European Cereals Genetics Co-operative Newsletter

2019

Proceedings of the 17th International EWAC Conference

3 – 8 June 2018

Bucharest, Romania

EUCARPIA EWAC 2018

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Leibniz-Institut für Pflanzengenetik und Kulturpflanzenforschung, Gatersleben, Germany

and

National Agricultural Research and Development Institute, Fundulea, Romania

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Edited by

A. Börner and M. Ciucă

Leibniz-Institut für Pflanzengenetik und Kulturpflanzenforschung, Seeland/OT Gatersleben, Germany
and
National Agricultural Research and Development Institute, Fundulea, Romania

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Preface

A. Börner

Leibniz Institute of Plant Genetics and Crop Plant Research, Corrensstrasse 3, D-06466, Seeland/OT Gatersleben, Germany

The 17[th] EWAC International Conference was organised by Matilda Ciucă and her colleagues in Bucharest, Romania from June 3 – 8, 2018. The organizing bodies were the National Agriculture Research and Development Institute, Fundulea and Ministry of Agriculture and Rural Development by the ADER116 project. It was the first EWAC conference in Romania since it was founded in 1967 (Table 1).

Table 1: Years and venues of EWAC Conferences.

1967	Cambridge	UK
1970	Weihenstephan	Germany
1974	Novi Sad	Yugoslavia
1979	Cambridge	UK
1981	Wageningen	The Netherlands
1984	Versailles	France
1987	Martonvasar	Hungary
1991	Cordoba	Spain
1994	Gatersleben	Germany
1997	Viterbo	Italy
2000	Novosibirsk	Russia
2002	Norwich	UK
2005	Prague	Czech Republic
2007	Istanbul	Turkey
2011	Novi Sad	Serbia
2015	Lublin	Poland
2018	Bucharest	Romania

Since 2016 EWAC is a working group 'Cereals Genetic Stocks' of the Cereals Section of the 'European Association for Research on Plant Breeding' (EUCARPIA). Fifty-five participants from 12 countries did attend the conference comprising 22 lectures and 15 poster presentations.

Under the general Motto 'Cereals for Tomorrow' two main subjects were discussed:

- Genetic gains through novel diversity and tools
- New approaches for cereals improvement and the future contribution of genetic stocks

The scientific programme but also the local organisation of the conference were excellent. Many thanks to Matilda Ciucă and her team for preparing and running this successful conference in a very kind and friendly atmosphere. We did enjoy the days in Bucharest and Fundulea very much.

Just before the conference Elena Khlestkina offered to organise the next EWAC Conference at the Vavilov Research Institute of Plant Genetic Resources in St. Petersburg in 2021.

We are looking forward to the 18[th] EWAC Conference.

Effects of *Ppd* alleles on heading and flowering time of wheat in climatic conditions of South-Eastern Europe

A. Kondić-Špika[1], D. Trkulja[1], S. Mikić[1], L. Brbaklić[1], S. Griffiths[2]

[1] *Institute of Field and Vegetable Crops, Novi Sad, Serbia*
[2] *John Innes Centre, Norwich, UK*

Summary

Photoperiod response (*Ppd*) genes play a key role in fine-tuning of heading and flowering time and adaptation of wheat to different agro-climatic conditions, which could increase crop yield. The aim of this study was to analyse genotypes carrying different *Ppd-1* alleles and their influence on wheat phenology in growing conditions of the South-Eastern Europe. The experiment was conducted with 10 well-adapted Serbian wheat varieties and 54 NILs of cv. Paragon with single, double and triple doses of *Ppd-1* alleles. The genotypes were sown in the plot size of 2 m^2 at the location of Rimski Sancevi (45°20`N, 19°51`E), in randomized complete block design with 3 replications. Heading and flowering time were recorded during three growing seasons (2014, 2015 and 2017). The results showed that the genotype, growing season and their interactions had significant effects on both analysed traits. The Serbian varieties (set 1) were significantly earlier regarding the heading and flowering time than cv. Paragon, and most of the NILs. The NILs with introgressed single (set 2) insensitivity *Ppd-1* alleles were earlier than the original cv. Paragon in 2014 and 2015, but not in 2017. When the same alleles were introgressed in a double dose (set 3), they significantly reduced heading and flowering time in all seasons. The NILs with introgressed *Ppd-1* null alleles and knock-outs (set 4) were significantly later than cv. Paragon, and all other sets of genotypes. All indicated changes caused by different *Ppd-1* alleles were variable expressed in different growing seasons.

