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Bread Wheat Variety "PARLA"

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ABSTRACT

The aim of this study is to present the yield and winter hardiness characteristics of PARLA variety developed by crossing method to the scientific world. PARLA is bread wheat "SABALAN" as the male parent and "PALANDÖKEN 97" as the female parent. It was registered under the name PARLA at the Field Crops Registration Committee meeting in March 2024 on behalf of the East Anatolia Agricultural Research Institute. This variety has white spikes with awns and red grain color. In yield trials conducted in different regions of East Anatolia of Türkiye, it gave an average grain yield of 7466.2 kg ha^{-1}. The average heading date of the PARLA variety is 10-15 June, plant height is 105-110 cm. 1000 kernel weight is 34 g, and hectoliter weight is 78 kg/hl. The average protein content was measured as 15.6%, flour yield as 62,3 %, Zeleny sedimentation as 59 ml, alveograph energy as 400 joule, gluten index as 93%. PARLA variety has 26.4% higher yield than the mean of yield (5907 kg ha^{-1}).

Keywords: Bread wheat, breeding, quality and yield

Introduction

Among cultivated plants, wheat has a cultivation area of 242.7 million/ha in the world. Total wheat production is 946 million tons and average yield is 3.4 ton ha^{-1}. Türkiye ranks 10th in the list of countries with 6.6 million hectares of wheat cultivation area (Anonymous, 2022a). Wheat, which is the main source of nutrition in human nutrition, has the largest cultivation area in our country as well as in all countries. Türkiye's total wheat production is 20.6 million tons and ranks 9th in the world in terms of production. However, the yield per hectare is considerably lower than many countries. Türkiye's yield average is 2.7 tons ha^{-1} and ranks 16th among the world countries. Grains constitute 73% of the arable land in the Eastern Anatolia Region. The total cereal cultivation area in the region is 1.2 million hectares and wheat is grown in approximately 701 thousand hectares of this (Anonymous, 2022b). Abiotic stress factors are the most important factors affecting yield. Many researchers are trying to develop varieties resistant to drought and cold. For this purpose, Cold and Drought Hardiness Centers have been established in Türkiye and resistance breeding studies have been focused on. It has been emphasized by Sharma and Thakur (2004) that the traits to be used in selection should be evaluated together with grain yield. Winter wheat and other cereal species must be tolerant to winter. Climate data and winter damage findings were compared in many locations in Finland and climate data were related to winter damage levels and that there was a significant connection between winter damage and yield (Peltonen et al., 2011). In the study conducted by Küçüközdemir et al. (2009), 45 genotypes were exposed to different temperatures with different cold acclimation periods, the tolerance of the genotypes were determined and as a result of the study, a winter-hardy variety named Ayyıldız was developed.

Increasing wheat yield in our region and our country will be possible by developing and producing varieties resistant to stress factors. The aim of this study is to introduce the PARLA bread wheat variety,

which ranks first in terms of yield and quality to the scientific world.

Materials and Methods

Materials

Our new variety PARLA was compared with 3 advanced breeding lines and Ayyıldız (AYZ), Alturna (ALT), Alparslan (ALP), Palandöken 97 (P-97), Doğu 88 (D-88) varieties. Phenological characteristics of the genotypes are given in Figure 1. According to the Go CHORD graph, the genotypes shown in the red area have red spike color, while the genotypes that are not red have white spike color. The grain color of the genotypes shown in the blue area is red, while the grain color of the ones that are not blue is white. In addition, the genotypes shown in the green area have awned spikes, while the genotypes that are not green have awnless spike structure. Accordingly, it is seen that the Parla variety has white, awned spike and red spike color (Figure 1).

