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A Comparative Study on Varieties of Autumn Barly Cultivars for Beer Production in the Conditions of Peja, Kosovo

Nexhdet SHALA, Bakir KELMENDI, Ismaj CACAJ
Public University "Haxhi Zeka" – Eliot Engel, 30000 Pejë, Kosova.

Abstract

Beer production in the Republic of Kosovo relies mainly on the use of distich barley, particularly, the use of locally produced barley. Kosovar farmers have planted traditional barley cultivars but, recently and onwards, new cultivars have been introduced, preferring those with high yields with good chemical and technological indicators.

It is obvious that farmers, respectively producers of distich barleyare interested in cultivating barley varieties that have the highest production capacity, on the contrary, the beer industry requires barley with the appropriate quality indicators.

While the cultivation capacity is not controlled only by genetic factors, but also by the environment, it is necessary, through conducting comparative studies of cultivars for several years, to select the most productive cultivars for concrete conditions. This may give the opportunity for a right choice, determining the adaptability to the environment, and / or the stability of production. Whereas,the yield stability is related to the ability of the cultivar to display production capacity at good levels, adaptation relates to the abilityof cultivar to react to any environmental circumstances expressing the best levels of productive capacity of cultivar.

Key words: genotype, cultivar, stability, adaptation, environment

INTRODUCTION

Beer production in the Republic of Kosovo relies on the use of distich barley,usingmainly locally produced barley. Kosovar farmers have planted traditional barley cultivars, but recently and onwards, new cultivars have been penetrated, preferring those with high yields, and which provide good chemical and technological indicators [1] .

Farmers and producers of distich barley are interested in cultivating cultivars that have the highest production capacity, on the contrary, the beer industry requires barley with appropriate quality indicators.

In these circumstances, especially in terms of the entry of new barley cultivars in Kosovo, we need to know and find the most suitable distich barley cultivars not only for their productive ability, which ultimately is more the interest of the farmer, the distich barley cultivator, but also the qualitative indicators that is the interest of the beer industri [2].

It is obvious that both production ability and quality indicators of cultivating a cultivar are controlled by genetic factors but are also affected by environmental conditions, particularly, the conditions of cultivation. The yield of agricultural crops fluctuates due to adaptation of varieties to different conditions of the year or seasonal conditions or cultivation ones. A particular genotype does not always express the same phenotypic characteristics in all environments, and different genotypes react differently to specific environments. Expression of the gene is subject to change of environment; consequently [7] , the genotype expression of the phenotype is subordinated to the environment (Kang, 1998) [10]. Unproductive genotypic responses to environmental factors such as temperature, soil humidity, soil type, or fertility level from one place to another and from one year to another are a function of the interaction of the genotype x environment (GE) [9] . The genotype x environment interactions are defined as failure of genotypes to achieve the same relative performance in different environments (Baker, 1988). Identifying features that contribute to performance and knowledge of GE interactions and yield stability are important for creating new cultivars with improved adaptations to environmental constraints in selected environments, as well as their recommendation in specific areas or beyond them [17].

Based on this reliable scientific information, in this paper was conducted a comparative study of barley cultivars in the conditions of Kosovo.

The study aims to determine the best cultivars of distich barley for both yield and quality indicators, as well as the influence of climate factors (temperature and soil humidity) and soil factors on the yield and the quality of barley production in two cultivation areas on Kosovo.

It is well known that the main characteristics of barley malt depend on the chemical composition, which has a direct effect on the quality of beer, characteristics that are genetically controlled, by the cultivar but also by the environmental conditions, that is, by the conditions of cultivation based on the soil, climatic conditions and the level of cultivation technology[15].

The average yield of barley, cultivated in our conditions over the recent years, is around 25 kv / ha. The agro-climatic and pedological data of Kosovo, compared with the yields obtained in the barley culture, indicate that the reserves for the amount of barley that can be produced are even greater. The production potential for barley cultivars, cultivated in Kosovo's conditions, is over 80 kv / ha, which means that, at country level, this potential is currently utilized by about 30-40%. To further increase the utilization rate of barley production potential, it is necessary to recognize the factors influencing it, mainly through finding crops with higher production capacity, and to adapt to Kosovo's climate and soil conditions. Obviously, the barley cultivation technology should be concidered and modified under concrete conditions.

RESEARCH METHODOLOGY AND MATERIALS

The study was conducted during the years 2011-2013 in the lands of the Agricultural Institute of Kosovo, in Arbnesh village, (Dukagjini Plain) 6 km away from Peja, and 488 m above sea level.

