AcademicPres

Available online at www.notulaebotanicae.ro

Print ISSN 0255-965X; Electronic 1842-4309

Not. Bot. Hort. Agrobot. Cluj 38 (3) 2010, 135-139

Notulae Botanicae Horti Agrobotanici Cluj-Napoca

Evaluation of the Agronomical and Biochemical Characteristics of New Lines of Bread Wheat in Turkey

Ramazan DOĞAN

Uludağ University, Agricultural Faculty, Field Crops Department Bursa, Turkey; rdogan@uludag.edu.tr

Abstract

Sixteen new lines of bread wheat obtained from the CIMMYT/ICARDA and a standard cultivar were evaluated during three successive years (2003, 2004 and 2005). The experiments were conducted at the experimental farm of the Faculty of Agriculture of the Uludağ University in Bursa. The lines and the standard cultivar showed significant differences in plant height, number of seeds/spike, seed weight/spike, seed yield and a 1000-kernel weight. The lines numbered 4, 6, 7, 9, 11, 14 and 15 produced significantly higher seed yields than the standard cultivar. Therefore, they formed the highest group (a) of seed yield. Similarly, these lines had a higher number of seeds/spike value than the standard cultivar. However, lines 6 and 11 produced higher seed yields than lines 4, 7, 9, 14 and 15. In particular, the gluten composition and the zeleny sedimentation test values of whole flours revealed that lines 6 and 11 could be suitable for high-quality pasta production with good sensory characteristics. To summarize, there were significant differences between the lines with respect to agronomic and biochemical characteristics. In particular, lines 6 and 11 had better performance than both the other lines and the standard cultivar because of their seed yield and quality.

Keywords: bread wheat, agronomy, biochemical characteristics, lines

Introduction

Wheat is one of the most important cereal crops in the world. In Turkey, wheat accounts for the largest portion of cereal production, approximately 21.5 million tons in 2005. Turkey is one of the major wheat-producing countries with 3.5 % of the world wheat production (Anonim, 2005). Approximately 70% of world wheat production is used as food. It is mainly manufactured as bread and other baked products such as cakes and cookies. Wheat is the main source of protein and dietary fiber for many people around the world, especially in Turkey. Experts recommend cereals as the first food to be introduced in infant diets, and evidence from recent research suggests that a healthy adult diet should have most of its calories in the form of complex carbohydrates, such as cereal starch. A healthy human diet must also include 20 to 30 g/day of dietary fiber, which can be easily achieved by eating whole grain cereal products (Dendy and Dobraszczyk, 2001).

Regarding nutrition, studies on *in vitro* starch digestibility showed the presence of a considerable amount of resistant starch, which, together with the soluble fiber fraction, makes wheat an interesting source of prebiotics for the sustainment of intestinal bacteria (Galterio *et al.,* 2003).

In this research, 16 lines obtained by selection from the CIMMYT/ICARDA bread wheat program under moderate rainfall conditions were characterized from agronomical and biochemical points of view to determine if they were suitable for the preparation of pasta, cakes, bread, etc.

Materials and methods

The selected 16 lines and the standard cultivar were grown in the field. The experiment was conducted at the Applied and Research Centre of the Faculty of Agriculture of the Uludağ University in Bursa, Turkey during the experimental years (2002-2003, 2003-2004 and 2004-2005). The structure of the soil is clayey and neutral in reaction. It is poor in organic matter and rich in available P and K (Katkat *et al*., 1985).

The temperatures recorded during the experimental years (2002-2003, 2003-2004 and 2004-2005) were almost equal to long-term average. The total rainfall during the experimental period was slightly lower than the long-term average (Tab. 2).

In this study, 16 bread wheat lines were selected among a great number of lines tested under Bursa's ecological conditions (Ekingen, 1988; Yağdi, 1999). The lines were originally obtained from the CIMMYT/ICARDA bread wheat program under moderate rainfall conditions. The pedigree of the lines is shown in (Tab. 1).

The experiment was conducted based on a randomized complete block design with three replicates. The area of each plot was 1.2 m x 6 m (7.2 m^2). Before sowing, 50 kg ha^{-1} of N and P was applied in the form of compost (20/20/0), and 100 kg ha^{-1} of N in the form of CAN (Calcium Ammonium Nitrate) was applied after sowing.

