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Research Paper

Production of some of Different Varieties of Winter Barley (*Hordeum vulgare*) for Beer in Two Climatic Zones in Kosovo

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Abstract: The purpose ofthis study is the analysis of breeding/cultivationand production of autumn barley for beer (*Hordeum vulgare*)in the climatic conditions of the Republic of Kosovo. In the cultivation analysis and production have been included atotal of five barley cultivars: Bingo, Zlatko, Vannesa, Esterel and Rex as comparative (standard). Analysis of breeding and production are conducted in two regions: Dukagjini Plain, and Kosovo Plain. The experiments have been settled by the method of randomized blocks in their repetitions. Area of each experimental plot was 10 m^2. In analyzing the cultivation and production, have been analyzed yield (kg/ha), weight (1000 seeds in grams) hectoliters weight (kg), protein content (%) humidity (%), and starch/amidon. Results obtained showed that there were significant statistical differences at different levels for all traits investigated cultivars involved in plots and compared with the standard (Rex) and also between regions.

Keywords: *barley varieties, seed weight, hectoliters weight, yield.*

Introduction

Barley is a plant that in Europe occupies an important place, in the structure of cultivated plants.The main use of barley is for the production of beer.(Gaqesha *et al.*, 1990) In our country, in the years of transition, it has been a significant decrease in the surface area planted with barley. Currently in Kosovo areplanted around 2,200 ha areas with barley couplet, the bulk of which is used for beer production (Paunovic & Madic, 2011). Also, the statistics of Ministry of Agriculture show a significant change in the structure of the variety, as a result of the reintroduction of a large number of new varieties that have not been previously planted.To gain high production of barley, but primarily to get a quality production of it in relation to the production of beer, it is necessary the adaptability of cultivars that will be planted with the main climatic conditions of particular areas (Voltas *et al*., 1998; Kunze, 2004).

From results of various researches, the main characteristics of malt production from barley seeds are the content of proteins and their sprouting energy.Among the most important climatic factors affecting the quantity and quality of production of barley destined for production of beer, are temperature and precipitation (Macgregor, 1991; Van Gastel, 2005; Anderson *et al*, 1988).

Both these factors has a huge impact, in particular during the formation stage of grains beans, barley beans until the ripening stage defining the transporting of assimilated materials from other organsparts of the plant to grains or beans, barly ripened beans (Finnie *et al*., 2002; Bertholdsson, 1999; Bhuta, 2007). High temperatures, or the lack of moisture during these stages of development of barley can cause inhibition of this transport in this way affecting to reducing the average weight of grains as well as reducing the content of carbohydrates and proteins in barley grains beans.Recently, planting of barley cultivars in the Republic of Kosovo is not based on any study that determines the impact of climatic factors, temperature and humidity, on the quality of barley for beer production, but mainly based on recommendations of seed distributors (Van Gastel *et al*., 2005). Additionally, planting of barley is mainly concentrated in two zones of the Plain of Kosovo, these are: 1. Plain of Dukagjin and 2. Plain of Kosova, which differ from each other based on different climatic conditions (Costa & Boller, 2001). For this reasonhas been planned this experiment, which aims to study the suitability of the main varieties of barley for beer that are currently planted in the Republic of Kosovo with climatic conditions of two major ecological areas of theRepublic of Kosovo (The Plain of Dukagjin and The Plain of Kosovo). The average yield achieved in recent years is around 2.5 t/ha. Agro-climatic data and pedological characteristics of Kosovo, compared with the yields obtained in

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the culture of barley indicate that, potentially, reserves that can be produced for the amount of barley are huge (Paunovic & Madic, 2011).

The productive potential of barley cultivars that are grown in our conditions is over 8 t/ha and the use of this potential in the country's average scale ranges from 30-40% (2.5 t/ha).The difference between production capability of varieties grown, and efficiencies (yields) achieved, we think it is not only because of the deficiencies in the technology of cultivation of this crop, but also climate impacts in different areas and non-compliance with the requirements of different varieties totemperature and humidity towards avhievement and fulfillment of these requirements in two key ecological areas of the Republic of Kosovo.

