

THE INFLUENCE OF METEOROLOGICAL CONDITIONS  
ON MAJOR QUANTITATIVE AND QUALITATIVE  
TRAITS OF BUCKWHEAT (*Fagopyrum esculentum Moench.*)

**Radojka Maletić<sup>1</sup> and R. Jevdžović<sup>2</sup>**

**Abstract:** The results of two-year investigations of buckwheat raised in agro-ecological conditions of South Banat (Pančevo) and West Serbia (Gorobilje) are presented in the paper. Based on the obtained investigation data, we confirm the hypothesis that buckwheat is a plant suited to more humid regions, since we have determined higher yield of the plant on locations with higher precipitation amount. During 1999, the yield of buckwheat was higher at the location in Pančevo and the next year at the location in Gorobilje. Also, in the year 2000, values of average plant height, number of seeds per plant and seed mass per plant were higher at the location in Gorobilje, whereas in the year 1999 (first year of investigation), which from the aspect of climatic conditions could be considered as optimal, plant yield and all other investigated parameters were better in case of buckwheat originating from the location in Pančevo.

In the year 2000, in regard to the seed, proportionally medium fractions were more present, which is, among other things, the result of the influence of higher precipitation amount.

In regard to the exploitation value of the seed, better germination was registered for seed produced in 2000 (at both locations), although it had lower mass compared to the seed produced in 1999.

Blossoming (blooming) in the first study year at both locations started 5 to 7 days earlier compared to the second year of investigations and lasted 5 to 8 days longer. On the other hand, in the second year of investigations at both locations harvesting started 10 to 12 days earlier compared to the previous year.

**Key words:** buckwheat, yield, temperature, precipitation, seed fractions.

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## Introduction

Buckwheat is an annual herbaceous plant from the family of *Poligonaceae* plants. *Fagopyrum tataricum*, *Fagopyrum rotundatum* and several other plants also belong to the abovementioned plant family, however, our research concerns only *Fagopyrum esculentum* Moench.

This plant is most suitable for deep and fertile soils, however, good results are obtained on soils of lower natural fertility, especially if fertilizers are used or any other method of soil meliorations (Dražić, Vukićević, 1996). It is important to point out that significantly better results are achieved in more humid regions (Djordjević, 1961). Buckwheat is relatively resistant to inducers of plant diseases and pests although certain researches point out cases where buckwheat was attacked by aphids and specific viral diseases (Bellaradi et. Al., 1997).

Buckwheat is a good pasture for bees since its flower is suitable for insects and has a very long flowering period, up to 50 days (Jevdjović, 2000). Fruit of buckwheat plant is of triangular shape. Fruit casing (shell) makes up 40% of the plant mass. Seed is used for nutrition. This plant is also used in pharmaceutical industry because it contains flavone heteroside rutine in fresh leaf 1.8%, in flower 0.7% and in stem 0.1%. Fruit and seed contain no flavone heteroside rutine. By the process of drying, rutine disappears quickly, it isn't poisonous and is used as preparation to increase the resistance of capillaries, reduces blood pressure to some extent and increases the excretion of urine.

The objective of this paper was to investigate the influence of agro-ecological factors on quantitative and qualitative traits of buckwheat.

## Material and Methods

Investigations were carried out in agro-ecological conditions of South Banat (Pančevo, 72 m above sea level) and West Serbia (Gorobilje, 420 m above sea level). The quality of soil at the location in Pančevo was as follows: soil type-marsh dark fertile soil, weak acid reaction (pH KCl = 5.7), medium humus content (3.5%), medium phosphorus content (12 mg/100 g) and rich in potassium (38 mg/100 g). The quality of soil at the location in Gorobilje was as follows: soil type-“gajnjača”, weak acid reaction (pH KCl = 6.3), humus content of 3%, phosphorus content of 4.1mg/100g and potassium content of 10.7 mg/100 g.

Investigations were carried out in climatically two different vegetation seasons.

Buckwheat seed used for this investigation originated from the cultivars “Bedija” produced and multiplied at the Institute for Medicinal Plant Research “Dr Josif Pančić” from Belgrade. In both study years, the size of plots was 20 m<sup>2</sup>,

four repetitions. Seeding was carried out in wide rows, distance between rows was 50 cm, 4 cm depth. Seed used in the investigation was 97% pure with germination percentage of 98%.

