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Full Length Research Paper

Grain yield and agronomic characteristics of Romanian bread wheat varieties under the conditions of Northwestern Turkey

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In this study, fourteen bread wheat varieties, twelve of which were introduced into Turkey from Romania, were evaluated for grain yield and seven agronomic properties in Biga, Çanakkale in northwest part of Turkey in 2005 - 2006 and 2006 - 2007 growing seasons. The objectives of the research, carried out in a completely randomized block design with 3 replicates, were to investigate Romanian wheat varieties, to study the associations between yield and yield components, and to determine the most promising varieties suitable to Biga conditions. Based on a two-year data, all the characteristics examined showed significant difference (P < 0.05) and varied with a wide range in grain yield (344.0 - 475.5 kg da^{-1}), plant height (78.1 - 103.3 cm), spike length (9.2 - 16.4 cm), number of spikelets (15.3 - 19.3 number), number of grains per spike (35.7 - 43.3 number), grain weight per spike (1.25 - 1.73 g), harvest index (34.2 - 43.8%) and 1000 grain weight (35.2 - 47.8 g). Except for harvest index, genotype x year interactions (GxY) was found to be significant for all the traits studied. Correlation coefficient analyses showed that the grain yield had positive and significant associations with plant height (r = 0.416*), grain weight per spike (r = 0.345**), number of grain per spike (r = 0.220*) and 1000 grain weight (r = 0.388***). Consequently, new bread wheat varieties, Joseph followed by Dumbrava and Trivale, from Romania gave rise to higher yield compared to the local varieties.**

Key words: *Triticum aestivum*, introduction, yield components, correlation coefficient.

INTRODUCTION

Wheat is adapted to diverse environments, between the temperatures of -35°C in the vegetative stage (Haji and Hunt, 1999) and over 40°C during grain fill period (Elahmadi, 1994). It grows under a broad range of latitudes and altitudes. It is not only the most widely cultivated crop but also the most consumed food crop all over the world. It has also been commonly utilized in Turkey as bread, bulgur, macaroni, biscuit, pasta, etc. High yielding ability with good bread-making quality is the main aim in bread wheat breeding programmes. Increased fertilization, grain quality, resistance to biotic or abiotic factors, earlier maturity, improved harvest index and straw strength, semi dwarf varieties are of great significance in view of wheat breeders. Although the science of wheat breeding started in the beginning of 20th century (Kronstad, 1998), international studies started in the 1940s (Reynolds and Borlaug, 2006). The Green Revolution and its impacts have been well reported (Borlaug, 2003; Evenson and Gollin, 2003). Based on the international collaborative studies many new varieties have been released and the yield has been remarkably increased throughout the world.

After establishing CIMMYT in Mexico in 1966, wheat varieties with higher yield were introduced into Mediterranean and Aegean coasts of Turkey (Kronstad, 1998). Of the genotypes from Mexico, the yield of Sonora 64 (400 kg da^{-1}) was higher than the local cultivars (150 kg da^{-1}). Earlier, some wheat introductions (Manitoba from Canada, Floransa from Australia, and Mentana from Italy) also took place (Zencirci et. al., 1998). In Turkey, the area cultivated with wheat covered 9 250 000 ha, producing 21 500 000 tons with a yield of 232.4 kg da^{-1} in 2005 (Anonymous, 2007a). Wheat is also a major crop for Çanakkale province where this study was conducted.

It was grown in 111 330 ha area and production was about 399 000 tons with a yield of 358.0 kg da^{-1} in the province in 2006 (Anonymous, 2007b). There were also 18 agro-based milling factories in the province (Anonymous, 2007c).

The primary methods of wheat breeding are introductions, selection and crossing (Demir et al., 1997). Also there has been some research on hybrid wheat in the last decades (Carver et al., 1987; Bruns and Peterson, 1998). The grain yields of wheat have steadily improved over the past years (Sears, 1998). Due to high increase in world population and decreasing agricultural lands, plant breeders and agronomists have been doing many efforts to overcome these concerns through a combination of genetic studies and better agricultural practices. Stability of grain yield and quality characteristics over locations and years are important. Wheat shows highly significant genotype by environment interaction (GxE) (Reynolds et al., 2002; Vargas et al., 1998 and 1999). It is rather difficult to determine GxE interactions, because of the statistical complexity presented by numerous environmental factors.

