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Ex situ BEHAVIOUR OF SOME OAT (*Avena sativa* L.) LANDRACES COLLECTED FROM A POLLUTED AREA IN THE MIDDLE JIU RIVER BASIN (GORJ DISTRICT)

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***ABSTRACT**.*

Avena sativa is a specie which can be cultivated on soils with a high amount of heavy metals or with some radionuclids, it being phytoextractive for some elements (zinc, copper, cadmium, uranium, a/o). On the sterile waste dumps from the middle Jiu river basin (Gorj district), and on neighbour area, this species is cultivated more than 20 years ago. The landraces of Avena sativa present adaptation at the presence in soil of a high content in heavy metals and/or radionuclides. From the population farmsteads situated in this area, were harvested 23 landraces of Avena sativa, which were cultivated ex situ in the Experimental Research Station of USAMVB-Timişoara (Timiş district). The analysis of the main quantitative features of these landraces, in comparison with Mureş sort (Control), point out significant differences (notable in some cases), which underlined the variability in this species and the adaptation to environmental conditions. The best oat genotypes, can be used further in a breeding program, in order to obtain for culture on the degraded soils (with a high content in heavy metals and radionuclides), the most proper sorts.

INTRODUCTION

The plant domestication conduct to the formation of a lot of landraces, important for the breeeding programs (Gupta, 2004). With a century ago, started the collection and preservation of the vegetal biodiversity, especially in the gene banks. The gene banks, established for genotype collections, represent deposits of genetic variability, useful for the breeding programs of different crops (Tanksley and McCouch, 1997). The climatic global changes, as well as the anthropic pollution of the environment, induced perturbations in spread and abundancy of the wild communities, being a mainly cause of the diversity reduction in different species (Parmesan and Yohe, 2003).

The **landrace** is an individuals community, belonging to a species, which in a long time period present a great generations succesion and are spread in a certain areal; in this areal take place a certain degree of panmixis. The individuals from a landrace are separated by neighbour populations by territorial and reproductive isolation, having a distinct genome (Ştefănescu, 2003). In conclusion „the landrace is performed by all individuals of a species spread on an certain areal, which are increased through panmixis" (Mohan and Ardelean, 2004). Because all individuals from a local population are spread in a certain environment, they present the same adaptations to this environment, reflected in their genetic features. Because they cross in the same group, they present a common genetic essence. In time, were survival the individuals and genic combinations which presented successful through descends. At the presence in environment of a some stress factors, survived the individuals (and thus the genes combinations), with the best adaptations. Thus, the collecting of different landraces from affected local populations, will leads to the identification of the resistant individuals at a certain stress factor.

Macnair et al. (2000), considered that tolerance at heavy metals at plants, represent their capacity for survival in a soil which is toxic for other plant species, being manifested as an interaction between genotype and environment. This term is widely used in scientific literature, and included the all exchanges which are induced in an experimental manner, as response at heavy metals. After some authors, the tolerance at heavy metals, can be controled by a small genes number with major implication, in the interaction with other genes with secondary implication (Macnair, 1993; Macnair et al., 2000; Schat et al., 2000). There were described a *multiple tolerance* and a *co-tolerance* at the plants which are developed on a ground with a higher content for many heavy metals. This tolerance can result after some specific mechanisms, which confer either a generally resistance at different heavy metals (*co-tolerance*), or can implied different independent mechanisms, metal-specific (*multiple tolerance*; Schat et al., 2000).

The vegetal *genetic diversity* represent a valuable resource (Ramanatha and Hodgkin, 2002), which provide the genetic variability, need for breeding activity, for obtaining of new sorts with valuable features. For the actual society, is need the the collection, evaluation and preservation of the germplasm from the local populations, as well as of the germplasm of wild related species, as potential resources of genes for breeding activities (Zender et al, 2006).

Oat (*Avena sativa*) is an important forager's plant, used also in human alimentation, cosmetics, for its medicinal properties, adaptogen plant feature and for phytoremediatory activity. *Avena sativa* descent probably from ancestor forms of *Avena sterilis*, cultivated in the *Fertile Crescent* area from Orient (New East). It is considered a secondary culture, derived from the first domesticated cereals (wheat and barley), in the Bronze age. After the world genetic centres emitted by Vavilov (1992), its origin was in the four centre (*Near-Eastern Center*), in which are included also *Fertile Crescent* area, from which are provenance the majority of the stalk cereals. References to its cultivation can be found in the epic Mahabharata.

In present, *Avena sativa* is extensively cultivated in Northern temperate regions, especially in Europe and North America. Also, is cultivated in Africa: Ethiopia, Kenya, South Africa, Morocco, Algeria and Tunis. Its spread areal is between 40^0 and 60^0 latitude and in Norvege until 65^0 North latitude. Is not pretentious for the soil, having a reduce necessity because a strong solubilisation force of the root system. His culture is frequently on the poor soils, the oats having a high ecological plasticity.

Avena sativa is a primary adaptogen species, belonging to the first seven adaptogen species described from the middle of XX Century (Corneanu and Corneanu, 2013). Also, this species present many therapeutic properties, characteristic both to the adaptogen species (unspecific resistance to stress factors), as well as some specific properties (anticarcinogen, hypoglycemic, antispasmodic, antiemetic, emollient).

