Institute of Agricultural Resources and Economics

Assessment of spring barley populations in comparison to homogenous varieties

Indra Ločmele[1,2], Linda Legzdiņa[2], Dace Piliksere[2], Zinta Gaile[1], Arta Kronberga[1,2]

[1]Latvia University of Life Sciences and Technologies

[2]Institute of Agricultural Resources and Economics

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Introduction

- Most of varieties currently used in production are bred under conventional growing conditions and are genetically similar;
- Such varieties are not appropriate for growing in organic farming because genetically uniform varieties cannot adapt to variable growing conditions;
- Heterogeneous populations is one of the ways to increase genetic diversity in varieties of self-pollinating cereals.

The aim of this research was to compare grain yield, its stability, foliar diseases severity and competitiveness against weeds of three types of spring barley populations and homogenous varieties.

Materials and Methods

Locations of investigation

- Field trials at Institute of Agricultural Resources and Economics in two locations:
    - in Priekuli Research Centre,
    - in Stende Research Centre,

  during four years (2015-2018);
- Conventional (C) and organic (O) farming systems;
- In C sites according to the soil properties mineral fertilizer was applied;
- In O growing sites harrowing was performed, but in C – herbicide was applied.
- The data of seven C and seven O environments were obtained:
    - the field trial in Stende under O growing conditions in 2015 was significantly damaged by heavy rainfall after sowing;
    - under C conditions in Stende in 2018 trial was not established

Investigated material

Population	Type of population	Number of parents and generation (F) in 2015 – 2018
SP1; SP2	simple	Two parents, F_{12}–F_{15}
SP3; SP4	simple	Two parents, F_5–F_8
CP1; CP4	complex	Three parents, F_6–F_9 and F_5–F_8
CP2; CP3	complex	Seven and six parents, F_6–F_9
CP5	complex	Eight parents consecutively crossed to male sterile sample, F_4–F_7
CCP1	composite	Dialell crosses among group of 10 parents, bulked, F_3–F_6
CCP3	composite	10 parents crossed to 5 male sterile samples, bulked, F_3–F_6

- **Three check varieties bred in Latvia were used:**
  - **‘Rubiola’** – released for growing under organic conditions;
  - ‘**Rasa**’ – control variety in official trials for testing of value for cultivation and use (VCU) under organic growing conditions;
  - **‘Abava’** – characterized as variety with good adaptability to various environments.

Observations and methods of data processing

- In Priekuli, in natural infection background the infection with foliar diseases was assessed:
  - powdery mildew caused by *Blumeria graminis;*
  - net blotch caused by *Pyrenophora teres.*
- To evaluate competitiveness against weeds visual assessment of :
  - crop ground cover (GS 25–29, GS 29–31) and
  - weed ground cover (GS 31–39, GS 59–65, GS 87–92) were carried out.
- Methods of data processing statistical analysis:
  - analyses of variance; analyses of regression; ranking method; .

Meteorological conditions

- Meteorological conditions during the investigation differed both between the years and field trial locations:
  - more favorable for barley development in both locations in 2015 and 2016;
  - dry conditions in May 2016 at Priekuli slightly delayed the development of the plants and in vegetation period in 2017 prolonged plant vegetation period;
  - in both locations in 2018 very dry and warm meteorological conditions caused stress to the plants and had a significant negative impact on plant development.

Results

Yield of simple populations (n=4) in comparison with check varieties

Growing place	Yield* of populations	Comparison with check variety					
		Abava		Rasa		Rubiola	
		yield*	+/-**	yield*	+/-**	yield*	+/-**
Priekuli organic n=4	2.23-3.34	2.78-3.25	-16	2.19-3.07	-7; +9	2.20-3.59	-16
Stende organic n=3	2.23-4.01	2.25-4.12	-8;+4	2.25-4.15	-11;+1	2.46-4.71	-11(4);+1
Priekuli conventional n=4	3.13-5.48	3.88-5.52	-11(1)[&];+5(4)	3.57-5.39	-9(4);+7(2)	3.34-5.93	-15(11);+1
Stende conventional n=3	5.09-7.00	5.16-6.28	-6;+6	5.57-6.40	-7(4);+5(1)	6.47-8.26	-12

*min and max values; ** number of cases when yield was lower (-)/higher (+) than that of check variety; [&] in brackets – number of cases when differences are significant (p<0.05).

