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Performances of Popcorn Hybrids in Three Geographical Regions of Turkey Based on Yield and Quality Traits

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ABSTRACT

Evaluation of popcorn experimental hybrids in different geographical regions gives valuable clues to breeders in selection of best hybrids for the target environments. In the present study, 49 popcorn crosses (44 test hybrids and 5 commercial checks) were tested in three different ecological condition in Turkey. A 7×7 lattice design using three replications were used. The field experiments of this research was carried out in Samsun (Northern Turkey), Çankırı (Middle Anatolia) and Antalya (South Anatolia) ecological conditions in 2016. Yield and quality parameters such as popping volume, unpopped kernels ratio and kernel size were determined. According to the results, 10 hybrids have a high performance over than 5 commercial checks. Yield and quality results showed that TBCM2015-41, 56, 62, 76 and 80 candidate hybrids were promising popcorn hybrids for the tested environments.

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Introduction

Zea mays belongs to the *Gramineae* family (Wheatgrass) and is divided into seven sub groups. Among these groups popcorn has a special significance thanks to rich nutrient content, high vitamins and minerals [1]. Popcorn also is a prudent choice for those wanting to reduce feelings of hunger while managing energy intake and ultimately, body weight [2]. A major trait that distinguishes popping maize from other types of maize is a formation of large flake after kernel popping as a response to the heat treatment [3]. Popcorn, flint corn and dent corn are different each other by grain appearances. The most important observation in terms of seed differences is the shape and size of the seeds. Popcorn is smaller and has a thicker layer of endosperm than other two types. High quality hybrid popcorn must have high and stable yield and high level of popping volume [4].

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The popping volume (PV) is the most important parameter of quality and principal trait distinguishing popping maize from other types of maize [3]. Major quality characteristics of popcorn is high PV, a good appearance, low unpopped kernel rate and kernel size. Popcorn varieties traded in the world, consist of many different species in terms of seed color, size and seed shape. No industry standards have been developed for kernel size determinations; but a commonly used measure is based on number of kernel in 10 grams and defines kernel size as follow: 52-67= large, 68-75=medium and 76-105= small, >105=very small [5].

Turkey's popcorn cultivation has increased significantly in recent years. However, production is not enough for the demand of the country. Turkey imports popcorn as a result of insufficient production [6]. Popcorn agriculture is made with farmer contract ten thousand ha in Turkey. The consumption of popcorn is dramatically increased after 1980's depend on rise of shopping centers and cinema in Turkey [7]. Hybrids with high yield and quality are needed for the country.

The objective of this research was to determine new popcorn hybrids with high yield and quality which can meet the demands not only producers but also consumers.

Materials and Methods

In the present study, 44 experimental hybrids plus 5 commercial checks total 49 popcorn crosses were tested in three regions of Turkey. The research was carried out in Antalya Bati Akdeniz Agricultural Research Institute (BATEM) (36053' N, 30042' Mediterranean of Turkey), Samsun Black Sea Agricultural Research Institute (KTAE) (41016' N, 36020' Northern Turkey) and Çankırı Karatekin University (40032'N, 33035' Middle Anatolia) ecological conditions in 2016. The meteorological conditions of locations during growing seasons are shown in Table 1. Hybrid seeds obtained from three locations were also used for quality analysis.

Tablo 1 The meteorological conditions of locations during growing season of 2016

	Antalya		Samsun		Çankırı	
	Temperature (°C)	Precipitation (mm)	Temperature (°C)	Precipitation (mm)	Temperature (°C)	Precipitation (mm)
April	18.2	11.0	13.7	44.4	12.2	52.5
May	20.3	15.0	16.3	191.8	16.5	57.0

June	26.1	18.0	21.4	98.5	22.0	50.2
July	29.1	0.0	23.5	50.9	24.3	22.5
August	26.6	0.0	24.7	59.0	23.2	20.2
September	24.6	24.0	19.5	108.2	20.2	18.5
October	21.3	5.0	14.6	39.6	12.5	31.7
November	14.7	78.0	10.6	94.3	7.8	35.8
Avaerage/ Sum	22.6	151.0	18.04	686.7	17.34	288.4

