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Evaluating Yield And Yield Components Of Pure Lines Selected From Bread Wheat Landraces Comparatively Along With Registered Wheat Cultivars In Canakkale Ecological Conditions

[a]Onur Hocaoğlu*, [a]Mevlüt AKÇURA
[a]Department of Field Crops, Faculty of Agriculture, University of Canakkale Onsekiz Mart, Canakkale, Turkey
*Corresponding author: onurhocaoglu@gmail.com

Abstract

In this study, 49 advanced lines from local bread wheat landraces that are originated from Denizli, Edirne, Kahramanmaraş and Konya regions of Turkey are compared with 7 selected cultivars regarding to their yields and yield components. Trial is analyzed according to the incomplete block design lattice with two replications with ANOVA and are conducted at Dardanos Agricultural Experimental Station, Çanakkale Onsekiz Mart University, during 2011-2012 growing season. Means are separated by Duncan's Multiply Range Test and genotype differences are evaluated. Generally and individually, some local bread wheat landrace pure lines are tended to have lesser grain yield, 1000 grain weight, harvest index, grain weight per spike and grain number per spike comparing to the present cultivars while exceeding them over protein content, plant length, number of spikets per spike, lenght of uppermost internode, biomass and spike length. Due to these results, promising wheat landraces that are superior by their grain yield and yield components are chosen as genetic resources to be used in the following bread wheat breeding programs.

Keywords: Lines of Bread Wheat Landraces, Çanakkale, Grain Yield, Yield Components

Çanakkale Ekolojik Koşullarında Yerel Ekmeklik Buğdaylardan Seçilen Saf Hatların Tescilli Çeşitlerle Verim Ve Verim Unsurları Bakımından Karşılaştırılması

Özet

Bu çalışmada 2011–2012 yetiştiricilik döneminde Türkiye'nin Denizli, Edirne, Kahramanmaraş ve Konya illerinden toplanmış yerel buğday çeşitlerinden seçilmiş 49 adet yerel buğday hattı ile 7 tescilli ekmeklik buğday çeşidi tane verimleri ve verim unsurları bakımından karşılaştırılmıştır. ÇOMÜ Dardanos Yerleşkesinde eksik bloklar deneme desinine göre iki tekerrürlü olarak kurulan denemeden elde edilen veriler, varyans analizi yapılarak duncan gruplarının oluşturulmasıyla değerlendirilmiştir. Bazı yerel buğday hatlarının tane verimi, bintane ağırlığı, hasat indeksi, başakta tane ağırlığı ile başakta tane verimi özelliklerinde tescilli çeşitlerin arkasında kaldığı, bitki boyu, üst boğum arası uzunluğu, başak uzunluğu, biyolojik verim ve başakta başakçık sayısı gibi verim unsurları ile protein oranı bakımından tescilli çeşitlerin bazılarını geçtiği belirlenmiştir. Çalışma sonucunda, tane verimi ve verim unsurları yönünden üstün olan yerel ekmeklik buğday hatları ileriki yıllarda yapılacak ıslah çalışmalarında genetik kaynak olarak kullanılmak üzere seçilmiştir.

Anahtar Kelimeler: Yerel Ekmeklik Buğday Çeşitleri, Çanakkale, Tane Verimi, Verim unsurları.

Introduction

Wheat landraces are mainly preferred for local bakery products (Bardsley and Thomas, 2005) among other reasons. Wheat landraces are blend populations containing a broad spectrum of wheat genotypes, which is why they used to tolerate extreme conditions and diseases better (Harlan, 1972). Additionally, lines derived from these populations are a variation source for plant breeding programs; in that case a proper selection method is important (Frankel 1977, Gollin et al., 2000).

Natural selection and long years of domestication inevitably narrowed rich genetic variation of wild wheat races. Wheat were being cultivated into landrace populations, whose will be subjected to plant breeding efforts of 19th century to ultimately evolve into modern wheat varieties.

(Dotlacil et al. 2002). Abundant cultivation of these varieties replaced landrace populations, narrowing wheat gene pool a second time (Reif et al, 2005), therefore endangering their genetic variation to be lost (Karagöz 2014).

Anatolia flora shows a great variability for wheat landraces (Harlan 1981, Zencirci and Kün 1996, Dokuyucu et al. 2004, Bardsley and Thomas 2005, Zencirci and Karagöz 2005, ve Akçura 2006) and believed to be located into wheat's center of origin. Along many other studies aimed to investigate, some studies are aimed to collect, classify and study these valuable gene resources (Gökgöl 1939, Zhukovskyi et al., 1951). First and the most comprehensive Turkish book written on wheat landrace systematics was "Türkiye Buğdayları II" by Dr. Mirza Gökgöl, published in 1939. In his work, Gökgöl examined ecotypes and taxonomy of Turkish wheat landraces and he underlined the importance of the variety concept – which was unusual at that time.

Bread wheat landraces have reported to have high variability in their populations several times (Dreisigacker et al. 2005, Tahir et al. 1996, Barcaccia et al. 2001) and may be used to improve grain yield, yield stability and disease resistance (Warburton ve ark., 2006). This potential of Turkish landraces are also a subject which is generally agreed upon (Zencirci, 1995; Karagöz and Zencirci 2005; Akçura and Topal 2006) and opportunities to exploit this variation are investigated (Balfourier et al. 2007, Akçura and Topal, 2008, Bilgin 2009).
In this study, 49 advanced lines from local bread wheat landraces are compared with 7 varieties by their yield and yield components. Results are evaluated and potential usages of our landrace materials are discussed.