The objectives of this research were to examine the grain yield capacity and yield components of twelve Romanian bread wheat varieties with two local varieties as control in Biga conditions, to assess relationships between yield and yield components, and than to determine, for the region, the most suitable high yielding new variety or varieties originating from Romania.

MATERIALS AND METHODS

The trials were conducted at Aşağı Demirci, Biga, Northwest part of Turkey, during two consecutive crop years of 2005 - 2006 and 2006 - 2007. Twelve Romanian wheat varieties (Apullum, Ardeal, Boema, Crina, Dumbrava, Eliva, Fundulea, Gabriela, Joseph, Simnic, Trivale and Turda) which were obtained from University of Agronomical Sciences and Veterinary Medicine, Bucharest/ ROMANIA and two varieties (Gönen and Saqittario) which were commonly grown by the farmers in the region were used as the plant materials. Soil of the experimental field was a clay-loam with pH 6.3, 0.81% lime and a 3.0% average organic matter content (Anonymous, 2005). Meteorological data of Çanakkale province was given in Table 1 (DMİGM, 2008).

The experiment was set up according to completely randomized block design with 3 replications. Each plot had five rows, 5 m long with row spacing of 20 cm. The seeds were planted at a seed rate of approximately 500 seeds m^{-2}. Grain yield and other agronomic data were determined by the three center rows in each plot to avoid edge effects. The seeds were planted at the end of November and plants were harvested at the beginning of July in the two years. The N application was split, half at sowing and half in the beginning of stem elongation (total 120 kg ha^{-1}). Phosphorus (P_2O_5) at a 70 kg ha^{-1} dose was applied at sowing. Weed control was achieved by the application of post emergence herbicides. Data on grain yield (GY), plant height (PH), 1000 grain weight (GW), harvest index (HI), spike length (SL), number of spikelets (NS), number of grains per spike (NGS) and grain weight per spike (GWS) were recorded (Genç, 1974; Tayyar and Gül, 2008; Tosun et al., 2006). The data obtained from the study was statistically evaluated by the SAS package programme (SAS, 1999). Differences between means were compared using LSD test.

RESULTS AND DISCUSSION

The results from analyses of variance over two years for the investigated characteristics are presented in Table 2. It was found that the effects of genotype (G) and year (Y) were significant for all the parameters. GxY was also significant except for harvest index. The differences among varieties were significant for grain yield and yield components (Tables 3 and 4).

Grain yields varied considerably from year to year. GYs of the varieties ranged between 344.0 (the variety Turda) and 475.5 (the variety Joseph) kg da^{-1}. Mean GY of the first year (378.2 kg da^{-1}) was lower than the second year (453.4 kg da^{-1}). The local varieties, Gönen and Saqittario, which are widely cultivated in the region, gave 454.4 kg da^{-1} and 419.4 kg da^{-1} grain yield, respectively. Of the introductions, Joseph gave the highest GY, than Dumbrava and Trivale cultivars compared to the local common cultivars. Turda and Eliva gave the lowest GY. As far as PHs of the varieties are considered, the variety and environmental factors caused a variation (from 78.1 to 103.3 cm). The varieties in second year (99.2 cm) were higher than the first year (83.4 cm). Local cultivars, Gönen with a height of 78.1 cm and Saqittario with a height of 78.6 cm were the lowest with compared to the Romanian varieties. With respect to HI, the wheat varieties varied with a wide range (34.2 - 43.8%). With compared to Romanian varieties, Gönen (42.5%) and Saqittario (41.7%) resulted in high values. Dumbrava variety (47.8 g) had the highest GW, while Apullum variety (35.2 g) and Ardeal variety (35.6 g) had the lowest.

In respect of spike-related properties, the highest SL was measured for the variety Dumbrava (16.4 cm), whereas the lowest for the variety Gönen (9.2 cm). Mean values of SL for the first year, second year and over the years were 13.9, 14.2 and 14.0 cm, in order. NS values of the varieties ranged from 15.3 (Gönen) to 19.3 (Apullum). First years' mean (15.8) was lower than the second year (17.9). The highest NGS was counted as 43.3, while the lowest as 35.7. Mean over the years for NGS was 38.7. GWS was weighed from 1.25 g (Ardeal) to 1.73 g (Dumbrava). Local cultivars had the values of 1.51 g for Gönen and 1.53 g for Saqittario.

