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RESEARCH ARTICLE

Determination of the Yield Quality and Winter Durability Characteristics of Some Bread Wheat (*Triticum aestivum*) Genotypes in Pasinler and Erzincan Locations

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ABSTRACT

Bread wheat is the most important plant species used in human nutrition and most of the daily protein and calorie needs of people are met from this plant. 13 advanced bread wheat lines, 1 candidate for registration and 6 bread wheat varieties have been compared in terms of yield, number of spikes per square meter, 1000 grain weight, hectoliter weight, plant height, protein ratio, zeleny sedimentation value and 3 different (-17, -19 and -21 °C) cold level parameters in this study. Durable genotypes were determined according to the LT50 value (the degree when 50% of the plants perish with cold stress). As a result of the observations, it was noted that lines 1, 2, 3, 4, 5, 8 were superior in terms of resistance to cold and line 10 displayed superiority in terms of yield compared to the other varieties. It is concluded that these lines may be suitable variety candidates for wheat cultivation in the region. Furthermore, it has been concluded that it is important to include cold test studies in breeding programs in regions like the East Anatolia Region where harsh winters prevail.

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Introduction

Wheat is the leading cultivated plant that in the World as well as Turkey to counter food needs and is a strategically important cereal species (Nohutcu, 2018). Wheat, one of the most grown cereals in the world, is an important food source in human nutrition (Hossain et al., 2018). Wheat ranks second after corn in terms of total production amount (FAO, 2016). Most of the daily protein and calorie requirements of humans worldwide are supplied by wheat grains (Shiferaw et al., 2013). In recent years, wheat demand has increased in parallel with the increase in human population. Therefore, wheat production has a strategic importance in terms of world economy and food security. As a matter of fact, in 2017, 21 million tons of wheat was produced from 76 million decares of land and the average yield was 280 kg da^{-1} (Anonymous, 2018). Wheat has supplied approximately 20% of the calories consumed daily by the world's population as the main energy and protein source of people for thousands of years (Braun et al., 2010). Wheat ranks first among cultivated crops in agriculture for reasons such as the range of its adaptation limit, mechanization, ease of transport, storage and processing (Kılıc et al., 2012). Grain yield in wheat is genetically influenced by many cultivation techniques and climate factors as well as the yield potential of the variety. Knowledge of the relationship between the various characters in the breeding programs to increase grain yield contributes to the correct orientation of the program as well as selection (Goksoy et al., 2002). In order to be effective on the foreign market, we need to increase our competitiveness by producing

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high quality. Bread wheat breeding works endeavor to improve quality and develop varieties with high yield, that are resistant to diseases and pests and are compatible with environmental conditions.

In addition, one of the important factors that limit plant breeding is low temperature. Morphological and physiological deterioration occurs in plants that are subjected to low temperatures depending on the duration of exposure. The development of cold resistant varieties is very important as this situation causes great material losses in the agricultural sector (Svec and Hodges, 1972; Cakmakci and Acıkgoz, 1992).

Since the climate and soil factors of our country are rather variable, it is necessary to generate varieties with stable grain yield in different climate and soil conditions and whose quality characteristics are not very variable and offer them to farmers. Although the yield potential of the varieties developed in recent years is high, the yields are decreased by abiotic stress factors. Almost every year there are yield losses due to cold damage in various regions. Cold damage affects the yield negatively especially in Central Anatolia, East and Northeast Anatolia where wheat production is the most intense. The development of varieties resistant to stress factors will increase the yield and therefore the production. Wheat is affected by the cold and drought because it is planted mainly in winter in dry conditions. This is also the case in other regions. In winter and cold resistant varieties, the output after winter is 80-95%, while the output of susceptible varieties is down by 40-50%. Considering the strategic importance of wheat in the agriculture of our country, increasing the yield and production of this species will make a great contribution to the national economy. In order to increase yield, limiting factors must be eliminated. Drought, cold and high temperature are the most important factors limiting yield. Therefore, the development of varieties resistant to abiotic stress factors is very important in obtaining high yields. Resistance to stress factors is also associated with the period, duration, and severity of the factor (Kuçukozdemir, 2016). The aim of this study is to develop high yield and high quality cold resistant varieties suitable for Eastern Anatolia Region.