Materials and Methods

This study is derived from a master thesis published in 2011 and observations are made on multi location trials conducted for 111O255 no. Tubitak Project in Çanakkale conditions 2011 - 2012 season. 49 advanced lines are derived from bread wheat landrace genotypes which had collected earlier from different regions of Turkey (Table 1), examined and compared with 7 commercial varieties by their yield and yield components.

Table 1. Material list

No	Collected Province	Local Name	G.B Registeration No	Selection	No	Collected Province	Local Name	G.B Registeration No	Selection
1	Denizli	Sarı buğday	TR-52859	7.Bitki	30	Konya	Kırmızı buğday	Doğanhisar-45	24.bitki
2	Denizli	Polatlı buğdayı	TR 52863	5. Bitki	31	Konya	Buğday	Doğanhisar-46	20.bitki
3	Edirne		TR 33419	2. Bitki	32	Konya	Göremez	Seydişehir-47	3.bitki
4	Edirne		TR 33257	3. Bitki	33	Konya	Göremez	Seydişehir-48	4.bitki
5	K.Maraş	Beyaz buğday	M-396	6. Bitki	34	Konya	Karabuğday	Seydişehir-5	15.bitki
6	K.Maraş	Beyaz buğday	M-397	6. Bitki	35	Konya	Kamçı	Derebucak-6	12.bitki
7	K.Maraş		TR 32009	1. Bitki	36	Konya	Karabuğday	Seydişehir-7	16.bitki
8	Konya	Kamçı	Doğanhisar-22	13.bitki	37	Konya	Karabuğday	Seydişehir-8	22.bitki
9	Konya	Kamçı	Doğanhisar-23	13.bitki	38	Konya	Karabuğday	Seydişehir-9	23.bitki
10	Konya	Kamçı	Doğanhisar-24	21.bitki	39	Kütahya	Kobak buğdayı	TR 55146	4. Bitki
11	Konya	Sarı buğday	Doğanhisar-26	16.bitki	40	Kütahya	Akçalıbasan	TR 55212	2. Bitki
12	Konya	Beyaz Kelle	Doğanhisar-28	1.bitki	41	Kütahya	Gulümbür	TR 55143	5. Bitki
13	Konya	Beyaz Kelle	Doğanhisar-29	3.bitki	42	Kütahya	Ak buğday	TR 55174	5. Bitki
14	Konya	Morbuğday	Seydişehir-3	18.bitki	43	Kütahya	Akçalıbasan	TR 55167	2. Bitki
15	Konya	Beyaz Kelle	Doğanhisar-30	10.bitki	44	Kütahya	Sümter	TR 55141	2. Bitki
16	Konya	Beyaz Kelle	Doğanhisar-32	20.bitki	45	Kütahya	Kobak buğdayı	TR 55144	5. Bitki
17	Konya	Sert buğday	Doğanhisar-33	13.bitki	46	Kütahya	Delihüseyin buğdayı	TR 55166	6. Bitki
18	Konya	Sert buğday	Doğanhisar-34	11.bitki	47	Kütahya	Kobak buğdayı	TR 55138	5. Bitki
19	Konya	Akbaş	Akşehir-35	14.bitki	48	Tokat	Yerli buğday	TR 55001	5. Bitki
20	Konya	Akbaş	Akşehir-36	18.bitki	49	Tokat	Yerli buğday	TR 55001	3. Bitki

21 Konya	Akbaş	Akşehir-37	22.bitki		**Varieties**	**Year of Registration**	**Institution**
22 Konya	Kırmızı buğday	Akşehir-38	15.bitki	50	Gelibolu	2005	TTAE-Edirne
23 Konya	Kırmızı buğday	Akşehir-39	23.bitki	51	Flamura-85	1999	TAREKS
24 Konya	Morbuğday	Seydişehir-4	24.bitki	52	Konya-2002	2002	BDUTAE-Konya
25 Konya	Kırmızı buğday	Akşehir-40	2.bitki	53	Tekirdağ	2005	TTAE-Edirne
26 Konya	Kırmızı buğday	Akşehir-41	3.bitki	54	Sönmez-2001	2001	ATAE-Eskişehir
27 Konya	Dede buğday	Doğanhisar-43	16.bitki	55	Kate A-1	1984	TTAE-Edirne
28 Konya	Dede buğday	Doğanhisar-44	20.bitki	56	Aldane	2009	TTAE - Edirne
29 Konya	Kırmızı buğday	Doğanhisar-44	19.bitki				

Climate and Soil Properties

Soil analyses (Table 2) shows that experiment area soil is loamy, low on organic matter content, slightly alkaline and calcareous. Area properties are generally proper for wheat cultivation.

Climate data of 2011 – 2012 growing season in Çanakkale Dardanos Agricultural Experimental Station are given in Table 3. Total amount of precipitation in 2011 – 2012 (455 mm) is visibly lower than long years average (533.2 mm). Contrarily, monthly averages of December, February, April and May of trial season were reported higher.