Tab. 1. Pedigrees of the lines and the standard cultivar

Lines	Pedigree
1	'Van"S"/4/Sr/Cal//Tob/8156/3/7C//Bb/Cno' ICW80-0038-4AP-2AP-1Ap-0AP
2	'SD 648.5/8156/3/Chr//Sn64/Kl.Rend/4/Cc/5/IWP19' ICW80-0679-2AP-1AP-4AP-0Ap
3	'SD648.5/8156/3/Chr//Sn64/Kl.Rend/4/Cc/5/IWP19' ICW80-0679-4AP-2AP-1AP-0AP
4	'F134-71/Crow"S" SWM11147-1AP-2AP-4AP-1AP-0AP
5	'Tl/3/Fn/Th/ /Nar 59* 2/4/Bol"S" CM56569-1AP-1AP-3AP-2AP-1AP-0AP
6	'Gh"S"/Anza' CM67349-06AP-300AP-1AP-0AP
7	'Bow"S"/Crow"S" CM69599-4AP-2AP-2AP-1AP-0AP
8	'Jup73/Bjy"S"//Bow"S" Cm73861-03AP-300AP-5AP-3AP-300 L-0AP
9	'Chat"S"/Kvz/Cgn' Cm72111-03AP-300AP-1AP-2AP-00 L-
10	'Ron/Cha//Ot4081 Path/Cndr* 3' ICW81-0726-03AP-300AP-4AP-3AP-300 L-0AP
11	'SD648.5/8156/3/Chr//Sn64/Kl.Rend/4/Cc/5/Iwp19' ICW80-079-2AP-1AP-2AP-2AP-1AP-300 L-0AP
12	'Maya/Bjy"S" CM39424-1Y-1M-1Y-2M-1Y-0B
13	'Nac//F76/Ald"S" CM52164-1BJ-11Bj-1Bj-1Bj-3Bj-0BJ
14	'Ald'S'/Bow"S" CM67318-17Y-3M-1Y-1M-0Y
15	'Yd'S'/Bow"S" CM49586-3BJ-1BJ-2BJ-2BJ-12BJ-1BJ-0BJ
16	'Nac F76/Ald"S" CM52164-1Bj-3Bj-13Bj-1BJ-1Bj-0Bj
17	'Pehlivan' (Standard cultivar)

The seeds were sown by Oyjord drills in plots consisting of eight rows. Agronomical characteristics, such as plant height (cm), number of seeds/spike, weight/spike, 1000-kernel weight and seed yield (kg ha^{-1}), were examined.

The percent of broken grains was determined by the method of Özkaya and Kahveci (1990). Wheat hardness was determined using the Scott barley pearlier standard method, which measures the amount of material eliminated after the abrasion of a sample of 20 g during 1 min (AACC, 1983).

The weight of 1 l of seeds was determined using a standard hectoliter apparatus. Moisture content was calculated by the weight difference before and after drying the grain samples at 110°C for 24 h (AOAC, 1984). In addition, whole wheat grains were blended and milled using a Cyclotec mill equipped with a 1 mm sieve. The following analyses were carried out to assess the quality of the whole grain flour. A sodium dodecyl sulphate (SDS) sedimentation test was performed using the method of Dick and Quick (1983). The wet gluten was measured according to the approved method (AOAC, 1984) with the glutomatic 2,200 system. The α-amylase activity was measured with the Falling Number test (AACC, 1983).

The data of each variable were subjected to the analysis of variance using MSTAT-C (version 2.1, Michigan State University, 1991) and MINITAB (University of Texas at Austin) software.

Results and discussion

Agronomical characters

Under the climatic conditions of Bursa, the highest dry matter accumulation in wheat grainsoccurred in May. Therefore, the amount of precipitation in May seems to be appropriate for that particular developmental stage of wheat.