Method

PARLA bread wheat variety was developed by Eastern Anatolia Agricultural Research Institute by hybridization method. The female of PARLA variety is Palandöken 97 variety registered by Eastern Anatolia Agricultural Research Institute in 1997, and its male is Iranian local variety called Sabalan. Hybridization study was carried out in 2005-2006 wheat growing season in Erzurum Central location. It was purified by using modified bulk selection method during it's breeding. Bulk method was made selection from F_1 population to F_5 population. 20 spikes were selected by pedigree (single spike) method in F_5, selected sister lines were planted separately as pure line in F_6. 3 of the lines which were purified in F_6 were selected and taken to the observation nursery and their seeds were multiplied. Selections were made from lines that were prominent in terms of agro-morphological characteristics, resistance to winter and diseases. After obtaining sufficient seeds from the selected lines, standard varieties and many advanced breeding lines were taken to one year preliminary yield and two years yield trials and the trials were established in dry conditions in the Erzurum-Aziziye location. While yield trials were ongoing, all lines in these trials were tested to winter hardiness under controlled conditions at the Cold Hardiness Test Center of the Eastern Anatolian Agricultural Research Institute to determine how many degrees they could be tolerance in without snow environment (Küçüközdemir, 2016). In the winter hardiness tests conducted, it was determined that PARLA showed resistance to -19°C under controlled conditions in without snow environment. From the three sister lines in the yield trials, the best line (PARLA) in terms of yield, yield components, quality, disease and winter resistance was selected and transferred to the regional yield trials together with standard varieties and advanced breeding lines.

Regional yield trials were established in Aziziye, Pasinler, Erzincan and Muş locations for 3 years to determine the yield, yield components and quality characteristics in the region. Trials sowing were made between September 1 and October 1, the most suitable date for winter in Erzurum (Akkaya and Akten 1989; Özcan and Acar 1990). The sowing of trials was completed in mid-October in Muş and Erzincan. Cultural procedures (fertilization, herbicide etc.) were carried out on time. İt was sown 500 seeds/m^2, plots size were 7.2 m^2 in sowing, were reduced to 6 m^2 in harvest. Harvests were done in Muş and Erzincan in July, and in Aziziye and Pasinler in August with a plot harvester (Hege®). Seeds from all plots coming from the locations were cleaned by using plot threshing machines, weighed, yields were calculated as kg/ha, and necessary samples were taken for quality analyses. Quality samples of standard varieties and the candidate (PARLA) were sent to Ankara Field Crops Central Research Institute Plant Food Research Center. Their quality analyses were carried out by the Center. The registration application of Parla, which had high yield in all locations in regional yield trials and whose quality characteristics (Table 1) were at the desired values, was made with the Erzurum B1 code in 2021.

Results and Discussion

In hybridization studies, it is very important to select the selected parents from genotypes with high adaptation to regional conditions. The fact that the parents of the PARLA variety are high yielding and resistant to abiotic and biotic stress factors has caused it to have high yield and adaptation ability. Tan et al. (2005) emphasized that the resources to be used in plant breeding studies should be selected consciously in order to use plant resources more quickly and effectively in plant breeding studies. Özgen (2005) stated that plant breeding studies have an important role in the increase in product in the last 50 years; thanks to classical plant breeding methods, especially cross varieties, significant increases have been achieved in the amount and quality of the product obtained. The data obtained from the Muş location, where the regional yield trials were established, were excluded from the statistical evaluation because they were not in accordance with normality. While no statistical difference was found between years in the Pasinler location, it was determined that there were very significant ($p < 0.01$)

differences between years in the Aziziye and Erzincan locations; between locations in the average of years; and between years in the average of locations. Since rainfall was sufficient and temperatures were at optimum levels in both years in the Erzincan location, yields were also high. Winter drought was experienced in Erzurum in the 2021-2022 and 2022-23 growing seasons, but since air temperatures were above the long-term average, winter damage wasn't occurred. In September, October and November 2021, there was sufficient rainfall in the Aziziye location and the plants emerged, but in the Pasinler location, since the lack of rainfall in September delayed field preparation and therefore planting, the plants did not germinate well and entered the winter very weakly. In years when winter drought occurs, since there is not enough snow cover, there is significant winter damage and therefore plant deaths in varieties sensitive to winter and cold. Therefore, the development and production of winter-resistant varieties is very important. Battenfield et al. (2013) stated that in recent years, the private and public sectors have made major investments in wheat breeding studies, and despite the negative impact that climate change will have on wheat yield in the large plains, genetic progress can minimize this effect and probably balance some of it. Toklu et al. (2001) reported that there has been progress in the potential yields of the selected genotypes in recent years and that this potential can be increased even further.