Five distich cultivars were obtained in the study [11]. Field evidence practice were raised with three repetition, sorted by the randomized block scheme. Each variant in a repetition was planted on a surface of 10 m2 with a size of 10 x 1 m, represented by 6 lines spaced 11 cm apart. Planting took place in the optimal terms of the area and the usual barley cultivation agrochemicals were used. Also, during the planting period were recorded the growth and plant development phases. Before the harvesting phase, plant samples were taken for biometric measurements and chemical analyzes such as: weight of 1,000 grains, hectolitre weight, grain content was determined, grain moisture, ash and protein content, and sediment determination. After harvest, the yield of each cultivar was recorded for all three repetitions. All the data obtained were evaluated through the analysis of the variance and on them were also evaluated the correlation between different indicators[14].

During three years,from 2011 to 2013, five cultivars of distich barley were studied in the conditions of Peja, Kosovo, in three repititions, according to the randomized block. Plant growth and

development phases data, biometric measurements and final yield for each cultivar and repitition were recorded. Finally, the data was evaluated with the variance analysis.

FINDINGS AND DISCUSSION

Data obtained from observations and field measurements, biometric measurements, and laboratory and chemical analyzes were in the function of selecting the best cultivar for the conditions of the Dukagjini Plain. The study was conducted in the lands of the Kosovo Agricultural Institute, in Arbnesh village in Peja, respectively, finding outthe impact of environmental performance conditions and quality production indicators[6].

Based on the quantitative point of view, the yield is the most important indicator for evaluating a cultivar. It represents and includes all the elements of production by combining them because of the abilityof plants to compensate the various factors and elements through their interaction. Accordingly, yield is the ultimate goal of cultivating a cultivar, whichever one it is. Also, yield is multifactorial; it is determined by the number of plants per unit of surface, by the number of double grains per plant, by the number of grains per cob, by the weight of the grain, or by the weight of barley cob. All these elements of production end up in the yield of that cultivar. Therefore,in this paper wereanalyzedthe performance of the yield data[5].

Although data on the yield of barley cultivars differed in Peja's evidence, statistically confirmed for the three years of the study, differences were observed between cultivars and years of study. Based on DMV values, but also in absolute yield figures of cultivars, it appears that the five cultivars in the study do not have the same behavior as the environmental conditions represented by the years of the study. Thus, for example, while in 2011 the first three cultivars, Vanessa (53.5a kv / ha), Bingo (52.8a kv / ha) and Zlatko (52.0a kv / ha), in 2012 only the cultivar Zlatko cultivated in the first group (69.7a kv / ha), while in 2013 were listed three cultivars, but not all of 2011: Bingo (67.8a kv / ha) , Zlatko (66.3a kv / ha) and Rex (66.0a kv / ha).

Since cultivars express different production capacities between them, the yield is controlled by genetic factors, but the different yield level of the year shows that this indicator is also influenced by environmental conditions, hence the conditions of its cultivation, in our case, it is represented by the year of study. The yield of cultivars varies depending on the cultivation conditions (year) due to their adaptation to the different conditions of the year or the cultivation. Different genotypes have reacted differently to specific environments. Thus, for example, Bingo and Vanessa cultivars have expressed the highest production capacity in 2011 and 2013, compared to other cultivars, but at a low level in 2012. The fact that cultivar Zlatko has expressed the highest yield to other cultivars, in the three years of the study, show that this cultivar is characterized by stability in production. Esterel cultivars have the lowest yield levels in the three years of study, which means that it is not appropriate for cultivation under the conditions of Peja. The knowledge of GE interactions and yield stability are important for the recommendation of cultivars in specific areas or beyond[13].

The data obtained from observations and field measurements, biometric measurements, and laboratory and chemical analyzes are in line with the objectives of the study. In other words, all their analysis, interpretation and evaluation is done in line with study objective, namely the selection of the best cultivar for the conditions of the Dukagjini Plain, represented by the study point in the lands of the Agricultural Institute of Kosovo, in Arbnesh village, in Peja, the impact of environmental performance conditions and quality production indicators.

Initially, experimental data underwent variance analysis for each trait for the three test years, then the average has been drawn over the three years, but also the repetition ofyears forbarley cultivars.

The yields is the most important indicator for evaluating a cultivar, certainly from a quantitative point of view. It represents and summarizes all the elements of production by combining them also because of the plant's ability to compensate the various factors and elements through their interaction. Accordingly, yield is the ultimate goal of cultivating a cultivar. Thus yield is multifactorial; it is determined by the number of plants per unit of surface, by the number of variants per plant, by the number of grains, by the number of grains per cob, finally, by the weight of the grain or by the weight of barley cob. All these elements of production end up in the yield of that cultivar. In the case of selective genetic work, all the elements of production are important to direct the selective work. In view of this paper, was analyze the yield data, and then the qualitative production indikator[16].