Trials are conducted in ÇOMÜ Çanakkale Dardanos Agricultural Experimental Station in lattice design with 49 incomplete plots each with 2 replicates. Materials are sowed by a hand marker in 2 November 2011 when appropriate soil moisture, precipitation period and air temperature is observed. Plots contained 6 rows of plants with 20 cm space between. Sowing rate was fixed in 550 plants / m^2 and each plot is fitted 0.8 m wide and 2 m long (1.6 m^2).

2.7 kg/da N fertilizer (Ammonium Nitrate) with 6.9 kg/da P in (Diammonium phosphate) is applied with sowing, which was followed by 4.3 kg/da N topdress of ammonium nitrate right after tillering. Weed control is carried out by hand. Days to heading were observed as the difference between sowing date and %50 head emergence. Plant length and length of the uppermost internode was measured along with heading when other parameters such as grain yield, 1000 kernel weight, harvest index, biomass, spike length, weight per spike, number of spikelets per spike, grain number per spike and protein content were measured after the harvest. Spike parameters, 1000 kernel weight and protein content were obtained by measuring 10 spike samples per each plot when biomass, harvest index and grain yield are measured directly from harvested plots. Observed values are multiplied into kg or kg/da before statistical analysis. Dumas method with LECO protein analysis device used to obtain protein content values (Etheridge et al. 1998).

Experiments are analyzed using GLM procedure of SAS 9.0 (SAS Institute, 1999). Materials are evaluated by grouping due to results of Duncan's Multiple Range Test and relations between variables were investigated with Pearson’s correlation test.

Table 2. Soil Analyses

Property (Analyse Method)	Value	Evaluation
Saturation (1:2,5) (%)	53	Loamy
Salinity (ECMeter)% Salt	0.03	Low
pH (pHmeter)	7.9	Slightly Alkaline
Lime (Calsimetric) (%)	4.73	Medium
Organic Matter (Walkley Black) (%)	1	Low
Phosporus (Olsen-Spektro) (kg/da)	2.4	Low
Potasium (A.Asetate-AAS) (kg/da)	41.3	Very High
Iron (DTPA-AAS) (ppm)	3.12	Low
Copper (DTPA-AAS) (ppm)	1	Medium
Mangan (DTPA-AAS) (ppm)	2.36	Medium
Zinc (DTPA-AAS) (ppm)	4.08	Medium

Table 3. Çanakkale Climate Data (Anonymous, 2013)

2011-2012 Growing Season			Long Years Average(1960-2012)	
Month	Average Tempera ture (^{O}C)	Precipitation (mm)	Average Temperature (^{O}C)	Precipitat ion (mm)
Nov.	7.38	8.40	11.90	83.50
Dec.	8.29	143.60	8.40	115.70
Jan.	3.78	77.20	6.20	85.50
Feb.	2.95	77.40	6.50	70.40
Mar.	6.95	26.00	8.30	64.90
Apr.	13.65	58.40	12.50	47.00
May	17.32	61.00	17.50	33.00
June	23.01	3.00	22.40	21.10
July	26.76	0	25.00	12.10
Total	110.09	455	118.7	533.2

Results and Discussion

Days to Heading

Results showed no significant differences between replicates in terms of days to heading, therefore evaluations are made without a variance of analysis. Averages of all genotypes are observed 122.51 days when the averages of landrace lines are 127.35 days and varieties 87.71 days. Even though there is not enough variation between replicates to investigate days to heading any further, it is safe to say that landrace lines number 3, 16, 17, 22, 28, 35, 44, 47 and 49 developed ears latest with 132.0 days in average, when 2 is the earliest among landrace pure lines with 112.0 days. All varieties are observed to generally develop ears earlier than landrace lines similar to the results of Moghaddam et al. (1997) and Akçura (2006). Kate A-1, Gelibolu and Aldane are noted to be the earliest of all genotypes. Akçura (2006) suggested that pure lines delivered from landraces have longer vegetation comparing to commercial varieties, which may explain this phenomenon. In terms of potentials for breeding, 2 and 6 may be used in a breeding program for their earliness characteristics.

Plant length and Length of the uppermost internode (LUN)

Results shows that differences between genotypes for their lengths of the uppermost internodes (LUN) and plant lengths were statistically different (P<0.01). All genotype LUN averages were found 43.03 cm when landrace lines and variety averages are found 44.21 cm and 34.78 cm, respectively. This indicates that average LUN of varieties were significantly lower than the average of all genotypes. Individually, genotype no. 10 had the longest LUN (53.75 cm) when Aldane variety had the shortest (27.50 cm).

Top three Duncan groups for LUN were all consisted of landrace genotypes which indicate a clear distinction between landraces and varieties. Genotypes with highest LUN are 10, 8, 9 and 25 no. landrace lines. Commercial varieties took place in middle and low Duncan groups, which is consistent with Akçura (2006).

Plant length average of the experiment is found 106.67 cm when landrace averages are higher (109.47 cm) and variety average is significantly lower (87.93 cm). Plant length differed between 125.00 cm (Genotype no. 8) and 81.00 cm (Flamura – 85).

Duncan's Multiple Range test results for plant length showed that top three groups were consisted of landrace pure lines only just as LUN (highly correlated, r = 0.722), which is consisting with plant length results of Moghaddam et al. (1997), Akçura (2006) and Bordes et al. (2008).

Spike Parameters

Differences between genotypes for all spike parameters were found statistically important (P<0.01). Spike length were significantly higher for landrace genotypes when varieties showed better performance for number of spikelets per spike, Grains per spike and grain weight per spike, which in case may be associated with varieties having higher yield and 1000 kernel weight values comparatively.

