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Original article

Cultivation of Local Popcorn Genotypes as a Second Crop in Kahramanmaras Conditions

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Abstract

Popcorn is a snack plant with widespread consumption in our country and around the world. Although the increasing commercialization rate in agriculture with the spread of hybrid varieties has narrowed the production area of local plant species, the production of local pop corn varieties still continue today. Therefore, in this study, 17 local popcorn genotypes and 3 commercial popcorn cultivars were grown as the second crop in Kahramanmaraş climatic conditions. In the study, local popcorn genotypes were determined by plant height, first ear height, first node diameter, ear length, ear diameter, the row number of ear, the number of grain on the ear row, number of ears per plant, and ear tassel-out time, ear silk-out time, grain yield per decare and the relationships between these properties were investigated. According to the results of the research, the plant height of the local popcorn populations was 216 - 166 cm, the height of the first ear 107 -63 cm, the diameter of the first node 22.6 - 16.7 mm, the diameter of the node of ear 16.4 -11.8 mm, ear length 17.267 – 12.833 cm, ear diameter 32.513 – 26.120 mm, the row number of ear 16.8 -12.26, the number of grain on the ear row 38.86 -26.33, the number of ears per plant 1.8 -12 pieces, ear silk-out time 56 -48 days, the ear tassel-out time 68 -56 days and grain yield per decare 478 -260 kg da-1. In the study, positive correlations were found between first ear height and plant height, ear length and ear diameter, the number of grain on the ear row and ear length, the ear tassel-out time and grain yield per decare, ear silk-out time and first node diameter, ear silk-out time and the ear tassel-out time.

Keywords: Popcorn, Local Genotypes, Grain Yield, Correlation.

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INTRODUCTION

Corn is an important cereal plant that ranks third in the world after wheat and paddy in terms of grain cultivation area and second in terms of production (Tekkanat and Soylu 2005). In our country, corn has the largest cultivation area after wheat and barley among cereals, and it is produced as the main product and second product. Dent corn and flint corn varieties constitute the majority of corn grown both in the world and in our country (Şahin and Kara 2021). Corn is also widely used in the human diet and is often referred to as "popcorn". The economic value and usage areas of corn, which is an important plant in our country, are increasing day by day. Corn grain contains about 70% starch, 10% protein, 5% oil, 2% ash (Tekkanat and Soylu 2005). Corn plant has 600 thousand hectares of cultivation area, 6.5 million tons of production and an average yield of 939.2 kg/da in Turkey (TUIK, 2021). While 70% of the total corn produced in the world is used in animal nutrition, 25% in human nutrition and 5% in industry as raw material, popcorn, whose consumption is increasing in our country, is directly used in human nutrition (Tekkanat and Soylu 2005).

The popcorn plant differs from other maize subspecies in terms of grain size and usage area. The plant height of popcorn is shorter, leaf, cob and grain sizes are smaller and harder than flint corn, horsetooth corn and sweet corn. Corn is mostly consumed as a human food as a snack in the form of popcorn and a small amount is used in the confectionery industry. Popcorn is a good dietary product due to its vitamins, minerals, high carbohydrate, low calorie and fat content, keeping it full and absorbing stomach acid (Ülger 1998).

Corn is grown as the main and second crop in Kahramanmaraş conditions. In addition to the fact that the cultivation of the main crop corn is more common, the second crop corn is planted in the regions where irrigation conditions are suitable, and the vacant planting land is evaluated. When the products that are compatible with each other in the second crop planting are in rotation, both sustainability in agriculture is ensured and soil monoculture is protected from the negative effects of agriculture. Popcorn is in the class of foreign pollinated plants and hybrid seed use is common. Commercial hybrid corn production suitable for all regions and conditions has accelerated the extinction of local varieties. The widespread use of hybrid varieties, the use of too many inputs and the increasing commercialization rate in agriculture have narrowed the production area of local plant species (Tekkanat and Soylu 2005).With the use of hybrid varieties in corn breeding, open pollinated populations have left their place to hybrid varieties. However, genetic variation in maize has narrowed significantly with hybrid breeding (Troyer, 2001). Although high-yielding hybrid varieties predominate, native varieties are still cultivated in some areas. When breeding needs to be done in line with the new needs that may arise over time, there is not much action within the narrow genetic diversity available (Kahriman et al.2019). Village populations, whose production is locally limited, are valuable as an important gene source in such cases. Our local corn varieties have been able to produce products in generally unfavorable conditions by completing

their natural selection in their current environment. Even within themselves, the characteristics of local varieties with different genetic variations can complement each other's deficiencies and be superior to commercial varieties in terms of some characteristics (Allard and Bradshaw, 1964).