The field experiments were conducted in a 7×7 lattice design with three replications. Plots consisted of two rows. Row length was 5.0 m. 0.18 m and 0.70 m were used as on row and inter row distances, respectively. All cultural practice used in the experiments were as follow; Fertilizing was made as pure 8 kg phosphorus and 20 kg N/ha totally per decare according to soil analysis. All phosphorus and 8 kg/ha of nitrogen were given at the time of sowing as bottom fertilizer, the rest of the nitrogenous fertilizer was applied in four equal parts using drip irrigation system. Planting of popcorn seeds were done in 10th of April in Antalya location, in 2nd of May in Samsun location, in 18th of May in Çankırı location. Crops were harvested on September 20-22 in Antalya location, on October 20-22 in Samsun location, on November 1-2 in Çankırı location. The harvesting process was done manually on different dates because of plants reached to harvesting status at different dates. Experiment plots were harvested, measured and adjusted to 15% kernel moisture content to obtain grain yield (GY). Below formula was used for determination of GY. GY= Plot weight x [(100- grain moisture % /85) x ((Grain / ear ratio)/100)] Popping volume (PV), unpopped kernels ratio (UKR), kernel size (KS) traits were examined in Karamanoglu Mehmetbey University Food Engineering Department Laboratory in 2017. PV (cm^3g-1) was determined according to methods described [8]. A hot air popping machine was used for PV. The moisture content of samples was 10±0.5% before popping. Popped samples were poured into a 2000 mL plastic graduated cylinder, and volume recorded [6]. The method described by [9] was used for UKR (%). For UKR, before and after popping, the number of kernels for each sample was counted according to following formula. Percentage of unpopped kernel ratio= (Number of total unpopped kernels / Original number of kernels)×100. KS (number/10g) was measured according to [5]. All data obtained within this study was analyzed according to ANOVA procedures.

The multiple comparison of the group averages were made according to LSD multiple range tests.

Results

The difference between genotypes, locations and genotype by environment interactions for GY, PV, UKR, KS traits were found statistically significant at P <0.01 (Table 2). Due to significant environmental interaction, the locations were evaluated separately (Supplementary Table 3).

Table 2 Analysis of variance (ANOVA) for investigated traits

Source	DF	GY	PV	UKR	KS
Blok(Rep)	18	0.7315	0.0863	0.2046	0.4108
Replication	2	0.0061	<.0001	0.2450	0.5602
Location	2	<.0001	<.0001	<.0001	<.0001
Genotype	48	<.0001	<.0001	<.0001	<.0001
Genotype x location	96	<.0001	<.0001	<.0001	<.0001
LSD		66.81	0.29	1.86	2.20
CV (%)		11.79	1.23	10.63	2.74

The mean performances of the 49 popcorn crosses were given in supplementary Table 3. The average GY of genotypes was found to be 4.18 t ha-1, and it was varied between 1.91 t ha-1 (TBCM2015-86) and 6.75 t ha-1 (TBCM2015-56) in Antalya Location. Mean experiment yield in Çankırı location was 6.0 t ha-1. Yields varied between 3.85 t ha-1 (TBCM2015-61) and 7.39 t ha-1 (TBCM2015-80) in Çankırı site. Yields in Samsun location were changed between 4.52 t ha-1 (TBCM2015-99) and experiment average was 7.13 t ha-1 (TBCM2015-80) for this location (Supplementary Table 3).

The mean of PV of genotypes was found as 24.73 cm^3g-1 and the PV ranged from 19.5 (TBCM2015-89) to 30.5 (TBCM2015-76) cm^3g-1 in Antalya site. Experiment average for PV in Çankırı was found 23.39 cm^3g-1, and it was varied between 12.0 (TBCM2015-86) and 31.5 (TBCM2015-68) cm^3g-1. Experiment average was 19.3 cm^3g-1 in Samsun location and PV varied in that location from11.3 (TBCM2015-72) to 35.2 (TBCM2015-93) cm^3g-1 (Supplementary Table 3).

The average UKR of the genotypes was found 6.4%, and it varied from 2.2 (TBCM2015-76) to 12.3 (TBCM2015-52) % in Antalya Location. An experiment average was found to be 23.5% for Çankırı location. UKR was changed between 5.2 (TBCM2015-70) and 44.8 (TBCM2015-65) % in this location. It was found that experiment average was 20.3% UKR in Samsun. Values were changed between 3.3 (Baharcin) to 52.3 (TBCM2015-49) % in this location (Supplementary Table 3).