Also, *Avena sativa*, present a remediatory activity (Sonar and Kumar, 2013), having phytostabilization and phytoextraction properties (Malone et al., 2013). In experiments performed with *Avena sativa* genotypes, were established its phytoextractive properties, being capable to absorbe through the root system, different heavy metals as Zn (Ebbs and Kochian, 1998; Prasad and Freitas, 2013), Zn, Pb, Cd, Cu, Fe (Gutiérrez-Ginés et al., 2010) as well as uranium radionuclide (Ebbs et al., 1998). Recent researches point out that the phytoremediatory activity is enhanced in the presence of a chelating substance as EDTA, or others (Farid et al., 2013).

In *Avena sativa* genotypes was met a great variability, as a result of different genotypes adaptation to different environmental conditions. Large *Avena sativa* germplasm collections are present in the United States, the Russian Federation, Canada and Kenya. In numerous papers was analyzed the adaptation of different oat landraces at various environmental conditions. These researches were performed in Turkey

(Dumlupinao et al., 2011, with 196 landraces of different provenance; Hisir et al., 2012, with 17 oat landraces), Poland (Boczkowska and Tarczyk, 2013) with 67 oat landraces, a/o.

In the middle Jiu river basin (Gorj district, Romania), as result of the coil extraction and energetic industry activity, were formed sterile waste dumps and ash waste dumps, with a high content in heavy metals and radionuclides. Thus, the all plant species from this region present adaptation at these stress factors. In the frame of POLMEDJIU grant, were performed studies in this area, in this paper being presented and discussed the behaviour of some *Avena sativa* landraces harvested from different sites from this area and *ex situ* cultivated (Corneanu, 2011).

MATERIAL AND METHODS

Biological material. A number of 23 landraces of oat (*Avena sativa* L.) were collected from the population farmsteads situated in the villages: Fântânele, Moi, Urdari (2009). This species is cultivate on the sterile waste dumps from this area, more than 20 years ago, every family having a proper landrace, of different provenance. In different villages, and in different sites, the amount of heavy metals and radionuclides are different (Corneanu, 2011), being dependent on different factors (waste dump type, distance from waste dump or surface coal exploitation.

Work methods. The *ex situ* collection of oats (sowed) with landraces harvested from the middle of Jiu river basin, was sowed at Experimental-Didactic Station of the University of Agricultural Sciences and Veterinary Medicine of Banat, Timişoara. Oats culture was effected with respect to the needs of this species (Madoşă, 2000; Nedelea and Madoşă, 2004): the sowing in 21 February and the harvesting in 20 July. No fertilizers were added. Each variant was sowed in rows of 1.5m long, in three replicates.

On the plants of these landraces were effected, at harvesting, biometrical observations of some quantitative features (on all harvested plants): stem and panicle length; total secondary shoots number, fertile shoots number; stages, branches and spikelets number/ panicle, grains number/panicle, total grains weight /panicle, 1000 grains weight (TGW).

The data were statistically analyzed using **STATISTICA 10.0** soft – ANOVA test, analysis of variance , Duncan's multiple range test for difference significance analysis.

RESULTS AND DISCUSSIONS

The analysis of the *Avena sativa* plants development on soil with heavy metals and/or radionuclide's, was reported by many researchers. Kochian et al. (1995) established that *Avena sativa* present a good resistance and development on a soil with a big amount of Zn, Cd or Cu. Gutiérrez-Ginés et al. (2010) analysed the content in some heavy metals in soil (at two abandoned mines of silver and copper from the Central Spain) and in the surrounded soils, as well as the amount of the same heavy metals accumulated in the roots of *Avena sativa*. This area was polluted with Al, Fe, Mn, and more than one of the heavy metals Zn, Pb, Cd, Cu, Cr or Ni, a/o. The results reported by many researchers (Schat et al., 2000, a/o) underlined that the levels of Zn, Pb, Cd, Cu and Fe were high in roots as well as in the above-ground parts of the plants. The accumulation of heavy metals by this plant was assessed in terms of its possible use for phytoremediation but also in view of its possible detrimental impacts on humans as well as wild and domestic animals.

The content in heavy metals from soil in different villages from the middle Jiu river basin, from which are originated the 23 *Avena sativa* landraces, is presented in Table 1. These values, point out that in many sites from these villages, the heavy metals amount was higher towards to Control, especially for Zn, Ni, Co, Cr, Cd, Mn, a/o.

Table 1.

The content in heavy metals in the 0-20 cm level soil in different villages from the middle Jiu river basin (limits, in mg/kg soil) (data extracted from Lăcătuşu et al., 2011).

Village	Zn	Cu	Fe	Mn	Pb	Ni	Co	Cr	Cd
Control	43.5	28.2	20,073	325	43.5	22.6	8.64	9.43	0.151
Fântânele	236.-49.3	22.3-15.9	232132-16576	561-389	23.1-23.1	36.6-27.3	18.0-11.4	36.0-19.7	2.7-2.6
Moi	66.2-64.5	19.6-15.6	26567-17820	702-568	26.3-16.9	37.8-18.5	10.4-9.6	19.1-15.2	Udl
Urdari	148-143	22.3-13.6	23719-13024	462-341	24.9-20.3	47.6-26.2	14.7-8.6	14.9-9.7	1.6-1.4

Udl = under detection limit.