T a b. 1. - Average monthly temperatures (in °C) and precipitation (in mm) during vegetation season for locations where investigations were carried out in 1999 and 2000

Locations	M o n t h s							
	III	IV	V	VI	VII	VIII	IX	X
Pančevo 1999, °C	8.3	13.3	16.8	19.6	22.4	22.4	19.9	13.3
mm	11	59	73	74	334	16	61	13
Gorobilje 1999, °C	7	12	15.9	19.6	20.6	21.2	18.6	14.3
mm	16	88	109	107	181	9	76	68
Pančevo 2000, °C	7.4	15.7	18.8	21.5	22.2	24.3	18.1	15.2
mm	22	17	37	17	17	19	31	5
Gorobilje 2000, °C	6.1	13.2	16.8	19.4	20.6	21.4	16.1	13.1
mm	21	46	54	68	7	34	102	21

During the period of vegetation standard measures such as loosening of soil, weeding and preventing of crust formation, etc. were applied. Weed was destroyed mechanically, without herbicides. During vegetation period, no plant diseases or pests were registered. Harvesting was carried out manually when 2/3 of plant fruits obtained dark color. Seed was further processed and dried to 9% moisture content, and samples for the investigation of quality (germination energy, total germination and seed mass) were taken. Using a sieve with round openings, seed was divided into three fractions of different sizes (small – 4 mm, medium – 4.5 mm and large – 5 mm). Investigation of the quality was also carried out for the standard (seed from the mass not distributed into fractions) for all fractions, and the standard in 10 repetitions, 100 seeds per each repetition in Petri dishes on filter paper. Investigations were carried out at constant temperature of 20°C.

T a b. 2. - Dates of certain agro-technical operations and certain phenological stages in buckwheat plant development

Operations	1999		2000	
	Pančevo	Gorobilje	Pančevo	Gorobilje
Seeding	26.04.	26.04.	24.04.	24.04.
Sprouting	03.05.	04.05.	03.05.	05.05.
Blossoming	25.05.	28.05.	17.05.	20.05.
Forming of seed	28.06.	03.07.	15.06.	19.06.
Harvesting	26.08.	01.09.	14.08.	20.08.

Statistical analysis of the obtained data was carried out using parameters of descriptive statistics (mean value, absolute and relative variation values) – Hadživuković, 1991. Statistical significance of demonstrated differences

between mean values of certain quantitative and qualitative traits of buckwheat seed was determined by using variance analysis model – MANOVA and LSD-test (Snedecor and Cochran, 1967).

### Results and Discussion

Average annual values of investigated buckwheat quantitative and qualitative traits as well as variation values are presented in table 3.

The highest average height of buckwheat plant stem, number of seeds as well as mass of seed per plant at both locations were registered in the year 1999 with higher total precipitation amount. Also, in the same year, investigated factors demonstrated lower degree of variation, which indicated greater compactness. Height of plant stem and seed mass per plant show no significant statistical difference between years ( $P>0.05$ ), table 3. Difference in the number of seeds per buckwheat plant, at different locations and in different years, shows no statistical significance ( $P>0.05$ ).

T a b. 3. - Parameters of descriptive statistics of investigated buckwheat traits

Traits	Statistical parameter	Pančevo		Gorobilje	
		1999	2000	1999	2000
Height of plant stem (cm)	$\bar{x}$	147.4	87.4	144.5	95
	$I_v$	37	38	25	32
	$C_v(\%)$	6.36	14.49	4.87	9.60
Number of seeds per plant	$\bar{x}$	356.6	287.6	332.2	310.1
	$I_v$	372	513	214	409
	$C_v(\%)$	31.07	50	18.35	37.97
Mass of seed per plant (g)	$\bar{x}$	13.227	7.165	11.283	7.776
	$I_v$	12.843	12.613	8.035	10.541
	$C_v(\%)$	26.74	48.09	23.08	37.48

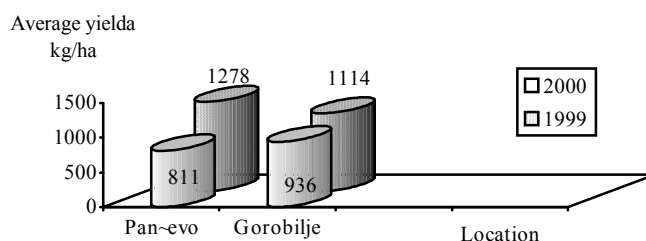
Source of variation	LSD <sub>0,01</sub>		
	Height of stem (cm)	Number of seeds per plant	Mass of seed per plant (g)
Year	8,395**	96,665 <sup>NZ</sup>	2,708**
Location	8,395 <sup>NZ</sup>	96,665 <sup>NZ</sup>	2,708 <sup>NZ</sup>
Year x Location	11,872 <sup>NZ</sup>	136,705 <sup>NZ</sup>	1,404 <sup>NZ</sup>