Tab. 2. Monthly rainfall (mm), temperature (°C) in 2002-2003, 2003-2004, 2004-2005 growing seasons with long-term averages (1928-2002)

Months	2002-2003		2003-2004		2004-2005		Long-Term	
	Temp. (°C)	Rainfall (mm)	Temp. (°C)	Rainfall (mm)	Temp. (°C)	Rainfall (mm)	Temp. (°C)	Rainfall (mm)
October	15.6	60.4	16.6	125.1	13.2	15.9	14.6	58.6
Novemb.	12.3	76.3	10.1	64.5	9.3	94.9	10.3	86.3
Decemb.	7.6	99.9	6.2	91.0	6.3	44.0	6.6	73.2
January	8.6	65.3	5.0	154.8	6.2	150.4	6.3	114.8
Fabruary	2.7	106.2	5.1	72.6	6.6	77.7	5.2	80.7
March	4.4	33.1	9.4	62.1	8.5	77.9	7.7	63.8
April	9.9	112.1	13.1	50.4	14.0	43.1	12.5	60.3
May	18.8	45.7	17.6	22.8	17.9	35.5	18.0	35.4
June	23.8	2.4	22.6	37.5	21.6	20.9	22.5	24.9
Mean	11.5		11.7		11.5		11.5	
Total		601.4		680.8		560.3		596.0

Plant height, number of seeds/spike, seed weight/spike, 1000-kernel weight and seed yield (kg ha^{-1}) of the lines and the standard cultivar are given in (Tab. 3). According to an average of several years, there were significant differences in the plant heights of the lines and the standard cultivar ($p<0.01$). The plant height of cereals is an important agronomic characteristic because of the lodging and harvest indices. The height of the lines ranged from 80.30 to 97.50 cm. The plant heights of six lines (1, 2, 3, 4, 5, 9 and 12) and the standard cultivar were in the ideal ranges (i.e., between 90 and 100 cm) (Tosun, 1987; Yürür, 1998). The plant height results of this experiment were similar to results from other studies (Tosun, 1987; Yaradat *et al.,*1996; Yürür, 1998; Yağdi, 1999).

The number of seeds/spike of the lines and the standard cultivar were significantly different, ranging from 34.90 to 41.40. Most of the lines had a higher number of seeds/spike than the standard cultivar. Certainly, the number of seeds/spike is closely and positively correlated with the grain yield in wheat (Thorne, 1966; Genç, 1978; Yürür *et al.,* 1983).

Similarly, the lines significantly differed in seed weight/spike this variable ranged from 1.42 to 1.76 g. However, the seed weight/spike of the lines was similar to that of the standard cultivar with the exception of lines 2, 4, 6, 9, 10, 11, 12, 13, 14 and 16 (Tab. 3). Our results are in agreement with other studies (Yilmaz and Dukuyucu, 1994; Dukuyucu *et al.,* 1997; Şener *et al.,* 1997).

The 1000-kernel weight of the lines was significantly different; it ranged between 32.50 and 43.60 g. According to average values from previous years, lines 11, 13, 14, 15 and 16 produced lower 1000-kernel weight values while the other lines produced values higher than the standard cultivar. Similarly, our results are in agreement with results obtained by other researchers (Donald, 1968; Singh and Stoskopf, 1971; Tosun, 1986; Şener *et al.,* 1997; Toklu *et al.,* 1999; Ereifej *et al.,* 2001). Several studies suggest that the 1000-kernel weight is related to the number of seeds/spike and the seed weight/spike (Donald, 1968; Singh and Stoskopf, 1971; Tosun, 1986; Şener *et al.,* 1997).

Seed yield (kg ha^{-1}) is one of the most important variables in studies that goal to evaluate the quality of new genetic materials (Yağdi, 1999; Doğan *et al*., 2006). Significant differences were found in the seed yields of the lines and the standard cultivar (Tab. 3). The seed yield three-year average ranged from 5428 to 4396 kg ha^{-1}. The highest seed yields were obtained from lines 4, 6, 7, 9, 11, 14 and 15, which formed group (a) and produced yields higher than the standard cultivar. In contrast, the other lines produced less seeds than the standard cultivar. Obtaining a good quality and the highest seed yield is the main goal in plant growth. Taking this goal into consideration, lines 6 and 11 may be grown for higher seed yield in this experimental region.