Spike Length differed from 12.6 cm with genotype no. 40 to 5.18 cm with genotype no. 5; when genotype, landrace lines and varieties average were 8.81 cm, 8.66 cm and 9.85 cm respectively.

Table 4. Plant Length and Length of the Uppermost Node (LUN) of Genotypes with corresponding Duncan groups

No	LUN		Plant Length		No	LUN		Plant Length	
1	42.50	A-E	108.75	A-G	30	46.00	A-D	113.25	A-F
2	39.50	A-E	102.00	A-G	31	47.00	A-D	100.25	A-G
3	46.50	A-D	116.25	A-E	32	44.75	A-E	112.75	A-G
4	49.50	A-D	119.25	A-C	33	43.75	A-E	107.00	A-G
5	39.50	A-E	99.25	A-G	34	34.50	B-E	93.75	A-G
6	40.25	A-E	101.75	A-G	35	44.00	A-E	105.00	A-G
7	38.25	A-E	112.75	A-G	36	42.75	A-E	114.00	A-F
8	52.00	A-B	125.00	A	37	45.75	A-D	115.00	A-F
9	51.75	A-B	121.00	A-B	38	46.25	A-D	120.25	A-C
10	53.75	A	120.00	A-C	39	41.25	A-E	95.75	A-G
11	44.00	A-E	113.00	A-F	40	39.00	A-E	104.25	A-G
12	47.50	A-D	115.00	A-F	41	38.00	A-E	98.00	A-G
13	47.75	A-D	123.25	A	42	47.50	A-D	108.75	A-G
14	45.75	A-D	114.75	A-F	43	41.00	A-E	100.50	A-G
15	44.50	A-E	105.25	A-G	44	38.00	A-E	98.00	A-G
16	45.50	A-D	105.75	A-G	45	38.75	A-E	96.00	A-G
17	47.75	A-D	120.00	A-C	46	41.50	A-E	105.00	A-G
18	48.75	A-D	119.25	A-C	47	43.25	A-E	100.00	A-G
19	47.50	A-D	109.75	A-G	48	48.75	A-D	111.00	A-G
20	44.50	A-E	110.25	A-G	49	41.50	A-E	106.00	A-G
21	49.75	A-D	117.50	A-D	*Landrace Avr.*	44.21		109.47	
22	42.50	A-E	107.00	A-G	Varieties				
23	42.75	A-E	105.25	A-G	Gelibolu	35.75	B-E	87.00	D-G
24	33.50	D-E	107.00	A-G	Flamura - 85	42.75	A-E	81.00	G
25	51.25	A-C	119.75	A-C	Konya - 2002	32.50	D-E	91.00	B-G
26	46.00	A-D	112.00	A-G	Tekirdağ	36.50	A-E	88.75	C-G
27	45.25	A-D	115.25	A-F	Sönmez - 2001	34.00	C-E	94.50	A-G
28	40.00	A-E	105.25	A-G	Kate A-1	34.50	B-E	84.25	E-G
29	45.25	A-D	108.50	A-G	Aldane	27.50	E	83.25	F-G
Total Avr.	43.04		106.67		Varieties Avr.	34.79		87.63	

Landrace lines separated from varieties with their spike length, just as Akçura (2006), Dotlacil et al. (2003) and Karagöz and Zencirci (2005) reported. Karagöz and Zencirci (2005) also reported a positive relation with grain yield and spike length which is not apparent in our data (Table 8).

Averages of all genotypes for spikelets per spike were found 17.60 when landrace averages were 17.40 and varieties averages were 18.98. Even though variety averages were higher than all genotypes, no clear segregation between landrace lines and varieties are identified. Highest number of spikelets per spike is found on genotype no. 23 (20.44 cm) when lowest is found in no. 32 (13.85 cm).

Duncan groups for spikelets per spike are shown in Table 5. Genotypes no. 23, 34 and 9 were the top three of all experiment. First three and several bottom duncan groups were mainly consist of landrace lines when varieties seemed to stack in middle groups, showing only little variation from each other. This pattern is hard to explain, but it could be interpreted by landrace genotypes showing remarkable variation for their spikelet numbers per spike (compatible with Moghaddam et. al. 1997) therefore having potential to be exploited in breeding programs.

Number of grains per spike (GNS) showed a distinctive bias towards varieties. Variety average were significantly higher (41.15) than both genotype (31.56) and landrace pure lines. These results also supports relationship we report on 1000 kernel weight and yield. Aldane has the highest number of grains per spike in the experiment by 49.95 when genotype no. 44 had the least by 19.20. Duncan test apparently reflects this bias towards varieties, and genotype no. 2 were along with Aldane, Sönmez - 2001 and

Table 5. Spike Length (SL), Number of Spikelets per Spike (NSS), Grain Numbers per Spike (GNS) and Grain weight per Spike (GWS) of genotypes.