In 2021-22, a total of 426.5 mm of precipitation occurred in Aziziye and 310.5 mm in Pasinler; and in 2022-23, a total of 449.6 mm of precipitation occurred in Aziziye and 423.7 mm in Pasinler. Although there was not much difference in total precipitation in Aziziye in both years, in the second year, the fact that precipitation was more in the beneficial period for plants (April-June) doubled the yields. The average yield in the first year was around 2500 kg ha^{-1}, but Parla, which stands out with its earliness, had a yield of 30-40% more than other varieties with 4208.3 kg ha^{-1}. Our other early variety, Alparslan, followed with 3458.3 kg ha^{-1}. In the second year, all genotypes gave yields close to each other. Demir and Turgut (1999) stated that breeding provided a 30-50% increase in yield and that these varieties obtained were suitable for the region, resistant to drought, cold, pests, early maturity, disease and high yield. Also, the situation is similar for the Parla variety in the Pasinler location. 310.5 mm of rainfall occurred in the first year in the Pasinler location. The Parla variety was not affected by the winter and early spring drought experienced this year, and the average yield of the trial was 5246 kg ha^{-1}, while the Parla variety had a yield of 9103 kg ha^{-1}, which was approximately twice the yield of the other genotypes. The highest yield in all locations was obtained from the Parla variety in the year averages, and 9483.3 kg ha^{-1} was obtained in Erzincan, 7251.4 kg ha^{-1} in Pasinler and 5663.9 kg ha^{-1} in Aziziye. Again, when the data of three locations and two years were evaluated together, the highest yield belonged to the PARLA variety with 7466.2 kg ha^{-1}. Similarly breeding research work was also carried by Panwar et al. (2013) and developed a new high yielding bread wheat variety WH 1105, it was also good in quality parameters and resistant to stress.

According to the Heatmapper graph (Figure 2), as the color goes from red to green, while the yield values of the genotypes in the relevant location increase, the black color represents the average. Accordingly, it was seen that the Palandöken 97, Doğu 88, Line-2, Ayyıldız and Line-3 genotypes had average and below average yield values. However, it was determined that the Line-1, Alturna, Alparslan and PARLA genotypes had high yield values. In addition, the fact that the color tone of the PARLA variety had a lighter green color compared to the Line-1, Alturna and Alparslan genotypes showed that it had the highest value in the trials.

According to the PCA graph (Figure 3), it was seen that the genotypes were divided into 3 different groups. While the first group included Ayyıldız, Alparslan, Line-2, Line-1 and Alturna genotypes, the second group included D-88, Line-3 and Palandöken-97 genotypes. The PARLA variety was separated from the other genotypes in terms of yield value alone and was included in the 3th group.

In the Venn graph, the intersection cluster of locations and location averages is generally seen. According to this graph, the PARLA variety stands out as the genotype with the highest yield value in all locations and location averages. While Alturna and LINE-1 genotypes were the genotypes with the highest yield after Parla in all 3 locations, the Ayyıldız variety was the prominent variety in the Erzincan location, and the Alparslan variety was the prominent variety in the Aziziye and Erzincan locations (Figure 4).

When examined in terms of quality characteristics, it is seen that PARLA's 1000 grain weight is 34 g, hectolitre weight is 78 kg/hl, protein ratio is 15.6%, Zeleny sedimentation is 59 ml, waiting sedimentation is 61 ml, alveograph energy value is 400 W, gluten index is 93%, and flour yield is 62.3% (Table 2). Ayrancı et al. (2004) reported that the aim of breeding is to develop stable varieties in terms of yield and quality and that promising genotypes can be tested in different places and years and the superior ones can be used as variety candidates.

Wheat has strategic importance in Türkiye and the world. Many crises that have occurred in the world have

shown the importance of countries being self-sufficient in terms of food. Although Türkiye is a self-sufficient country in terms of wheat production, exports need to be increased in terms of the country's economy. Global climate changes necessitate the development of high-yielding, high-quality varieties that are highly adaptable, resistant to abiotic and biotic stress factors.

Conclusions

In winter wheat breeding studies, productivity and quality, as well as resistance to winter, cold and drought, are the most important selection criteria. The PARLA bread wheat variety stands out in many ways. The PARLA is a variety that tolerant to winter, drought and rust diseases. İt has high-yielding and high-quality parameters. An application has been made for the variety to be taken under protection and production has started as of 2024. The elite seed of the variety will be produced by the Eastern Anatolia Agricultural Research Institute. It will contribute to the country's economy by benefiting Turkish agriculture.