The KS ranged from 72.3 (TBCM2015-71) to 116.3 (TBCM2015-86) number/10g and the average of KS was found 84.8 number/10g in Antalya Location. Values in this location ranged from 48.0 (TBCM2015-100) to 131.7 (TBCM2015-65) number/10g. In Çankırı location experiment average was 72.0 number/10g and values were changed between 56.7 (TBCM2015-71) and 93.6 (TBCM2015-47) number/10g. It was found that experiment average 73.2 number/10g in Samsun (Supplementary Table 3).

Discussion

According to the mean GY values, Çankırı location was the best, while Antalya was the worst. Location ecological conditions may affect the GY. Especially, unfavorable high temperature during flowering period seemed to be one of the reason for low yield in Antalya location when compared to Çankırı. While mean of checks for GY was 5.20 t ha-1 (the highest of them is 5.46 ton ha-1, Nermincin), 17 genotypes (TBCM2015-80, 56, 52, 68, 46, 87, 53, 81, 62, 98, 93, 92, 96, 73, 101, 70, 60) gave higher GY than 5.46 t ha^{-1} respectively.

GY is one of the most important trait for both producers and consumers. The GY of popcorn usually depends on genotype and growth conditions [10]. Different genotypes had different grain yield in different environments [6], [11]. GY of Antcin-98 and Nermincin hybrids reported to be 3.75 and 4.47 t ha-1 respectively in a study [12]. It was reported that GY of popcorn hybrids varied from 2.72 to 4.64 t ha-1 in Turkey [13]. [14] Researcher investigated 30 single cross popcorn hybrids and reported that the mean of genotypes were 4.38 t ha-1 for GY, yield ranged from 3.55 to 5.40 t ha-1. A research team investigated grain component of eight popcorn varieties and reported GY of popcorns ranged from 3.73 to 5.38 t ha-1 [15]. It was reported GY of popcorns ranged from 4.78 to 7.38 t ha-1 [16]. Our results are generally similar those studies were given. According to the average of PV of genotypes, the highest value was obtained from Antalya location, while lowest result obtained from Samsun. The studies showed that GY and PV is negatively correlated [1, 17-20]. Yield was found to be the lowest in the Antalya location, but the high PV at the same location confirms the negative relationship. Again, nonpopped kernels reduce the volume of the PV. The high nonpopped kernel rate (6.4%) in the Antalya location might be effective in finding the high PV volume. While mean of checks for PV is 24.57 cm^3g-1 (the highest of them was 26.90 cm^3g-1 (Baharcin), 3 genotypes (TBCM2015-41, 76, 93) had higher PV values than 26.90 cm^3g-1 respectively. In a study carried out with 35 inbred popcorn lines, mean of the genotypes for PV determined as 19.49 cm^3g-1 [21]. The researchers reported that there was an important positive correlation between PV and kernel size, and negative correlation between PV and UKR. It was reported that PV changed from 19.79 cm^3g-1 to 22.92 cm^3g-1 in another study [22]. Our results seem to be higher than other reports. Hybrids potential for these traits probably increased the values in our study. It was reported that the means of PV was 42.00 cm^3g-1 and changed from 38.20 cm^3g-1 to 46.50 cm^3g-1 [14]. In another study PV changed from 28.00 cm^3g-1 to 40.17 cm^3g-1 [16]. Our results in terms of these traits were lower than mentioned studies. It is thought that both environment and genotypes affected the different results.

UKR is one of the most important quality parameter and significantly affects the PV. Popcorn consumers prefer high PV, delicious, low gumminess, and low unpopped kernel. Also crop breeders have been striving to develop genotypes with superior grain yield, quality and other desirable characteristics over a wide range of different environmental conditions. As a result of this research, it was determined that genotypes TBCM2015-76,78,53,75 and, 70 are promising as low 12% according to UKR.

KS is another important quality trait and affects indirectly PV UKR [23]. Home consumers generally prefer small kernel types. Vendors usually prefer larger kernel, while medium kernels preferred by both home users and vendors [5].

Four of the hybrids studied in this research, (TBCM2015-100, 71, 46 and Antcin98) were in the small class (52-67 number/10g), 16 of them (TBCM2015-48, Elacin, 99, 83, 82, 98, 44, 60, SH9201, 53, 92, 87, 64, 96, 45 and 103) were in the medium class (68-75 number/10g) and 29 of them (TBCM2015-80, Baharcin, 70, 84, 49, 77, 56, 52, 68, 81, 97, 62, 43, 72, 61, Nermincin, 55, 101, 75, 73, 76, 78, 93, 47, 86, 65 and 67) were in the large class (78-105 number/10g). It was suggested that larger-sized grains produced greater flake size than small-medium sized grain [24].