Biochemical Characters

As seen in Tab. 4, the broken grains of the lines were lower than 0.7% (except for samples 12, 13 and 14). Grain hardness of the lines ranged from 14 to 86%.

There were no statistically significant differences between hectoliter weights of the lines, which ranged from 77.0 to 82.5 kg/hl. Vazquez *et al.* (2001) reported that hectoliter weights of wheat grains ranged from 63.2 to 81.4 kg/hl. Our findings on hectoliter weight were higher than those of Vazquez *et al.* (2001). According to the Turkish standard (TS 2974), the best quality bread wheat

Tab. 3. The agronomical characteristics of new lines of *Triticum aestivum* var. *aestivum*

Genotypes	Broken grain (%)	Grain hardness %)	Hectoliter weight (kg)	Moisture (%)	Wetgluten (%)	Z Sindex (ml)	α-amylaseactivity (sn)
1	0.4	36	82.1	10.52	24.6	25	482
2	0.3	74	81.9	10.31	24.6	15	425
3	0.3	60	82.2	10.39	20.2	17	390
4	0.5	44	80.8	10.51	25.4	20	442
5	0.5	16	81.4	9.70	22.4	14	453
6	0.5	38	82.1	9.59	24.2	25	415
7	0.1	86	82.5	10.05	25.5	23	393
8	0.5	36	79.6	9.79	24.0	19	404
9	0.2	66	82.2	10.53	22.9	21	343
10	0.2	80	81.4	10.07	22.5	22	315
11	0.3	14	79.1	9.98	26.7	29	369
12	1.1	72	82.5	10.15	26.8	23	376
13	--	24	77.0	10.21	20.5	18	228
14	1.6	80	80.7	10.36	24.4	20	418
15	0.3	76	81.2	9.91	23.6	20	413
16	0.7	86	82.5	10.21	23.2	22	405
17	0.1	16	82.5	9.69	23.7	23	315
Means	0.5	53	81.2	10.12	23.8	21	387

Tab. 4. The biochemical characteristics of new lines of *Triticum aestivum* var. *aestivum*

Genotypes	Plant height (cm)	Seed number/spike	Seed weight/spike	1000-kernel weight (g)	Seed yield (kg ha^{-1})
1	92.60 a-d	38.30 abc	1.76 ab	40.30 a-d	5038.0 ab
2	92.80 a-b	35.00 c	1.57 a-d	42.40 a-d	4829.0 ab
3	96.50 ab	38.80 abc	1.75 ab	43.60 a	5162 .0 ab
4	93.70 abc	36.90 abc	1.54 cde	39.60 bcd	5310.0 a
5	93.80 abc	36.70 abc	1.72 abc	43.60 a	4641.0 ab
6	89.50 bcd	34.90 c	1.62 a-d	40.80 a-d	5428.0 a
7	89.60 a-d	37.60 abc	1.71 abc	43.40 ab	5346.0 a
8	87.80 cde	38.90 abc	1.71 abc	40.50 a-d	5109.0 ab
9	97.50 a	38.00 abc	1.67 a-d	42.60 abc	5234.0 a
10	86.70 cde	36.00 bc	1.57 b-e	40.00 a-d	4945.0 ab
11	81.50 e	38.70 abc	1.42 e	32.50 f	5428.0 a
12	91.80a-d	36.40 bc	1.58 a-e	39.60 a-d	5109.0 ab
13	81.50 e	39.20 abc	1.63 a-d	38.50 de	4396.0 b
14	80.30 e	40.90 ab	1.66 a-d	35.50 ef	5389.0 a
15	86.10 cde	41.40 a	1.76 a	39.30 cde	5361.0 a
16	84.90 de	36.90 abc	1.51 de	35.50 ef	4942.0 ab
17	93.00 abc	35.40 c	1.72 abc	41.40 a-d	5012.0 ab
Means	89.40	37.60	1.64	39.90	5099.0

genotypes took into consideration broken grain, grain hardness, 1000-kernel weight and hectoliter weight.