Yield of complex populations (n=5) in comparison with check varieties

Growing place	Yield* of populations	Comparison with check variety					
		Abava		Rasa		Rubiola	
		yield*	+/-**	yield*	+/-**	yield*	+/-**
Priekuli organic n=4	2.21-3.53	2.78-3.25	-18(4)[&];+2	2.19-3.07	-4;+16(2)	2.20-3.59	-13(1);+7
Stende organic n=3	2.18-4.37	2.25-4.12	-8(1);+7	2.25-4.15	-8;+7(1)	2.46-4.71	-10(3);+5
Priekuli conventional n=4	3.15-5.54	3.88-5.52	-12(3);+8(5)	3.57-5.39	-6;+14(5)	3.34-5.93	-18(4);+2(2)
Stende conventional n=3	5.37-6.53	5.16-6.28	-2;+13(6)	5.57-6.40	-7(4);+8(2)	6.47-8.26	-13(12);+2

*min and max values; ** number of cases when yield was lower (-)/higher (+) than that of check variety; [&] in brackets – number of cases when differences are significant ($p<0.05$)

Yield of composite cross populations in comparison with check varieties

Growing place	Yield* of populations		Comparison with check variety					
			Abava		Rasa		Rubiola	
			yield*	+/-**	yield*	+/-**	yield*	+/-**
Priekuli organic n=4	CCP1	2.79-3.87	2.78-3.25	+4	2.19-3.07	+3(1)	2.20-3.59	+3(1)
	CCP3	2.36-3.30		-3;+1		-2;+1(1)		-3;+1(1)
Stende organic n=3	CCP1	2.71-4.58	2.25-4.12	-1;+2	2.25-4.15	-1;+2	2.46-4.71	-2;+1
	CCP3	2.54-4.22		-2;+1		-2;+1		-2;+1
Priekuli conventional n=4	CCP1	4.39-5.78	3.88-5.52	+3(1)	3.57-5.39	+3(1)	3.34-5.93	-1(1);+1(1)
	CCP3	3.47-5.43		-1(1);+1(1)		-2;+1(1)		-2(1);+1
Stende conventional n=3	CCP1	6.04-6.81	5.16-6.28	+1(2)	5.57-6.40	-1;+2	6.47-8.26	-2(1)
	CCP3	5.86-6.56		+2(1)		-1;+2		-2(1)

*min and max values; ** number of cases when yield was lower (-)/higher (+) than that of check variety; & in brackets in bold – number of cases when differences are significant ($p<0.05$).

Average yield and yield stability indicators over 14 sites

Genotype	Average yield, t ha^{-1}	Coefficient of regression (b)	Number of rankings					
			Organic (n=7)			Conventional (n=7)		
			I**	II**	III**	I	II	III
CCP 1	4.52*	0.93	7	–	–	5	2	–
Rubiola	4.51*	1.22***	5	1	1	5	2	–
CP4	4.37	0.91	6	1	–	4	2	1
CP1	4.34	1.19***	2	5	–	5	1	1
CP5	4.20	1.07	3	1	3	5	1	1
CCP 3	4.17	1.01	2	4	1	2	5	–
Abava	4.17	0.84***	5	1	1	2	2	3
CP2	4.15	0.99	2	4	1	1	5	1
Rasa	4.11	1.01	1	4	2	3	2	2
SP3	4.08	0.99	–	3	4	1	3	3
SP4	4.07	1.01	–	6	1	2	3	2
SP2	3.98	0.89***	2	1	4	–	2	5
SP1	3.82*	0.89***	–	3	4	–	–	7
CP3	3.81*	1.01	–	1	6	–	3	4

* significantly different from average yield (4.16 t ha^{-1}) over 14 sites ($p<0.05$) ($LSD_{0.05}$= 0.23); **ranked in the upper (I), middle (II) and lower (III) third; ***significantly different from 1 ($p<0.05$).