There are no statistical records about the cultivation and production of popcorn in Turkey. However, although its cultivation and production is not yet widespread in our country in recent years, the production and consumption of popcorn has started to increase and its cultivation has become widespread in the Western Mediterranean, Aegean and Central Anatolia Regions, including the provinces of Isparta and Burdur (Anonymous, 2020). In the Elbistan district of Kahramanmaraş, which has an important place in the production of popcorn in Turkey and meets 80 percent of the consumption in the country, popcorn is planted as the first product. The production area in the Elbistan Plain is increasing every year and it is cultivated on an area of approximately 60 thousand decares (Anonymous, 2019). For this reason, it is important to grow strong varieties that are resistant to adverse environmental conditions, diseases and pests, as well as high grain yield. Local varieties are generally strong varieties that are well adapted to their region and are also important breeding materials. Hybrid varieties suitable for the purpose can also be grown by using local varieties. Especially in open pollinated genotypes such as maize, the loss of genetic material occurs very quickly. Renewing the seeds of local populations, which are of great importance for breeding, every few years is important for the protection and continuity of gene resources. For this reason, important studies should be carried out that will benefit the use of future generations by protecting the genetic resources of our local varieties. In the previous years, there were studies using local popcorn genotypes in main crop conditions in Kahramanmaraş, but there were no studies using local popcorn populations in second crop conditions. For this reason, some phenotypic characteristics and grain yield values were investigated by using local popcorn populations in second crop conditions in Kahramanmaraş. Researching the breeding possibilities and yield performances of local populations as a second crop is important in terms of the continuity and protection of genetic resources.

MATERIALS and METHODS

The experiment was carried out in 2019 by planting 17 local popcorn genotypes and 3 commercial popcorn varieties as the second crop in Kahramanmaraş Sutcu Imam University, Faculty of Agriculture, Field Crops Department. The local genotypes used in the experiment were Antcin 98 (1), Çanakkale Red (2), Samsun Yellow Popcorn(3), Ordu Çatalpınar (4), Edirne White (5), Tokat Erbağ (6), Çanakkale White (7), Çanakkale Yellow Popcorn (8), Sakarya Han Village (9), Samsun Bafra Kasu Village (10), Nermin Popcorn (11), Balıkesir Popcorn (12), Kadirli Popcorn (13), Ordu Persembe Kovanlı (14), Balıkesir White (15), Ordu Kargan Tepe Area (16), Ordu Çamaş (17), Samsun White (18), Ordu Kabartur (19), Composite 13 (20). Soil properties at a depth of 0-30 cm of the experimental site, Saturation, pH, soil of salinity (%), calcareous (%), organic matter (%), potassium (mg/kg), phosphorus

(mg/kg) values are 61.6, 7.45, 0.14, , 1.60, 1.82, 141.5 and 5.76 respectively. It has been determined that the soil structure of the experimental area has a clay loam texture, low in organic matter, salt-free and calcareous, sufficient in potassium and low in phosphorus. The research was carried out under the conditions of Kahramanmaraş, which has a Mediterranean climate effect. Kahramanmaraş province, which is 568 m above sea level, has a monthly minimum (11.41, 21.0, 14.6, 18.30 C^0), maximum (43.44, 38.7, 36.4, 38.50 C^0), average temperature (25.4, 27.9, 29.9, 24.8), average relative humidity (50.07, 35.4, 37.9, 38.8) and precipitation (5.20 1.2, 0.9, 8.9 mm) values were recorded for the months of June, July, August and September, when the research was conducted in 2019. Before planting, the trial land was plowed with a cultivator, then the cultivator was removed and the trial land was made ready for parcellation and planting. The experiment was sown by hand on 19 June in a randomized block design with three replications, each plot being 5 m long, 4 rows, 70 cm spacing and 20 cm row spacing. With the planting, 18-46-0 (DAP) fertilizer was applied net 6 kg da^{-1} phosphorus as base fertilizer. When the plants were 40-50 cm tall, 46% urea fertilizer and top fertilizer were applied so that a net 25 nitrogen per decare was dropped. Two tractor hoes and three hand hoes were applied to the plants, two doses of cob worm medicine were applied and drip irrigation was applied ten times for 8 hours in total. Harvest was carried out by hand on September 30.

In the study, the local popcorn genotypes were determined by ear-tassel out time (days), ear silk-out time (days), plant height (cm), first ear height (cm), first node diameter (mm), diameter of the node to which the cob is attached (mm), ear length (cm), ear diameter (mm), number of rows per ear (pieces), number of grains per ear (pieces), number of ears per plant (pieces), and grain yield per decare (kg/da) and the correlation of these characteristics with each other relationships were examined.

The data obtained at the end of the research were analyzed using the SAS statistical program according to the ANOVA method. The means of the features that differed statistically significantly were grouped according to the Duncan multiple comparison test.