In this research genotype x environment interaction (GEI) was statistically significant at P <0.01. Likewise [25] reported that there was a significant GEI in popcorn hybrids evaluated in different locations of Turkey. In maize breeding, the effects of Genotype x Environment interaction on the stability and adaptability are very important because of the fact that every cultivar has a connatural capacity to respond to the changes of environment [26]. But especially in popcorn, the correlations between the stability and adaptability statistics are not yet well understood, and selection of genotype based on the average crop yield is ineffective [27]. There are many methods to determine stability analysis. In the regression methods, it is assumed that performance of genotypes will may increase in good environmental. Hence, it is important to know not only average performance of genotypes but also magnitude of the genotype x environment interaction in the selection. [25].

The researchers proposed a model to test the stability of varieties under various environments [28]. They defined a stable variety as having unit regression over the environments (b= 1.00) and minimum deviation from the regression (S2di= 0).

Therefore, a variety with a high mean yield over the environments, unit regression coefficient (b=1) and deviation from regression as small as possible (S2d= 0), will be a better choice as a stable variety. The average results of both grain yield and PV and stability analyze of popcorn genotypes investigated three locations were given in Table 4, the diagrammatic presentation of GY and PV were given figure 1, 2 respectively.

Table 4 The stability parameters for both GY and PV in popcorn genotypes in three different environments

	Grain Yield (GY)						Popping Volume (PV)					
	X	b	a	VK	r2	S^2d	X	b	a	VK	r2	S^2d
2015-41	514.83	1.7	-391	0.06	0.94	3957.5	29.93	-0.83	48.65	0.01	1	0.05
2015-43	447.96	1.51	-356.6	0	1	3.41	23.23	1.67	-14.43	0.14	0.75	15.13
2015-44	525.85	0.49	263.02	0.08	0.47	5563.4	19.3	1.5	-14.49	0.14	0.71	14.27
2015-45	519.94	1.05	-41.71	0.11	0.65	12289	21.73	2.27	-29.27	0.23	0.68	38.88
2015-46	599.79	0.73	211.9	0.04	0.86	1707.7	21.93	0.88	2.05	0.14	0.45	14.98
2015-47	412.09	1.52	-400.7	0.02	0.99	513.51	19.77	0.3	13.01	0.11	0.14	8.9
2015-48	518.44	0.46	272.57	0.11	0.27	11675	24.43	2.55	-32.81	0.06	0.98	2.58
2015-49	531.38	0.44	295.54	0.02	0.94	243.62	22.53	3.1	-47.26	0.23	0.79	41.56
2015-52	613.88	0.34	434.7	0.07	0.33	4615.7	22.33	2.55	-34.94	0.17	0.82	21.78
2015-53	590.37	0.58	281.75	0.11	0.38	11299	25.43	0.41	16.23	0.14	0.15	14.6
2015-55	503.49	1.17	-121.4	0.01	0.99	206.43	21.93	1.08	-2.31	0.29	0.23	62.33

