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Research Article/Araştırma Makalesi

PRODUCTIVE POTENTIAL AND ADAPTABILITY OF ADVANCED OAT BREEDING LINES (*Avena sativa* L.)

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Abstract: This comparative study was performed on advanced oat breeding lines within the period of 2011-2013 in order to determine the productive potential of the studied genotypes and the variation of productivity, which determines the varietal adaptability. The results showed that the studied group of advanced oat lines was highly productive. The yield variation was most strongly affected by the genotype x environment interaction. Genotype played the greatest role in the variation of the traits: length of panicle, grain weight per panicle and 1000-grain weight. The greatest significance in yield formation was displayed in the number of spikelets per panicle, the number of grains per panicle and grain weight per panicle. The weakest contribution was observed for length of panicle. Lines 1104-19-1, N. Pr. 1 and 1402-2 appeared to have the highest productivity, which was relatively constant by years. Lines 1058 Re 1, 1089 Re 3 and 1176-1 were also highly productive, but they have specific responses to environmental changes.

Key words: Oats varieties, productivity, adaptability.

Gelişmiş Yulaf (*Avena sativa* L.) Soy Hatlarının Üretim Potansiyelleri ve Uyumlulukları

Özet: 2011-2013 yılları arasındaki periyotta yulaf hatları üzerinde gerçekleştirilen bu karşılaştırmalı çalışma, çalışmaya dahil edilen genotiplerin üreme potansiyellerinin ve çeşit uyumululuğunun bir göstergesi olan üreme çeşitliliğinin belirlenmesi amacıyla yapılmıştır. Elde edilen sonuçlar kullanılan yulaf hatlarının oldukça üretken olduklarını göstermiştir. Ürün varyasyonu en çok genotipxçevre etkileşiminden etkilenmiştir. Genotip, salkım uzunluğu, salkım başına dana ağırlığı ve 1000 dana ağırlığı gibi özelliklerdeki varyasyon üzerine büyük etkili olmuştur. Ürün oluşumundaki en büyük anlamlılık salkım başına başakçık sayısında, salkım başına dane sayısında ve salkım başına dane ağırlığında gözlenmiştir. En zayif genotip katkısı ise salkım uzunluğunda tespit edilmiştir. 1104-19-1, N. Pr. 1 ve 1402-2 hatlarının üretkenliklerinin en yüksek olduğu ortaya çıkmış ve bu bu durum çalışma süresince devam etmiştir. 1058 Re 1, 1089 Re 3 ve 1176-1 hatlarındaki üretkenlik de yüksektir ancak bu hatlarda çevresel değişikliklere karşı spesifik yanıtlar söz konusudur.

Anahtar Kelimeler: Yulaf varyeteleri, verimlilik, uyum yeteneği.

Introduction

In modern agriculture the variety plays an important role in ensuring high yield and stability of crop production. The main criterion to evaluate a variety is its productivity.The development of varieties, which can be adapted to a wide range of diversified environments, is the ultimate goal of plant breeders in oat improvement programs (Rodgers et al. 1983). The adaptability of a variety over diverse environments is usually tested by the degree of its interaction with different environments under which it is planted. A variety or genotype is considered to be more adaptive or stable if it has a high mean yield, but a low degree of fluctuations in yielding ability when grown over diverse environments (Arshad et al. 2003).

A significant precondition to increase and stabilize the yield is to create varieties with high adaptability, which have the physiological and genetic mechanisms and responses, neutralizing the stress impact of the environment (Momchilovic and Przulj 2005, Tsenov et al. 2006, Ganusheva et al. 2011, Valcheva et al. 2012).

The breeding strategy on oats at the Institute of Agriculture in Karnobat, Bulgaria, includes expansion and acceleration of the breeding improvement work and redirecting the breeding research towards the creation of genotypes with high adaptability, which combine productivity, quality and complex resistance to the stress impact of abiotic and biotic environmental factors (Savova et al. 2012).

The goal of this study was to determine the productive potential of 10 advanced oat breeding lines (Table 1) and the variation in their productivities, which determines the adaptive varietal characteristics.

Table 1. Mean grain yield (t.ha^{-1}) of the 10 oat genotypes during the study.

Variety Lines	2011		2012		2013		Mean	
	t.ha^{-1}	Rang	t.ha^{-1}	Rang	t.ha^{-1}	Rang	t.ha^{-1}	%
Kalojan	4.25 c	10	4.64 fg	9	4.28 e	10	4.39	100.0
N-1	5.12 ab	3	5.88 b	2	4.98 cd	6	5.33	121.4
N.Pr.-1	5.56 a	2	5.17 def	7	5.30 b	4	5.34	121.6
1050-1	5.02 ab	5	5.73 bcd	4	4.89 d	7	5.21	118.7
1058 Re 1	5.61 a	1	4.64 g	10	4.88 d	8	5.04	114.8
1089 Re 1	4.53 bc	9	5.78 bc	3	5.45ab	2	5.25	119.6
1089 Re 3	5.07 ab	4	6.55 a	1	4.83 d	9	5.48	124.8
1104-19-1	4.84 bc	6	5.63 bcd	5	5.35 b	3	5.27	120.0
1176-1	4.69 bc	7	4.81 efg	8	5.72 a	1	5.07	115.5
1402-2	4.66 bc	8	5.24 cde	6	5.24 bc	5	5.05	115.0
Mean	4.93		5.39		5.09		5.14	
VC %	9.82		7.26		4.44			

Means followed by the same letter in the colunm are not significanltly different by the LSD test (P=0.05);
VC % - coefficient of variation.