Materials and Methods

The experiment has been set up in two consecutive years 2010 and 2011. Where, in the first year, in the experiment have been included five varieties of barley: Rex, Bingo, Esterel, Vanesa and Zlatko.While in the second year of the experiment have also been included Barun variety as one of the varieties that has been used enough in regional countries and has had very good results in the production of barley for beer (Van Gastel *et al*., 2005).

In the climatic zone of Dukagjini Plain the experimental plots have been set up in surface area of the property owned by Kosovo Agriculture Institute in Arbnesh location, that is situated 6 km away from Peja.Type of soil was brown on reddish sediments, where surface altitude is 488 meters.In the area of Plain of Kosovo the experiments have been set up in Pestova, where the type of soil is smonic, and the surface altitude is 560 meters. The process has been evaluated during the period of year2011/2012. Planting of plots has been made with the experimental seeding/planting machine Hege 80.

The specifics of the plot (cadastral parcels)

The length of the patch/line	10 m
Width of plot	1.0 m
The width of the line/patch	11 cm
Number of patches	6
Depth	3 cm

The planting process of the experiment has been made with four repetitions of sampling by randomizing block scheme. Before the planting of the experiment, it has been made chemical analysis of soils in both experimental points (Kovacevic *et al*., 2012). Details of these analyzes are presented in Table 1. As seen from the data there are major differences between the experimental points on the content of mineral nitrogen, phosphorus and especially potassium (Ruiter &Brooking 1994; Alley et al., 1997). Knowing that the nutrients in the soil play a very important role in the quantity and quality of production of barley for beer and to put barley plants in the same conditions of fertilization in both areas was estimated the quantity of elements in order to be the same proportion for planted crops for barley yields. Moreover, it was also made the determination of the pH value of the soil that came out to be slightly acidic in both experimental regions. In the experimental point of Peja, the soil is reddish - dark brown on reddish sediments, while in the experimental point of Pestova, the type of soil is Smonic as are nearly 25% of all arable areas in Kosovo.

While the study of the experiment, have been collected data on the number of plants, the process of phenological phases, as well as data of cob and kernel, barley cob kernel (Dofing, 1995; Araus, 1998; Kunze, 2004; Schellinget al, 2003).

Also, during the experiment have been analyzed the protein and amidon content in the barley grains kernels and the energy and power of barly germination (Costa & Boller et al, 2001; Anonym 1995)(Betreib Anteilungen 1992-1995.). Whereas, the climate data were provided by the Hydro-meteorological Institute of the Republic of Kosovo for two years of the experiment and two climatic zones (Munck , 1991; Jenneret al., 1998).

Results and Discussion

On the 10^{th} day after planting to all varieties of barley in plots has been defined the density of plants per unit of land.Based on data presented in Tables 2 and 3 (*i.e* 2010-2011 and 2011-2012) have

been shown that the varieties have approximate density among them.It was intended thatplants of different varieties to be grown on equal/same conditions.In the second period of April (12.04.2012), for each variety have been counted all primary and secondary stems in order to determine the level of brotherhood (likewise) varieties.The findings of ths section have been shown in Table 2 and Table 3 (*i.e* 2010-2011 and 2011-2012). The tables show clearly that all varieties have approximate number of stalks without presenting statistically validated changes as between varieties and between climatic zones.However, significant tendency of a higher brotherhood-likeliness (seven brothers) has been noticed at the variety Vanesa during the first year,in the two studied areas, and during the second year at Zlatko variety, whereas, the lowest brotherhood was observed in variety Esterel, during the two years of experimentation and to two climatic zones.Other varieties present avaregae value and without many differences between climate zones.The hight of the stem of the plant was measured at the stage of full ripeness of grains/beans through measuring 5 plants for each variant and this process was repeated.While there are no proven statistical differences between the values recorded in different climatic zones for each variety.Brothers/likeliness data show that there are some differences between varieties, but no differences between climatic zones.It can be assumed that the climatic factors have not exerted any differentiated influence between areas druing brotherhood process of plants.The same thing can be said for the height of the stalk, knowing that the height of the stalk is a characteristic that is influenced by climatic conditions mainly to the formation of grains, we can say that the climatic factors at this stage did not affect differentlyin the development of plants in different climatic zones.Nevertheless, there are some changes in the height of the stems between the two years of the experiment. However, these changes represent more tendency than statistically proven differences. From the chemical analysis carried out on the barley grains generally resulted a high content of proteins.This content is found in all varieties, in both years of the experiment and in both experimental areas.Protein analysis have been done in the laboratory of Peja Brewery, where at the same time a very large number of analyses have been done for the barley samples submitted for beer.Comparing the results of our experiment to the results of other samples of barley, insignificant differences emerge.Therefore, based on the findings, it can be concluded that there is no analytical errors in these results.In our opinion, the high content of protein in the barley beans must be as a result of favorable weather conditions during the filling/growing of grains of barley, which has led to a translocation of large amounts of nitrogen from the leaf to grains of barley. There have been noticed differences between the two areas of cultivation, in the first year of the experiment is recognized a higher content of protein in the region of Pestova, and in the second year of the experiment in the region of Peja. These changes are relatively minor, but the aforementioned tendencies are confirmed in all varieties. The content of Amidon in all cases varies slightly from one variety to another, regardless of year of the experiment or the cultivation area.