No	SL (cm)	NSS	GNS	GWS	No	SL (cm)	NSS	GNS	GWS (g)
1	11.27 F-E	16.50 I-B	25.00 D-F	1.24 E-J	30	10.30 J-M	16.65 I-B	26.95 D-F	1.31 E-J
2	10.11 L-M	17.65 H-A	47.35 A-B	1.86 C-F	31	8.72 T-S	13.95 I-H	25.25 D-F	1.39 E-J
3	12.22 B	17.35 I-A	29.05 C-F	1.51 D-I	32	10.57 H-K	13.85 I	26.85 D-F	1.38 E-J
4	10.25 K-M	16.10 I-C	29.40 B-F	1.58 D-I	33	6.62 Y-Z	19.05 F-A	34.60 A-F	1.40 E-J
5	5.18 EE	17.21 I-A	35.26 A-F	1.25 E-J	34	6.47 Z-AA	20.00 B-A	37.90 A-E	1.48 E-J
6	8.40 T-U	17.05 I-A	35.25 A-F	1.53 D-I	35	10.32 J-M	17.70 G-A	31.65 B-F	1.08 J-F
7	12.00 B-C	18.15 G-A	29.35 B-F	1.24 E-J	36	6.22 AA-BB	16.00 I-D	28.05 D-F	1.44 E-J
8	10.67 G-J	16.65 I-B	27.10 D-F	1.38 E-J	37	6.94 V-Y	18.28 G-A	37.55 A-F	1.82 C-G
9	6.70 X-Z	20.00 B-A	34.95 A-F	1.73 C-H	38	6.47 Z-AA	16.85 I-A	26.50 D-F	1.21 E-J
10	10.00 M-N	16.93 I-A	26.40 D-F	1.16 E-J	39	7.15 V-W	17.50 I-A	30.40 B-F	1.55 D-I
11	10.60 H-K	18.00 G-A	26.90 D-F	1.01 G-J	40	12.60 A	19.35 E-A	34.75 A-F	1.69 C-H
12	9.67 N-P	15.50 I-F	26.50 D-F	1.19 E-J	41	11.02 F-G	18.00 G-A	30.05 B-F	1.46 E-J
13	10.32 J-M	15.40 I-F	21.75 E-F	1.13 F-J	42	10.02 M-N	15.70 I-E	24.60 D-F	1.22 E-J
14	6.60 Y-AA	16.95 I-A	35.70 A-F	1.78 C-G	43	10.39 I-M	17.79 G-A	28.51 D-F	1.33 E-J
15	9.35 O-R	15.00 I-G	22.80 E-F	1.03 G-J	44	10.47 H-L	16.85 I-A	19.20 F	0.86 I-J
16	5.50 DD-EE	15.40 I-F	24.15 D-F	0.80 I-J	45	7.05 V-X	17.65 H-A	30.55 B-F	1.16 E-J
17	6.87 V-Z	18.75 G-A	33.25 A-F	1.35 E-J	46	11.45 D-E	17.00 I-A	25.35 D-F	1.34 E-J
18	6.82 W-Z	19.40 E-A	36.10 A-F	1.69 C-H	47	6.90 V-Y	17.35 I-A	31.60 B-F	1.10 F-J
19	6.90 V-Y	19.70 D-A	30.55 B-F	1.34 E-J	48	10.75 G-I	16.35 I-B	23.50 E-F	0.70 J
20	7.05 V-X	19.85 C-A	34.25 A-F	1.46 E-J	49	9.10 R	17.66 G-A	35.85 A-F	1.71 C-H
21	6.77 W-Z	19.35 E-A	27.65 D-F	1.51 D-J	Landraces Avr.	8.66	17.40	30.20	1.35
22	8.17 U	15.55 I-F	22.55 E-F	0.93 H-J	Varieties				
23	6.73 X-Z	20.44 A	36.15 A-F	1.72 C-H	Gelibolu	9.72 N-O	17.45 I-A	31.00 B-F	2.29 B-D
24	6.47 Z-AA	17.30 I-A	31.70 B-F	1.42 E-J	Flamura - 85	9.20 Q-R	19.10 F-A	30.05 B-F	1.79 C-G
25	5.70 CC-DD	18.00 G-A	32.45 A-F	1.40 E-J	Konya - 2002	10.87 G-H	19.37 E-A	38.20 A-E	1.96 C-E
26	7.27 V	17.75 G-A	30.30 B-F	1.39 E-J	Tekirdağ	9.30 P-R	18.39 G-A	47.20 A-C	2.78 A-B
27	6.05 BB-CC	18.75 G-A	37.80 A-E	1.60 D-I	Sönmez - 2001	11.75 C-D	19.70 D-A	49.80 A	2.71 A-B
28	11.67 C-D	17.75 G-A	31.40 B-F	1.28 E-J	Kate A-1	9.15 R-Q	18.80 F-A	41.90 A-D	2.43 B-C
29	9.52 O-Q	18.75 I-A	28.95 D-F	1.29 E-J	Aldane	9.00 R-S	19.75 D-A	49.95 A	3.17 A
Total Avr.	8.81	17.60	31.56	1.49	Varieties Avr.	9.85	18.98	41.55	2.45

Table 6. Biomass (kg/da) and Harvest Index averages of genotypes with corresponding Duncan groups.

