, wide adaptive capacity and resistant to various stressors. The enrichment of the gene pool, the better research and effective use in the breeding process are ways that can overcome the negative impact of stressors.

The aim of the present study was to examine the yield of spring barley and the coefficient of ecological valence in the regions of Sadovo and Karnobat, towns situated in South Bulgaria.

Material and methods

Seven spring barley cultivars were planted in the first and second ten days of March (2012-2014), in comparative cultivar trials on the block method in four repetitions of an area of 10 m^2, with sowing rate of 450 germinating seeds per m^2 in the regions of Sadovo and Karnobat. They were assessed on the standard for the French cultivar Josefin used of the Executive Agency of Varietal Testing, Field Inspection and Seed Control (EAVTFISC).

The statistical processing of the results was carried out by ANOVA (Ganusheva et al., 2010). The coefficient of ecological valence (W) is calculated by Mokreva (2007).

Results and discussion

Agro-meteorological characteristics of years of study
Agro-ecological region – Sadovo

The agro-climatic conditions during the study were presented by average monthly air temperature and mean values of the amount of precipitated rain during the growing season. Mean average monthly temperatures and precipitation are compared to multi-average temperatures and rainfall by months for the period 1931-2010. The closest to the average multiannual temperature by months is 2014 (Figure 1).

In May 2012, the amount of precipitation is the highest for the survey period and the multiannual period. Critical is the month of May 2013, when the period of spike formation and grain filling moisture is less. Due to the fall rainfall during the months of June and July 2013 it is possible to harvest the tested cultivars (Figure 2).

Agro-ecological region – Karnobat

In March 2012, despite insufficient rainfall (7.6 mm) spring barley germinated. Frequent, local precipitation (26.9 mm) in mid-

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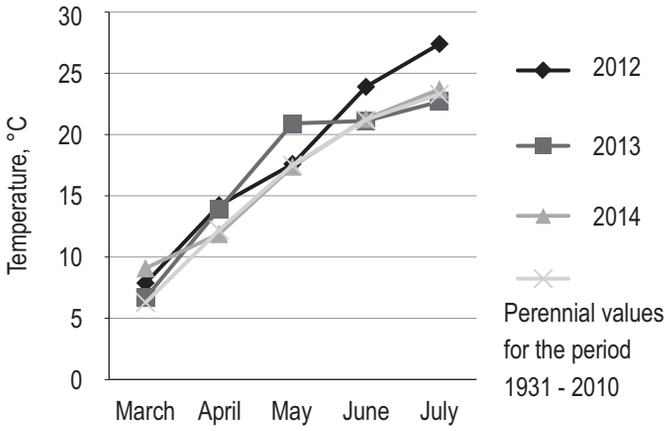

Figure 1. Mean temperature (°C) per month for the period of study and perennial values from 1931 to 2010 in Sadovo region

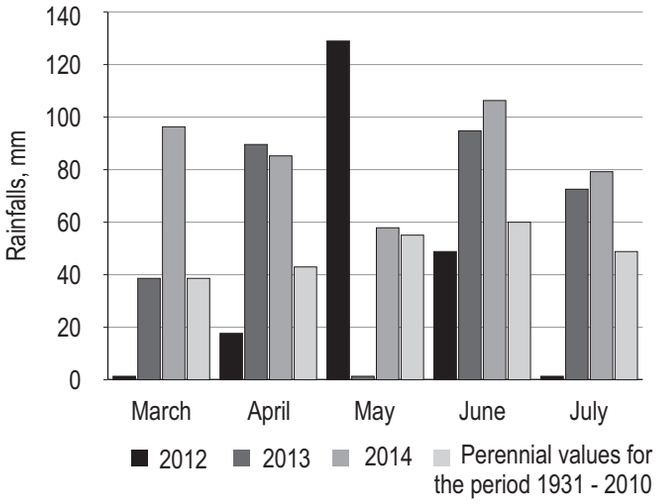

Figure 2. Average rainfall (mm) per month for the period of study and perennial values from 1931 to 2010 in Sadovo region

April, and above all in the second ten days of May (117.8 mm) accompanied by cooling the weather of 18.9°C during the first ten days and 16.0°C in the second and third ten days of the month significantly improve conditions for spring barley vegetation (Figure 3). Weak and no-economical rainfall was reported in June (5.6 mm; 8.4 mm and 12.2 mm). No precipitation was reported during the first ten days of July i.e. spring barley for a period of 40 days is placed in the conditions of acute water deficit. On 13 and 22 June 34.8°C absolute maximum temperatures negatively affect of grain filling of spring barley (Figure 4). The growth and development of spring crops in June with rainfall of 20.6 mm and temperatures up to 34.8°C July with 14.2 mm rainfall and temperatures up to 36.6°C occur in the setting of acute water deficit.