Table 1. Nutrient values on the soil in both experimental points before the planting of barley

		$CaCO_3$	N-Mineral mg/100 g			Humus	Nutritional elements mg/100g			
Zone	**pH-water**	**%**	**$N\text{-}NH_4$**	**$N\text{-}NO_3$**	**N Min total**	**%**	**P_2O_5**	**K_2O**	**Ca**	**Mg**
Peja	5.6	5	0.431	0.382	0.813	4.2	15.8	27.2	204.7	17.2
Pestova	5.9	6	0.29	0.321	0.611	3.6	13.8	17.9	365.5	48

Table 2. Density of plants, number of brothers/likeliness and the height of the plant in two climatic zones for 2010-2011

Variety	**Peja**			**Pestova**		
	Density (plant/m^2)	**Number of brother varieties**	**Highness of stalk (cm)**	**Density (Plant/m^2)**	**Number of brother varieties**	**Highness of Stalk (cm)**
Bingo	500	5	82	510	6	84
Vanessa	490	7	80	490	7	80
Zllatko	495	6	72	500	5	73
Rex	490	5	80	500	6	82
Esterel	470	5	85	480	5	86

The performance of the stages of plant development in the two years is similar for each variety (Tables 6 & 7).This similarity makes us understand that climate performance in both years of the experiment was the same, at least in terms of its impact on the development of plants.We discern a difference

between varieties in a maximum of 8 days (during the first year), speicifically between Bingo and Esterel varieties. Other varieties present average value of the length of the vegetative cycle.It is important to note that the difference between the lengths of the vegetative cycle between these two varieties is mainly due to the greater length of the stage of grain filling and riping phase of the Esterel variety, compared with Bingo variety.

Table 3. Density of plants, number of brothers/likeliness and the height of the plant in two climatic zones for 2011-2012

Variety	Peja			Pestova		
	Dendësia (plant/m^2)	Number of brother varieties	Highness of stalk (cm)	Density (Plant/m^2)	Number of brother varieties	Highness of stalk/stem(cm)
Bingo	480	5	79	475	5	78
Vanessa	500	7	80	492	7	79
Zllatko	510	8	85	500	7	82
Rex	485	6	83	480	5	81
Esterel	480	6	78	475	5	77
Barun	490	7	73	485	6	72

Table 4. This chart shows the results of humidity %, Proteins % and Amidon (Year 2010-2011)

Variety	**Peja**			**Pestova**		
	Humidity %	**Proteins %**	**Amidon %**	**Humidity %**	**Proteins %**	**Amidon %**
Bingo	11.6	13.4	60.10	12.6	13.9	60.20
Vanessa	12.1	12.7	60.10	12.6	13.8	60.15
Zllatko	11.1	13.2	60.10	11.4	13.4	60.40
Rex	10.8	13.2	60.20	11.2	13.8	60.35
Esterel	11.4.	12.9	60.30	11.8	13.2	60.10

Table 5. This chart shows the results of humidity %, Proteins % and Amidon/Starch (Year2011-2012)