No	Biomass		Harvest Index		No	Biomass		Harvest Index	
1	1184.74	A-B	27.67	E-A	30	1162.24	A-I	25.07	E-A
2	978.49	A-I	33.71	E-A	31	1197.24	A-F	22.67	E-C
3	1427.24	A	27.24	E-A	32	1172.24	A-I	29.25	E-A
4	1212.24	A-E	25.73	E-A	33	1022.24	A-I	27.22	E-A
5	1013.49	B-I	25.66	E-A	34	1049.74	A-I	21.42	E-D
6	1077.24	A-I	37.38	E-A	35	934.74	B-I	25.37	E-A
7	923.49	H-I	30.64	E-A	36	1017.24	H-I	28.18	E-A
8	969.74	B-I	24.40	E-A	37	1164.74	A-I	32.20	E-A
9	1012.24	A-I	30.91	E-A	38	1222.24	A-I	28.63	E-A
10	1062.24	B-I	29.11	E-A	39	1048.49	A-I	23.60	E-B
11	1055.99	C-I	26.54	E-A	40	1269.74	A-I	28.93	E-A
12	1162.24	A-I	23.22	E-C	41	993.49	B-I	24.77	E-A
13	1019.74	D-I	28.65	E-A	42	902.24	H-I	29.96	E-A
14	999.74	F-I	26.44	E-A	43	862.24	D-I	29.22	E-A
15	1113.49	A-G	31.26	E-A	44	843.49	B-I	24.17	E-B
16	1043.49	A-I	23.87	E-B	45	812.24	C-I	27.70	E-A
17	1248.49	A-I	26.95	E-A	46	1123.49	A-H	29.13	E-A
18	914.74	F-I	24.65	E-A	47	967.24	G-I	24.21	E-B
19	1004.74	C-I	28.07	E-A	48	973.49	A-H	24.90	E-A
20	1313.49	A-I	24.55	E-A	49	1303.49	A-D	32.84	E-A
21	1064.74	A-I	26.67	E-A	Landraces Avr.	1083.52		26.68	
22	1082.24	A-I	19.17	E	Varieties				
23	1230.99	A-C	27.79	E-A	Gelibolu	1169.74	A-I	33.98	E-A
24	1237.24	F-I	23.01	E-C	Flamura - 85	767.24	F-I	41.23	C-A
25	1198.49	A-I	26.94	E-A	Konya - 2002	1079.74	I	42.04	B-A
26	1144.74	A-I	20.73	E-D	Tekirdağ	964.74	B-I	39.46	D-A
27	1045.99	A-I	21.47	E-D	Sönmez - 2001	1037.24	C-I	36.16	E-A
28	1075.99	F-I	21.48	E-D	Kate A-1	998.49	I	41.02	C-A
29	1232.24	A-E	23.70	E-B	Aldane	842.24	C-I	42.98	A
Total Avr.	1070.56		28.28		Varieties Avr.	979.92		39.55	

Tekirdağ whose had highest number of grain per spike, respectively. Other studies about landrace lines showed similar relations (Karagöz and Zencirci 2005, Moghaddam et al 1997 and Akçura 2006). Results are compatible with the studies of Hoeser et al. (1979) and Slafer and Andrade (1989), implying that commercial varieties of today were improved by their number of grains per spike (Feil 1992) as a result of systematical breeding. Additionally, positive relationship between grain yield and GNS (Table 8) is also generally known (Yürür et al. 1981).

Grain weight per spike averages of genotypes were 1.49 g when average of landrace pure lines were 1.35 g and varieties were 2.45 g. Genotype with maximum grain weight per spike is Aldane with 3.17 g when minimum grain weight per spike value observed from genotype no. 48 with 0.70 g. Although varieties are found significantly higher on grain weight per spike than landrace lines, several landrace pure lines had relatively higher values, which is supported by studies of Dotlacil et al. (2003) and Akçura (2006).

Biomass and Harvest Index

Variance analysis for biomass and harvest index are also showed statistical importance (P<0.01). Biomass averages of landraces are found 1083.52 kg/da which exceeds both the averages of genotypes (1070.56 kg/da) and varieties (979.92 kg/da). Maximum biomass is observed in Genotype no.3 with 1427.24 when minimum was Kate A-1 variety with 767.24 kg/da.

Table 7. Grain Yield (kg/da), 1000 Kernel Weight (TKW, g) and Protein Ratio (PR, %) of genotypes and corresponding Duncan groups.