Materials and Methods

This study was carried out in a randomised complete block design with three replications in the fields of East Anatolia Research Institute Erzurum Pasinler Location and Erzincan Garden Cultures Research Institute in the 2017-2018 production year. The trial was carried out between 1 September-1 October, which is the most suitable time for winter wheat cultivation. The seeds were planted with a 20 cm row spacing at a depth of 4 - 6 cm and 475 seeds per m^2 with a seed drill in the study (Akkaya, 1993). Parcel dimensions were arranged as 6 m x 1.2 m =7.2 m^2. Half of the nitrogen fertilizer used in the trial was applied during planting and the other half during bolting while the Phosphor fertilizer was all applied with the planting at a rate of 6 kg N and 6 kg P per decare (Kıral and Ozcan, 1990; Akkaya, 1993).

13 advanced bread wheat lines, 1 candidate for registration and 6 bread wheat varieties were used in this study. The pedigrees of the varieties are given in Table 1.

Table 1. Hybrids and pedigrees of varieties and lines in the study

Number	Pedigree
1	DOGU 88
2	PALANDÖKEN 97
3	AYYILDIZ
4	ALPARSLAN
5	KARAHAN 99
6	ALTURNA (Candidate for registration)
Line 1	T67/X84W063-9-45//KARL92/3/GUN91/MNCH/4/SAULESKU #44/TR810200
Line 2	W0405D/HGF112//W7469C/HCF012/3/MERCAN-2
Line 3	MV DALMA//SHARK/F4105W2.1
Line 4	T67/X84W063-9-45//KARL92/3/GUN91/MNCH/4/SAULESKU #44/TR810200
Line 5	W0405D/HGF112//W7469C/HCF012/3/MERCAN-2
Line 6	SAULESKU #44/TR810200//ORKINOS-1
Line 7	BILINMIYEN96.7
Line 8	RAN/NE701136//CI13449/CTK/3/CUPE/4/TAM200/KAUZ/5/BWD
Line 9	W96X1375-06//OR4910006/OR920609
Line 10	MILAN/KAUZ/6/TOB/ERA//TOB/CNO67/3/PLO/4/VEE#5/5/KAUZ/7/SHARK/F4105
Line 11	HXL8088*2/CBRD/3/KS91W009-6-1/MV EMMA//BETTY
Line 12	SKAUZ//AGRI/NAC/4/SNI/TRAP#1/3/KAUZ*2/TRAP//KAUZ/5/ADMIS
Line 13	ARG/R16//BEZ*2/3/AGRI/KSK/5/TRK13/6/494J6.1111/MNCH
Line 14	W96X1375-06//OR4910006/OR920609

When the wheat reached harvest maturity, 50 cm was cut off from each parcel as edge effect and the remaining parts were harvested and blended with a parcel harvester (Kıral and Ozcan, 1990; Akkaya, 1993).

Observations made during the trial

Number of spikes of grain per Square meter; During the maturation period, spikes in a row in the randomly selected 1 meter area within the harvest area of each plot were counted and these values were converted to the number of spikes per square meter. ***Grain yield***; The grain product collected from each parcel was harvested and blended and weighed after cleaning with a small selector. The grain yields obtained as a result of weighing were collected and converted to kg da^{-1}. ***1000 grain weight***; Each piece of grain taken from the product was counted and weighed four times as 100 grains and the average was taken and multiplied with 10 to determine the 1000 grain weight g. ***Hectoliter weight***; A 1 liter hectoliter measuring tool was used to weigh the grain product obtained from each parcel, weighed and calculated as kg. ***Proportion of protein in grain***; Samples of wheat taken from each parcel were milled in the crushing mill and 100 g flour was obtained after which the protein rate was established in % with an NIR device. ***Zeleny sedimentation***; Samples of wheat taken from each parcel were milled in the crushing mill and 100 g flour was obtained and a method developed by Elgun et al. (1987) was used to determine sedimentation as ml. ***Cold tests*** were carried out according to the method used by Küçüközdemir (2016).