In Table 2, is presented the radionuclide activity in the 5-20 cm soil layer (in Bq/kg soil), in the farmstead from which were harvested the oats populations (landraces).

Table 2.

The radionuclide activity in the 5-20 cm soil layer in different villages from the middle Jiu river basin (limits, in Bq/kg soil) (data extracted from Lăcătuşu et al., 2011).

Village	U-238 Th-234	Ra-226	Pb-210	Bi-214	Pb-214	U-238	Ac-228 Th-232	Pb-212	K-40	Cs-137
Control	12.7 19.3	33.1 38.2	18.8 31.9	12.2 13.3	13.7 13.8	2.02 2.32	14.4 23.5	17.7 23.7	325.4 378.1	3.57 25.5
Fântânele	41.1	25.1	36.1	21.0	27.3	1.6	37.8	42.6	580.5	93.4
Moi	36.0 39.5	20.8 28.1	30.3 45.0	18.9 28.16	25.3 28.1	3.75 5.4	30.4 35.5	35.2 41.6	471.7 500.4	29.7 38.3
Urdari	32.0	61.8	31.2	20.2	23.2	3.76	36.7	39.8	469.5	2.25

On the cultivated farmsteads from the waste sterile dumps, the radionuclide activity recorded upper values in comparisson with Control, except the Ra-226 activity recorded in the Fantanele and Moi villages (Table 2). The upper values for the radionuclide activity were recorded for Cs-137 (Fântânele), Ra-226 (Urdari), Ac-228 [Th-232] on the all locations, U-238 [Th-234] especially in Fântânele and Moi, a/o (Table 2).

The main features of the *Avena sativa* populations, harvested from the polluted area with heavy metals and radionuclide's from the middle Jiu river basin, and variance analysis, are presented in Table 3.

Table 3.

The variance analysis of some features in oat landraces, *ex situ* culture (2010)

Variance analysis (oat, 2010, *ex situ* culture) Marked effects are significant at p < ,05000								
Feature	**SS**	**df**	**MS**	**SS**	**df**	**MS**	**F**	**P**
Stem length	349267.5	22	15875.80	101257.2	817	123.9378	**128.0949**	**0.000000**
Panicle length	15239.1	22	692.69	13163.6	817	16.1121	**42.9916**	**0.000000**
Secondary shoots number	154.1	22	7.00	587.3	817	0.7189	**9.7417**	**0.000000**
Secondary fertile shoots number	41.8	22	1.90	366.6	817	0.4488	**4.2386**	**0.000000**
Branches number/panicle	13189.9	22	599.54	12456.4	817	15.2465	**39.3233**	**0.000000**
Stages number/panicle	369.2	22	16.78	649.7	817	0.7952	**21.1046**	**0.000000**
Little ears number/panicle	82767.7	22	3762.17	121759.6	817	149.0326	**25.2439**	**0.000000**
Well grains number/panicle	258426.7	22	11746.67	405946.8	817	496.8750	**23.6411**	**0.000000**
Stunted grains numar/panicle	7322.0	22	332.82	12189.1	817	14.9193	**22.3078**	**0.000000**
Total grains number	248201.6	22	11281.89	450154.3	817	550.9844	**20.4759**	**0.000000**
Well grains weight	192.9	22	8.77	359.1	817	0.4395	**19.9479**	**0.000000**
Stunted grains weight	3.8	22	0.17	5.6	817	0.0068	**25.4210**	**0.000000**
Total weight grains/panicle	190.3	22	8.65	387.8	817	0.4747	**18.2200**	**0.000000**
TGW	10850.1	22	493.19	17877.8	817	21.8822	**22.5383**	**0.000000**

The analysis of variance, pointed out the significant influence of the provenance situs of the landrace and genotype, on all analysed features(Table 3).

Root length feature, manifested a certain uniformity in the studied populations, with insignifiant statistical differences, between them and in comparisson with Control, except the Urdari 2313, Urdari 2316 and Fântânele 2314 genotipes, which recorded positive singnificant values versus the other populations and Control. This feature, was positive correlated with the plant size, probably as result of their adaptation at the environment conditions (Table 5).

Stem length (plants size) is a feature with genetic determinism, specific for stalky cereals, inclusive for oat. This feature is an important desideratum for oat breeding and the determining of the harvested technologies (Donini et al., 2000). In time, the stem size decrease was a pursue, this feature being correlated with enhanced of the genotypes productivity (Christiansen et al., 2002). Thus the breedings programs were mainly focussed on this oppinion (Åkerman, 1948), correlated with other features implies in the determining of the productivity capacity (Peltonen-Sainio and Mäkelä, 1995). This, conduct to diminished of the genetic variability of the selected cultivars (Vellve, 1993), in detriment of other features liked mainly with resistance at stress factors and adaptability capacity at extreme cultivation conditions.