RESULTS and DISCUSSION

Avarega and groups of ear-tassel out time (days), ear silk-out time (days), plant height (cm), first ear height (cm), first node diameter (mm) and diameter of the node to which the cob is attached (mm) are given in Table 1, ear length (cm), ear diameter (mm), number of rows per ear (pieces), number of grains per ear (pieces), number of ears per plant (pieces), and grain yield per decare (kg da^{-1}) are given in Table 2 and the correlation of these characteristics with each other relationships are given Table 3.

Table 1. Mean Values and Groupings Between Features

Populations	TOT(days)**	SOT(days)**	PH(cm)**	FEH(cm)**	FND(mm)*	DNC(mm)*
1	59.00 g-ı	51.00 e	169.07 ef	72.20 e	18.40 b-f	13.26 bc
2	58.00 hı	55.33 b-c	176.53 ef	68.60 e	19.80 a-f	13.80a-c
3	58.00 hı	54.66 c	185.20 c-f	74.53 ed	20.00 a-f	15.46 ab
4	56.66 ı	55.00 bc	206.80 ab	97.20 ab	22.60 a	15.60 ab
5	56.66 ı	53.33 d	167.07 f	65.13 e	17.20 d-f	12.86 bc
6	61.33 e-g	55.00 bc	181.53 d-f	78.26 ed	20.13 a-e	15.73 ab
7	62.66 d-f	55.33 b-c	168.40 ef	73.66 ed	17.13 d-f	12.66 bc
8	63.33 c-f	56.00 ab	178.07 ef	78.86 c-e	20.46 a-d	15.46 ab
9	64.00 b-e	56.00 ab	172.00 ef	71.66 e	19.60 a-f	14.20 a-c
10	68.66 a	56.66 a	167.67 f	70.20 e	20.20 a-e	13.53 a-c
11	63.33 c-f	51.00 e	166.27 f	63.00 e	17.73 c-f	13.00 bc
12	62.66 d-f	55.66 a-c	171.93 ef	69.00 e	19.86 a-f	14.46 a-c
13	62.00 ef	55.66 a-c	189.00 b-e	73.40 ed	19.00 a-f	14.86 a-c
14	58.00 hı	55.33 b-c	200.07 b-d	88.26 b-d	19.73 a-f	14.13 a-c
15	66.33 ab	56.66 a	173.33 ef	72.66 ed	21.93 ab	16.40 a
16	66.00 a-c	54.66 c	204.40 a-c	94.33 a-c	21.80 ab	14.60 a-c
17	66.00 a-c	55.33 b-c	216.87a	107.00 a	21.00 a-c	13.20 bc
18	65.00 b-d	55.66 a-c	170.73 ef	64.93 e	16.53 ef	11.80 c
19	56.33 ı	48.33 f	179.33 d-f	65.93 e	17.53 c-f	14.60 a-c
20	60.66 f-h	51.66 e	174.23 ef	67.60 e	16.26 f	13.33 a-c
ORT	54.41**	61.73**	180.95**	75.82**	19.35*	14.15*
CV	1.44	2.73	6.93	12.78	11.84	13.30

TOT: Tassel Out Time, SOT: Silk Out Time, PH: Planth Height, FEH: First Ear Height, FND: First Node Diameter, DNC: Diameter of the Node to Which the Cob is Attached P<0.05 * P<0.01 **

Ear-Tassel Out Time (Days)

The difference between the ear-tassel out time of the popcorn varieties included in the experiment was found to be statistically significant at the level of 1%. The highest tassel out time was obtained from genotypes 15 and 10 with 56.66 days. This was followed by the tassel out time obtained from genotypes 8 and 9 with 56.00 days in decreasing order. The lowest tassel out time was obtained from genotype 19 with 48.33 days. The average tassel out time of popcorn varieties was found to be 54.41 days. According to Duncan test, genotypes 10 and 15 were included in the 1st group (a) and genotypes 8 and 9 were included in the 2nd group (ab) in the grouping made between the tassel out time obtained from different cultivars (Table 1.). In the studies conducted with the main crop popcorn, the tassel out time was determined as 63-73 days in lines, 64-72 days in hybrids by Özkaynak and Samancı (2003), 69- 73 days by Tekkanat and Soylu (2005), 58-67 days by Kapar and Öz (2006), 79.8-82.4 days by Bulut et al. (2008), 66-76 days for main crop, 52-60 days for second crop popcorn by Özsisli et al. (2009), 66-86 days by Köse and Turgut (2011), 68.8-75.5 days by Öz and Kapar (2011), 54.75-64.50 days by İdikut et al. (2015). The fact that the tassel out times are different from previous studies is due to the fact that

the genotypes we used are local and the conditions of the region are different. Rattalino Edreira and Otegui (2012) stated that environmental factors such as temperature create variation in flowering between genotypes. İdikut and Kara (2011) explained that the tassel out time creates a significant difference according to years and that the tassel is affected by genotype, climate and environmental factors.