2015-56	638.88	-0.31	801.68	0.01	0.97	51.68	20.57	2.26	-30.24	0.01	1	0.07
2015-60	547.73	0.49	285.9	0	1	3.53	20.2	2.24	-30.2	0.12	0.88	10.74
2015-61	466.53	0.72	82.73	0.2	0.22	37265	20.6	2.03	-24.99	0.1	0.9	6.92
2015-62	580.67	-0.07	617.18	0.05	0.03	2692.6	20.6	3.01	-47.05	0.05	0.99	2.06
2015-64	486.1	1.36	-240.9	0.05	0.93	2847.2	20	2.07	-26.53	0.03	0.99	0.86
2015-65	540.76	1.58	-303.5	0.01	1	152.63	20.13	0.95	-1.13	0.05	0.9	1.59
2015-67	453.95	0.91	-29.82	0.08	0.73	6174.6	21.07	0.92	0.43	0.01	0.99	0.15
2015-68	613.16	0.49	349.59	0.01	0.99	74.36	23.9	2.29	-27.51	0.26	0.62	51.54
2015-70	552.12	0.28	404.44	0.01	0.96	61.44	23.87	0.52	12.08	0	1	0.01
2015-71	529.03	0.84	81.37	0.05	0.84	2757.2	23.03	0.53	11.02	0.12	0.29	11.14
2015-72	531.57	1.29	-156	0.04	0.96	1487.2	19.03	2.44	-35.88	0.01	1	0.04
2015-73	563.66	1.5	-235.6	0.02	0.99	315.13	23.3	2.48	-32.49	0.13	0.89	12.32
2015-75	481.1	1.16	-137.1	0	1	3.57	22.37	1.99	-22.46	0.1	0.9	6.99
2015-76	545.04	1.35	-173.4	0.07	0.9	4200.9	27.43	-0.22	32.37	0.22	0.02	36.47
2015-77	530.86	0.57	227.49	0.04	0.83	1313.7	25.47	0.21	20.85	0.18	0.03	25.42
2015-78	514.75	1.75	-416.3	0	1	13.01	22.07	1.74	-17.04	0.05	0.96	2.18
2015-80	692.31	0.59	378.1	0.01	0.98	124.28	20.63	1.94	-22.99	0.17	0.73	22.38
2015-81	587.72	1.36	-140.5	0.05	0.94	2491	23.7	-1.5	57.53	0.03	0.99	0.52
2015-82	481.49	1.29	-208.4	0.05	0.92	2794.5	20.6	2.2	-28.83	0.09	0.93	5.92
2015-83	543.84	0.07	508.85	0.09	0.01	7614.3	21.77	2.15	-26.55	0.02	1	0.24
2015-84	528.51	0.35	341.75	0.09	0.22	8666	22.63	1.22	-4.8	0.04	0.96	0.94
2015-86	423.83	2.05	-671.5	0.07	0.94	5072.7	16.03	1.21	-11.13	0.24	0.35	42.78
2015-87	593.15	0.47	342.8	0.12	0.25	13574	23.17	2.04	-22.66	0.05	0.98	1.58
2015-92	570.12	-0.06	600.5	0.03	0.06	1128.3	18.83	0.48	8.04	0.31	0.05	74.53
2015-93	572.1	0.87	106.68	0.13	0.48	16472	26.97	-2.55	84.2	0.04	0.99	1.2
2015-95	519.75	1.09	-63.01	0.14	0.57	18445	19.1	2.1	-28.02	0.06	0.97	2.35
2015-96	568.9	1.04	12.81	0.08	0.78	6164.5	20.53	-1.78	60.49	0.31	0.4	73.54
2015-97	530.23	0.98	9.67	0.05	0.9	2046.5	22.33	-0.37	30.56	0.28	0.03	60.57
2015-98	574.53	1.29	-113.6	0.1	0.79	9108.6	23.37	0.06	21.93	0.09	0.01	5.72
2015-99	459.45	1.66	-425.4	0.12	0.79	15049	22.27	-0.86	41.6	0.05	0.85	2.01
2015-100	440.36	1.69	-461.3	0.01	1	43.49	25.77	0.6	12.37	0.2	0.15	31.41
2015-101	561.46	1.79	-394.9	0.08	0.9	6869.6	19.7	1.15	-6.07	0.04	0.96	0.94
2015-103	540.76	0.77	129.24	0.01	0.99	105.55	25.43	-0.75	42.28	0.19	0.25	26.74
Antcin-98	542.66	1.71	-371	0	1	1.34	23.6	1.38	-7.4	0.16	0.61	19.37
Baharcin	530.66	1.78	-419.1	0.06	0.95	3463.4	26.9	-1.79	67.15	0.24	0.55	41.95

Elacin	542.99	1.63	-324.2	0	1	17.53	26.1	-1.65	63.24	0.13	0.77	12.79
Nermincin	545.68	1.07	-24.39	0.03	0.97	720.31	21.2	2.24	-29.24	0.23	0.66	40.15
Sh9201	437.87	1.61	-419.1	0.06	0.94	3274.4	25.07	0.55	12.66	0.14	0.26	14
Confidence interval	¯x=±18.0						¯x=±0.17					