Introduction

In a global climate change scenario, with increasing probability of extreme climate episodes (IPCC, 2014), a further improvement of wheat production could be achieved by fine-tuning of plant development cycles in order to avoid or escape from extreme drought or heat events during the most sensitive phases of yield formation. To achieve this goal, breeding programs should create varieties with more efficient and precise phenology, maximizing yield in the prevalent environmental conditions (IPCC, 2014; Hunter et al., 2017). Furthermore, for each particular environment, a balance must be found between late flowering time that would allow unhindered grain development and increase grain number, and early flowering that would avoid severe heat and drought stress during the most vulnerable wheat stages, namely flowering and grain filling (Arjona et al., 2018).

Adaptation genes play a major role in plant response to environmental signals (Bentley et al., 2013). Flowering time in wheat is controlled by at least 20 genes dispersed over the wheat genome (Sanna et al., 2014). However, most of the genetic variation for this important trait accounts for three genes: vernalisation requirement (*VRN* genes), photoperiod sensitivity (*PPD* genes), and earliness per se (Eps genes) (Distelfeld and Dubcovsky, 2009). This complex of genes can help breeders to realize optimal adaptation to local eco-geographic region (Novoselović et al. 2015).

The aim of this study was to use specific genetic material (near isogenic lines (NILs) of cv. Paragon) in order to determine the effect of different *Ppd-1* alleles on heading and flowering time of wheat genotypes in environmental conditions of the South-eastern Europe.

Materials and methods

The experiment was conducted at the experimental field of the Institute of Field and Vegetable Crops in Novi Sad (IFVCNS), the location of Rimski Šancevi, Serbia (45°20`N, 19°51`E). The material contained the following sets of the genotypes:

Set 1 - 10 modern Serbian wheat cultivars
Set 2 - 15 NILs of cv. Paragon with introgressed single insensitivity *Ppd-1* alleles (early alleles)
Set 3 - 21 NILs with introgressed double insensitivity *Ppd-1* alleles (early alleles),
Set 4 - 18 NILs with single, double or triple introgressed *Ppd-1* null alleles and knock-outs (late alleles).

The near isogenic lines (NILs) were produced at the John Innes Centre, UK and obtained during the project FP7-KBBE-2011-5: ADAPTAWHEAT. The introgressed *Ppd-1* alleles originated from different donors and different wheat genomes (A, B and D). In order to evaluate the effect of each *Ppd-1* allele, the original cultivar Paragon, from which the NILs were produced, was used in the experiment as a control.

The genotypes were sown in the plot size of 2 m^2 with 6 rows per plot in 3 replications. Standard agronomical practice for wheat production was applied. Heading (GS 55 after Zadoks et al. 1974) and flowering time (GS 61 after Zadoks et al. 1974) as a number of days from the date of sawing were recorded during three growing seasons (2014, 2015 and 2017), representing variable climatic conditions of the South-Eastern Europe.