Ear Silk-Out Time (Days)

The difference between the ear silk out time of the popcorn varieties included in the experiment was statistically significant at a rate of 1%. The highest silk out time was obtained from genotype 10 with 68.66 days. This was followed by the silk out time obtained from genotype 15 with 66.33 days in decreasing order. The lowest silk out time was obtained from genotypes 5, 4 and 19 with 56.66, 56.66, 56.33 days, respectively. The average ear silk out time of popcorn varieties was found to be 61.73 days. In the grouping made according to Duncan test, genotype 10 was included in group 1 (a), genotype number 15 was in group 2 (ab), while genotypes 5, 4 and 19 were included in the last group (i) (Table 1.). In previous studies, ear silk out time was determined 67-79 days in lines and 68-79 days in hybrids by Özkaynak and Samancı (2003), 84.7-86.3 days in silage maize by Bulut et al. (2008), 55-72 days in the first crop corn by İdikut et al. (2012) and 58.75-70.12 days in the first crop corn İdikut et al. (2015). The ear silk out time takes place 2-10 days after the tassel out time. The ear silk out time varies according to the cultivar, soil and environmental conditions (İdikut et al. 2012). It is thought that the differences in the ear silk out time of the local cultivars used in the research are affected by the cultivar characteristics and environmental conditions.

Plant Height (Cm)

The difference between plant heights of the local gin corn populations included in the experiment was statistically significant at the rate of 1%. The highest plant height of 216.87 cm was obtained from the local genotype number of 17. This was followed by plant heights obtained from genotype number of 4 with 206.80 cm in decreasing order, and plant heights obtained from genotype number of 16 with 204.40 cm in the third row. The lowest plant height of 166.27 cm was obtained from commercial cultivar number of 11. The average plant height of the popcorn populations was found to be 180.95 cm. According to Duncan test, genotype number of 17 was included in group 1 (a) and genotype number of 4 was in group 2 (ab), while genotype number of 16 was in group 3 (a-c) and commercial variety number of 11 was included in the last group (f) (Table1.).

As can be understood from our study, the plant heights of most of the local genotypes were found to be longer than the plant heights of the commercial varieties used as controls. The difference between the varieties in terms of plant heights is due to the genetic structure of the genotypes. Coimbra et al. (2002) reported that they found the plant heights of popcorn to be between 178-223 cm in their study

conducted on five local popcorn populations. Scapim et al. (2005) found plant heights of popcorn to be between 210-268 cm in their study with eight popcorn genotypes. Junior et al. (2021) reported that they found the plant height of popcorn to be between 180-320 cm in their study conducted with 20 popcorn populations. In other studies on popcorn, as a main crop, the plant height was found to be between 98-128 cm by Ozkaynak and Samancı (2003), 255-282 cm by Kapar and Oz (2006), 206-230 cm by Konuşkan (2006), 240-194.95 cm by Tekkanat and Soylu (2005), 193-185 cm by Idikut et al. (2012) The similarities and differences between the results of this research and our research are due to the similarity and difference in the ecological conditions in which the research was conducted and the genetic structures of the popcorn varieties used in the experiments. In this study, which was carried out as a second crop with local genotypes, the plant height was similar to the findings obtained from the previous main crop popcorn studies and the commercial popcorn varieties used in the experiment, and it was found to be higher than the results obtained from some studies. It shows that the results obtained are significant in terms of genetic material.

First Ear Height (cm)

The highest first ear height was obtained from the local population number of 17 (107 cm). This was followed by the first ear heights obtained from population number of 4 (97.20 cm) and number of 16 (94.33 cm) in descending order. The lowest first ear height was obtained from commercial variety number of 11(63 cm). The average first ear height of the popcorn varieties was found to be 80,51 cm. According to Duncan test, in the grouping made between the first ear heights, population number of 17 was in group 1 (a), population number of 4 was in group 2 (ab), while population number of 16 was in the third group (ac), and commercial variety number of 11 was in the last group (e) recorded as included. The first ear heights of the popcorn varieties included in the experiment varied between 107 cm and 63 cm (Table 1.). There is a close relationship between first ear heights and plant heights, and the difference between cultivars in terms of first ear heights was generally parallel to plant heights. First ear height was found, as a main crop, between 53-74 cm in lines and 61-100 cm in hybrids by Ozkaynak and Samancı (2003), 73-109 cm by Tekkanat and Soylu (2005), 95-126 cm by Kapar and Oz (2006) and 74,1-111,4 cm by Oktem ve Kahramanoglu (2021). Although this study is the second crop of popcorn, the findings are in line with the findings of the main crop of popcorn. These results show that as with plant height, first ear height is a morphological feature that occurs under the influence of genetic structure of varieties and ecological factors. It was observed that there was a positive correlation between plant height and first ear height, and the first ear heights of genotypes with longer plant height were higher than commercial varieties and other genotypes.