Comparing the values recorded for the phenotypical features in 17 landraces from Norvege, with the help of statistically estimations, implicite with variance analysis, were evidenced very significant differences between the studied genotypes, for stem size and TGW values, which influenced the productivity index (49,3%; Nersting et al., 2006).

The analysis of the recorded values at *ex situ* culture in Timişoara, of the oat landraces originating from sterile waste dumps from middle Jiu river basin, point out an enhanced variability for stem size feature, the differences between analysed genotypes being very significant statistically (Table 4). The growth habit was erect for analysed landraces and the stem length was between 64.9 ± 7.1 cm in Urdari 2316 and 141.3 ± 5.0 cm in Fântânele 2318. The Control, sort Mureş, registered a mean of 125.4 ± 9.3 cm for the stem length (Table 4). Duncan’s test permitted the clustering of the landraces in six groups, with significant differences between them (Table 4). The analysis of correlations between productivity characters revealed that stem length is positevelly correlated with all characters, less with TGW, were a negative correlation was registered (Table 5). These results are in accord with the ones obtained by other reaserchers which made comparative studies on oat landraces variability (Ahokas and Manninen, 2000, Katsiotis et al., 2008).

A big variability of the phenotypically features, respectively the ones correlated with plant productivity, was evidenced in local populations from Finland, which presented also a reduction of the genetic diversity, along the transition to obtaining of the breeding cultivars (Ahokas and Manninen, 2000). The original landraces, were replaced with cultivars with a longer vegetative period, feature correlated with a tardive flowering period, which conduct to obtaining of the genomes with longer size and TGW enhanced (Nersting et al., 2006). These changes in a relative short time period, can be the result of an indirect requirement for uniformity size plant and for enhanced productivity. This process isn’t meet in usual landraces which presented a big heterogeny (Ahokas and Manninen, 2000). The high plant size has preferate initially in the selection of the breeding cultivars, because these genotypes will gain the competition with weeds for nutrients, water and light (Rasmusson and Phillips, 1997). Katsiotis et al. (2008) analyzed the genetic diversity of about 1,000 *Avena sativa* and *A. byzantina* landrace accessions from European gene banks. A number of 29 morphological and agronomic characters have been recorded under in different environments and controlled disease resistance screenings were performed for crown rust, stem rust and powdery mildew. Only few landraces were found to be immune or very resistant to the mentioned pathogens. Protein content for all accessions ranged from 9.8%

to 19%, with an average value of 14%. Thus, the oat landraces can be used in the breeding programs in order to increase the protein content. Protein content analysis was performed using seeds planted within a single site.

Table 4.

The stem and panicle length, fertile secondary shoots number in oat landraces, *ex situ* cultivated in Timişoara, in 2010 year.

Var	Stem length (cm)				Fertile secondary shoots number				Panicle length (cm)			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Mures	125.4 **b**	9.3	97.0	137.0	0.7 **ab**	0.6	0.0	2.0	24.0 **b**	3.3	17.4	30.3
M 2003	94.4 **de**	10.6	75.0	110.0	0.1 **c**	0.3	0.0	1.0	12.8 **f**	3.8	6.0	20.0
U 2308	112.5 **c**	15.5	85.0	150.0	1.1 **a**	1.3	0.0	4.0	19.3 **d**	5.4	12.0	35.0
U 2313	68.4 **f**	20.1	35.0	95.0	0.5 **b**	0.7	0.0	2.0	11.0 **f**	2.4	7.0	15.0
U 2315	101.5 **d**	15.8	75.0	130.0	0.4 **b**	0.7	0.0	2.0	15.9 **e**	4.8	10.0	25.0
U 2316	64.9 **f**	7.1	53.0	78.0	0.9 **a**	0.7	0.0	2.0	10.9 **f**	2.5	6.0	15.0
U 2319	88.9 **e**	6.0	80.0	100.0	0.6 **b**	0.6	0.0	2.0	21.4 **c**	2.2	15.3	25.8
U 2320	101.7 **d**	8.5	90.0	119.0	0.5 **b**	0.6	0.0	2.0	21.1 **c**	3.2	15.6	28.2
U 2323	136.2 **a**	5.5	124.0	144.0	0.6 **b**	0.5	0.0	1.0	27.8 **a**	4.5	19.3	35.4
U 2324	88.6 **e**	9.5	70.0	110.0	0.6 **b**	0.7	0.0	2.0	19.9 **d**	1.6	15.9	23.0
U 2328	121.5 **b**	17.8	91.0	147.0	0.4 **b**	0.5	0.0	1.0	24.8 **b**	6.7	12.4	38.2
F 2309	121.2 **b**	5.8	110.0	131.0	0.6 **b**	0.5	0.0	1.0	19.1 **d**	2.8	14.5	23.3
F 2310	115.9 **c**	9.2	96.0	127.0	0.8 **a**	0.6	0.0	2.0	22.9 **c**	4.2	15.8	29.7
F 2311	113.5 **c**	9.2	90.0	130.0	0.2 **c**	0.4	0.0	1.0	17.5 **ed**	5.9	10.0	25.0
F 2312	115.1 **c**	12.7	85.0	140.0	0.8 **a**	0.9	0.0	3.0	19.0 **d**	5.9	8.0	30.0
F 2314	71.2 **f**	9.0	54.0	88.0	0.5 **b**	0.6	0.0	2.0	16.7 **e**	5.2	9.0	26.0
F 2317	114.4 **c**	11.5	90.0	131.0	0.8 **a**	0.8	0.0	2.0	25.4 **ab**	6.0	17.0	38.0
F 2318	141.3 **a**	5.0	131.0	148.0	0.5 **b**	0.7	0.0	2.0	26.1 **a**	2.8	20.8	29.7
F 2322	97.2 **d**	9.4	81.0	113.0	0.5 **b**	0.6	0.0	2.0	21.9 **c**	2.2	17.5	25.4
F 2326	122.8 **b**	12.9	98.0	142.0	0.6 **b**	0.6	0.0	2.0	22.3 **c**	1.8	19.8	25.1
F 2327	94.0 **de**	7.0	80.0	102.0	0.0 **c**	0.0	0.0	0.0	16.4 **e**	3.6	10.0	21.0
F 2329	134.4 **a**	6.0	122.0	143.0	0.5 **b**	0.5	0.0	1.0	19.8 **d**	2.9	15.7	27.3
F 2330	120.6 **b**	16.8	82.0	142.0	0.6 **b**	0.6	0.0	2.0	20.8 **cd**	3.1	15.7	26.7
All grp	108.5	23.2	35.0	150.0	0.6	0.7	0.0	4.0	20.2	5.8	6.0	38.2