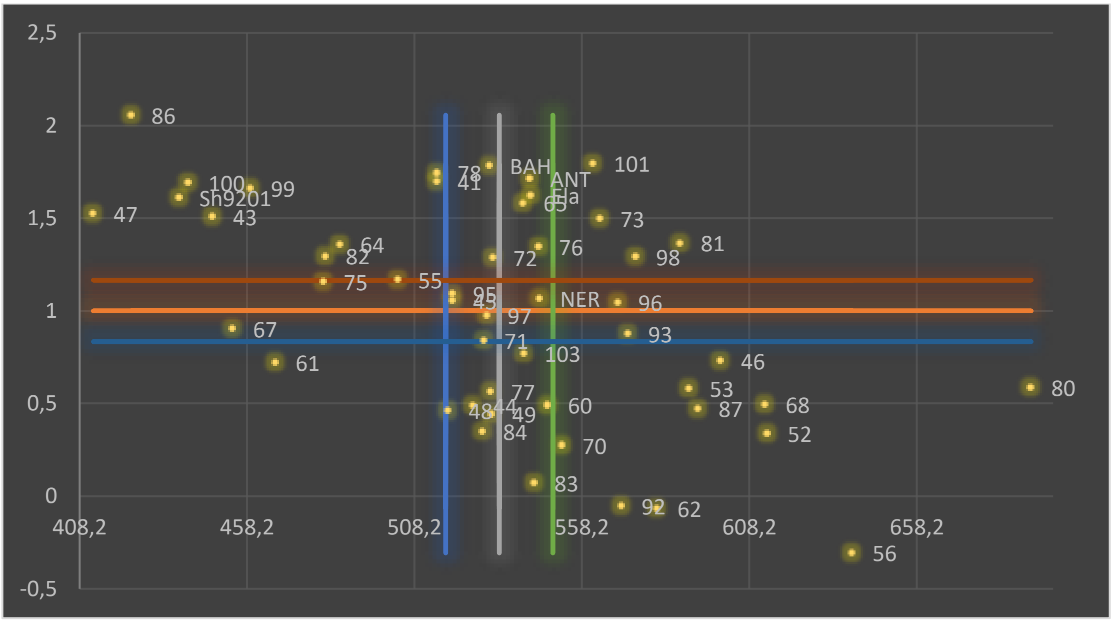

Fig 1 Scattered diagram for GY of popcorn genotypes in three locations

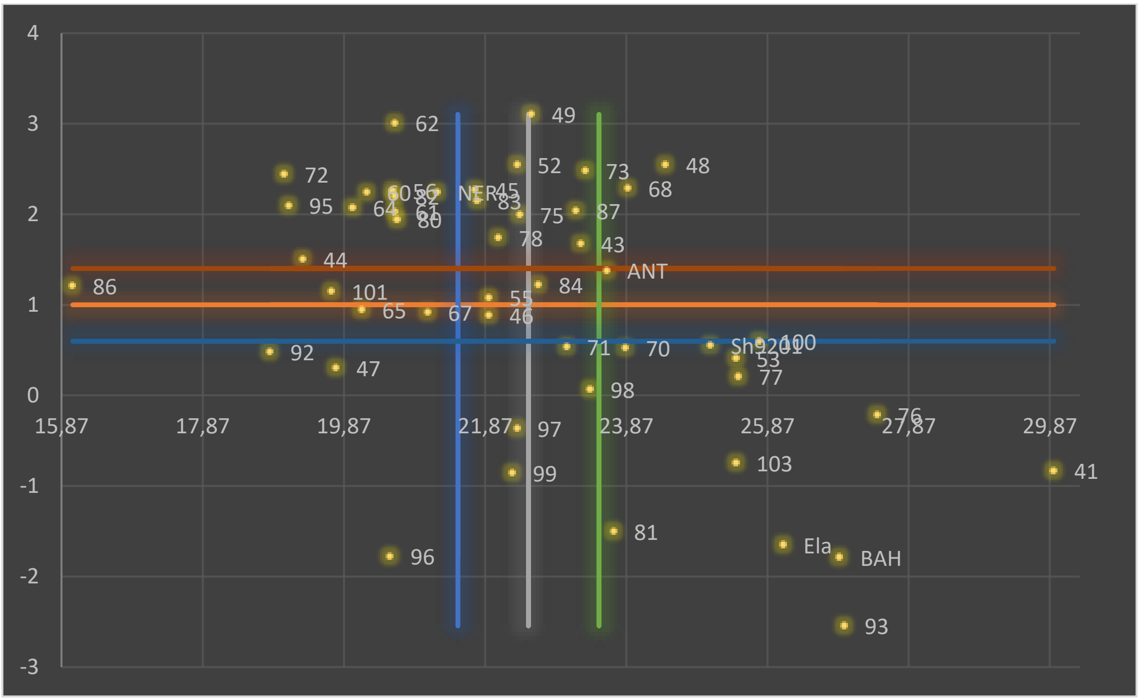

Fig 2 Scattered diagram for PV of popcorn genotypes in three locations

The GY of experimental varied between 4.12 and 6.92 t ha-1. The highest GY of experimental mean was found in TBCM2015-80, TBCM2015-56 and TBCM2015-52 respectively. While the highest of checks for GY is 5.46 t ha-1 (Nermincin), the 30 genotypes gave higher GY than Nermincin (Supplementary Table 3). TBCM2015-43,60,75,78 and 100 genotypes are thought as the most stabile genotypes due to b and R2 values of them are closed 1 and 0. TBCM2015-52, 56 and 52 genotypes giving the highest GY in research have shown good adapt in good environmental condition about GY. According to researchers [28] , TTM2015-56, 87 and 95 genotypes are thought as the most stabile genotypes due to b and R2 values of them are closed 1 and 0 respectively.

Conclusion

As a result of the research, TBCM2015-41, 56, 62, 76, 80 and 93 popcorn hybrids selected for their high yield and quality characteristics. These popcorn hybrids are promising and could be used to meet both producer and consumer demands in the future.

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Supplementary Table 3 Mean grain yield (t ha -1), popping volume (cm³ g-1), unpopped kernel ratio (%) and kernel size (number/10g) obtained from popcorn hybrids across locations

	Genotype	Grain Yield (GY)			Popping volume (PV)			Unpopped kernel (UKR)			Kernel Size (KS)		