No	Grain Yield		TKW		PR		No	Grain Yield		TKW		PR	
1	325.00	K-H	45.90	B-J	12.06	A-E	30	295.00	P-I	46.80	B-G	11.73	A-E
2	336.25	J-E	46.20	B-I	12.50	A-E	31	271.25	T-M	49.60	B-E	12.37	A-E
3	388.75	D-B	49.10	B-E	12.84	A-E	32	336.25	J-E	46.50	B-H	10.37	D-E
4	312.50	N-H	48.95	B-E	14.31	A	33	277.50	S-K	37.90	L-Q	12.51	A-E
5	256.25	V-P	32.80	Q	13.65	A-B	34	223.75	X-T	37.40	M-Q	13.07	A-E
6	417.50	B-A	44.55	B-O	11.81	A-E	35	240.00	X-R	32.10	Q	13.21	A-D
7	276.25	S-L	35.00	P-Q	13.50	A-C	36	283.75	R-K	44.85	B-N	13.00	A-E
8	220.00	X-U	48.90	B-E	11.90	A-E	37	375.00	E-B	45.05	B-M	12.98	A-E
9	317.50	L-H	42.50	D-P	10.68	C-E	38	350.00	H-D	44.60	B-O	13.23	A-D
10	313.75	N-H	48.35	B-F	11.56	A-E	39	245.00	X-Q	38.00	L-Q	12.45	A-E
11	278.00	S-K	39.50	G-Q	11.97	A-E	40	366.25	E-C	43.60	C-O	11.81	A-E
12	280.00	R-K	46.00	B-J	11.59	A-E	41	247.50	X-P	50.00	B-D	12.96	A-E
13	286.25	R-K	48.95	B-E	10.87	B-E	42	268.75	T-O	46.70	B-H	11.98	A-E
14	267.50	U-O	45.70	B-L	12.18	A-E	43	251.25	X-P	49.00	B-E	11.30	B-E
15	350.00	H-D	45.85	B-K	12.62	A-E	44	203.75	X	38.25	J-Q	12.15	A-E
16	253.75	W-P	37.80	M-Q	12.02	A-E	45	225.00	X-T	35.40	P-Q	12.69	A-E
17	322.50	L-H	39.25	G-Q	11.82	A-E	46	325.00	K-H	44.10	B-O	11.23	B-E
18	218.75	X-V	42.20	D-P	12.48	A-E	47	242.50	X-R	37.05	N-Q	12.25	A-E
19	271.25	T-M	38.85	H-Q	12.75	A-E	48	242.50	X-R	36.75	O-Q	13.06	A-E
20	317.50	L-H	38.40	I-Q	12.16	A-E	49	226.00	X-T	42.30	D-P	11.07	B-E
21	277.50	S-K	38.95	G-Q	12.00	A-E	Landrace Avr.	288.83		42.31		12.33	
22	207.50	X-W	40.80	F-P	11.69	A-E	Varieties						
23	338.75	I-E	38.00	L-Q	12.38	A-E	Gelibolu	400.00	C-B	46.4	B-H	10.70	C-E
24	288.75	R-J	44.20	B-O	13.79	A-B	Flamura - 85	316.25	N-H	50.4	A-C	11.44	A-E
25	322.50	L-H	38.40	I-Q	13.19	A-D	Konya - 2002	455.00	A	50.85	A-C	10.97	B-E
26	231.25	X-S	43.80	C-O	13.35	A-C	Tekirdağ	376.25	E-B	51.2	A-C	11.36	B-E
27	220.00	X-U	39.40	G-Q	12.38	A-E	Sönmez - 2001	375.00	E-B	42.1	E-P	11.57	A-E
28	226.25	X-T	37.40	M-Q	13.19	A-D	Kate A-1	416.25	B-A	55.2	A	11.36	B-E
29	292.50	Q-I	41.80	E-P	11.54	A-E	Aldane	362.50	E-C	51.82	A-B	10.15	E
Total Avr.	296.63		43.24		12.17		Varieties Avr.	385.90		49.71		10.88	

Duncan's Multiple Range Test for biomass shows clear distinction between landrace lines and varieties just as other vegetative parameters, suggesting that landrace genotypes are more improved in a vegetative aspect. In addition to this, these results may also support Feil (1992) as plant breeding decreased biomass in wheat in a long period of time.

Contrary to biomass, harvest index averages of varieties (% 39.55) are found significantly higher than genotype (% 28.28) and landrace (% 26.68) averages. Aldane variety has the maximum harvest index with % 42.98 and followed by Konya – 2002 and Flamura – 85, when genotype no.22 has the minimum with %19.17. Top three Duncan groups are all consist of varieties, which shows an exact opposite pattern to biomass. When genotypes with higher biomass are expected to accumulate soil nitrogen better, varieties having significantly higher harvest index may be a result of their higher grain yields which can be improved with quality breeding programs (Feil 1992). There is also a positive and statistically important correlation (r=0.63) between grain yield and harvest index as expected (Sharma and Smith 1986, Sharma 1992).

Landraces usually reported to have higher biomass and lower harvest index when they are compared to varieties (Akçura 2006, Moghaddam 1997). As with longer plant length (Aktaş 2010), greater vegetative development of landrace lines may have endorsed this relation to be decisive.

Grain Yield, 1000 Kernel Weight and Protein Content

Grain Yield, 1000 Kernel Weight (TKW) and Protein Content differences of 56 genotypes are also found statistically significant (P<0.01). Total average for grain yield is found 296.63 kg/da, with a slightly lower landrace line average of 288.83 kg/da and significantly higher variety average of 385.90 kg/da. Highest grain yield is obtained from Konya 2002, Genotype no. 6 and Kate A-1 with 455 kg/da, 417.50 kg/da and 416.25 kg/da respectively; when lowest grain yield is obtained from Genotype no. 44 with 203 kg/da. Longer plant length and heavier biomass of landrace lines caused lodging to be an important problem, especially in windy Çanakkale climate. Lodging in different levels from few to severe is observed in experimental area, which would explain a certain level of grain loss. With or without lodging, higher harvest index for varieties over landraces are observed in many other cases (Akçura 2006, Moghaddam 1997), but Akçura (2006) reported some higher yielding landrace lines exceeding commercial varieties. In our study, landrace lines of Genotype no.3 and 6 are found as potentially higher yielding.