Note: The means ± standard deviation (SD) within a column followed by the same letter are not significantly different estimated by One-Way ANOVA followed by a post hoc Duncan's multiple range at $p \leq 0.05$

In the last 80 years of breeding in oat, some desiderata as the cultivars obtaining of high size and a long vegetation period, were replaced with other desiderata as obtaining of early cultivars, with shorter stem (Allard and Bradshaw, 1964). This tendancy was intensified in the last 50 years, probably due to mecanization works, and use of pesticids and fertilization (Donini et al., 2000).

Fertile secondary shoots number is an important productivity element, but is also dependent by climate conditions. Individuals registered values between 0.0-4.0 fertile secondary shoots, with mean values from 0.1 ± 0.3 (Moi 2003) to 1.1 ± 1.3 (Urdari 2308) (Table 4). This character is positivelly correlated with the number of stages, spikelets and grains/panicle, grains weight/panicle (Table 5).

Panicle length is an important element for the productivity of a species, being in generally correlated with the spikelets and the grains number per panicle (Madoşă, 2000). The analysis of correlations for the considered landraces revealed positve significant correlations with all productivity elements, less TGW (Table 5). The values for panicle length were between 27.8 ± 4.5 cm (Urdari 2323) and 10.9 ± 2.5 cm (Urdari 2316), genotype that registered also the smallest stem length (Table 4). The landraces are clustered in six groups (Duncan's test), as for the stem length.

The shorter length of panicles, specific to heterogenous landraces, as a result of the natural selection, with an advantage for survival competition, were replaced with panicles of bigger weight and length, in the homogenous cultivars (Nersting et al., 2006).

Table 5

Correlations between analysed features

Correlations Marked correlations are significant at p < ,05000 N=840 (Casewise deletion of missing data)										
	Root length	Stem length	Panicle length	Secondary shoots number	Secondary fertile shoots number	Braches number /panicle	Stages number /panicle	Little ear number /panicle	Grains number /panicle	Grains weight /panicle
Stem length	**-0.3147**	1.0000								
	p=0.00	p= ---								
Panicle length	**-0.3557**	**0.5887**	1.0000							
	p=0.00	**p=0.00**	p= ---							
Secondary shoots number	**0.1149**	**0.0770**	**0.1379**	1.0000						
	p=0.001	**p=0.026**	**p=0.000**	p= ---						
Secondary fertile shoots number	**0.1310**	**0.1107**	**0.1486**	**0.6786**	1.0000					
	p=0.000	**p=0.001**	**p=0.000**	**p=0.00**	p= ---					
Braches number /panicle	**-0.2517**	**0.3693**	**0.5956**	0.0278	0.0307	1.0000				
	p=0.000	**p=0.00**	**p=0.00**	p=0.421	p=0.374	p= ---				
Stages number /panicle	**0.1452**	**0.1122**	**0.1468**	**0.2084**	**0.0996**	**0.2934**	1.0000			
	p=0.000	**p=0.001**	**p=0.000**	**p=0.000**	**p=0.004**	**p=0.000**	p= ---			
Little ears number /panicle	**-0.2944**	**0.5654**	**0.6954**	**0.1397**	**0.1472**	**0.6578**	**0.2673**	1.0000		
	p=0.000	**p=0.00**	**p=0.00**	**p=0.000**	**p=0.000**	**p=0.00**	**p=0.000**	p= ---		
Grains number /panicle	**-0.2638**	**0.4894**	**0.6660**	**0.1014**	**0.1426**	**0.6243**	**0.2277**	**0.8851**	1.0000	
	p=0.000	**p=0.00**	**p=0.00**	**p=0.003**	**p=0.000**	**p=0.00**	**p=0.000**	**p=0.00**	p= ---	
Grains weight /panicle	**-0.2199**	**0.3858**	**0.5148**	0.0596	**0.1008**	**0.5941**	**0.2521**	**0.8196**	**0.9181**	1.0000
	p=0.000	**p=0.00**	**p=0.00**	p=0.085	**p=0.003**	**p=0.00**	**p=0.000**	**p=0.00**	**p=0.00**	p= ---
TGW	**0.0992**	**-0.1689**	**-0.1683**	**-0.0939**	-0.0574	0.0530	**0.1086**	0.0271	0.0163	**0.3382**
	p=0.004	**p=0.000**	**p=0.000**	**p=0.006**	p=0.096	p=0.125	**p=0.002**	p=0.433	p=0.637	**p=0.00**