Table 5 shows correlation coefficients of grain yield and yield components of the varieties investigated in 2006, 2007 and over two years. The GY gave positive and significant correlation with PH ($r = 0.416^{***}$), GWS ($r = 0.345^{**}$), GW ($r = 0.388^{***}$) and NGS ($r = 0.220^{*}$), whereas no significant correlations were observed between GY and SL, NS and HI. PH was highly and positively correlated with SL ($r=0.524^{***}$), NS ($r = 0.610^{***}$), GWS ($r = 0.354^{**}$) and GW ($r = 0.411^{***}$). HI had negative and significant relationships with SL ($r = -0.419^{***}$) and PH ($r = -0.208^{*}$).

The overall data indicate that the grain yields of the varieties recorded over the two years are largely depended on varieties. Mean grain yield of the cultivars in first

Table 1. Some climatic data for Çanakkale province.

Climatic parameter	Years	Month											
		1	2	3	4	5	6	7	8	9	10	11	12
Maximum average temperature (°C)	2005	10.1	8.4	12.6	17.2	22.7	27.1	30.4	30.7	26.8	19.5	13.9	12.1
	2006	6.3	9.1	12.8	18.5	22.8	27.3	30.1	31.9	26.3	19.8	14.5	11.4
	2007	13.1	10.9	13.3	18.4	23.9	30.2	33.1	32.3	26.5	21.7	14.4	9.7
	Long	9.7	9.8	12.3	16.9	22.3	27.7	30.5	30.1	26.1	20.6	15.2	11.2
Average temperature (°C)	2005	6.8	6.0	8.2	12.8	17.9	21.9	25.5	25.7	21.7	14.9	10.5	9.1
	2006	3.1	5.6	8.7	13.2	17.7	22.2	24.8	26.4	21.3	16.2	10.4	7.5
	2007	9.2	8.1	10.0	12.7	18.8	24.5	26.9	26.4	21.0	17.2	10.9	6.8
	Long	6.4	6.4	8.3	12.5	17.4	22.3	25.0	24.7	20.8	16.0	11.4	8.1
Minimum average temperature (°C)	2005	4.0	3.7	4.5	9.2	14.0	16.6	20.5	21.0	16.9	11.4	7.4	6.4
	2006	0.3	2.3	5.3	9.2	12.7	16.8	20.1	21.4	17.1	13.4	6.9	4.4
	2007	6.0	5.6	7.0	7.5	14.5	19.1	21.6	21.3	16.2	13.8	8.4	4.5
	Long	3.3	3.3	4.8	8.6	12.9	17.0	19.6	19.6	16.0	12.1	8.1	5.1
Total rainfall (mm)	2005	90.1	143.5	27.3	7.7	73.2	4.9	32.7	0.2	12.9	46.8	218.8	71.3
	2006	53.2	84.7	124.0	3.8	16.7	23.0	8.2	1.2	70.6	38.0	33.9	25.6
	2007	30.2	48.4	151.5	18.1	44.7	35.2	-	0.1	3.2	61.5	140.8	54.1
	Long	86.8	62.7	66.5	48.2	34.2	21.3	12.7	4.0	18.3	46.0	93.2	101.8

Long year's data was between the years of 1975 - 2007.

Table 2. Analysis of variance for grain yield and yield-related traits over two years.

Source	DF	Mean square							
		GY	PH	HI	GW	SL	NS	NGS	GWS
Genotype (G)	13	10161.5***	536.4***	61.0***	87.7***	17.2***	8.8***	34.8***	0.1***
Year (Y)	1	118778.4***	5234.5***	32.7***	805.4***	1.7*	95.4***	52.0***	0.6***
G X Y	13	11029.7***	20.6***	3.2	20.0***	1.1**	1.9**	9.2**	0.03***

GY = Grain yield, PH = Plant height, HI = Harvest index, GW = 1000 grain weight, SL = Spike length, NS = Number of spikelets, NGS = Number of grains per spike, and GWS = Grain weight per spike.
*, ** and *** indicate the significance at 5, 1, and 0.1 %, respectively.

year was 378.2 kg da^{-1}; it is lower than the second year (453.4 kg da^{-1}). This reduction in grain yield as well as all agronomic properties of the varieties investigated was due to rainfall shortage and extended dry period which occurred throughout anthesis and seed development during the first

Table 3. GY, PH, HI and GW of the varieties studied.