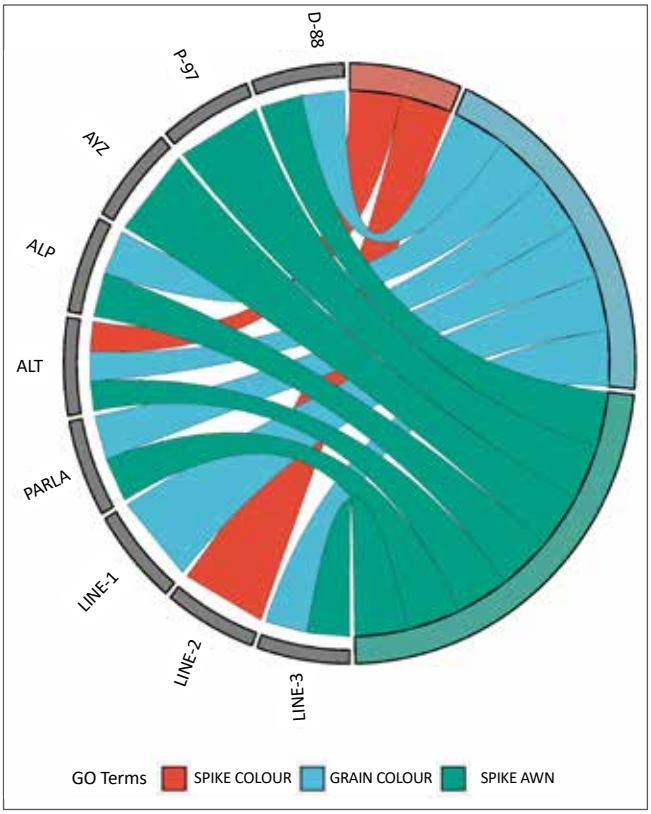

Figure 1. Go CHORD graph (Morphological characteristics of the genotypes in the trials).

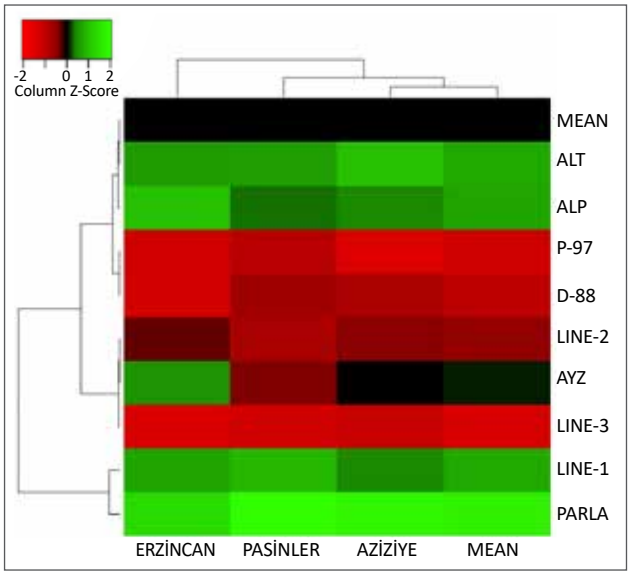

Figure 2. Heatmapper graph (Status of genotypes based on locations).