First Node Diameter (mm)

The difference between the first node diameters of the local popcorn populations included in the experiment was statistically significant at the 5% significance level. The highest first node diameter was

obtained from population number of 4 (22.6 mm). This was followed, in descending order, by the first node diameters obtained from population number of 12 (21.9 mm), population number of 16 (21.8 mm) and population number of 17 (21.0 mm). The lowest first node diameter was obtained from commercial variety number of 20 (16.2 mm). The mean first node diameter of the popcorn varieties was found to be 19.0 mm. According to the Duncan test, in the grouping made between the first node diameters, population number of 4 was in the 1st group (a), population number of 15 and population number of 16 were in group 2 (ab), while population number of 17 was in the third group (ac) and commercial variety number of 20 was included in the last group (f) (Table 1.). Gözübenli et al. (1997) determined the first node diameter in hybrid grain maize varieties as between 22.0-26.0 mm, İdikut et al.(2009) found between 16-18 mm. As can be seen from previous studies, the diameter of the first node is an agricultural character. It was determined that it was affected by cultivar and growing conditions.

Diameter of the Node to Which the Cob is Attached (mm)

The difference between the diameter of the node towhich the cob is attached of the local popcorn populations included in the experiment was statistically significant at the 5% significance level. The highest value was obtained from population number of 15 (1.64 cm). In the second rank, population number of 6 (15.7 mm), population number of 4 (15.6 mm), population number of 3 (15.4 mm) and population number of 8 took place. Population number of 13 (14.8 mm) took place as a third rank.The lowest value was obtained from population number of 18 (11.8 mm). The mean of diameter of the node to which the cob is attached of the popcorn varieties was found to be 14.1 mm. According to the Duncan grouping test, the population number of 15 (a) was included in the 1st group. Population numbers of 6, 4, 3 and 8 were in group 2 (ab), while population number of 13 was in group 3 (a-c). Population number of 18 was included in the last group (c) (Table 1.). İdikut et al. (2020) reported the diameter of the node to which the cob is attached between 10.5 mm and 19.1 mm in their study on the local population popcorn that they grow as the main crop. In this study, it was determined that the local popcorn populations had thicker and stronger stems than the commercial variety popcorn and the diameters of the nodes were larger.

Ear Length (cm)

The difference between the ear lengths of the local popcorn genotypes included in the experiment (0.05<) was found to be statistically significant. The highest ear lengths were determined as 17.26 cm from population number of 15. The lowest ear length was obtained from population number of 2 as 12.83 cm. The average ear length of the popcorn varieties was found to be 15.44 cm. According to the Duncan test, in the grouping made between ear lengths obtained from different populations, population number of 15 was in group 1 (a), genotypes 6, 4, 3, 8, 1.7, 9, 10, 11, 12 and 13 were in the transition group (ab) while population number of 2 took place in the second group (b) (Table 2.). In previous studies on popcorn Gökmen et al.(2001) determined the ear length as 15.7-16.9 cm in main crop

popcorn, Özkaynak and Samancı (2003) determined the ear length as 11-15 cm in popcorn lines, found the ear lenghts as 11-17 cm in hybrids, Eşiyok et al. (2004) found the ear lenghts as 19-21 cm in main product popcorn, Öktem et al. (2004) reported the ear length as 17-19 cm in main product popcorn, Saruhan and Şireli (2005) found the ear length as 12-18 cm in horse tooth corn, Çetinkaya and Dura (2010) determined the ear length as 21-23 cm in main crop popcorn, Tekkanat and Soylu (2005) reported the ear length as 17,17- 20,27 cm in main crop popcorn, İdikut et al.(2012) found the ear length as 15.11-13.00 cm in main crop popcorn, Olakojo et al.(2019) determined the ear length as 14-18 cm in main crop popcorn, Bbebe et al. (2021)found the ear length as 10,7-18,5 cm in main crop popcorn, Junior et al. (2021) found that it varies between 12.7-20.3 cm.

Ear Diameter (mm)