Results and Discussion

In the study conducted with 20 bread wheat genotypes, significant statistical differences were found among the characteristics of the examined genotypes in Erzincan location in the studied parameters other than hectoliter weight, plant height and spike number per m^2. The mean values of all these properties and the statistical significance groups of the subjects according to these averages (P <0.01 and P <0.05) are given in Table 2, Table 3, Table 4 and Table 5.

Table 2. Yield, number of spikes per m2 and plant height of genotypes

Genotypes	Yield (kg da^{-1})			Number of spikes per m^2 (units)			Plant height (cm)		
	Erzincan	Pasinler	Average	Erzincan	Pasinler	Average	Erzincan	Pasinler	Average
DOĞU 88	157 d-f	55 kl	106 k	392 ab	677 a-d	535 a-e	71	**128 a**	**100 a**
PALANDÖKEN 97	155 d-f	69 j-l	112 k	327 b	**892 a**	609 ab	68	125 ab	**97 a**
AYYILDIZ	231 b-e	39 l	135 g-k	396 ab	767 a-c	581 a-c	73	118 a-c	96 ab
ALPARSLAN	160 d-f	196 de	178 e-h	415 ab	589 b-d	502 a-e	59	103 f	81 c
KARAHAN 99	146 d-f	191 de	169 e-j	468 ab	532 cd	500 a-e	68	114 b-f	91 a-c
ALTURNA	203 b-e	113 g-k	158 e-k	359 b	665 a-d	512 a-e	70	117 a-d	94 a-c
Line 1	159 d-f	138 e-h	148 f-k	563 a	517 cd	540 a-e	70	119 a-c	95 a-c
Line 2	105 f	207 cd	156 e-k	335 b	484 cd	409 de	65	114 b-f	90 a-c
Line 3	185 c-f	315 b	250 b	351 b	604 b-d	477 b-e	68	111 c-f	90 a-c
Line 4	289 ab	124 f-j	207 b-e	391 ab	753 a-c	572 a-d	77	111 c-f	94 a-c
Line 5	**317 a**	76 j-l	197 c-f	476 ab	823 ab	**649 a**	71	111 c-f	91 a-c
Line 6	211 b-e	87 h-l	149 f-k	408 ab	632 a-d	520 a-e	75	122 a-c	98 a
Line 7	152 d-f	93 g-l	122 j-k	308 b	479 cd	393 e	65	113 b-f	89 a-c
Line 8	194 c-f	150 d-g	172 e-j	437 ab	463 d	450 b-e	71	118 a-c	95 a-c
Line 9	139 ef	175 d-f	157 e-k	387 ab	488 cd	437 c-e	62	**103 f**	83 bc
Line 10	220 b-e	**413 a**	**316 a**	341 b	523 cd	432 c-e	78	108 c-f	93 a-c
Line 11	145 d-f	322 b	234 b-d	377 b	493 cd	435 c-e	68	110 c-f	89 a-c
Line 12	232 b-d	256 c	244 bc	348 b	533 cd	441 b-e	70	105 d-f	87 a-c
Line 13	153 d-f	100 g-k	127 g-k	352 b	571 b-d	461 b-e	71	117 a-e	94 a-c
Line 14	269 a-c	108 g-k	189 d-g	361 b	687 a-d	524 a-e	68	104 ef	86 a-c
Average	191**	161**	176**	390 ns	609**	499**	69 ns	114**	92**

According to the Duncan test, the averages shown with the same letter are not important in their group (p<0.05)

When the grain yield parameter was examined according to the variance analysis table, it was observed that the location of the Pasin, the location of the Erzincan and the average of the location were important (P<0.01). Both the Number of spikes per m^2 hektoliter weight and plant height were found insignificant in Erzincan location (0.05<P). These two parameters were found to be important in terms of Pasinler location and average of location (P<0.01).

