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EFFECT OF AGRO-ECOLOGICAL CONDITIONS ON GRAIN YIELD IN SOME GENOTYPES OF BUCKWHEAT

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Abstract

Buckwheat (*Fagopyrum esculentum)* is an important field crop in our mountainous areas. It has long been neglected, but more recently, the area under buckwheat has increased. There is no official data on the areas where buckwheat is grown, or what are its average yields in Republic of Srpska.

In the two-year period, our research has included four varieties of buckwheat (Gray, Darya, Bednja and Novi Sad) at two sites (Sarajevo and Sokolac). On the basis of the survey, data confirms the hypothesis that the buckwheat plant is suited to more humid regions, because of the higher yield at the sites and years that were richer with precipitation. Year 2012 was with unfavorable sum and distribution of precipitation and high air temperatures which resulted in average yield and other quality characteristics of the tested varieties of buckwheat. Varieties Darya and Bednja in extreme conditions achieved the same average yields. In both years of testing these varieties had significantly higher yields compared with gray and Novi Sad varieties of buckwheat.

Key words: buckwheat, variety, temperature, precipitations, yield.

Introduction

Buckwheat (Fagopyrum esculentum) is an important field crop in our mountainous areas. It has long been neglected, but more recently, the area under buckwheat has increased. There is no official data on the areas where buckwheat is grown, or what are its average yields in Republic of Srpska.

Buckwheat is grown for its fruits, which hulled have great nutritional value. Due to its favorable chemical composition, buckwheat is suitable in nutrition of diabetics and children. Nutritionists classify it in the group of plants suitable for the production of biologically valuable food and as such they have declared it a health beneficial food.

Peeled fruit of buckwheat contains 9.07% of total protein, 70.98% NFE, 3.7% cellulosic material, 1.73% oil, 1.72% mineral salts I2, 8% water (***Glamočlija***,2004).

It is of particular importance for people with diabetes due to the fact that the food of buckwheat grain influences the reduction of the concentration of sugar and fat in the blood. The buckwheat biomass above the ground there is bioflavonoid rutin, which is of great importance in the pharmaceutical industry to obtain drugs that lower blood pressure, stop capillary bleeding, and reduce cholesterol in the blood. Because of these qualities buckwheat was declared a medicinal herb of the year in Germany in 1999 (***Gadžo***, 2009).

Buckwheat belongs to the group of melliferous-honey plants. The flowers are rich in nectar and blooming lasts for a long time, which is excellent bee pasture. Buckwheat has a great importance for soil management; as dense crop it covers the land and suppresses weeds.

The aim of our studies was to determine the effect of agro-ecological conditions on grain yield in some genotypes of buckwheat.

Material and method

Three factorial experiment included the effect of variety (A), year (B) and location (C) on the yield of buckwheat. The experiment consisted of testing four varieties: Gray, Darya, Bednja and Novi Sad. Sowing buckwheat was performed on 20th April 2011 and 23 April 2012 in Sarajevo, and 08th May 2011 and 10 December 2012 at Sokolac.
Area of elementary plot was 12 m^2 (4 m long and 3 m wide). Trials were conducted in five replicates on private farms in two locations: in the Romanija near Sokolac at an altitude of 872 m and in Sarajevo Field (Lukavica) at an altitude of about 550 meters. Common cultural practices that are used in the cultivation of buckwheat were applied.
Buckwheat was harvested on 25 July 2011 and 20 July 2012, and on 14 August 2011 and 11 August 2012 in the area of Sarajevo and Sokolac respectively. Buckwheat grain yield was determined by measuring each basic plot and converted to 12% humidity.
The results were analyzed using analysis of variance for three factorial experiment (ANOVA) using SPSS 4.5 software. The significance of differences in mean values of treatment was tested by LSD test.
The experiment was conducted on brown valley land in Lukavica and sour brown (dystric kambisol) in Sokolac. Soil reaction at both sites is acidic. In Lukavica, the land is moderately secured with phosphorous and potassium, while at Sokolac, it was poorly secured with phosphorus and well secured with potassium.

Tab.1 Chemical properties of soil

Location	pH		Humus (%)	N (%)	mg/100 g	
					P_2O_5	K_2O
Lukavica	6,28	5,45	2,76	0,17	16,4	19,02
Sokolac	6,22	5,17	5,1	0,34	1,43	34,3

The experiment in Lukavica (Sarajevo area) was set on loamy soil and sandy clays. Sokolac experiment was set up on land belonging to the class of cambic soil type or distric brown soils which are very widespread in the mountains of central Bosnia (Jovandić,1977).
Tab.2 Meteorological data (2011-2012)

Location	Year / Month		IV	V	VI	VII	VIII	IX
Lukavica	2011	°C	11.0	14.0	18.9	20.5	21.7	19.1
		mm	32.7	103.6	76.3	134.4	4.8	38.9
	2012	°C	10.4	14.7	23.7	24.6	24.5	17.4
		mm	135	125.2	9.3	34.6	25.9	158.6
Sokolac	2011	°C	7.7	11.0	15.8	17.5	18.2	15.5
		mm	42.7	123.0	62.8	82.2	9.2	36.7
	2012	°C	7.4	10.9	18.7	19.5	18.8	16.2
		mm	93.7	205.1	11.6	5.2	7.6	22.4

Sokolac is located at an altitude of 872 meters. The average annual temperature is 6.8 °C, absolute maximum air temperature is 33.6 °C and the absolute minimum temperature is -30.0 °C. Climate of Romanija region, whose center is in Sokolac, is extremely mountainous, with cold winters and cool summers. Growing season begins around the 8th April and lasts until 22 October, or an average of 197 days. It is a period when air temperatures are above 5 ° C and when the growing movement of woody plants is observed. During the year, there are about 800 mm of rainfall, of which about 430 mm during the period April-September (***Mićević***,1979).