The difference (5%) between the ear diameters of the popcorn genotypes included in the experiment was statistically significant. The highest ear diameter was obtained from population number of 14 as 32.51 mm and population number of 15 as 31.87 mm. This was followed by the ear diameters obtained from populations number of 4 and 17 as 31.01 mm and 30.06 mm in decreasing order. The lowest ear diameter was obtained from population number of 2 as 26.12 mm. The mean ear diameter of the popcorn genotypes was found to be 29.64 mm. In the grouping made according to Duncan test, genotypes 14 and 15 were included in group 1 (a), while population number of 4 and 17 were included in group 2 (ab), population number of 2 was included in the last group (e)(Table 2.). In previous studies on popcorn Özkaynak and Samancı (2003) found that the ear diameters of the main crop popcorn lines were 24-29 mm, and in hybrids as 26-30 mm, Eşiyok et al. (2004) found found that the ear diameters of the main crop popcorn as 42-43 mm, Saruhan and Şireli (2005) determined that the ear diameters of the main crop horse tooth hybrid corn as 36-39 mm, Tekkanat and Soylu (2005) reported that the ear diameters of the main crop popcorn as 33-44 mm, Çetinkaya and Dura (2010) found that the ear diameters of the main crop popcorn as 52-55 mm, İdikut et al. (2012) reported that the ear diameters of the main crop popcorn as 28.3-30.66 mm, Ematne et al. (2012) found that the ear diameters of the main crop popcorn as 16.4-18.0 mm, Olakojo et al.(2019) determined that the ear diameters of the main crop popcorn as 70-80 mm, Junior et al. (2021) found that the ear diameters of the main crop popcorn as 23.5-42.5 mm add they reported that the diameter of the cob differed according to the genetic structure. Köycü and Yanıkoğlu (1987) and Sencer et al. (1992) stated that ear diameter is a character that directly affects the number of kernels on the ear and the ear diameter varies according to the varieties. It is understood from previous researches that the diameter of the ear is a variety as well as environmental and ecological conditions.

The Row Number of Ear (piece)

The difference between the number of rows on the ear of the popcorn populations included in the experiment was found to be statistically significant at the rate of 5%. The highest number of rows on the

ear was obtained from population number of 18 as 18,8 pieces. This was followed by the population number of 6 as 15.6 pieces and the number of rows on the ear obtained from the commercial variety number of 1 as 15.00 pieces in descending order. The lowest number of rows on the ear was obtained from population number of 4 as 12.26 pieces. The average number of rows on the ear of the popcorn populations was 14.03. According to the Duncan test, population number of 18 was included in group 1 (a) and population number of 6 was included in group 2 (ab) while population number of 4 was included in the last group (c) (Table 2.). It was observed that the local popcorn genotypes had higher row numbers than the commercial cultivars used as control. In previous studies, Özkaynak and Samancı (2003) determined the number of rows on the ear, as 12-14 pieces in lines, as 13-15 pieces in hybrids, Eşiyok et al. (2004) as 15-17 pieces, İdikut et al.(2005) as 17.5-14.66 pieces, Tekkanat and Soylu (2005) as 13-17 pieces, Todorovic et al. (2012) as 11-17 pieces in inbred corn lines and as 13-15 pieces in hybrids, Lashkmi et al. (2014) found the mean number of rows on the ear as 13,8 pieces, İdikut et al.(2015) determined as 12.75-15.95 pieces, Sanjay et al.(2018) found between 10-18 pieces in their study of popcorn which carried out by applying nitrogen at different doses. It is seen from previous studies that the number of rows on the ear varies between 12-18 pieces. Similar results were obtained in the research conducted. These results show that genetic conditions are more effective on ear diameter.

Table 2. Mean Values and Groupings Between Features

Populations	EL*(cm)	ED*(mm)	RNE*(piece)	NGER*(piece)	NEP*(piece)	GY**(kg da^{-1})
1	16.13ab	27.44b-e	15.00 a-c	36.06 ab	1.61 ab	444.21 b-d
2	12.83b	26.12e	13.80 a-c	26.33 b	1.59 a-c	440.85 b-d
3	15.16	28.74a-e	14.00 a-c	34.13 ab	1.49 a-c	464.58 ab
4	15.73	31.21ab	12.26 c	34.40 ab	1.44 a-c	428.85 cd
5	15.26	30.41a-d	13.33 bc	34.80 ab	1.47 a-c	456.51 a-c
6	16.40	29.90a-e	15.6 ab	36.73 ab	1.37 b-c	478.00 a
7	13.56	26.44de	13.86 a-c	30.46 ab	1.42 b-c	369.90 fg
8	15.33ab	26.78c-e	14.00 a-c	38.53 a	1.52 a-c	291.23 kj
9	15.50ab	29.89a-e	14.80 a-c	33.20 ab	1.20 c	285.17 kj
10	15.43ab	28.98a-e	12.46 bc	34.06 ab	1.62 ab	260.41 k
11	14.00ab	30.53a-c	13.60 bc	29.80 ab	1.62 ab	365.91 f-h
12	15.73ab	30.53a-c	14.26 a-c	35.60 ab	1.66 ab	355.00 g-h
13	15.63ab	30.68a-c	13.06 bc	34.53 ab	1.52 a-c	335.98 hı
14	15.53ab	32.51a	13.73 a-c	38.26 a	1.54 a-c	315.88 ıj
15	17.26ab	31.87a	14.13 a-c	38.86 a	1.82 a	393.16 ef
16	15.26	29.84a-e	14.8 a-c	33.93 ab	1.44 a-c	364.98 f-h
17	16.26	31.06ab	14.00 a-c	35.33 ab	1.71 ab	420.68 de
18	16.46	29.58a-e	16.8 a	37.86 a	1.34 bc	298.87 j
19	17.00	30.53a-c	14.26 a-c	35.53 ab	1.54 a-c	347.59 g-ı
20	14.30	29.74a-e	12.93 bc	31.06 ab	1.59 a-c	464.55 ab
ORT	15.44*	29.64*	14.03*	34.47*	1.52*	379.11**
CV	14.54	8.09	13.63	18.64	15.73	5.30