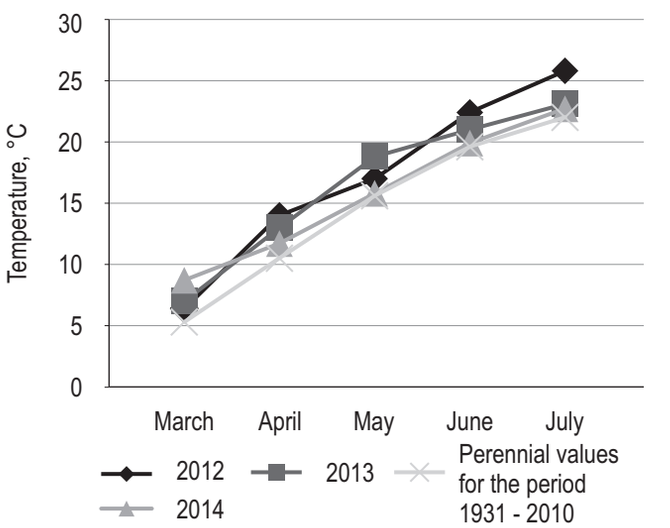

Figure 3. Mean temperature (°C) per month for the period of study and perennial values from 1931 to 2010 in Karnobat region

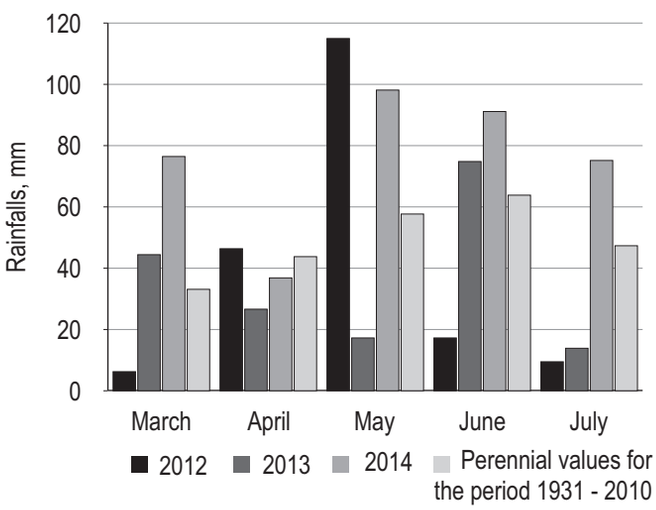

Figure 4. Average rainfall (mm) per month for the period of study and perennial values from 1931 to 2010 in Karnobat region

March 2013 began with unusually warm weather (13.0°C). Rain during 8-23 March did not have a significant economic importance. On 27 March the weather and temperatures drop to about 0.9 - 4.0°C. April began with warm and sunny weather (Figure 3). During the third ten days of April temperatures sharply increase. Drought continue until the middle of the second ten days of May.

Insufficient rainfall in May 19.5 mm and 58.5 mm for multi-annual period hampered normal growth and development of spring crops (Figure 4). Insufficient rainfall accompanied by high maximum temperatures accelerated the development of plants by shortening the time of phenophase.

Sowing of spring barley in 2014 was carried out in the second ten days of March due to precipitation at the beginning of the month, which adversely affects the yield. Favorable year for the development of spring barley was 2014 in terms of temperature and precipitation during the growing season.

The yield data from spring barley by years and average for the period 2012-2014 in the region of Sadovo are presented in Table 1. The Barke, Scarlett, Zernogradskii and Bodega varieties exceeded the standard Josefin with statistically proven differences.

The yield data from spring barley by years and average for the period 2012-2014 in the region of Karnobat are presented in Table 2. The Barke, Scarlett and Bodega varieties exceeded the standard Josefin with statistically proven differences.

Table 1. Biometric data on yield (kg/ha), variations and statistically proven differences at spring barley in Sadovo region by years and average for the research period 2012-2014