Material and Methods

This study was performed at the Institute of Agriculture in Karnobat (IA - Karnobat), Bulgaria during the period of 2011-2013. The subjects of the study were 10 advanced oat lines, created at IA - Karnobat. The trial was set on the leached vertex soil type by the method of Latin rectangle in 4 replications on a harvest area of 10 m^2. The dynamic of the main climatic factors – temperature and rainfall over the period of study, yield (t.ha^{-1}) and some yield components – length of panicle (cm), number of spikelets per panicle and number of grains per panicle, grain weight per panicle (g) and 1000-grain weight (g) were recorded.

An analysis of variance was carried out on grain yield of the varieties used for different years. The significance of data and interrelations between the traits were tested with ANOVA, PCA and Fit analyses using SPSS 19.0 and JMP version 5.0.1a (2002).

Results and Discussion

The yields of the tested oat lines ranged from 4.25 to 6.55 t.ha^{-1} (Table 1). In 2011 the yield was 4.93 t.ha^{-1}, and in 2012 was the higher than standard. (5.39 t.ha^{-1}). The standard variety Kalojan produced the lowest yield during the study. The other genotypes exceeded it in yield with 14.8% to 24.8%. The varieties were divided into several groups, with the best differentiated yield being observed in 2012. Average for the period, the highest yield above the standard Kalojan was realized by 1089 Re 3 (124.8%). Lines N.Pr.-1, N-1 and 1104-19-1 were also highly productive, as their yield exceeded the standard with an average of 120.0-121.6%.

It becomes clear from the analysis of variance and its components that the impact of genotype was mostly manifested for the traits of length of panicle, grain weight per panicle and 1000-grain weight. The greatest impact on the variation of yield was observed with the genotype x environment interaction (Table 2). An almost equal role was played by the genotype and the year for number of spikelets per panicle.

The correlation between the yield and productivity components was evaluated by running a principal component analysis. 3 principal components with weight of over 1 were extracted and a 83.39% of variance was determined (Table 3). The first principal component was connected to the number of spikelets and grains per panicle and to grain weight per panicle, the second – to yield, 1000-grain weight and number of spikelets per panicle, and the third – to length of panicle (Table 4).

Table 2. Analysis of variance of yield and some components of productivity of the 10 oat genotypes.

Traits	Source of Variation					
	Genotype		Year		Interaction	
	MS	η^2	MS	η^2	MS	η^2
Yield	11358.319***	31.55	23325.433***	14.40	9728.230***	54.04
Length of panicle	217.578***	89.08	26.590***	3.63	8.908***	7.29
Number of spikelets per panicle	693.650***	38.94	2067.297***	38.69	199.284***	22.37
Number of grain in the panicle	1695.955***	36.08	3998.937***	28.35	835.979***	35.57
Grain weight per panicle	5.020***	62.93	4.617***	19.29	0.709***	17.78
1000-grain weight	321.375***	75.97	189.007***	14.89	19.335***	9.14

*** Significant at 0.001 probability level; MS - mean square, η^2 - part of the Genotype, Year and Interaction sum of square to the total yield variation, in %.

Table 3. Percent of variation and cumulative value of the first three panicle components (PC) for 6 traits of the 10 oat genotypes.

Panicle Components	Percent of Variation	Cumulative Value
PC 1	37.79	37.79
PC 2	27.65	65.45
PC 3	17.94	83.39

Figure 1 shows the three-dimensional projection of the varieties in the factor space. The longest vectors were the traits of number of spikelets per panicle, number of grains per panicle and grain weight per panicle, which means that in the studied group of lines they have the greatest impact on yield formation. The acute angles between the vector of 1000-grain weight and grain weight per panicle with the vector of yield display the strong positive relation between them. Length of panicle had the weakest impact on yield formation.

In the right quadrant of the figure the most highly productive lines are located and among them 1104-19-1, N.Pr.-1 and 1402-2 had high and relatively constant yield by years. Lines 1058 Re 1, 1089 Re 3 and 1176-1 were highly productive but responded specifically to the environmental changes.

Table 4. Factor loadings of 6 traits on the first principal components (PC) of the 10 oat genotypes.

Traits	PC 1	PC 2	PC 3
Yield	-0.13	0.47	0.34
Length of panicle	-0.15	0.18	-0.90
Number of spikelets per panicle	-0.46	-0.51	0.09
Number of grains per panicle	-0.61	-0.14	-0.12
Grain weight per panicle	-0.57	0.14	0.23
1000-grain weight	-0.22	0.67	-0.01

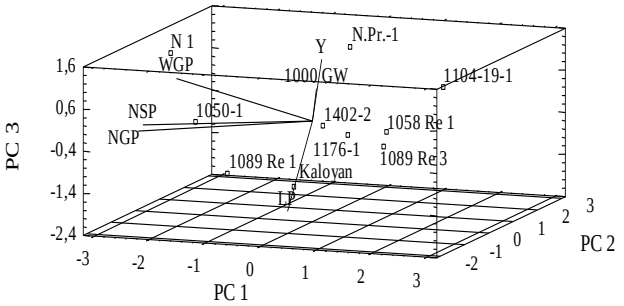

Fig. 1. Projection of varieties and lines in a factor space.

Conclusion

The studied group of advanced oat lines was highly productive. The greatest influence on the variation of yield is due to the genotype x environment interaction. The role of genotype was greatest for the variation of the studied traits length of panicle, grain weight per panicle and 1000-grain weight.

In yield formation the greatest impact was seen with number of spikelets per panicle, number of grains per panicle and grain weight per panicle, whereas the weakest contribution was by length of panicle.

Lines 1104-19-1, N. Pr. 1 and 1402-2 were found to have the highest productivity, which was relatively constant by years. Lines 1058 Re 1, 1089 Re 3 and 1176-1 were also highly productive, but they have specific responses to environmental changes.

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