EL: Ear Length, ED: Ear Diameter, RNE: The Row Number of Ear, NGER: The Number of Grain on The Ear Row, NEP: Number of Ears per Plant, GY:Grain Yield per Decare P<0.05 * P<0.01 **

The Number of Grain on The Ear Row (pieces)

The difference between the number of grains per ear of popcorn populations was statistically significant at the rate of 5%. The highest number of grains on the ear was obtained from populations 15, 8, 14 and 18 as 38.86, 38.53, 38.26, and 37.86, respectively. This was followed by populations 6, 1 and 12 as 36.73, 36.06 and 35.60 in decreasing order. The lowest number of grains in the ear row was 26.33 pieces and was obtained from population number 2. The mean number of grains per ear of the popcorn genotypes was found to be as 34.47 pieces. In the grouping which made according to Duncan test, population number of 15, 8, 14 and 18 were included in group 1 (a), population number of 6, 1 and 12 were included in group 2 (ab) while population number of 2 was included in the last group (b)(Table 2.). In previous studies, Özkaynak and Samancı (2003) determined the number of grains per ear row as 20-33 pieces in main crop popcorn lines and 30-42 pieces in hybrids, Eşiyok et al. (2004) found as 36-41 pieces in main crop popcorn, Tekkanat and Soylu (2005) reported as 36-46 pieces in main crop popcorn, İdikut et al. (2012) reported that they found as 28.56-36.73 pieces and Sanjay et al.(2018) found as 22-42 pieces in main crop popcorn.

Number of Ears per Plant (piece)

The difference between the number of grains per ear of popcorn populations was statistically significant at the rate of 5 %. The number of ear in the highest plant was obtained from population number of 15 as 1.82 pieces. This was followed by genotypes 17, 12 and 10 as 1.71, 1.66, 1.62 and 1.61 pieces, respectively and the number of ear per plant obtained from the commercial variety of population number 1. The lowest number of ears per plant was obtained from the population number of 9 as 1,2 pieces. The mean value was found to be 1,52 pieces. In the grouping made according to the duncan test, population number of 15 was included in group 1 (a), population number of 17, 12, 10 and 1 were included in group 2 (ab) while population number of 9 was included in the last group (c)(Table 2.). In previous studies, Kün (1994) reported that popcorn can have 3-5 fertile ears per plant. The number of ears per plant in popcorn was reported as 1.14-1.21 pieces by Esiyok et al. (2004), 1-1.6 pieces by Tekkanat ve Soylu (2005), 1.5-2.7 pieces by Kalyani (2011), 1.00-1.60 pieces by Chakma et al.(2011), 2.46-1.86 pieces by İdikut et al.(2015) and 1.13-2.07 pieces by Barad et al(2016). In the local genotypes used in our studies, it was observed that the number of ear was higher than the values determined by previous researchers. Since the kernels of popcorn are smaller than flint and horse-tooth hybrid corns, they tend to produce more ears (İdikut et al., 2012). It was stated that among the maize varieties, the popcorn variety showed the highest number of ears (Tekkanat and Soylu 2005) and the number of ears per plant was important in increasing the yield (Komproth et al. 1982; El-Lokany and Russell 1971; Moll and Kamprath 1977).

Grain Yield per Decare (kg da^{-1})