Stages and branches number per panicle are important elements for the productivity, and are positivelly correlated with stem and panicle length. The shorter panicles, characteristics for these local populations, are not positive correlated with the braching number per panicle or with the stage number per panicle (Table 4 and 6), underlined that the their productivity is not usually dependent on this feature, the panicles being lax or compacte, depending on genotype. The Mureş sort, presented a middle position in comparison with the other landraces, regarding the braches number per panicle, with a average value of 16.5 ± 0.8, near the mean average of the all landraces (15.8 ± 3.0) recorded for this feature (Table 6). The highest number of branches per panicle was recorded in Fântânele 2318 landrace (22.4 ± 2.7), and the lowest at Urdari 2315 landrace (8.4 ± 2.3), the both having statistically significant differences towards the Control and the average value for this character.

Little ears and **grains number per panicle**, are two features between which there is a positive very significant correlation (Table 5), the little ear number per panicle, being determinant in the obtaining of a significant grains number, this character being correlated with the productivity of a genotype (Nedelea and Madoşă, 2004). Also, this feature manifest a big interpopulation variability, the very signifiantly differences being recorded so much between the oat landraces and towards to the Control. The highest little ears number was recorded in Fântânele 2323 landrace (50.6 ± 13.0), followed by Fântânele 2326 (48.7 ± 13.4; Table 6), which registered also the highest grains number per panicle (90.2 ± 36.7) (Table 7), with significant positive differences in comparison with Control. In Control, sort Mureş were registered medium values for this charcters: 35.3 ± 10.5 little ears/panicle and 62.6 ± 21.7 grains/panicle. In general, the stunded grains number per panicle, at these landraces, as well as in Control, recorded small values (between 0 – 7), with few exceptions (Urdari 2328:12.2 ± 3.5, Fântânele 2317:8.6 ± 1.3 and Fântânele 2327: 7.3 ± 0.8), but the percentage of stunded grains per panicle, has recorded a variability between 0.00 – 4.74 % (1.67% in Control).

Table 6.

Stages number/panicle, braches number/panicle and little ear number/panicle in oat landraces, *ex situ* cultivated in Timişoara (2010).

Var	Stages number/panicle				Braches number/panicle				Little ears number/panicle			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Mures	3,9 **c**	0,6	3,0	5,0	15,8 **c**	3,0	11,0	21,0	35,3 **c**	10,5	20,0	60,0
M 2003	3,9 **c**	1,0	2,0	6,0	9,4 **e**	3,5	4,0	15,0	15,4 **e**	8,2	5,0	36,0
U 2308	4,0 **cb**	0,8	2,0	5,0	10,8 **de**	4,0	5,0	19,0	27,8 **d**	21,6	9,0	105,0
U 2313	5,1 **a**	1,6	3,0	8,0	9,3 **e**	2,4	6,0	14,0	9,9 **e**	4,5	3,0	19,0
U 2315	3,0 **d**	0,7	2,0	4,0	8,4 **e**	2,3	5,0	12,0	21,6 **d**	14,1	7,0	60,0
U 2316	4,6 **ba**	2,2	2,0	10,0	12,6 **d**	4,6	5,0	25,0	14,8 **e**	6,9	7,0	30,0
U 2319	3,4 **dc**	0,5	3,0	4,0	17,2 **cb**	5,1	9,0	25,0	30,2 **cd**	10,3	17,0	49,0
U 2320	3,4 **dc**	0,5	3,0	4,0	17,5 **cb**	4,8	9,0	27,0	28,1 **d**	10,6	16,0	53,0
U 2323	4,4 **b**	0,5	4,0	5,0	19,4 **b**	2,4	16,0	24,0	50,6 **a**	13,0	25,0	67,0
U 2324	5,3 **a**	0,7	4,0	6,0	19,5 **b**	2,5	14,0	23,0	31,9 **cd**	8,7	17,0	48,0
U 2328	4,8 **ba**	0,8	3,0	7,0	16,6 **cb**	3,4	8,0	22,0	46,1 **ab**	19,3	17,0	100,0
F 2309	4,5 **b**	0,5	4,0	5,0	17,5 **cb**	2,9	12,0	22,0	35,6 **c**	9,6	23,0	52,0
F 2310	3,9 **c**	0,7	3,0	5,0	16,4 **c**	3,5	10,0	22,0	36,1 **c**	8,5	16,0	52,0
F 2311	3,6 **c**	1,4	1,0	6,0	10,8 **de**	4,6	3,0	20,0	25,1 **d**	14,6	9,0	60,0
F 2312	5,0 **a**	0,7	4,0	6,0	10,5 **de**	4,0	3,0	19,0	21,8 **d**	10,8	7,0	45,0
F 2314	3,1 **d**	0,9	2,0	5,0	14,8 **c**	6,7	6,0	27,0	22,9 **d**	13,6	8,0	56,0
F 2317	4,3 **b**	0,8	3,0	5,0	15,9 **c**	5,1	8,0	24,0	33,8 **cd**	16,9	12,0	71,0
F 2318	3,9 **c**	0,7	3,0	5,0	22,4 **a**	2,7	17,0	27,0	41,9 **b**	7,7	28,0	54,0
F 2322	3,4 **dc**	0,5	3,0	4,0	20,6 **ab**	3,9	11,0	29,0	32,4 **cd**	8,7	18,0	49,0
F 2326	5,4 **a**	0,5	5,0	6,0	19,3 **b**	2,9	15,0	26,0	48,7 **a**	13,4	32,0	75,0
F 2327	4,0 **c**	1,0	2,0	5,0	10,9 **d**	2,8	4,0	13,0	27,1 **d**	11,6	6,0	40,0
F 2329	4,6 **ba**	0,6	4,0	6,0	19,6 **b**	3,5	12,0	27,0	42,5 **b**	11,4	27,0	68,0
F 2330	3,7 **c**	0,7	3,0	5,0	18,5 **b**	5,1	9,0	27,0	34,6 **cd**	12,4	18,0	68,0
All grp	4,1	1,1	1,0	10,0	15,6	5,5	3,0	29,0	31,3	15,6	3,0	105,0