Variety	GY (kg da^{-1})			PH (cm)			HI (%)			GW (g)		
	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean
Joseph	510.6a*	440.4efg	475.5a	90.1cd	107.8b	99.0bc	42.3a	40.7bcd	41.5b	37.9ef	36.8f	37.4de
Dumbrava	411.4c	503.2abc	457.3b	93.1ab	110.5ab	101.8a	32.9d	36.8gh	34.9ef	46.5a	49.1ab	47.8a
Trivale	387.9ef	525.2a	456.5b	90.4bcd	113.1a	101.8a	37.9b	38.0fg	38.0c	37.0fg	44.7cd	40.9c
Gönen	398.7cde	510.2ab	454.4b	73.2h	82.9f	78.1i	41.5a	43.4a	42.5ab	37.5ef	44.1cde	40.8c
Apullum	477.1b	400.8h	439.0c	89.3de	107.8b	98.6c	34.0cd	35.6h	34.8ef	33.5j	36.9f	35.2f
Boema	415.2c	460.0de	437.6c	77.2g	92.2d	84.7fg	41.1a	40.6bcd	41.0b	35.8gh	41.1e	38.5d
Saqittario	389.8def	449.0e	419.4d	71.8h	85.5ef	78.6i	41.2a	42.1abc	41.7b	40.9bc	48.9ab	44.9b
Ardeal	408.6cd	416.3gh	412.4de	86.9e	97.4c	92.2d	37.3b	39.4def	38.3c	34.7hij	36.5f	35.6f
Gabriela	338.8g	483.7cd	411.2de	82.7f	94.4cd	88.5e	33.5d	34.9h	34.2f	34.3ij	42.7de	38.5d
Fundulea	309.9h	488.4bc	399.1e	74.1h	88.6e	81.3h	37.1b	40.2cde	38.7c	35.7ghi	46.9bc	41.3c
Simnic	373.7f	421.9fgh	397.8e	94.3a	112.2a	103.3a	35.2bcd	36.8gh	36.0de	38.8de	45.4cd	42.1c
Crina	292.0h	446.1ef	369.1f	78.8g	92.9d	85.9f	36.3bc	38.5efg	37.4cd	30.7k	42.7de	36.7ef
Eliva	249.1i	447.2e	348.2g	72.7h	92.8d	82.8gh	43.7a	43.9a	43.8a	39.5cd	44.6cd	42.1c
Turda	332.3g	355.7i	344.0g	92.5abc	109.8ab	101.2ab	41.4a	42.5ab	42.0b	41.1b	50.3a	45.7b
Mean	378.2	453.4	415.8	83.4	99.2	91.3	38.3	39.5	38.9	37.4	43.6	40.5
C.V.%	3.09	3.29	3.18	2.07	2.17	2.37	4.22	3.16	3.70	2.39	4.29	3.61
$LSD_{0.05}$	19.60	25.05	15.29	2.90	3.61	2.50	2.71	2.10	1.67	1.50	3.14	1.69

GY = Grain yield, PH = Plant height, HI = Harvest index, and GW = 1000 grain weight.
*Means shown by the same letter are not significantly different.

year. The fluctuations in wheat production, typical of the Mediterranean climate, are mainly due to year to year variations in precipitation and heat and consequently drought stress. In second year of the study, all varieties gave high grain yield except for Joseph and Apullum varieties in comparison of the first year. These could be owing to the fact that average temperatures in 2007 was higher than those in 2006 for January, February, March, May and June. These two varieties may be more sensitive to high temperatures compared to the remaining. Both genotype and environment significantly influenced yield and yield components in this present investigation. The cultivars employed in the study exhibited a wide range of variation with respect to spike-related characters as well. Yield and yield components of wheat are influenced by several factors such as water stress (Hassan et al., 1987; Ozturk and Aydin, 2004), cultivar (Tayyar, 2005; Tayyar and Gül, 2008; Yağbasanlar et al., 1997; Yağdi, 2000), planting date (Akkaya and Akten, 1989; Akdamar et al., 2002; Gençtan and Sağlam, 1987; Gomez-Macpherson and Richards, 1995; Ozturk et al., 2006), seeding rate (Beuerlein and Lafever, 1989; Ellen, 1987), tillage (Douglas et al., 1994; Alp, 2007), fertilization (Guarda et al., 2004; Sowers et al., 1994; Soylu et al., 2007), vernalization (Massle et al., 1989), biotic stresses (Brakke, 1987; McIntosh, 1998; Singh et al., 1994), and causing high significant GxE associations (Reynolds et al., 2002; Vargas et al., 1998 and 1999).