Table 8. Correlation Coefficients of Variables, N = 112, Prob > |r| under H0: Rho=0

	GY	TKW	PR	GNS	GWS	SL	NSS	PL	LUN	BIO	HI
GY		0.475**	-0.246**	0.362**	0.527**	0.222*	0.164	-0.242*	-0.266**	0.308**	0.630**
		<.0001	0.009	<.0001	<.0001	0.019	0.084	0.010	0.005	0.001	<.0001
TKW	0.475**		-0.392**	0.086	0.438**	0.315**	-0.193	-0.134	-0.056	0.031	0.415**
	<.0001		<.0001	0.366	<.0001	0.001	0.042	0.159	0.555	0.743	<.0001
PR	-0.246**	-0.392**		-0.073	-0.312**	-0.138	0.077	0.133	0.038	0.123	-0.384**
	0.009	<.0001		0.444	0.001	0.145	0.420	0.163	0.689	0.195	<.0001
GNS	0.362**	0.086	-0.073		0.795**	-0.052	0.596**	-0.387**	-0.392**	-0.052	0.472**
	<.0001	0.366	0.444		<.0001	0.588	<.0001	<.0001	<.0001	0.583	<.0001
GWS	0.527**	0.438**	-0.312**	0.795**		0.087	0.492**	-0.406**	-0.414**	-0.056	0.583**
	<.0001	<.0001	0.001	<.0001		0.359	<.0001	<.0001	<.0001	0.559	<.0001
SL	0.222	0.315**	-0.138	-0.052	0.087		-0.045	-0.133	-0.136	0.004	0.176
	0.019	0.001	0.145	0.588	0.359		0.639	0.161	0.152	0.970	0.063
NSS	0.164	-0.193*	0.077	0.596**	0.492**	-0.045		-0.186	-0.216	-0.096	0.206
	0.084	0.042	0.420	<.0001	<.0001	0.639		0.050	0.022	0.316	0.029
PL	-0.242*	-0.134	0.133	-0.387**	-0.406**	-0.133	-0.186		0.722**	0.316**	-0.380**
	0.010	0.159	0.163	<.0001	<.0001	0.161	0.050		<.0001	0.001	<.0001
LUN	-0.266*	-0.056	0.038	-0.392**	-0.414**	-0.136	-0.216	0.722**		0.191	-0.337**
	0.005	0.555	0.689	<.0001	<.0001	0.152	0.022	<.0001		0.044	0.001
BIO	0.308**	0.031	0.123	-0.052	-0.056	0.004	-0.096	0.316**	0.191*		-0.183
	0.001	0.743	0.195	0.583	0.559	0.970	0.316	0.001	0.044		0.053
HI	0.630**	0.415**	-0.384**	0.472**	0.583**	0.176	0.206*	-0.380**	-0.337**	-0.183	
	<.0001	<.0001	<.0001	<.0001	<.0001	0.063	0.029	<.0001	0.001	0.053	

*Correlation is significant at the 0.05 level; ** Correlation is significant at the 0.01 level.

Thousand Kernel Weight (TKW) averages of all genotypes were found 43.24 g. Landraces and varieties had TKW averages of 42.31 g and 49.71 g respectively. TKW varied from 55.20 g (Kate A-1) to 32.10 g (Genotype no. 35). Duncan test results indicate a higher TKW for varieties as many other studies also reported (Moghaddam et al. 1997, Akçura 2006). Landraces are mainly concentrated in between 4th and 11th Duncan groups and seemed to have shown only little variation.

On the other hand, landrace lines had remarkably higher protein content. Genotypes were statistically different in terms of their protein contents (P<0.01) and the average of landrace genotypes for their protein content were found % 12.33 when varieties and total average of all genotypes were % 10.88 and % 12.17 respectively. Genotypes with the highest protein content were genotype no. 4 with %14.31, followed by 23, 5, 7, 25, 36, 33, 24 and 27. Aldane variety had the minimum protein content among all genotypes with % 10.15. As discussed before, while as plant breeding improved genotypes to better respond higher proportions of soil N and acquire higher levels of grain yield (Feil 1992); varieties having lesser proportions of protein in their grain may be associated with their intensive carbohydrate accumulation to the grain (thereby increased TKW) and having improved grain yield. Negative correlation between grain yield and protein content is observed (r=-0.246) which is also widely known (Tuğay 1978, Aydın et al. 2005) and other studies on landraces reported similar results (Dotlacil et al 2003, Akçura 2006, Bordes et al. 2008).

Conclusion

Landrace lines did not segregate in terms of their origin locations. Landrace pure lines derived from Konya – Doğanhisar are more likely to have higher plant length and number of spikelets per spike when some landrace lines from Edirne, Denizli and Kahramanmaraş provinces have potential to be examined further by their high protein contents and biomasses.

Correlation of variables are also showed significant and positive relations between grain yield with TKW and harvest index. Protein content were negatively correlated with TKW and HI. Most significant relations are found between plant length and length of the uppermost node (r=0.722) and grain weight per spikelet with grain number per spikelet (r=0.795) which are considered casual.

Differences are observed between maximum and minimum values of many parameters, indicating a high variability between landrace pure lines. Especially for landrace lines with high protein ratio and biomass, examining sources of this variation may unveil valuable information to guide future breeding approaches.

Heavier biomass and long plant length made it difficult for landrace lines to endure weather factors that causing lodging such as wind and rain. Further studies may aim on developing landrace lines resistant to lodging that have improved grain yield and harvest index. Taking into account for increasing hay prices, lodging – resistant landraces will contribute breeding new varieties with improved hay yield, therefore making wheat farming more profitable for farmers. In addition to their improved vegetative attributes, high protein content of landrace genotypes also implies a potential for quality breeding programs, giving us another angle to discuss the value of landraces in future plant breeding programs.

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