Sarajevo area is under the influence of middle-European continental climate in the north and the Mediterranean climate of the south. These effects, as well as the diversity of terrain, give this area features a moderate continental climate. The average annual temperature in Sarajevo is 9.5^{o}C. Usually the first frost in Sarajevo occurs on 23rd October and the last on 29th April, with an average of 28 days of ice. The warmest month is July with a mean temperature of 19.1^{o}C, and very close to it is August (mean temperature 18.8^{o}C), which can often be even hotter. The fact that autumn is warmer than spring, as well as the delay in temperature extremes that occur in August, results in a considerable maritime influences. Rainfall in Sarajevo occurs in all seasons and all months and average annual distribution is evenly distributed. Average annual precipitation is 919 mm/m^2.

Research results and discussion

The average yield of buckwheat (table 3) for tested years, at both sites and for the four tested varieties was 1.819 t / ha.

Tab.3. Grain yield of buckwheat (t/ha)

Variety	Location (C)						Average (A)
	Lukavica			Sokolac			
	2011	2012	Average	2011	2012	Average	
Gray (a_1)	1.943	1.743	1.843	1.652	1.473	1.562	1.703
Darya (a_2)	2.206	2.148	2.177	1.803	1.603	1.703	1.940
Bednja (a_3)	2.272	2.165	2.218	1.824	1.603	1.713	1.965
Novi Sad (a_4)	1.862	1.702	1.782	1.655	1.459	1.557	1.669
Average	2.070	1.939	2.005	1.733	1.534	1.634	1.819

LSD	A	B	C	AxB	AxC	BxC	AxBxC
0.05	0.065	0.050	0.050	0.120	0.120	0.106	0.239
0.01	0.111	0.085	0.085	0.205	0.205	0.282	0.408

Varieties Darya (1.940 t / ha) and Bednja (1.965 t / ha) achieved significantly higher yields compared with varieties Gray and Novi Sad. The effect of genotype on the grain yield of buckwheat indicates that some varieties have a high genetic potential for yield and that yield potential is stable regardless of agro-ecological conditions (altitude, average temperature, amount and distribution of precipitation). These results are in accordance to the results of ***Bogdanović*** (1980) and ***Milić et. al***., 2013.

In 2011 the average yield of buckwheat was 1.901 t / ha, and in 2012 1,736 t / ha. High temperatures and uneven distribution of rainfall in 2012 influenced very significantly lower yields of buckwheat compared with 2011. Buckwheat achieves better yields in wetter regions and wetter years (**V. Djordjevic, 1961; Bogdanovic M, 1980; Maletic R. and Jevdjovic R, 2003**). For buckwheat, it is very important that there is sufficient rainfall in the stage of flowering and fruiting. The optimum temperature for growth of buckwheat is 20-25 ° C, while the temperature above 30 ° C is unfavorable for development of buckwheat. In strong drought and high temperature there is almost no grain.

In the area of Sarajevo (Lukavica) the average yield was 2.005 t / ha, while at the area of Romanija (Sokolac) it was 1.634 t / ha. Highly statistically significant difference in the yield on the research areas was influenced by weather conditions and time of sowing. In 2011 in the vegetation period (April-September) there was 390.7 mm of rain in Lukavica, and 356.6 mm in Sokolac, while in 2012 there was 488.6 mm in Lukavica, and 345.6 mm in Sokolac which had a significant impact on the yield of buckwheat in years of research. Although in 2012 there was more rain in Lukavica the yield was lower due to the uneven distribution of rainfall.

Variety Bednja proved to be the most suitable for the cultivation at both sites.

In mountainous area, the attention must be paid to the date of sowing as early sowing brings danger of late spring frosts and late sowing has risks of lack of moisture in the flowering phase of buckwheat and entering in the autumn, rainy weather that can affect the uneven grain ripening. Buckwheat should be reaped when more than 2/3 of grain was ripe.

Varieties Bednja and Grey are so prone to shattering and this point has to be taken into account while growing buckwheat and we should not wait for full maturity, especially in mountainous areas because they are exposed to severe weather conditions that can cause tremendous damage.

Conclusion

Based on results of two years in this experiment it can be concluded that the weather conditions had a significant effect on the yield of buckwheat. Year 2012 was with unfavorable sum and distribution of precipitation and high air temperatures which resulted in average yield and other quality characteristics of the tested varieties of buckwheat.

Varieties Darya and Bednja in extreme conditions achieved approximately the same average yields. In both years of testing these varieties had significantly higher yields compared with gray and Novi Sad varieties of buckwheat.

In the mountainous areas it is important to determine the favorable planting date to avoid late spring and early autumn frosts, lack of moisture in the stage of buckwheat flowering and adverse weather conditions in the fall.

By proper selection of varieties and cultural practices high yields of buckwheat can be achieved.

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