Variety	**Peja**			**Pestova**		
	Humidity %	**Proteins %**	**Amidon %**	**Humidity %**	**Proteins %**	**Amidon %**
Bingo	11.3	13.39	61.6	10.4	13.35	60.85
Vanessa	11.1	12.9	63.6	10.5	12.85	62.15
Zllatko	10.2	13.35	62.6	10.3	13.3	60.85
Rex	10	13.73	62.5	10.45	13.5	61.55
Esterel	11.26	13.4	61.4	11.05	13.3	61.2
Barun	9.9	13.46	62.9	10.45	13.25	62.3

Table 6. This chart shows the process of phenophase development in days – Year 2010-2011

Vaiety	**Zone**	**Planting**	**Sprouting**	**Growing**	**Showing**	**Blossoming**	**Ripeness**
Bingo	Pejë	15.11.2010	10	157	168	175	230
	Pestovë	19.11.2010	11	160	170	177	232
Vanessa	Pejë	15.11.2010	10	162	171	178	233
	Pestovë	19.11.2010	11	165	173	180	235
Zllatko	Pejë	15.11.2010	10	155	165	172	230
	Pestovë	19.11.2010	10	157	166	174	234
Rex	Pejë	15.11.2010	11	160	170	177	234
	Pestovë	19.11.2010	11	162	172	178	236
Esterel	Pejë	15.11.2010	11	162	172	179	235
	Pestovë	19.11.2010	12	164	173	180	240

Through the analysis of the 1000 seed weights and hectoliter weight, it is noted that, in all varieties, during the first year the weight of 1000 seeds is greater in Pestova, while in the second year

is greater in the region of Peja (Table 8 and 9).Even among varieties has significant changes, the largest weight of 1000 seeds have Bingo and Vanessa varieties in the first year and Vanessa and Barun varieties in the second year.Also, regarding the results of the yiled according to varieties and cultivation areas, there are significant differences (Table 10).

Table 7. This chart shows the process of phenophase development in days-Year 2011-2012

Variety	Zone	Planting	Sprouting	Growing	Showing	Blossoming	Ripeness
Bingo	Peja	03.11.20	10	159	169	176	232
	Pestova	04.11.20	11	161	172	178	234
Vanessa	Peja	03.11.20	11	161	172	179	235
	Pestova	04.11.20	12	163	174	182	238
Zllatko	Peja	03.11.20	10	160	170	178	233
	Pestova	04.11.20	11	163	173	180	235
Rex	Peja	03.11.20	11	162	172	178	234
	Pestova	04.11.20	12	164	174	181	237
Esterel	Peja	03.11.20	12	165	175	182	236
	Pestova	04.11.20	13	167	177	184	241
Barun	Peja	03.11.20	11	161	172	178	234
	Pestova	04.11.20	12	163	174	181	239

Comparing varieties between each other, it can be said that in the first year of cultivation the highest yield gave Vanessa variety, planted in Pestova, while in the second year the highest yield reached Zlatko variety planted in Peja.If we compare yields between breeding/cultivation areas and years we can say that in the first year the highest yields were obtained in the region of Pestova, while in the second year in the region of Peja.From a value of average monthly temperatures and percipitation for both areas (Table 11) resulting in the spring season, have been shown higher temperatures in the area of Peja rather than in the area of Pestova, as for year 2011 and for 2012, while during June -July, when is the period of ripeness, have been noticed statistically significant differences between years. During2011 in Peja are slightly higher temperatures than in Pestova, while in 2012 the temperatures during those two months are higher in Pestova rather than in Peja.Regarding precipitation, during May-June-July, in 2011 there is much more percipitation in Pestova than in Peja, while in 2012 the difference in precipitation between the two regions is too small to influence the production or quality of barley.

Table 8. Weight of 1000 seeds, hectoliter weights under varieties and cultivation areas (Year 2010-2011).

Variety	Peja		Pestova	
	Weight of 1000 seeds (gram)	Hectoliter Weight (kg)	Weight of 1000 seeds (gram)	Hectoliter Weight (kg)
Bingo	54.20	58.85	54.30	59.90
Vanessa	52.90	61.30	54.10	61.90
Zllatko	42.90	60.10	44.50	61.20
Rex	41.90	64.56	42.60	65.42
Esterel	43.90	55.50	46.39	56.85

Table 9. Weight of 1000 seeds, hectoliter weights under varieties and cultivation areas (Year 2011-2012).