The yield obtained from the unit area is the most important agricultural parameter which is closely related to every branch of agriculture. According to the location averages, the highest grain yield was obtained with line 10 (316 kg da^{-1}). This line also ranked first in Pasinler location with 413 kg da^{-1}. The highest yield in the Erzincan location was found in line 5 (317 kg da^{-1}). In the study year, intensive stem rust at Pasinler location caused significant losses in yield, 1000 grain and hectoliter weights. While hectoliter values were found to be statistically insignificant in Erzincan location, those in Pasinler location and location averages were statistically very significant. In Pasinler location, the tallest plant height was found with DOĞU 88 variety (128 cm) and the shortest plant height was found in line 9 (103 cm). According to the location averages, DOĞU 88 (100 cm) and PALANDÖKEN 97 (97 cm) varieties stand out in terms of plant height (Table 2). Plant height is important in terms of hay yield especially in regions where animal husbandry is practiced and it indirectly affects grain yield (Kuçukozdemir, 2016). Similarly to the study, Doğan (2002) conducted a two-year study in Bursa, which determined differences in plant height over the years, and reported that the average plant height ranged from 84.3 to 108.6 cm. Many researchers indicate that the significant differences the plant heights of genotypes stem from genetic structures (Kaydan and Yagmur, 2008).

When the variance analysis table was analyzed, it was seen that 1000 grain weight was found to be very important in both locations and average of locations (P<0.01). In hectoliter weight, it is determined that the Erzincan location was not important (0.05<P) and Pasinler location and of the average of location were very significantly (P<0.01).

The highest hectoliter weight was measured as 77.6 kg in Pasinler location and a location average of 78.2 kg was weighed in line 10 (Table 3). While the highest value in Pasinler location was measured with PALANDÖKEN 97 variety (892 units) in terms of the number of spikes per square meter, the highest value was determined in line number 5 (649) in terms of location averages (Table 2). Some yield components directly affect yield. For example, it has been determined that there is a positive and significant association between hectoliter weight and 1000 grain weight in wheat. (Dokuyucu et al., 2001). Kurt and Yagdı (2013) emphasized that in order to increase yield in wheat, it was necessary to increase the number of spikes per m^2, number of grains per spike as well as 1000 grain weight. Bilgin and Korkut (2005) stated that in addition to the above mentioned features, genotypes with early spike growth as well as long spike growth and maturity periods should be emphasized.

Table 3. 1000 grain weight and hectoliter

Genotypes	**1000 grain weight (gr)**			**Hectoliter** (kg hl^{-1})		
	Erzincan	Pasinler	Average	Erzincan	Pasinler	Average
DOĞU 88	30 g	16 j	23 h	77,6	59,2 e-g	68,4 d-f
PALANDÖKEN 97	47 a	20 f-h	33,5 bc	77,2	59,2 e-g	68,2 ef
AYYILDIZ	41 b-d	16 j	28,5 fg	79,2	54,4 g	66,8 f
ALPARSLAN	40 b-e	22 ef	31 de	77,2	69,6 b-d	73,4 b-d
KARAHAN 99	42 bc	22 ef	32 c-e	79,2	66,4 cd	72,8 b-e
ALTURNA	41 b-d	20 f-h	30,5 ef	80	66 cd	73 b-e
Line 1	36 f	19 gh	27,5 g	78	66,8 cd	72,4 b-e
Line 2	41 b-d	28 c	34,5 b	77,6	74 b	75,8 ab
Line 3	39 c-f	30 b	34,5 b	77,2	73,6 b	75,4 ab
Line 4	39 c-f	18 h-j	28,5 fg	80,4	61,2 d-f	70,8 b-f
Line 5	39 c-f	18 h-j	28,5 fg	81,2	59,2 e-f	70,2 c-f
Line 6	42 bc	19 gh	30,5 ef	78,8	59,2 e-g	69 c-f
Line 7	43 b	18 hj	30,5 ef	80	62,4 d-f	71,2 b-f
Line 8	41 b-d	25 d	33 b-d	78,8	66,1 cd	72,45 b-e
Line 9	40 b-e	21 e-g	30,5 ef	78	64,1 c-e	71,05 b-f
Line 10	41 b-d	32 a	36,5 a	78,8	77,6 a	78,2 a
Line 11	37 e-f	30 b	33,5 bc	77,6	72,8 bc	75,2 ab
Line 12	40 b-e	23 d	31,5 c-e	80,4	67,2 b-d	73,8 a-c
Line 13	42 bc	20 f-h	31 de	80	57,2 f-g	68,6 d-f
Line 14	38 d-f	22 ef	30 ef	79,2	66 cd	72,6 b-e
Average	39.95**	21.95**	30.95**	78.82 ns	65.11**	71.965**