Comparison of infection level of populations and checks with net blotch in Priekuli

Growing site	Type of population	Range of AUDPC*^	Comparison with check					
			Abava		Rasa		Rubiola	
			AUDPC*	+/-**	AUDPC	+/-	AUDPC	+/-
organic n=4	simple n=4	21–178	67 – 220	-16(**15**)[&]	39 – 197	-16(**8**)	32 – 184	-16(**6**)
	complex n=5	23–176		-20(**19**)		-19(**5**);+1		-18(**6**);+1
	CCP1	13–160		-4(**3**)		-4(**3**)		-4(**3**)
	CCP3	28–184		-4(**2**)		-4(**2**)		-4(**1**)
conventional n=4	simple n=4	45–247	117 – 296	-16(**16**)	81 – 263	-15(**10**);+1	67 – 220	-7(**3**);+9
	complex n=5	41–238		-20(**20**)		-20(**10**)		-11(**3**);+9
	CCP1	53–214		-4(**4**)		-4(**4**)		-3(**1**);+1
	CCP3	47–214		-4(**4**)		-4(**4**)		-4(**1**)

*min and max values; **number of cases when infection level was lower (–)/higher (+) than that of check variety; [&] in brackets in bold – number of cases when differences are significant (p<0.05); ^ area under disease progress curve.

<u>Despite the different levels of genetic diversity of populations types, we did not get any evidence that severity of net blotch was affected by population types.</u>

Comparison of infection level of populations and checks with powdery mildew under C conditions (n=3) in Priekuli

Type of population	Range of AUDPC*^	Comparison with check					
		Abava		**Rasa**		**Rubiola**	
		AUDPC*	+/-**	AUDPC	+/-	AUDPC	+/-
simple n=4	3–151	11 – 61	-6(**3**);+6(**2**)	1 – 88	-5;+7(**3**)	0 – 82	-5;+7(**2**)
complex n=5	0–116		-12(**7**);+3		-9;+6(**1**)		-9;+6(**1**)
CCP1	6–118		-2;+1(**1**)		+4(**1**)		+3
CCP3	8–119		-2;+1(**1**)		+3(**1**)		+3

*****min and max values; **number of cases when infection level was lower (–)/higher (+) than that of check variety; & in brackets in bold – number of cases when differences are significant (p<0.05); ^ area under disease progress curve

<u>Obtained results varied, and the trend that any of populations is more resistant against powdery mildew was not observed</u>.

Crop ground cover and weed suppression ability

- Significantly greater four-year-average crop ground cover and insignificantly higher weed suppression ability among check varieties was observed for ‘Abava’,
  - all populations showed significantly lower four-year- average crop ground cover and insignificantly lower weed suppression ability than ‘Abava’;
- There were no differences between types of populations regarding to crop ground cover and weed suppression ability, indicating that these traits were not affected by the level of diversity.

Conclusions

1. No one population significantly out-yielded all check varieties in any of 14 sites. Significant differences were observed in some cases in comparison with one, rarely two check varieties within a site.
2. CCP1 was the most stable of 11 populations and ranked highest under organic growing conditions.
3. For most of populations lower severity of net blotch in comparison with check varieties was observed; severity of powdery mildew varied, not indicating that some of the populations would be more resistant against powdery mildew.
4. Competitiveness against weeds of all populations was lower than for check variety with the best competitiveness -‘Abava’.
5. Populations containing greater genetic diversity (CPs and CCPs) could ensure better yield performance than populations with lower diversity level (SPs). Evidence that severity of foliar diseases and competiveness against weeds would be affected by population type was not observed.

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