Various investigations were undertaken to examine grain yield and yield components of bread wheat in different parts of Turkey, and different results were obtained by several researchers. For example, Aydın et al. (2005) found that grain yield, plant height, hectoliter weight and 1000 kernel weight were 509.2 - 299.6 kg da^{-1}, 95.6-68.1 cm, 75.4 - 69.9 kg and 37.2 - 27.4 g, respectively. In a four-year research carried out by

Table 4. SL, NS, NGS and GWS of the varieties studied.

Variety	SL (cm)			NS (number)			NGS (number)			GWS (g)		
	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean	1st year	2nd year	Mean
Joseph	13.5cd*	13.7fg	13.6de	14.8fg	18.7bcd	16.8def	36.9d	38.7c-f	37.8cde	1.31de	1.38efg	1.35fgh
Dumbrava	17.2a	15.6ab	16.4a	15.5d-g	16.3ef	15.9fgh	35.9de	36.8fg	36.4de	1.74a	1.73ab	1.73a
Trivale	15.1b	14.9b-e	15.0b	16.3b-e	17.8cde	17.1de	39.8bc	41.6abc	40.8b	1.43bc	1.60a-d	1.52cd
Gönen	8.4f	9.9h	9.2g	14.7fg	15.9f	15.3h	38.4cd	41.1a-d	39.7bc	1.36cd	1.66abc	1.51cd
Apullum	14.3bc	15.2abc	14.8bc	17.6a	21.0a	19.3a	40.3bc	41.3abc	40.8b	1.29de	1.28g	1.29gh
Boema	14.2bcd	14.1d-g	14.2cd	15.2d-g	17.0ef	16.1e-h	39.6bc	39.3b-f	39.5bc	1.33cde	1.55c-f	1.44def
Saqittario	12.2e	13.5fg	12.9f	14.4g	17.0ef	15.7gh	33.3e	40.6a-e	37.0de	1.32cde	1.73ab	1.53bcd
Ardeal	14.5bc	16.1a	15.3b	17.6ab	20.4a	19.0ab	40.5bc	42.2ab	41.3ab	1.23e	1.27g	1.25h
Gabriela	14.5bc	13.9efg	14.2cd	17.1abc	17.2def	17.2cd	43.4a	43.2a	43.3a	1.49b	1.76a	1.63b
Fundulea	13.5cd	13.8fg	13.7de	15.9c-f	18.8bc	17.3cd	33.9e	37.5efg	35.7e	1.24e	1.56b-e	1.40ef
Simnic	15.1b	15.3abc	15.2b	16.2cde	17.1ef	16.7d-g	36.9d	34.7g	35.8e	1.49b	1.47def	1.48cde
Crina	13.2de	13.2g	13.2ef	15.1efg	16.9ef	16.0fgh	41.4ab	39.2b-f	40.3b	1.29de	1.38fg	1.33fgh
Eliva	13.7cd	14.3c-f	14.0cd	14.4g	17.2def	15.8gh	36.9d	39.3b-f	38.1cd	1.37cd	1.41efg	1.39efg
Turda	15.1b	14.9bcd	15.0b	16.5a-d	19.6ab	18.0bc	34.0e	37.9d-g	36.0e	1.39bcd	1.75a	1.57bc
Mean	13.9	14.2	14.0	15.8	17.9	16.9	38.0	39.5	38.7	1.38	1.54	1.46
C.V.%	4.62	4.23	4.58	4.66	5.10	4.94	4.07	5.13	4.72	5.11	6.95	6.23
$LSD_{0.05}$	1.08	1.01	0.74	1.24	1.54	0.97	2.59	3.40	2.12	0.12	0.18	0.11

SL = Spike length, NS = Number of spikelets, NGS = Number of grains per spike, and GWS = Grain weight per spike.
*Means shown by the same letter are not significantly different.