According to the Duncan test, the averages shown with the same letter are not important in their group. (p<0.05)

The amount of protein is the most commonly used criterion for determining the quality of wheat. The amount of protein may vary depending on the genetic structure and the environmental conditions in which the plant is grown. Important environmental factors affecting this are soil fertility; quantity, distribution and time of precipitation; temperature and diseases (Pomeranz, 1971; Bushuk, 1982). The protein ratio was found to be very significant in the locations and in terms of location averages (P <0.01) in this study. The highest protein ratios were measured in lines 2 (16.83%), 6 (16.80%), 8 (16.75%), and 13 (16.74%) in Erzincan location. The highest protein ratio in Pasinler location (15.74%) and the average of the locations (15.72%) was determined in line 11. The highest protein value for the location was obtained from Alturna (14.64%), which is the candidate for registration (Table 4). The higher protein ratios in Erzincan location are attributed to a more arid climate. Zeleny sedimentation value that indicates the volume of flour particles that settle after a certain time after being in a flour and lactic acid solution and then denote the characteristics of wheat flour is one of the most important indicators of the bread quality of the flour. Zeleny sedimentation tests (Peña, 2002), which are used to measure the strength or weakness of gluten structure in wheat, help breeders in early stage selection of genotypes. It is stated that higher volume bread can be made from wheat flour with a high amount of gluten and high quality, and wheat flour with these properties has a high zeleny sedimentation value (Elgun et al., 1987; Elgun et al., 2001). According to the Turkish Food Codex Wheat Flour Communiqué (Communiqué no: 2013/9) the zeleny sedimentation value for bread wheat must be at least 30 ml. The zeleny sedimentation values were statistically significant (P<0.01) in terms of location and location averages in this study. The highest zeleny sedimentation value was found in ALPARSLAN (52 ml) variety in Erzincan location, in line 1 (50 ml) in Pasinler location and in ALPARSLAN (46 ml) in terms of location average, in line 3 (45 ml) and in line 11 (45 ml).

Table 4. Protein rate and Zeleny sedimentation value

Genotypes	Protein (%)			Zeleny sedimentation (ml)		
	Erzincan	Pasinler	Average	Erzincan	Pasinler	Average
DOĞU 88	14,92 b-g	12,19 fg	13,56 e-g	33 gh	34 gh	33,5 gh
PALANDÖKEN 97	14,11 fg	11,30 g	12,71 g	40 b-d	23 k	31,5 h
AYYILDIZ	14,14 d-g	12,56 ef	13,35 fg	34 fh	36 fg	35 fg
ALPARSLAN	15,92 ab	13,06 d-f	14,49 b-e	**52 a**	40 de	**46 a**
KARAHAN 99	14,31 c-g	14,35 bc	14,33 b-e	35 e-h	37 e-h	36 fg
ALTURNA	15,62 a-d	13,66 c-e	**14,64 b-d**	42 b	39 d-f	40,5 cd
Line 1	15,58 a-f	13,12 c-f	14,35 b-e	38 c-e	**50 a**	44 b
Line 2	**16,83 a**	13,34 c-f	15,08 ab	37 d-f	47 a-c	42 bc
Line 3	15,60 a-f	12,46 e-g	14,03 c-f	45 b	45 cd	**45 a**
Line 4	14,83 b-g	13,32 c-f	14,075 c-f	36 e-g	46 bc	41 cd
Line 5	14,71 b-g	13,99 b-d	14,35 b-e	38 c-e	44 cd	41 cd
Line 6	**16,80 a**	12,81 d-f	14,81 bc	38 c-e	36 fg	37 ef
Line 7	14,60 b-g	12,81 d-f	13,71 d-f	33 gh	39 d-f	36 fg
Line 8	**16,75 a**	13,26 c-f	15,01 a-c	38 c-e	40 de	39 de
Line 9	15,81 a-c	12,66 ef	14,24 b-f	36 e-g	34 gh	35 fg
Line 10	13,92 g	12,75 d-f	13,34 fg	40 b-d	42 d	41 cd
Line 11	15,69 a-c	**15,74 a**	**15,72 a**	41 bc	49 ab	**45 a**
Line 12	14,43 b-g	14,88 ab	14,66 b-d	34 fh	44 cd	39 de
Line 13	**16,74 a**	12,26 fg	14,50 b-e	40 b-d	27 j	33,5 gh
Line 14	14,99 b-g	12,65 ef	13,82 d-f	32 h	32 h	32 h
Average	15.32**	13.16**	14.24**	38.1**	39.2**	38.65**