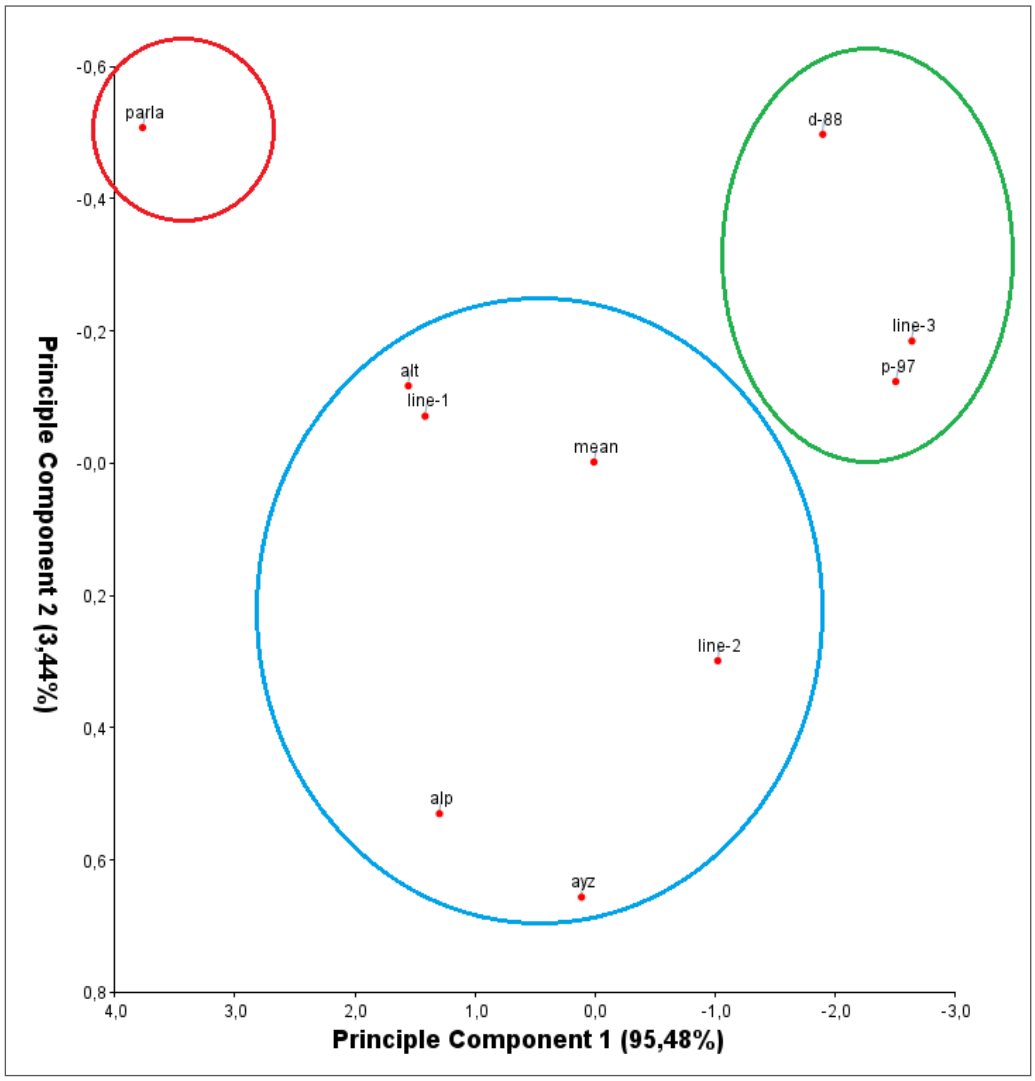

Figure 3. PCA graph (Grouping of genotypes).

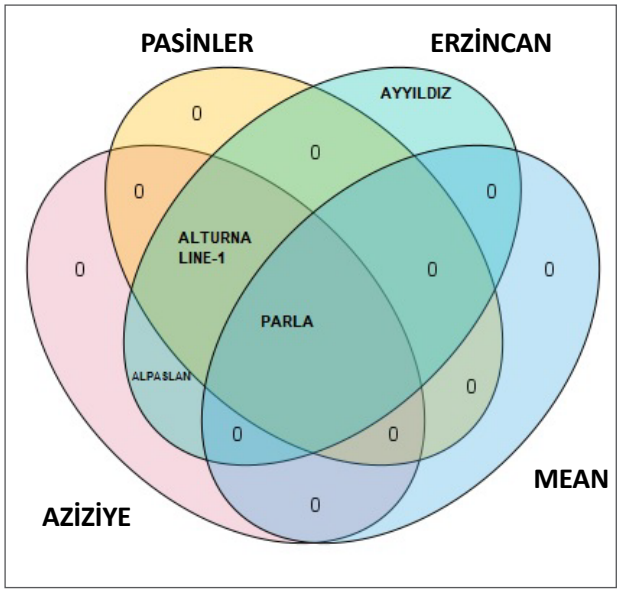

Figure 4. Venn graph (Prominent genotypes in locations).

Table 1. Yields of the genotypes based on locations in 2022 and 2023 (kg ha^{-1}).