Yağdı (2000), grain yield (608.9 - 484.6 kg da^{-1}), plant height (104.63 - 74.26 cm), number of grain per spike (36.04 - 29.31 number), grain weight per spike (1.43 - 1.17 g), 1000 kernel weight (43.64 - 33.05 g) and hectoliter weight (81.93 - 79.20 kg) were assessed. In another study with 12 varieties, grain yield (614.2 - 406.5 kg da^{-1}), plant height (112.4 - 71.7 cm), spike length (15.02 - 8.50 cm), number of spikelets (16.62 - 12.85), number of grain per spike (49.28 - 28.87), grain weight per spike (1.84 - 1.29 g), harvest index (46.8 - 30.9%) and 1000 grain weight (44.9 - 31.3 g) were investigated (Tayyar and Gül, 2008). Egesel et al. (2007) cultivated 4 lines and 15 varieties for 3 years and determined significant variations in grain yield and agronomic traits such as grain yield (460.1 -276.5 kg da^{-1}), plant height (98.3 - 59.4 cm), spike length (9.1 - 7.3 cm), number of spikelets (17.4 - 15.3) and number of grain per spike (46.9 - 32.0).

A number of studies were carried out to determine the association between yield and yield components of wheat, and considerable variability has been documented. In the present investigation, the grain yield was positively and significantly correlated with PH, GWS, GW and NGS, but not with SL, NS and HI. In some previous reports, correlations between grain yield with NGS, GWS and GW (Dokuyucu et al., 1997; Bruckner and Frohberg, 1987), with GW (Tahir et al., 2006), with GWS (Bilgin and Korkut, 2005), with NGS and GW (Baalbaki and Copeland, 1997) and with NGS (Sönmez et al., 1999) are in agreement with the present study. In a study with triticale conducted by Furan et al. (2005), grain yield was highly positive correlated with PH and GW, which is similar with this present research. However, a study by Egesel et al. (2007) showed that the grain yield was significantly correlated with HI positively and SL negatively.

In conclusion, the data of the research, based on a two-year trial, showed that new Romanian bread wheat varieties introduced into the country

Table 5. Correlations between grain yield and yield components.

Traits	Year	GY	PH	SL	NS	NGS	GWS	HI
PH	2006	0.427**						
	2007	-0.251	-					
	Mean	0.416***						
SL	2006	0.023	0.652***					
	2007	-0.395**	0.616***	-				
	Mean	-0.060	0.524***					
NS	2006	0.172	0.474**	0.392**				
	2007	-0.577***	0.315*	0.443**	-			
	Mean	0.200	0.610***	0.372***				
NGS	2006	0.078	0.094	0.032	0.274	-		
	2007	0.145	-0.236	-0.082	0.184			
	Mean	0.220*	0.103	0.006	0.321**			
GWS	2006	0.004	0.413**	0.450**	0.020	0.007		
	2007	0.312*	-0.072	-0.223	-0.349*	0.098	-	
	Mean	0.345**	0.354**	0.123	0.100	0.159		
HI	2006	-0.066	-0.421**	-0.462**	-0.501**	-0.378*	-0.359*	
	2007	-0.075	-0.460**	-0.411**	-0.170	-0.113	0.028	-
	Mean	0.041	-0.208*	-0.419***	-0.144	-0.208	-0.055	
GW	2006	0.068	0.209	0.261	-0.290	-0.607***	0.580***	0.153
	2007	0.153	-0.044	-0.071	-0.394*	-0.351*	0.656***	0.248
	Mean	0.388***	0.411***	0.126	0.117	-0.220*	0.713***	0.262*

GY = Grain yield, PH = Plant height, HI = Harvest index, GW = 1000 grain weight, SL = Spike length, NS = Number of spikelets, NGS = Number of grains per spike, and GWS = Grain weight per spike.
*, ** and *** indicate the significance at 5, 1, and 0.1%, respectively.

could be successfully cultivated under the experimental conditions. Of the introduced plant materials, the variety Joseph followed by the varieties, Dumbrava and Trivale, gave a higher grain yield than the local varieties. These three new varieties were also superior to the local varieties as regards to the plant heights, which is an important character in respect of obtaining more biomass for feeding animals during winter. The development of high yield cultivars, which respond to improved agricultural practices in accordance with national and international research centers and other public and private establishments, has had a major contributor to world food production. The results also underline the need to pursue a further research on variations of the quality and technological performances of introduced wheat materials.

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