Although data on the yield of barley cultivars differed in Peja's conditions, were statistically confirmed for the three years of the study. Based on the observation, there were differences between cultivars and years of study. Based on DMV values, but also in the absolute figures of cultivar yield, it seems that the five cultivars in the study do not have the same behavior as the environmental conditions represented by the study years (Table 1). For example, while in 2011 the first three cultivars, Vanessa (53.5a kv / ha), Bingo (52.8a kv / ha) and Zlatko (52.0a kv / ha), in 2012 only the cultivar Zlatko cultivated in the first group (69.7a kv / ha), while in 2013 were listed three cultivars, but not all of 2011: Bingo (67.8a kv / ha) , Zlatko (66.3a kv / ha) and Rex (66.0a kv / ha) [12].

Examining the yield values of cultivars for the three years, and their classification according to statistical processing, were observed several phenomena:

a) The environmental conditions were not the same for the three years of the study; comparatively higher yields were obtainedin 2013, followed by 2012, whereas, in 2011 lower yields were obtained;

b) Barley cultivators in the study have showed different behaviors to the environmental conditions represented by the years of study;

c) Three of the five cultivars in the study (Bingo, Zlatko and Vanessa) provided the best yields in the extreme years (2011 and 2013), the years in which the lowest yield (2011) and higher (2013);

d) Zllatko cultivarhas provided the highest yield in the three years of the study;

e) Rex cultivar has yielded the best performance in 2013, the year when the highest yields were generally achieved;

f) Esterelcultivar, has yielded the lowest yield during the three years of the study.

Based on the above mentioned phenomena it can be concluded that:

a) Since cultivars express different productive capacities between them, the yield is controlled by genetic factors, but the different yield level of the year shows that this indicator is also influenced by the environmental conditions, namely the conditions of cultivation that, in our case, is represented by the year of study[18].

b) The yield of cultivars varies depending on the cultivation conditions (year) due to their adaptationto the different conditions of the year or cultivation.

c) A particular genotype does not always express the same phenotypic characteristics in all environments, and different genotypes react differently to specific environments. Thus, for example, Bingo and Vanessa cultivars have expressed the highest production capacity in 2011 and 2013, compared to other cultivars, but at a low level in 2012. The fact that cultivar Zlatko has expressed the highest yield to other cultivars, in the three years of the study, indicate that this cultivar is characterized by stability in production.

d) Esterel cultivar has the lowest yield levels in the three years of study, which means that it is not suitable for cultivation under the conditions of Peja.
e) Knowledge of GE interactions and yield stability are important for the recommendation of cultivars in specific areas or beyond it[19].
The examination of study data in a different perspective, treating the study years as repetitions. In this case, according to the variance analysis, the differences between varieties / genotypes for the yield level are not verified, but the differences between the years / environments are verified (Table 2). The fact that the quadratic average of the environment / years is validated (225.9 **) indicates that the yield on test crops is influenced by the environment. These results are in accordance with the earliest findings of Dillion et al. (2009) and Jai Dev et al (2009). So, the quadratic average shows that environments vary widely between them and are quite different in relation to their effects on genotype performance for the yield.
Threfore, this indicates that expression of the gene is subject to changes of the environment; Consequently, the genotype expression of the phenotype dependes on the environment (Kang, 1998). Genotypic responses to environmental factors are a function of the interaction of the genotype x environment (GE). Such interactions are defined as failure of genotypes to achieve the same relative performance in different environments (Baker, 1988).
Varieties of barley cultivars differ in the study between them in relation to behavior towards different environments that, in our case, are represented by years of study. If we look at cultivars in this study based on their behavior towards the different years for grain yield, only Zlatko cultivar, which ranks in the groups ***a*** in the three years of study. This is an indicator of the stability of this cultivar for yield, but rather it is a static stability, ie a stability in different environments. Other cultivators, like Bingo and Vanessa, but also Rex, showed sensitivity to the environments (years of study)[21] . For the most emphasized reaction to the environment, the Rex cultivar has the highest yield in 2013, when it has given 66.0a kv / ha, while in the other years has yielded lower output, especially in 2011 and in 2012, respectively, 48.0cd and 58.0ce kv / ha. The highest average yield of the years was obtained in 2013, 64.6a kv / ha, and in 2012, 60.4a, while the lowest average yield was taken in 2011, 51.5bc kv / ha (table no.3) . From these data it seems that in 2012, only one cultivar fits the conditions of that year. Consequently, tested cultivars under these conditions better express their characteristics of behavior on the environment. In the 2011 and 2013 observations, three of the five tested cultivars best met their biological requirements. This indicates that these cultivars are adapted to environmental conditions, while cultivar Zlatko is characterized by static yield stability[20].
The adaptation of cultivars and the stability of production are two concepts often encountered in work on genetic improvement and in agricultural practice. In the sense of evolutionary biology, adaptation is the process during which a herbal material fits in a given environment; the appropriateness of a genotype implies its ability to adapt well to a wide range of environments (Tigerstedt, 1994).