The moisture content of the lines ranged from 9.59 to 10.53%. Wet gluten levels of the flour obtained from the wheat lines ranged between 20.20 and 26.80%. The percentages of gluten in line 11 and 12 were the highest. These values are higher than those reported in previous studies (Galterio *et al.,* 2001). However, our findings of the percentages of wet gluten were similar to findings by Atlı (1985), Ünsal (1993) and Ereifej *et al.* (2001). The Zeleny sedimentation (ZS) indices shows the amount and quality of wheat gluten (Özkaya and Kahveci, 1990). According to the references, ZS indices of bread wheat samples ranged from 30.00 to 39.00 ml. In our study, the ZS index of the lines ranged between 14 and 29 ml, and line 11 had the highest value. The falling number system measures the α-amylase activity in grains and flour to detect potential sprout damage, optimize flour enzyme activity and guarantee the soundness of the traded grain. α-amylase activity is crucial to assure the final product quality of bread and pasta, and its value should be higher than 250±25 second in flour (Dendy and Dobraszczyk, 2001). Our findings of α-amylase activity range from 228 to 482 seconds.

Agronomic and biochemical characteristics varied significantly, and they were influenced by the genotypes and the environment. Among all the evaluated lines and the standard cultivar, lines 6 and 11 were the most productive and suitable for specific biochemical uses.

According to the results of this three-year-experiment, the lines showed significant differences with respect to agronomic and biochemical characteristics. Specifically, lines 4, 6, 7, 9, 11, 14 and 15 produced higher seed yields than the standard cultivar. They formed the upper yield group (a). However, seed yields of lines 6 and 11 were the highest. Similarly, the plant heights of lines 6 and 11 are short enough to resist lodging, which is common in the region. In particular, the gluten composition and the ZS test values of whole flours revealed that lines 6 and 11 could be suitable for high quality pasta production with good sensory characteristics. Therefore, lines 6 and 11 are proposed to continue into variety registration experiments.

Acknowledgments

The authors also thank Uludag University for editing and English proofreading service support.

References

AACC (1983). American Association of Cereal Chemists. Approved Methods of AACC. St. Paul, MN.

Anonim (2005). Statistical Indicators (1923-2005). Prime Ministry Republic of Turkey, Turkish Statistical Institute, Ankara, Turkey pp. 188.

AOAC (1984). Official Methods of Analysis. Association of Analytical Chemists, Washington DC.

Atli, A. (1985). Effects of Environment and Variety on Quality Characteristics of Some Bread Wheat Varieties Grown in Central Anatolia. Ph.D. Thesis, Ankara, p:170 (in Turkish).

Dendy, D. A. V. and B. J. Dobraszczyk (2001). Cereals and Cereal Products, Chemistry and Technology. Aspen Publishers Inc., Gaitsburg, Maryland, USA.

Dick, J. and J. Quick (1983). A modified screening test for rapid estimation of gluten strength in early generation durum wheat breeding lines. Cereal Chem. 60:315-320.

Doğan, R., M. Türk and H. Gül (2006). Evaluation of Agronomical and Biochemical Characteristics of New Lines of *Triticum durum* Desf. in Turkey. Bangladesh Journal of

Botany 35(1):71-76.

Donald, C. M. (1968). The design of wheat ideotypes. The Third International Wheat Genetics Systems, Aust. Acard. Science pp. 377-388.

Dukuyucu, T., A. Akaya, A. Nacarve and B. Ispir (1997). Investigation of Yield, Yield Components and Phenological Traits of Some Bread Wheat in Kahramanmaras Condition. II. Field and Crops Congr. 16-20, 22-25 September Samsun, Turkey.

Ekingen, H. R. (1988). Plant Breeding. Courses Notebook of Uludag Univ. 31: 68-72 (in Turkish).

Ereifej, K. I., G. N. Al-Karaki and M. K. Hammouri (2001). Variability of some physico-chemical characteristics of wheat cultivars grown under arid and semiarid Mediterranean conditions. Internat. J. Food Properties 4(1):91-101.

Galterio, G., D. Cardarill, P. Codianni and R. Acquistucci (2001). Evaluation of chemical and technological characteristics of new lines of *Triticum turgidum* ssp. *dicoccum*. Nahrung 45(4):263-266.