\*\* Significant at the level of 1%

<sup>NZ</sup> not significant

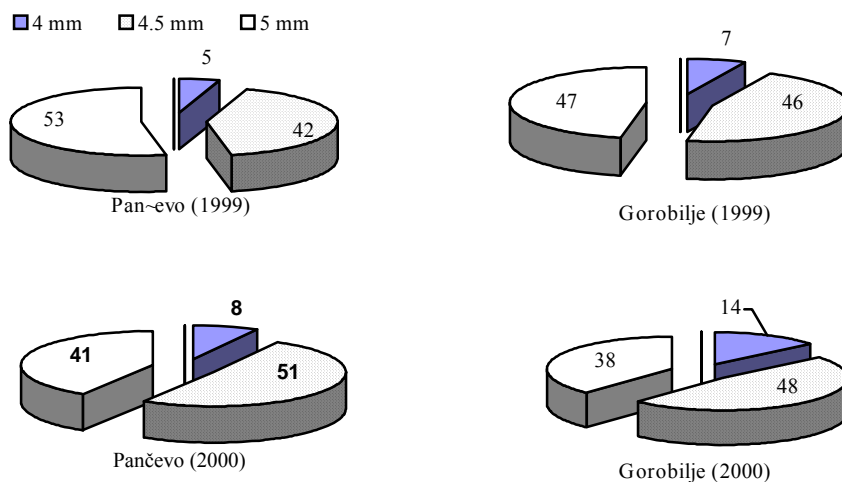
Average yield of buckwheat seed at both locations in the same study year showed equal seed yield, for instance, in 1999 at the location in Pančevo, yield was 1200 - 1350 kg/ha and at the location in Gorobilje 1090 - 1140 kg/ha; in 2000, at the location in Pančevo, it was 760 - 870 kg/ha and at the location in Gorobilje 900 - 1000 kg/ha. Yield level was higher in 1999 at both locations

(Graph 1) and registered differences in average yields between years differ significantly ( $LSD_{UZ} = 60.822 > LSD_{0.01}$ ). Differences between average yields at different locations are not statistically significant ( $P > 0.05$ ). Interaction of investigated factors differs significantly, which indicates that factors have mutual effect ( $LSD_{UZ} = 86.015 > LSD_{0.01}$ ).



Graph. 1. - Average buckwheat seed yield, kg/ha

At both locations, during 1999, the highest proportion in total seed was registered for large fraction (53% - Pančevo and 47% - Gorobilje). Medium fractions were not so much present in the structure, whereas the smallest fractions (4 mm) had proportion of 5% at locations in Pančevo and 7% at locations in Gorobilje. The next year, the proportion of medium fractions (4.5 mm) was the greatest (51% and 48%, respectively, according to locations), whereas the smallest fractions (4 mm) were still present in seed structure in a very small proportion (Graph 2).



Graph 2. - Proportion of fractions in buckwheat seed, %

T a b. 4. - Average values and dispersion measures of buckwheat seed qualitative traits

Location	Year	Parameters	Germination energy (%)						Total germination (%)					
			Fractions			Standard			Fractions			Standard		
			4mm	4.5mm	5mm	4mm	4.5mm	5mm	4mm	4.5mm	5mm	4mm	4.5mm	5mm
Pančevo	1999	$\bar{x}$	88.1	94.2	90.6	90.2	90.7	94.6	95.8	94.5	1.931	2.827	3.380	2.867
		Iv	6.92	3.50	3.38	11.38	6.04	3.35	2.69	2.88	3.02	2.03	3.65	2.55
	2000	$\bar{x}$	94.3	97.7	95.2	97.4	94.5	98.2	98.5	98.1	1.626	2.535	3.015	2.434
		Iv	3.97	1.37	4.11	1.20	3.81	0.94	0.86	1.01	7.61	4.36	4.35	2.43
Gorobilje	1999	$\bar{x}$	87.2	90.2	92.6	92.0	90.4	92.6	94.3	93.1	1.594	2.485	2.937	2.471
		Iv	4.38	3.69	2.61	2.51	3.87	3.31	2.87	2.79	5.29	3.73	3.38	2.68
	2000	$\bar{x}$	91.6	94.0	95.4	95.0	93.3	96.4	98.0	97.5	1.470	2.277	2.800	2.303
		Iv	3.14	2.56	2.53	2.33	2.95	2.60	1.92	2.01	5.66	3.31	4.29	4.65
F <sub>uz</sub>	location		3.6641 <sup>NZ</sup>			6.8348**			360.274**					
	year		49.0773**			64.1869**			287.070**					
	fraction		7.3797**			18.9854**			1457.028**					