Note: The means ± standard deviation (SD) within a column followed by the same letter are not significantly different estimated by One-Way ANOVA followed by a post hoc Duncan's multiple range at $p \leq 0.05$

Grains weight per panicle recorded a high variability, very significant differences being recorded both at interpopulational level, and in comparisson with the Control (Table 7). The best values were recorded in Fântânele 2326 landrace (2.7 ± 1.2 g total grains weight per panicle). This value presented a positive very significant difference, both to Control (1.7 ± 0.6 g) , and toward the other landraces. The smallest value was recorded in Urdari 2313 populations (0.6 ± 0.4 g) , which presented also the smallest number of little ears and grains per panicle (Table 6 and 7).

The thousand grains weight (TGW), a character for highlighting of the productivity of a genotype (Madoşă, 2000), presented a variability between the analysed genotypes.

TGW is positivelly correlated with the root length, stage number/panicle and grains weight/panicle (Table 5). Negative significant correlations were registered versus stem and panicle length and secondary shoots number (Table 5). In accord with these correlations, the landraces with shorter stem and panicle registered the best values for TGW: Fântânele 2314 (36.29 ± 3.68 g) and Fântânele 2327 (34.99 ± 5.46 g), both with significant positive differences toward Control (26.95 ± 4.03 g). Remarkable results obtained Fântânele 2326 (TGW = 29.73 ± 2.4 g), which registered the best values for the number of grains/panicle and grains weight/panicle (Table 7). The lowest value for TGW was 20.39 ± 7.5, registered by Urdari 2315 landrace.

Table 7.

Grains number/panicle, total grains weight/panicle and 1000 grains weight (TGW), in oat landraces, *ex situ* cultivated in Timişoara in 2010 year.