		Antalya	Çankırı	Samsun	Antalya	Çankırı	Samsun	Antalya	Çankırı	Samsun	Antalya	Çankırı	Samsun
1	2015-41	3.14	5.85	6.46	28.2	29	32.6	8.4	11.3	36.9	92.3	71.7	67.7
2	2015-43	2.73	5.47	5.24	24.7	27.8	17.2	6.1	23.8	30.0	95.7	65.7	74.3
3	2015-44	4.64	5.08	6.05	24.9	17.7	15.3	5.4	26.1	30.9	76.3	63.3	73.3
4	2015-45	3.90	5.15	6.54	30.5	18.9	15.8	4.1	40.7	33.2	87.7	72.0	64.3
5	2015-46	5.18	6.76	6.05	26.2	19.7	19.9	7.3	28.6	17.1	73.0	56.3	69.3
6	2015-47	2.34	4.98	5.05	22.2	17.7	19.4	6.1	39.4	9.7	91.0	72.0	96.3
7	2015-48	4.72	6.21	4.62	29.2	28	16.1	9.5	14.7	12.0	75.0	64.3	65.3
8	2015-49	4.79	5.50	5.65	25.7	30.4	11.5	11.8	17.4	52.3	83.7	79.3	65.0
9	2015-52	5.79	6.82	5.80	25.3	28.3	13.4	12.3	11.6	18.7	74.7	79.7	77.3
10	2015-53	5.30	7.00	5.41	24.1	28.8	23.4	5.4	11.4	16.2	79.0	60.7	77.3
11	2015-55	3.67	5.71	5.72	19.7	29.1	17.0	7.5	18.8	16.2	81.7	82.0	79.7
12	2015-56	6.75	6.24	6.18	25.8	22.4	13.5	4.3	22.1	18.5	84.3	70.0	76.7
13	2015-60	4.91	5.79	5.74	23.3	24.8	12.5	3.2	15.2	19.9	82.3	73.7	57.3
14	2015-61	3.70	3.85	6.45	23.6	24.5	13.7	6.2	24.4	34.8	89.0	87.0	60.7
15	2015-62	5.92	6.11	5.39	28.2	22.2	11.4	9.2	25.5	16.9	90.7	68.0	75.7
16	2015-64	3.25	5.40	5.93	24.1	22.6	13.3	10.4	14.5	33.2	78.7	71.3	69.7
17	2015-65	3.58	6.54	6.10	23	20	17.4	6.8	44.8	16.4	85.0	131.7	68.0
18	2015-67	3.44	4.61	5.57	22.9	22.2	18.1	4.0	40.5	12.9	95.3	125.0	94.7
19	2015-68	5.55	6.40	6.44	24.8	31.6	15.3	6.0	37.1	18.2	84.7	70.0	79.0
20	2015-70	5.20	5.65	5.72	25	24.4	22.2	11.4	5.2	18.6	83.0	81.0	62.7