\*\* significant at the level of 1%  
<sup>NZ</sup> non significant

Average values for germination energy of buckwheat seed indicate certain differences between fractions. At the location in Pančevo, buckwheat seed of 4.5 mm size (medium fraction), in both study years, demonstrated the highest germination energy (94.2% in 1999; 97.7% in 2000), whereas at the location in Gorobilje, the largest fraction (5 mm) had the highest germination energy (92.6% in 1999; 95.4% in 2000), table 4. The smallest fraction had the lowest value of germination energy at both locations and in both study years, as well as the lowest value of the seed homogeneousness (the highest  $I_v$ ). Seed of standard material had a high value for germination energy (>90%), average value was between the same values for the largest and medium fractions. In the year 2000, at both locations, the value of germination energy was higher for all fractions, including the standard. Registered differences in both germination energy between years and the smallest fractions (4 mm) compared to other fractions and the standard were statistically very significant ( $P<0.01$ ), whereas the difference in germination energy between medium and large fraction and the standard, as well as locations, was not significant ( $P>0.05$ ).

Average total germination of buckwheat seed (table 4) had dispersion similar to the one established for previous germination trait (germination energy). With the increase of seed mass and fraction, the value of total germination also increases. In this way, fractions of the largest seed had the highest total germination value at both locations and in both study years. Standard seed (control) also demonstrated high value of total germination that was slightly below the value of total germination determined for the largest fraction. Differences in total germination between locations, years and fractions were statistically very significant ( $P<0.01$ ). As for total germination, only between medium and large fractions and the standard no significant difference was established ( $P>0.05$ ). This confirms the hypothesis that size of seed considerably determines the germination level (germination energy and total germination).

Average values of seed mass decreased with the decrease of fraction dimension. At both locations and in both study years, the greatest seed mass was determined in the case of large fractions. Seed of standard material had average mass similar to the seed mass of medium fraction, so only in this case, no significant difference in seed mass was determined ( $P>0.05$ ). Differences between other fractions, as well as those between locations and analyzed years were statistically very significant ( $P<0.01$ ).

### **C o n c l u s i o n**

Based on the investigation of effects of agro-ecological factors on major buckwheat quantitative and qualitative traits, the following can be concluded:

- buckwheat seed yield, germination, specific mass and relation between fractions changed with the change of agro-ecological factors;

- height of buckwheat plant changed considerably under the influence of agro-ecological conditions;
- precipitation amount had the greatest effect on plant height and seed yield;
- number of seeds per plant demonstrated no significant changes under the influence of investigated factors;
- seed mass per plant, depending on absolute mass, changed significantly under the influence of investigated factors;
- the investigated factors, especially temperature and precipitation amount, had significant effect on fertilization period duration (from flowering to seed formation stages);
- absence of precipitation and high temperatures significantly influenced rapid maturing, which further caused early harvesting;
- the highest germination value (germination energy and total germination) was determined for seed of large fraction (4.5 and 5 mm), including the standard;
- large fractions had the greatest seed mass;
- seed of standard material had mass significantly different from other fractions, except medium fraction (4.5 mm).

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UTICAJ METEOROLOŠKIH USLOVA NA VAŽNIJE KVANTITATIVNE I  
KVALITATIVNE OSOBINE HELJDE (*Fagopyrum esculentum Moench.*)

**Radojka Maletić<sup>1</sup> i R. Jevđović<sup>2</sup>**

R e z i m e

Prikazani su rezultati dvogodišnjeg ispitivanja heljde gajene u agroekološkim uslovima Južnog Banata (Pančevo) i Zapadne Srbije (Gorobilje). Na osnovu dobijenih podataka istraživanja potvrđuje se hipoteza da je heljda biljka humidnijih rejona, jer je prinos veći na lokalitetima koji su bili bogatiji padavinama, tako je 1999. godine prinos veći na lokalitetu u Pančevu, a naredne godine u Gorobilju. Isto tako, u 2000. godini prosečna visina biljaka, broj semena po biljci i masa semena po biljci bili su veći u Gorobilju dok su u 1999. godini (prvoj godini istraživanja), koja je sa klimatskog stanovišta bila optimalna prinos, i svi drugi ispitivani pokazatelji bili bolji u Pančevu.

U 2000. godini bile su u semenu procentualno više zastupljene srednje frakcije što je između ostalog rezultat uticaja većih količina padavina.

Kada je u pitanju upotrebna vrednost semena bolje je klijalo seme proizvedeno u 2000. godini (na oba lokaliteta) iako je imalo manju masu u odnosu na seme proizvedeno 1999. godine.

Cvetanje je u prvoj godini istraživanja na oba lokaliteta počelo 5-7 dana ranije u odnosu na drugu godinu i trajalo je vremenski duže 5-8 dana. S druge strane, žetva je u drugoj godini na oba lokaliteta bila ranija u odnosu na prvu 10-12 dana.

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