GENOTİP	Yield (kg ha^{-1})											
	Aziziye			Pasinler			Erzincan			2022	2023	Mean
	2022	2023	Mean	2022	2023	Mean	2022	2023	Mean			
PARLA	4208.3	7119.4	5663.9	9102.8	5400.0	7251.4	1131.39	7652.8	9483.3	8203.3	6724.1	7466.2
	a	AB	A	A	CD	A	A	B	A	A	B	A
ALTURNA	2713.8	7522.2	5118.1	5297.2	6527.8	5912.5	9450.0	7666.7	8558.3	5820.4	7238.9	6529.6
	bc	A	AB	BC	A	B	A-C	B	AB	BC	A	B
LİNE-1	2925.0	6588.8	4756.9	6569.4	5716.7	6143.1	8958.3	8380.6	8669.4	6150.9	6895.4	6523.1
	a-c	BC	BC	B	BC	B	BC	A	AB	B	B	B
ALPARSLAN	3458.3	6055.6	4756.9	6013.9	5294.4	5654.2	10450.0	7655.6	9052.8	6640.7	6335.2	6487.9
	ab	CD	BC	B	DE	B	AB	B	AB	B	C	B
AYYILDIZ	2555.5	6452.8	4504.2	3966.7	5941.7	4954.2	9052.8	7900.0	8476.4	5191.7	6764.8	5978.2
	bc	C	B-D	D	B	C	BC	B	BC	CD	B	C
LİNE-2	2902.7	5580.6	4241.7	4100.0	5144.4	4622.2	7961.1	7166.7	7563.9	4988.0	5963.9	5475.9
	a-c	DE	C-E	CD	DE	CD	CD	C	C	CD	D	D
DOĞU 88	2366.7	5727.8	4047.2	4322.2	5088.9	4705.6	6230.6	6680.6	6455.6	4306.5	5832.4	5069.4
	bc	DE	C-E	CD	DE	CD	DE	D	D	DE	D	DE
PALANDÖKEN 97	1933.3	5305.6	3619.4	4447.2	4433.3	4440.3	6575.0	6500.0	6537.5	4318.5	5413.0	4865.7
	c	E	E	CD	F	CD	DE	D	D	DE	E	E
LİNE-3	1508.3	6158.3	3833.3	3394.4	4938.9	4166.7	5869.4	6730.6	6300.0	3590.7	5942.6	4766.6
	c	CD	DE	D	E	D	E	D	D	E	D	E
Average	**2730.2**	**6279.0**	**4504.6**	**5246.0**	**5387.3**	**5316.7**	**8429.0**	**7370.4**	**7899.7**	**5468.4**	**6345.6**	**5907.0**
	B	**A**	**C**	**ns**	**ns**	**B**	**A**	**B**	**A**	**B**	**A**	
LSD (P=0.05)	1463.7*	558.9**		1296.1**	383.9**		1886.2**	298.7**				
CV (%)	13	5	14	14	4	11	14	2	10	17	4	15
LSD (P=0.05)		Year: 486.1** Genotype: 757.4** Year x Genotype: 1071.2*			Year: 382.0 Genotype: 660.4** Year x Genotype: 933.8**			Year: 291.8** Genotype: 967.8** Year x Genotype: 1368.7**		Location: 461.9** Genotype: 890.2** LocxGen: 1541.9**	Location: 168.1** Genotype: 235.8** LocxGen: 408.4**	Year: 213.8** Genotype: 453.6** YearxGenotype: 641.5** LocxYear: 542.3** Genx Lok(Year):1111.1**

ns: non significant; **: significant at 0.01; *: significant at 0.05

Table 2. Quality values of varieties included in the trials.

Varieties	Grain color	SKCS (%)	1000 kernel weight (g)	Hectolitre weight (kg/hl)	Protein ratio (%)	Zeleny sedim. (ml)	Waiting sedim. (ml)	Water Absorb. (%)	Alveograph Energy (W)	Gluten (%)	Gluten index (%)	Flour yield (%)
Doğu 88	Red	60,11	34	78,8	13,94	48	48	62,9	219	33,5	26,5	61,0
Palandöken 97	White	13,44	39	77,2	13,86	36	34	54,0	158	31,4	43,8	57,3
Ayyıldız	White	77,6	35	76,8	14,97	41	61	62,9	422	23,8	97,9	57,0
Alparslan	Red	64,14	29	77,2	15,18	70	72	63,0	403	37,6	87,0	56,8
Alturna	Red	70,15	38	78,4	13,80	61	73	63,5	429	29,8	93,3	65,2
Erzurum B1 (PARLA)	Red	63,41	34	78,0	15,6	59	61	63,0	400	42,3	93,0	62,3

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