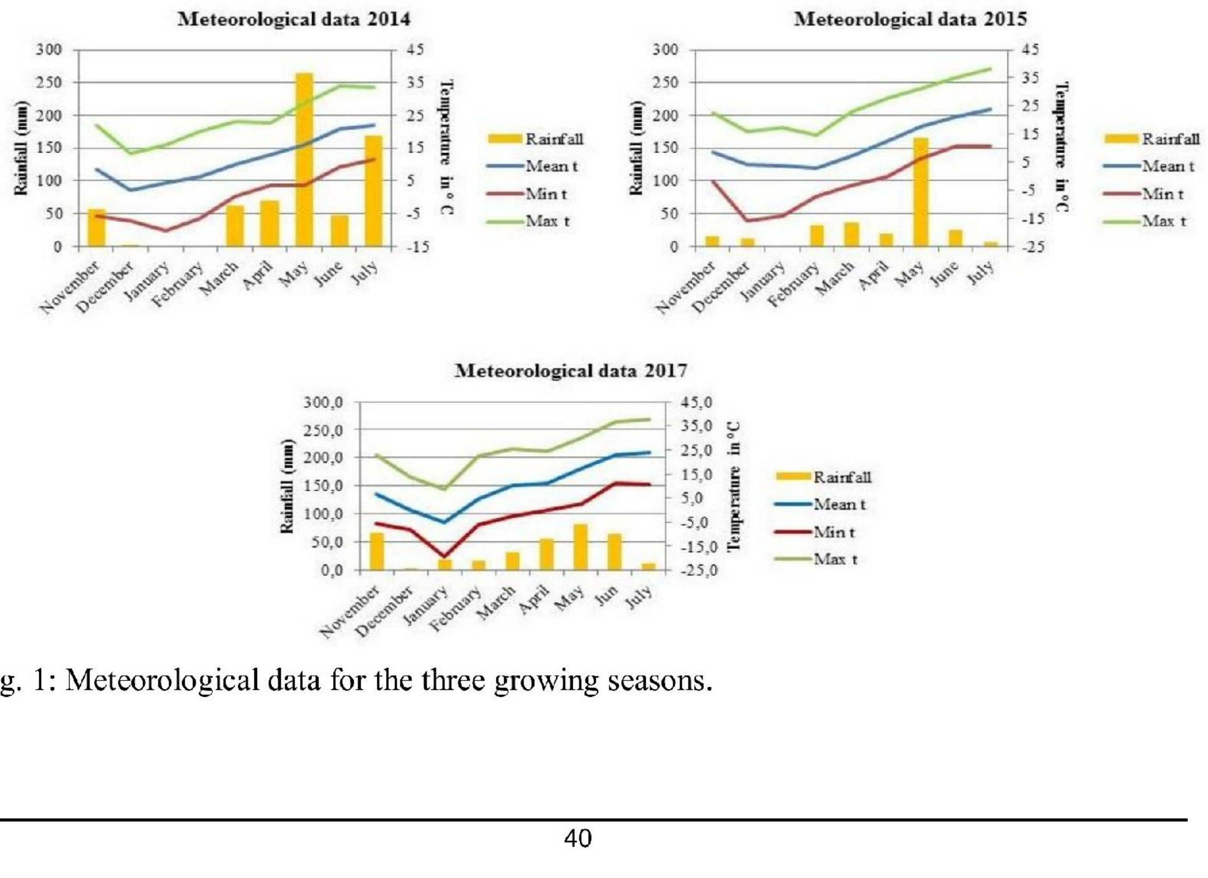

Fig. 1: Meteorological data for the three growing seasons.

Statistical data analysis (ANOVA, comparison of means) was carried out in STAR- Statistical Tool for Agricultural Research v. 2.0.1.program.

Results and discussions

The results have shown significant variations in heading time among different sets of the wheat genotypes, as well as among the growing seasons (Fig. 2.). The variations among the genotypes were the largest in the season 2014 and the smallest in the season 2015. Also, the heading time was the shortest in the season 2014 and the longest in the season 2017.

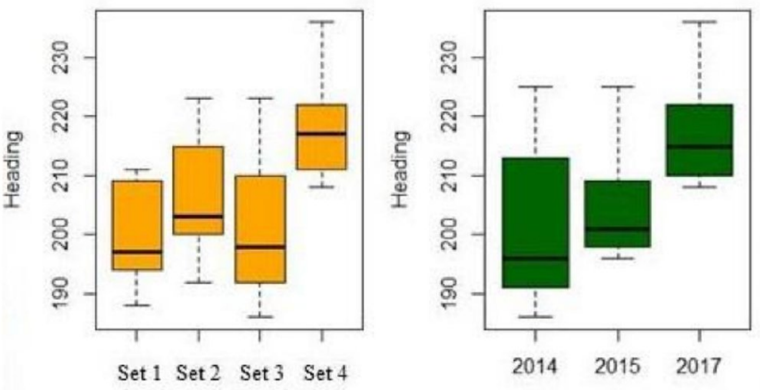

Fig. 2: Variations in heading time among the sets of wheat genotypes and the growing seasons.

Similar results were obtained for the flowering time too, but with smaller differences among the sets 1, 2 and 3, and no difference between the seasons 2014 and 2015 (Fig. 3).

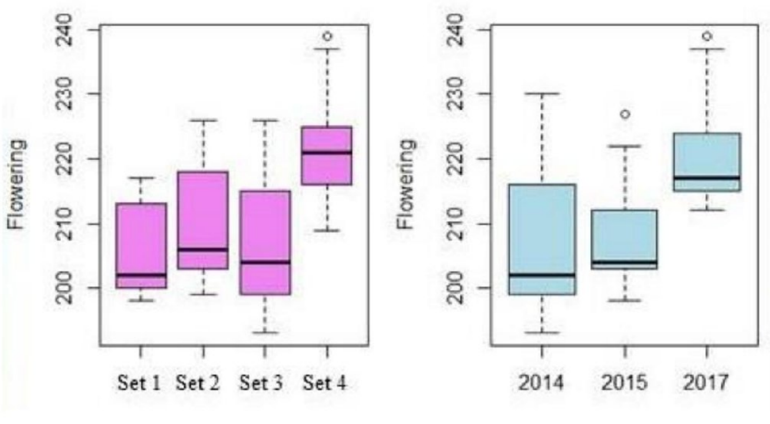

Fig. 3: Variations in flowering time among the sets of wheat genotypes and the growing seasons.