Galterio, G., P. Codianni, A. M. Giusti, B. Pezzarossa and C. Cannella (2003). Assessment of the agronomical and technological characteristics of *Triticum turgidum* ssp. *dicoccum*. Nahrung 47(1):54-59.

Genç, I. (1978). A research to Determination of Effects of number of Tillering per plant of Variety of Cumhuriyet-75 on Yield and Yield Components. Scientific Review and Research Thesis. Cukurova Univ. Agric. Faculty Press, No. 21, Adana, Turkey (in Turkish).

Katkat, A. V., F. Ayla and I. Guzel (1985). The State of Soil Etude and Productivity of The Research and Application Centre of Agriculture Faculty of Uludag University. Journal Uludag Univ. Agric. Faculty 3:71-78 (in Turkish).

Ozkaya, H. and B. Kahveci (1990). The Analysis Methods of Cereal and Crops. The Journal of Food Technology Association.14:152 (in Turkish).

Sener, O. P., M. Kilinc, T. Yagbasanlar, H. Gozubenli and U. Karadut (1997). Determination of Bread Wheat (Triticum aestivum L. Em Tell) and Durum Wheat (Triticum durum Desf.) Cultivars Suitable for Hatay Condition, II. Field Crops Congress, 22-25 September, Samsun, Turkey p. 1-5 (in Turkish).

Singh, I. D. and S. A. Stoskopf (1971). Harvest index in Cereals. Agron. J. 63:224-226.

Thorne, G. N. (1966). Physiological aspects of grain yield in cereals. Growth of cereals and cereals and grasses. Butterworths pp.88-106.

Toklu, F., T. Yagbasanlar and H. Ozkan (1999). A Research to Determination of Test Weight in Relation to the Physical and Quality Characteristics of Bread Wheat (T. aestivum L.). III. Field Crops Congress, 15-18 November, Adana, Turkey p. 339-342 (in Turkish).

Tosun, O. (1986) The Importance of Plant Breeding in Turkish Agriculture and Its Contribution to Agricultural Production, Plant Breeding Symposium, 15-17 October, İzmir, p. 55 (in Turkish).

Tosun, O. (1987). Problems of Cereal Cultivation and Solution Ways in Turkey. Cereal Symposium in Turkey (TUBITAK), Bursa Turkey (in Turkish).

TS 2974. (2001). Wheat Standard. Turkish Standard Institute. Ankara, Turkey.

Unsal, A. S. (1993). Effect of Different Application Times of Nitrogen Fertilizer on Quality of Some Important Bread Wheat Cultivars. Univesity of Cukurova, Ph.D. Thesis, Adana, p. 130 (in Turkish).

Vazquez, L., M. Vizcarra, A. Salazar, A. Castillo and I. Guerrero (2001). Effect of heat treatment on the industrial quality of two varieties of Mexican wheat. Intern. J. Food Properties 4(3):419-430.

Yagdi, K. (1999). Investigating Some Traits of Certain Bread Wheat (*Triticum aestivum* L.) Lines Improved in Bursa's Ecology. I. Agronomic Features. III. Field and Crops Congr., p:97-102, 15-18 Nowember, Adana, Turkey (in Turkish).

Yaradat, A. A., M. M. Ailuni and G. Karaki (1996). Genetic structure of durum wheat landrace in a center of diversity. 5th Int. Wheat Conf. Abst.

Yilmaz, H. A. and T. Dokuyucu (1994). Determination of Suitable Kahramanmaras Conditions and High Yielding Varieties of Bread Wheat. I. Field and Crops Congr., University of Ege Agriculture Faculty, p:303-306, 25-29 April, Izmir, Turkey (in Turkish).

Yurur, N. (1998). Cool Season Crops. (Cereals-I). Uludag Univ. Agric. Faculty Press, No7.: 035-0295, Bursa, Turkey (in Turkish).

Yurur, N., O. Tosun, D. Eserve and H. H. Gecit (1983). Relationships Between Yield of Main stem and Some Characters in Wheat. Scientific Reviews and Researches. Ankara Univ. Agric. Faculty Press, No. 755, Ankara, Turkey (in Turkish).