According to the Duncan test, the averages shown with the same letter are not important in their group (p<0.05)

Table 5. Cold test viability rates

	-17°C (%)	-19°C (%)	-21°C (%)
DOGU 88	93 a-c	93 ab	**67 a**
PALANDOKEN	90 a-c	87 a-c	37 c-e
AYYILDIZ	93 a-c	87 a-c	43 b-e
ALPARSLAN	93 a-c	93 ab	**60 ab**
KARAHAN 99	93 a-c	93 ab	43 b-e
ALTURNA (candidate)	97 ab	93 ab	**60 ab**
Line 1	90 a-c	77 b-d	**53 a-c**
Line 2	**100 a**	**97 a**	47 a-e
Line 3	90 a-c	80 a-c	**67 a**
Line 4	93 a-c	87 a-c	47 a-e
Line 5	87 a-c	83 a-c	47 a-e
Line 6	87 a-c	87 a-c	37 c-e
Line 7	93 a-c	90 ab	43 b-e
Line 8	80 bc	77 b-d	**57 a-c**
Line 9	90 a-c	83 a-c	43 b-e
Line 10	**100 a**	80 a-c	**57 a-c**
Line 11	90 a-c	77 b-d	**50 a-d**
Line 12	83 a-c	60 de	40 b-e
Line 13	77 c	70 cd	30 de
Line 14	90 a-c	53 e	27 e
Average	91 **	82**	48**

According to the Duncan test, the averages shown with the same letter are not important in their group (p<0.05)

Summer cultivation is still common, especially in regions with a short vegetation period and concerns regarding cold damage which decreases the region's average yield. In order to increase the yield of cereals in the Eastern Anatolia Region, winter cultivation should be carried out and winter varieties suitable for this purpose should be developed. The effects of cold or winter conditions on the yield will be less as the damage to the plant will be less than to susceptible varieties due to increased resistance to cold and winter (Gusta and Fowler, 1977). We found that the cold resistance tests between genotypes were statistically significant (P<0.01) in this study. The frost tests carried out after 49 days of cold application showed that lines no. 2 and 10 had not been affected at –17 °C by showing 100% viability. Line no. 2 maintained a 97% viability at -19 °C. Line 3 stood out with a viability rate of 67% after being subjected to -21 °C which was the lowest temperature in our study (Table 5). In a study carried out by Küçüközdemir et al. (2009) between 2006 and 2009, 45 bread wheat lines/varieties were tested under controlled conditions at various cold temperatures based on four different cold weather applications (0, 21, 35 and 49 days) and the highest durability was determined 49 days after the cold application. Cold and winter hardness emerges as a very important feature for high yield in the varieties developed in our region. Therefore, Doğu 88 and Alparslan varieties, the candidate variety Alturna, lines number 1, 3, 8, 10 and 11 were found to be resistant to -21 °C according to LT_{50}. Pomeroy and Fowler (1973) stated that durability tests carried out under controlled conditions can be applied at all times and results are achieved in a short time. Küçüközdemir et al. (2013) carried out a controlled study which compared the methods of cold resistance and determined that a bread wheat referred to as Krasunia O'deska and a durum wheat named Betadur had the highest durability. Yıldırım (2003) carried out a trial under controlled conditions with 15 wheat and 9 barley genotypes and determined that Norstar wheat (-10.9 °C) and Dictoo barley (-3.5 °C) varieties were the most durable genotypes. In a study involving cold tests carried out under controlled conditions with 90 local genotypes and 6 varieties of registered bread wheat, the registered varieties displayed a higher durability compared to local genotypes and the most durable genotype was Alparslan variety (Kuçukozdemir and Tosun, 2014). In the study conducted by Küçüközdemir et al. (2020), results similar to our study were found.