Cultivar	2012			2013			2014			2012-2014		
	$\bar{x}$	± Sx	CV	$\bar{x}$	± Sx	CV	$\bar{x}$	± Sx	CV	$\bar{x}$	± Sx	CV
Josefin, Standard	4010	70	5.00	3120	120	6.48	2920	50	4.09	3350	340	17.32
Barke	4570**	100	5.74	3560***	130	6.34	3330***	40	2.95	3820**	380	17.27
Fink	4150^{ns}	80	5.29	3330*	150	7.72	3060^{ns}	30	2.80	3510^{ns}	330	16.16
Scarlett	4510**	110	6.23	3290^{ns}	120	6.23	3260**	60	4.23	3690*	410	19.34
Astoria	4290^{ns}	100	5.85	3190^{ns}	130	6.91	3260**	90	5.92	3580^{ns}	360	17.20
Zernogradskii	4390*	80	5.19	3320*	130	6.64	3360***	90	5.47	3690*	350	16.44
Bodega	4430**	100	5.96	3850***	140	6.42	3230**	70	4.87	3830**	350	15.64
$GD_{5\%}$ (*)	290			190			200			240		
$GD_{1\%}$ (**)	410			270			280			340		
$GD_{0.1\%}$ (***)	570			380			390			480		

ns - non significant

Table 2. Biometric data on yield (kg/ha), variations and statistically proven differences at Karnobat region by years and average for the research period 2012-2014

Cultivar	2012			2013			2014			2012-2014		
	$\bar{x}$	± Sx	CV	$\bar{x}$	± Sx	CV	$\bar{x}$	± Sx	CV	$\bar{x}$	± Sx	CV
Josefin, Standard	5780	160	6.76	3620	60	5.06	2530	30	4.28	3980	950	41.60
Barke	6700***	120	4.99	3880*	70	5.14	3720***	40	4.05	4770*	970	35.17
Fink	5270^{ns}	120	5.84	3510^{ns}	60	5.12	3090***	50	5.07	3960^{ns}	670	29.23
Scarlett	7150***	160	5.89	4060***	110	6.72	3500***	100	6.95	4900*	1130	40.09
Astoria	5350**	180	7.84	3510^{ns}	70	5.45	3630***	90	6.20	4160^{ns}	590	24.73
Zernogradskii	6120*	70	4.06	3740^{ns}	60	4.57	4030***	90	5.79	4630^{ns}	750	28,05
Bodega	6630***	120	5.14	4640***	100	5.71	3330***	70	5.48	4870*	960	34.14
$GD_{5\%}$ (*)	260			190			100			780		
$GD_{1\%}$ (**)	370			270			150			1100		
$GD_{0.1\%}$ (***)	520			380			210			1550		

ns - non significant

The comparative assessment of the yields of spring barley and the coefficient of ecological valence on the varietal experience held at two points (Sadovo and Karnobat) for the study period are presented in Table 3. For the yield proven differences in the region of Sadovo exceeding the standard cultivars have Barke, Scarlett, Zernogradskii and Bodega. From the group of the standard Josefin are Fink and Astoria varieties. In the region of Karnobat proven differences exceeding the standard cultivar have Barke, Scarlett and Bodega. The yield in the region of Karnobat, average for the three years is higher by 18.8% to 27.9% compared with that of Sadovo.

Reliable differences by the indicator ecological valence compared with the control variant for Sadovo region have been established at Scarlett, Astoria and Bodega. Ecological valence of the other cultivars do not differ significantly from that of the standard. Barke and Fink varieties from the group of the standard have lower values of the indicator ecological valence and define them as cultivars with higher ecological stability in terms of yield. For Karnobat region significant differences by indicator ecological valence compared with the standard have been established by Scarlett, Astoria, Zernogradskii and Bodega cultivars. Barke differs substantially from standard regarding ecological valence. Barke has lower ecological valence value therefore has a higher ecological

Table 3. Data on spring barley yield and ecological valence coefficient (W) average for the period 2012-2014

No	Cultivar	Sadovo region		Karnobat region	
		Average yield, kg/ha	w	Average yield, kg/ha	w
1	Josefin, Standard	3350	83	3980	911
2	Barke	3820*	68^{ns}	4770*	511*
3	Fink	3510^{ns}	74^{ns}	3960^{ns}	760^{ns}
4	Scarlett	3690*	191*	4900*	1735*
5	Astoria	3580^{ns}	288*	4160^{ns}	1789*
6	Zernogradskii	3690*	208^{ns}	4630^{ns}	1138*
7	Bodega	3830*	487*	4870*	1331*
	GD5%	240	78	780	251

*p<0.05; ns - non significant

stability in terms of yield than the other cultivars grown in Karnobat.

Conclusion

Cultivars of tested group grown in the region of Sadovo show better ecological plasticity, but give lower yields. In the region of Karnobat the cultivars are more productive but difficult to adapt to environmental conditions. Suitable cultivars for growing spring barley in the regions of Sadovo and Karnobat are Barke, Scarlett and Bodega. They exceed yield with compared to the standard cultivar Josefin with proven differences at both test sites.

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The manuscript should be structured as follows: Title, Names of authors and affiliation address, Abstract, List of keywords, Introduction, Material and methods,Results, Discussion, Conclusion, Acknowledgements (if any), References, Tables, Figures.

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