The first growing season was characterised with a huge amount of precipitation during the spring, especially in May, when heading and flowering occur in Serbian agro-climatic conditions. The second and the third seasons had similar amount of precipitation during the spring and the early summer but with better distribution in the season 2017. It can be conditionally concluded that among these three seasons, the 2014 was the worst, while the 2017 was the most favourable for wheat production (Fig. 1).

It means that the heading and flowering time were the most variable and with the lowest average values in the less favourable conditions, trying to find and use the best possible moment for these important developmental events. In better growing conditions during the season 2017 these traits were less variable and with significantly higher values. These results are in agreement with the studies of Trevaskis (2010) and Cockram et al. (2007), stated that in temperate regions, time of flowering normally coincides with favourable climatic condition because developmental switch from vegetative to reproductive growth is critical for enabling wheat plants to flower at optimum time for pollination, seed development and dispersal as well as for adjusting a wheat life cycle for maximum yields.

Table 1: The average values for heading and flowering time of cv. Paragon, the Serbian cultivars (set 1) and different sets of NILs (sets 2, 3 and 4).

	Heading				**Flowering**			
	2014	**2015**	**2017**	**Mean**	**2014**	**2015**	**2017**	**Mean**
Paragon	214.0	208.0	214.0	212.0[a]	218.0	212.0	217.0	215.7[a]
Set1 Serbian varieties	192.6	197.2	209.4	199.7[b]	200.5	200.6	213.6	204.9[b]
Set 2 *Ppd-1* early alleles	198.3	201.9	216.7	205.6[c]	203.9	205.1	219.5	209.5[c]
Set 3 *Ppd-1* early alleles (double doses)	188.9	198.4	212.2	199.8[b]	197.3	202.6	216.9	205.6[b]
Set 4 *Ppd-1* late alleles	215.9	213.4	222.9	214.7[d]	220.2	218.0	226.3	221.5[d]
Mean	201.9[a]	203.7[b]	215.0[c]		208.0[a]	207.7[a]	218.7[b]	

Analyses of the effects of different *Ppd-1* alleles in comparison with the cultivar Paragon (Tab. 1) have shown that *Ppd-1* early alleles significantly decreased, while *Ppd-1* late alleles significantly increased heading and flowering time, especially when present in double and triple doses. In the season 2014, *Ppd-1* early alleles decreased heading time for 16 and 25 days in average in the sets 2 and 3, respectively, while flowering time was decreased for 14 and 21 days, respectively. At the same time, *Ppd-1* late alleles had very small effects on heading and flowering time (increased for 2 days only). For the second growing season (2015) the both *Ppd-1* early and late alleles had significant effects on heading and flowering time. Finally, in the season 2017, the effect of *Ppd-1* early alleles was significantly smaller than the effect of *Ppd-1* late alleles.

Serbian varieties (set 1) were significantly earlier regarding the heading and flowering time than cv. Paragon and the NILs from the sets 2 and 4. The NILs from the set 3 were the most similar to Serbian cultivars.

Matching the appropriate photoperiod response to eco-geographic region is of a great importance. Novoselović et al. (2015) reported that in general, "early" flowering group had higher yield than "late" group, suggesting the advantage of "early" over "late" alleles under conditions of eastern Croatia, which are very similar to Serbian agro-climatic conditions. More specifically, they also reported that among homoeologous loci *Ppd-A1* locus had the highest effect on grain yield. This could be a useful strategy for wheat breeders in a region to introduce such alleles and combine it with omni-present *Ppd-D1a* alleles in Southern European wheat germplasm (Worland 1996) to preserve or increase genetic yield potential.

Conclusions

The results have shown variable effects of different *Ppd-1* alleles during the three growing seasons. *Ppd-1* early alleles significantly decreased, while *Ppd-1* late alleles significantly increased heading and flowering time in comparison to the original cv. Paragon, especially when present in double and triple doses. In unfavourable growing conditions *Ppd-1* early alleles were more expressed then in optimal conditions, while for *Ppd-1* late alleles the situation was opposite. In general, all genotypes were significantly earlier in less productive and later in more productive growing conditions.

Acknowledgement

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