21	2015-71	4.28	5.49	6.10	26.2	20.9	22.0	10.5	30.5	29.8	72.3	69.7	56.7
22	2015-72	3.85	6.43	5.67	24.4	21.4	11.3	7.0	20.0	43.7	90.3	81.3	64.3
23	2015-73	3.89	6.51	6.51	26.8	28.3	14.8	4.4	18.0	16.2	88.0	75.0	89.7
24	2015-75	3.47	5.59	5.37	28.4	22.1	16.6	4.8	21.6	8.8	88.7	72.3	90.7
25	2015-76	3.85	5.91	6.60	30.5	22.5	29.3	2.2	17.7	9.2	92.0	74.0	87.7
26	2015-77	4.63	5.44	5.86	28.9	21.7	25.8	9.6	25.6	9.7	78.7	71.3	79.3
27	2015-78	3.13	6.33	5.99	25.1	24.8	16.3	6.5	18.2	7.5	89.0	75.0	91.0
28	2015-80	6.25	7.39	7.13	22.2	26.1	13.6	6.2	28.2	21.2	86.3	56.7	82.3
29	2015-81	4.26	6.45	6.92	19.9	22.9	28.3	7.7	17.3	16.3	85.3	78.0	70.7
30	2015-82	3.35	6.03	5.07	24.1	24.5	13.2	3.0	10.2	30.7	85.0	66.3	59.0
31	2015-83	5.30	4.90	6.12	26.3	24.1	14.9	3.6	21.1	34.2	82.7	65.3	61.7
32	2015-84	4.82	4.89	6.15	24.8	24.5	18.6	8.8	16.8	21.3	92.7	66.3	68.7
33	2015-86	1.90	6.08	4.73	22.6	12	13.5	7.4	43.8	28.8	116.3	70.7	75.3
34	2015-87	5.46	7.02	5.31	27	26	16.5	2.3	24.7	12.1	77.7	60.0	80.3
35	2015-92	5.74	5.44	5.92	25	12.5	19.0	7.3	24.1	12.3	79.7	61.7	76.0
36	2015-93	4.79	7.16	5.21	21.9	23.8	35.2	2.3	25.2	9.0	91.7	74.0	89.7
37	2015-95	3.84	5.01	6.74	22.9	22.2	12.2	3.0	21.8	14.7	81.7	64.0	82.3
38	2015-96	4.53	6.91	5.63	21.6	12.2	27.8	6.9	36.7	7.9	84.0	61.7	77.3
39	2015-97	4.20	6.25	5.45	26.1	15.9	25	2.2	30.8	6.6	85.0	65.7	83.3
40	2015-98	4.31	7.24	5.68	22.1	25.3	22.7	3.0	23.2	27.6	83.7	64.7	63.0

41	2015-99	2.75	6.52	4.51	19.5	22.6	24.7	6.5	17.4	18.8	80.7	67.7	60.3
42	2015-100	2.45	5.57	5.20	23.8	30.7	22.8	7.6	20.4	20.9	80.3	48.0	57.3
43	2015-101	3.59	7.36	5.90	21.7	21.5	15.9	5.1	9.5	25.8	91.7	90.7	69.0
44	2015-103	4.51	5.85	5.87	26.8	20.7	28.8	6.4	17.2	30.4	85.3	80.3	59.3
45	Antcin-98	3.44	6.57	6.27	24.1	28.3	18.4	6.7	21.5	38.2	80.7	60.0	59.7
46	Baharcin	3.20	6.09	6.63	26.7	20.2	33.8	8.7	37.7	3.3	73.3	67.7	84.7
47	Elacin	3.55	6.53	6.21	24.5	21.8	32	6.6	28.3	4.7	78.7	55.7	74.0
48	Nerminci	4.20	5.98	6.19	22.5	28.2	12.9	5.1	37.4	7.0	88.7	70.7	79.3
49	Sh9201	2.55	5.83	4.76	24.1	28.5	22.6	5.4	13.2	14.8	83.7	68.7	61.3
Standards Mean		3.39	6.20	6.01	24	25	24	6	27.6	13.6	81.0	64.5	71.8
Genotypes Mean		4.26	5.97	5.81	25	23	19	6	23.0	21.0	85.3	72.8	73.4
Experiment Mean		4.18c	6.00a	5.83b	25a	23b	19c	6	23.5	20.3	84.8	72.0	73.2
CV (%)		13.2	11.7	10.8	1.06	1.07	1.67	13.08	8.58	10.46	2.54	2.93	2.74
LSD		1.02	1.29	1.62	0.48	0.46	3.89	1.55	3.75	3.68	3.95	3.93	3.68
F		<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001