Conclusion

In this study carried out in Pasinler and Erzincan locations, the yield, spike number per square meter, hectoliter weight, protein ratio, zeleny sedimentation rate and cold resistance in 3 different degrees (-17, -19 and -21 °C) of genotypes were compared with the varieties in the study. Temperature stress reduced yield in Erzincan while stem rust reduced yield as well as 1000 grain and hectoliter weight in Pasinler. Line 10, which has high values in terms of yield and other characteristics at both locations is considered suitable for regional conditions and may have a profitable production potential for producers. Lines 1, 2, 3, 4, 5, 8 and 10 stand out in terms of cold resistance. The high durability of these lines is due to the fact that they are well adapted to the conditions of the region and have been transferred to advanced breeding stages at the end of a long-term breeding process.

Recent climate changes have generated new biotic and abiotic stresses. One of them is stem rust which coincides with the grain filling period of the plants. It has been concluded that resilience to this disease, which has not been considered important in our region to date, should be included in the breeding targets and that resistant varieties should be developed.

Furthermore, including cold durability studies into the breeding programs of regions such as Eastern Anatolia Region with harsh winters and high frost risk will play an important role in preventing the producers in the region from the impact of winter damage and minimize yield loss.

References

Açıkgöz, E. & Çakmakçı, S. (1992). Cold Resistance Mechanism and Field Durability Breeding in Field Crops. Uludag University. Faculty of Agriculture Journal, 9: 193-204.

Akkaya, A. (1993). Effect of Phosphorus Fertilizer Amount and Application Methods on Yield and Some Yield Components of Winter Wheat. Journal of Faculty of Agriculture, 24(2): 36-50.

Anonymous. (2018). Bitkisel Üretim İstatistikleri. Retrieved on October 10, 2019 from http://www.tuik.gov.tr/.

Bilgin, O. & Korkut, K. Z. (2005). Determination of some bread quality and grain yield characters in bread wheat (*Triticum aestivum* L.). International Journal of Agriculture and Biology (Pakistan), 7(1): 125-128.

Braun, H. J., Atlin, G. & Payne, T. (2010). Multi-location testing as a tool to identify plant response to global climate change. In: Reynolds MP, ed. Climate change and crop production. Surrey, UK: CABI Climate Change Series, 115–138.

Bushuk, W. (1982). Grains and Oil seeds. Third Edition. Canadian International Grains Institute, Winnipeg, Manitoba.10065.

Dogan, R. (2002). Determination of grain yield of some wheat lines (*Triticum aestivum* L.). Uludag University Faculty of Agriculture Publications, 16(1): 149-158.

Dokuyucu, T., Cesurer, L. & Akkaya, A. (2001). Determination of Yield and Yield Components in Some Bread Wheat (*Triticum aestivum* L.) Varieties. Kahramanmaras Sutcu Imam University, Faculty of Letters. Journal of Science and Engineering, 4(1): 109-117.

Elgun, A., Certel, M. & Ertugay, Z. (1987). Analytical Quality Control in Grain Products. Ataturk University Faculty of Agriculture Publication, p: 117.

Elgun, A., Selman, T. & Bilgicli, N. (2001). Analytical quality control of cereals and crops. Selcuk University Faculty of Agriculture Department of Food Engineering Lecture Notes. Konya Commodity Exchange Publication: 2.

FAO. (2016). FAO statistical year book 2016. World Food and Agriculture. Food and agriculture organization of the united nations, Rome, Italy.

Goksoy, A. T., Türkeç A. & Turan, Z. M. (2002). Correlation of yield and some yield components of newly developed synthetic sunflower (*Helianthus annuus* L.) varieties and Path Analysis. Uludag University Journal of the Faculty of Agriculture, 16(1): 139-150.

Gusta, L. V. & Fowler, D. B. (1977). Factors Affecting the Cold Survival of Winter Cereals. Canadian Journal of Plant Science, 57(1): 213-219.

Hossain, M., Hossain, A., Alam, A., El Sabagh, A., Faisal Ibn Murad, F., Haque, M., Muniruzzaman, Islam, Z., Das, S., Barutcular, C. & Kizilgeci, F. (2018). Evaluation of fifty irrigated spring wheat genotypes grown under latesown heat stress condition in multiple environments of Bangladesh. Fresenius Environmental Bulletin, 27(9): 5993- 6004.