Variety	Peja		Pestova	
	Weight of 1000 seeds (gram)	Hectoliter Weight (kg)	Weight of 1000 seeds (gram)	Hectoliter Weight (kg)
Bingo	43.9	59.68	42.94	55.1
Vanessa	48.17	58.68	47.93	58.45
Zllatko	43.73	59.63	42.98	57.07
Rex	42.47	59.77	41.47	57.3
Esterel	45.73	59.55	44.7	58.25
Barun	48.07	57.82	46.73	56.17

The change in productivity for the same varieties in both years of the experiment must have come as a result of changes in temperature and precipitation in the two zones.However, to be able to come to a more precised conclusion, the experiment will be repeated for the third year and will be targeted to provide daily data of temperature and precipitation in order to be able to understand more clearly the potential impacts of these two climatic factors in growing and riping processand performance of the barley grains/beans.Hence, based on the results of two years of study, we are able to come up with the following conclusions.

Table 10. Yield (barley bean; kg/ha) according to varieties and cultivation zones in both years of the experiment

Variety	**Yieldkg ha^{-1}(2010-2011)**		**Yield kg ha^{-1} (2011-2012)**	
	Peja	**Pestova**	**Peja**	**Pestova**
Bingo	5280	5420*	5613***	5220
Vanessa	5350	5850**	6117**	5450
Zllatko	5200	5400**	6972***	5485
Rex	4800	5000*	5798*	5388
Esterel	5100	5150	5702*	5225
Barun			5955**	5400

Table 11. Average monthly values of temperature and precipitation in the two zones and years of experimentation

Peja	Months	**Jan.**	**Feb.**	**March**	**April**	**May**	**June**	**July**	**August**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
2010	Temp.	-4.3	0.5	2.3	6.5	16.4	16.4	15.9	17.6	11.3	6.8	3.6	-1.2
	Precip.	69.9	80.7	44.3	58	50.8	45.8	10.5	15	25	77.7	89.9	50
2011	Temp.	-0.7	2.6	7.1	11.3	18.2	19.6	20.8	25.6	17.5	12.1	9.4	3.8
	Precip.	36	29	23	32	24	16	2	2.8	36.8	52.4	63	81.6
2012	Temp.	-1.5	4.1	7.6	11.8	16.3	23.1	25.3	26				
	Precip.	121.6	41	13.2	58.4	96.3	5.8	40.6	0.3				
Pestova	Months	**Jan.**	**Feb.**	**March**	**April**	**May**	**June**	**July**	**August**	**Sep.**	**Oct.**	**Nov.**	**Dec.**
2010	Temp.	0.5	3	6.6	11.5	16	19.5	21.7	23	17	9.5	10.4	2.1
	Precip.	70.7	86	50.1	78.5	77.2	67.8	14.9	27.6	31	84.7	95.6	111.1
2011	Temp.	-0.3	0.2	6.4	11.1	15.1	19.6	22.3	22.7	20.2	9.9	3.4	1.6
	Precip.	20.3	20.3	26.1	33.8	66	23.9	54.4	3.1	34.1	48.1	4.5	72.3
2012	Temp.	-1.7	3.7	7.1	11.1	15.5	22.2	24.9	24.2				
	Precip.	105.7	36.1	12.6	51.2	102	6	53.1	3.9				

Conclusion

Based on the results obtained in the research of barley crops in the Plain of Dukagjin(Arëbnesh- Peja) and the plain of Kosova (Pestova) it can be concluded that:

- The higher yields were taken during the first year of the experiment in the region of Peja, while in the second year in the region of Pestova. This change shows the huge impacts that have climatic conditions on the production of barley for beer.
- The higher yields in both climatic zones (Peja andPestova) were obtained respectively from varieties Barun and Vanessa.
- Additionally, to determine the most suitable varieties for different climatic zones is necessary to continue the experiment also for the third year.
- Finally, to determine the influence of climatic factors is needed to study the temperatures and precipitationon daily basis/level.

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