Var	Grains number/panicle				Grains weight/panicle				1000 grains weight (TGW)			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Mures	62,6 **b**	21,7	31,0	115,0	1,7 **b**	0,6	0,9	3,1	26,95 **bc**	4,03	21,48	35,90
M 2003	25,9 **d**	15,7	8,0	69,0	0,8 **de**	0,5	0,2	2,0	28,76 **b**	4,69	21,00	36,07
U 2308	43,5 **c**	33,3	14,0	155,0	1,0 **d**	0,9	0,3	3,9	23,26 **d**	5,10	16,66	33,33
U 2313	21,9 **d**	10,7	8,0	39,0	0,6 **e**	0,4	0,2	1,2	28,00 **b**	6,71	16,70	38,21
U 2315	36,8 **c**	23,2	11,0	102,0	0,8 **de**	0,6	0,1	2,2	20,39 **e**	7,05	0,63	35,63
U 2316	32,3 **d**	18,6	11,0	77,0	0,9 **d**	0,7	0,3	2,7	25,59 **c**	7,69	16,50	40,43
U 2319	57,3 **b**	20,2	26,0	98,0	1,6 **bc**	0,6	0,7	2,7	28,47 **b**	3,25	19,03	35,08
U 2320	52,7 **bc**	18,6	32,0	102,0	1,4 **c**	0,4	0,8	2,3	26,61 **c**	4,03	20,75	33,33
U 2323	82,4 **a**	28,4	39,0	138,0	2,0 **b**	0,7	0,9	3,7	24,26 **d**	2,21	21,29	29,06
U 2324	49,1 **c**	24,8	23,0	148,0	1,4 **c**	0,8	0,6	4,5	28,64 **b**	3,67	16,15	32,82
U 2328	79,7 **a**	34,9	26,0	175,0	2,0 **b**	1,1	0,7	4,3	24,27 **d**	5,23	16,80	36,19
F 2309	57,2 **b**	17,0	37,0	92,0	1,6 **bc**	0,5	0,8	2,8	28,73 **b**	3,41	21,35	38,50
F 2310	63,5 **b**	17,9	30,0	91,0	1,3 **cd**	0,4	0,5	2,0	20,49 **e**	2,50	16,33	25,00
F 2311	37,5 **cd**	28,2	15,0	118,0	1,0 **d**	0,9	0,3	3,8	27,87 **b**	5,74	17,50	35,76
F 2312	38,3 **c**	21,0	15,0	101,0	0,8 **de**	0,5	0,2	1,9	23,37 **d**	6,25	10,90	40,43
F 2314	40,3 **c**	23,9	11,0	92,0	1,4 **c**	0,8	0,4	3,1	36,29 **a**	3,68	30,75	42,25
F 2317	62,9 **b**	26,5	22,0	120,0	1,3 **cd**	0,6	0,5	2,6	20,59 **e**	3,58	16,77	28,24
F 2318	80,0 **a**	15,4	48,0	106,0	1,9 **b**	0,5	0,9	3,2	23,03 **d**	3,96	18,14	30,76
F 2322	62,4 **b**	19,8	39,0	99,0	1,6 **bc**	0,5	0,9	2,8	26,60 **c**	4,08	19,29	34,50
F 2326	90,2 **a**	36,7	43,0	185,0	2,7 **a**	1,2	1,1	5,6	29,73 **b**	2,40	24,78	32,12
F 2327	42,1 **c**	18,2	12,0	63,0	1,5 **c**	0,8	0,3	2,2	34,99 **a**	5,46	27,27	44,70
F 2329	62,4 **b**	24,2	27,0	110,0	2,0 **b**	0,7	1,2	3,5	29,73 **b**	4,18	19,69	34,76
F 2330	65,3 **b**	22,8	32,0	122,0	1,7 **bc**	0,7	0,6	3,5	25,65 **cd**	4,47	17,09	32,63
All grp	54,7	28,9	8,0	185,0	1,4	0,8	0,1	5,6	26,41	5,85	0,63	44,70

Note: The means ± standard deviation (SD) within a column followed by the same letter are not significantly different estimated by One-Way ANOVA followed by a post hoc Duncan's multiple range at $p \leq 0.05$

In the new oat sorts, the productive indices per plant was increase (Rasmusson and Phillips, 1997), total grains weight per panicle reaching optimum, but in detriment of the genetic diversity (Vellve, 1993).

Some researchers reported a decrease of the stem size plants, positive correlation with the resistance to downhall, but the TGW value remain constant in oat from Finland, in the breeding process (Nersting et al., 2006, Rekunen, 1988). Results reported by Ahokas and Maninnen (2000) evidenced a geographycal gradient regarding the biological material, function of the country of origin of the evaluated genotypes. The cultivars originate from Finland and Norway, were earliers, suggesting an adaptation at the shorter summer from these countries, while the cultivars originate from Sweden and Denmark, were more tardiness, because the climate conditions with long days and higher and constant temperatures in the vegetation period. Also, the production index present a variation depending on the geographical distribution of the cultivars from which provenanced the local populations in Finland, having bigger values at Norway and Finland cultivars, in comparison with values recorded in biological material originating from Denmark or Sweden. This variability can be induced also by the adaptation capacity at environment and edaphic conditions, of the local populations. Thus the bigger values recorded by Norway cultivars, can due to a better adaptation at the precarious environmental and geological conditions.

Similarly is the variability between the oat landraces from the middle Jiu river valley (at their *ex situs* culture in Timişoara), but who are native from unknown genomes.

CONCLUSIONS

The analysis of variance, pointed out the significant influence of the provenance situs of the landrace and genotype, on all analysed features involved in oat productivity.

The stem length recorded significantly variations between the analysed landraces, while the root length was a feature with small variability.

The panicle length, is correlate with the little ears and grains number per panicle, being recorded an insignificantly variability. The stages and branches number are correlated with the stem and panicle length. Depending on genotype, the panicle can be lax or compact.

The little ears and grains number per panicle, manifested a significant correlation, the both features having high intrapopulational variability.

The positive correlations were recorded between three features implied in the productivity determinism (the little ears number, the well grains number and total grains number per panicle).

TGW is positivelly correlated with the root length, stage number/panicle and grains weight/panicle. Negative significant correlations were registered versus stem and panicle length and secondary shoots number.

The best oat genotypes, can be used further in a breeding program, in order to obtain for culture on the degraded soils (with a high content in heavy metals and radionuclides), the most proper sorts. Remarkable results were obtained by Fântânele 2326, with a medium stem and panicle length, but which registered the best values for the number of grains/panicle and grains weight/panicle

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