Table no. 1: The yields of distich barley cultivars in the field tests in Peja for the years 2011-2013

No.	Cultivar	2011				2012				2013			
		P I	P II	P III	Average	P I	P II	P III	Average	P I	P II	P III	Average
1.	Bingo	54.0	51.8	52.6	**52.8a**	56.1	54.9	57.3	**56.1de**	67.2	70.0	66.2	**67.8a**
2.	Zllatko	53.3	51.7	51.0	**52.0a**	70.9	69.7	68.5	**69.7a**	67.8	64.5	66.5	**66.3a**
3.	Vanessa	54.5	52.4	53.6	**53.5a**	63.1	58.5	61.9	**61.2cd**	61.1	64.6	63.8	**63.2ab**
4.	Esterel	50.9	52.0	50.1	**51.0b**	58.4	55.2	57.4	**57.0de**	61.0	59.7	58.4	**59.7bc**
5.	Rex	47.9	48.4	47.7	**48.0cd**	56.9	59.1	57.9	**58.0ce**	68.0	66.0	63.9	**66.0a**
D_{01}		**2.40**				**4.13**				**5.01**			
D_{05}		**1.65**				**2.84**				**3.44**			

Table no. 2: Variance analysis for average performance data of yields by study years, Peja 2011-2013

Variation sources	df	Yield			
		Quadratic averages	Values of F		
			F factual	F Theoretical	
				0.95	0.99
Genotypes (G)	4	19.33	1,47	3,84	7,01
Environment / Years (E)	2	225.19	17,14**	4,46	8,65
Errors	8	13.14			

Chart no. 3: Average yields of distich barley cultivars by years, Peja 2011-2013

No.	Years	Yield by cultivars					Average
		Bingo	Zllatko	Vanessa	Esterel	Rex	
1.	2011	52.8	52.0	53.5	51.0	48.0	**51.5bc**
2.	2012	56.1	69.7	61.2	57.0	58.0	**60.4a**
3.	2013	67.8	66.3	63.2	59.7	66.0	**64.6a**
D_{01}		**7.69**					
D_{05}		**5.29**					

The stability of the yield is related to the ability of the cultivator to display production capacity at good levels, regardless of the environment where it is cultivated. Both concepts are used today to express a good sustainable performance in different environments. However, some authors have used the concept of yield stability with respect to the sustainability of the genotype yield, and the concept of adaptation in terms of space stability (Barah et al., 1981; Lin and Binns, 1988; Evans, 1993). This point of view implies that the adaptive analysis can only be related to the response to the sites, geographical areas and agro-tech level or other factors that can be controlled or anticipated prior to planting. In the recommendation of the cultivar, it should be considered the respective area and its available conditions, and the level of cultivation technology used. In the conditions of cultivation with minimal investment, crops with stabilized yields are preferable. But in the case of maximum investment, high-sensitivity cultivars to the environment, which imply low yield stability, would be preferable, but achieving the highest yields in better cultivation conditions.

CONCLUSION

The studied cultivas such as Bingo, Vanessa and Rex, are more characterized for their adaptation to the environment than to the production stability. The highest-yielding cultivar, like Zlatko, is distinguished for static stability. Cultivar Esterel has expressed the lowest yield for the three years of study in the conditions of Peja, which means that it is not suitable for cultivation under the conditions of the Dukagjini Plain.

The findings of this study show that:

1. Cultivars that have been studied, such as Bingo, Vanessa and Rex, are more characterized for their adaptation to the environment than the production stability;
2. The highest-yielding cultivar, like Zlatko, is distinguished for static stability;
3. Esterel cultivar expressed the lowest yield for the three years of study in the conditions of Peja;
4. Is is necessary to conduct the study of cultivars in an appropriate time in order to determine the stability of cultivar production.

RECOMMENDATIONS

Based on the three year study data of five barley cultivars in the conditions of Peja, as well as the above conclusions,the following recommendations are proposed:

1. In the usual conditions of cultivation, ie when no intensive agrotechnics is used, it may be good and appropriate to plant cultivar Zlatko;
2. If intensive agro-techs is used to obtain high yields, it is recommended to plant Bingo and / or Rex cultivars.

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