Kaydan, D. & Yagmur, M. (2008). A study on yield and yield components of some bread wheat (*Triticum aestivum* L.) varieties in Van ecological conditions. Journal of Agricultural Sciences, 14(4): 350-358.

Kılıc, H., Tekdal, S., Kendal, S. & Aktas, H. (2012). Evaluation of advanced durum wheat (Triticum turgidum ssp durum) lines based on augmented trial design by Biplot Analysis. KSU Journal of Natural Sciences, 15(4): 18-25.

Kıral, A. S. & Özcan, H. (1990). Seed, Phosphorus and Nitrogen Application Amounts of Lancer Winter Bread Wheat Varieties under Erzurum exchange rate conditions. Eastern Anatolia Agricultural Research Institute, Publication No: 5.

Küçüközdemir, U., Dumlu, B., Yalçın, Z. & Karagöz, H. (2020). Determination of the Yield and Cold Hardiness Characteristics of Some Bread Wheat (*Triticum aestivum*) Genotypes in Aqueous Conditions. Anatolian Journal of Biology, 1(1): 12-15.

Kuçukozdemir, U. (2016). Determiınaton of performance and cold tolerance of East Anatolıan wheat landraces under Erzurum conditions. Phd thesis. Atatürk University Graduate School of Natural and Applied Sciences Field Crops Department Department of Cereals and Pulse Crops.

Kuçukozdemir, U. & Tosun, M. (2014). Determination of Yield, Yield Components and Cold Resistance in Some Local Wheat Genotypes. Journal of the Faculty of Agriculture, Ataturk University, 45(1): 43-54.

Kuçukozdemir, U., Dorukoğlu, E., Denizer, B. & Kara, A. (2013). Determination of Convenient Method To Be Used in Testing Cold Hardiness in Some Cereal Genotypes. International Plant Breeding Congrees, 10-14 November 2013, Antalya, Turkey.

Kuçukozdemir, U., Gülen, D., Karadaş, K., Olgun, M., Akpınar, E. & Küçüközdemir, A. (2009). East Anatolian Region Winter Bread Wheat Cold Resistant Variety Development Studies Tübitak 105 O 722 Project Final Report.

Kurt, Ö. & Yağdı, K. (2013). Investigation of performance of some advanced wheat (*Triticum aestivum l.*) Lines in terms of yield characteristics in Bursa conditions. Uludag University Journal of the Faculty of Agriculture, 27(2): 19-31.

Nohutcu, L. (2018). Determination of yield and quality characteristics of some wheat lines that are reclaimed for use in biscuit industry (Doctoral dissertation, Selçuk University, Institute of Science and Technology).

Panozzo, J. F. & Eagles, H. A. (2000). Cultivar and environmental effects on quality characters in wheat. II. Protein Crop and Pasture Science, 51(5): 629-636.

Peña, R. J. (2002). Wheat for bread and other foods. Bread wheat improvement and production. Food and Agriculture Organization of the United Nations. Rome, 483-542.

Pomeranz, Y. Z. (1971). Wheat Chemistry and Technology. American Association of Cereal Chem. St. Paul. Minn. USA.

Pomeroy, M. K. & Fowler, D. B. (1973). Use of Lethal-Dose Temperature Estimates as Indices of Frost Tolerance for Wheat Cold Acclimated under Natural and Controlled Environments. Canadian Journal of Plant Science, 53: 489-494.

Shiferaw, B., Smale, M., Braun, H. J., Duveiller, E., Reynolds, M. & Muricho, G. (2013). Crops that feed the world 10. Past successes and future challenges to the role played by wheat in global food security. Food Security, 5: 291–317.

Svec, L. V. & Hodges, H. F. (1972). Cold-hardening and morphology of barley seedlings in controlled and natural environments. Canadian Journal of Plant Science, 52(6): 955-963.

Veisz, O. & Balla, K. (2007). Changes in the Quality of Cereals in Response to Heat and Drought Stres. Acta Agronomica Óvariensis, 49: 451–455.

Yıldırım, T. (2003). Determination of Cold Resistance and Need for Vernalization in Some Wheat and Barley Genotypes Grown in Eastern Anatolia Region. PhD Thesis. Atatürk University, Faculty of Agriculture, Erzurum.