The difference between the grain yields of the popcorn varieties included in the experiment was statistically significant (%1). The highest grain yield was obtained from genotype number of 6 as 478.00 kg da^{-1}. This was followed by population number of 3 as 464.58 kg/da and population number of 20 as 464.55 kg da^{-1}. The lowest grain yield was obtained from population number of 10 as 260.41 kg da^{-1}. The mean value of grain yield of popcorn varieties was found to be 379.11 kg da^{-1}. According to Duncan test, population number of 6 is in group 1 (a), population number of 3 and 20 are in group 2 (ab) while population number of 5 is in group 3 (a-c) and population number of 10 is included in the last group (k) (Table 2.). In previous studies, the grain yield per decare (kg da^{-1}) in popcorn was reported as 385-497 kg da^{-1}by Gökmen et al. (2001), 499-735 kg da^{-1} by Tekkanat ve Soylu (2005), in lines 141-442 kg da^{-1}, in hybrids 272-464 kg da^{-1} by Ozkaynak ve Samancı (2003), 499-735 kg da^{-1} by Tekkanat and Soylu (2005), 353-666 kg da^{-1} in 12 single cross popcorn by Gökmen et al.(2007), 721-753 kg da^{-1} by Grosbach (2008), 328-499 kg da^{-1}by Özkan ve Ülger (2011), 353-539 kg da^{-1} by Oz and Kapar (2011), 287.38-498.50 kg da^{-1} by İdikut et al.(2012), 197-307 kg da^{-1} by Ematne ve ark.(2012), 480.25-369.50 kg da^{-1} by İdikut et al. (2015) and 317-504 kg da^{-1} by Sahin and Kara (2021). llker et al. (2009) explained that genotypes are affected by the environment and some gonotypes have higher yields due to their high adaptation to the environment. Rattalino et al. (2012) stated that environmental factors such as temperature affect yield and create variation among genotypes. In this study, which was carried out with local popcorn genotypes in second crop conditions in Kahramanmaraş, it was observed that some genotypes had higher grain yield than commercial popcorn cultivars used as control.

The Correlation Relationship Between The Features Investigation

Correlation analysis was carried out to reveal the relationship between the investigated features. The correlation relationship between the traits examined in our study with local popcorn genotypes is given in Table 3. It was observed that there was a significant positive correlation between diameter of the node to which the cob is attached and first node diameter (0.7123*), plant height and first node diameter (0.5948*), first ear height and first node diameter (0.6797*), ear length and ear diameter (0.5626 *), tassel out time and first node diameter (0.4785*) and between tassel out time and silk out time (0.5091*).

Turgut (1998) reported that they found a positive correlation between plant height and first ear height in the correlation analysis they performed on horse tooth maize. These results support the findings of our study. Another important result of our study is the very important positive relationship between the length of the ear and the number of grains per ear. These findings are consistent with the findings of Turgut (1998), Gençtan and Başer (1994) and Sade (1994), who stated that there is a positive and significant relationship between ear length and grain number per ear. This relationship is directly related to grain yield. According to our research results, it was determined that the diameter of the first node,

which we examined, interacts with features such as the diameter of the node, plant height, first ear height and tassel out time and develops a positive correlation with these features. It has been determined that there is a positive correlation between the tassel out time and the silk out time. There was also a positive correlation between plant height and first ear height. According to the findings obtained in the study, the first ear heights of the genotypes with longer plant height were also determined. It has been determined that there is a very important and positive relationship between the number of grains on the ear and the length of the ear, which is directly related to the yield. Genotypes which longer ear lengths had higher grain counts on the ear. According to the results of the study, it has been determined that there is a negative and significant relationship between the silk out time and the grain yield. It has been determined that the yield per decare increases as the silk out of time decreases. According to our study results, it was observed that the local popcorn genotypes that completed flowering early had higher yields. From these results, it is understood that the early flowering genotypes of the local genotypes grown as a secondary crop yield higher yields.It is thought to be a distinctive feature in terms of qualities that directly concern the development of the plant, such as the diameter of the node diameter, the height of the plant, the diameter of the node where the cob is located, and the duration of flowering. It was thought that the diameter of the ear node is a distinctive feature in terms of the qualities directly related to the development of the plant, such as the plant height, the diameter of the node where the ear is located, and the flowering period.

Table 3. The Correlation Relationship Between the Features Investigation.

	FND	**DNC**	**PH**	**FEH**	**ED**	**EL**	**RNE**	**NGER**	**NEP**	**GY**	**SOT**	**TOT**
FND	1.0000											
DNC	**0.7123***	1.0000										
PH	**0.5948***	0.3024	1.0000									
FEH	**0.6797***	0.2682	**0.9270 ****	1.0000								
ED	0.2179	0.2294	0.4055	0.2745	1.0000							
EL	0.2573	0.3611	0.2042	0.1907	**0.5626***	1.0000						
RNE	-0.1803	-0.1580	-0.1497	-0.1279	-0.1165	0.3525	1.0000					
NGER	0.2514	0.3488	0.1858	0.2310	0.4388	**0.8586****	0.3415	1.0000				
NEP	0.1982	0.1219	0.0381	0.0473	0.1645	0.1037	-0.3570	0.0653	1.0000			
GY	-0.0059	0.1265	0.1360	0.1055	-0.0549	-0.1339	-0.0712	-0.2529	0.1682	1.0000		
SOT.	0.2193	-0.0994	-0.0547	0.1091	0.0233	0.1431	0.1876	0.1446	0.1608	**-0.5064***	1.0000	
TOT	**0.4785***	0.1769	0.1379	0.2628	-0.0139	0.0093	0.0698	0.2169	-0.0922	-0.3219	**0.5091***	1.0000

FND: First Node Diameter DNC: Diameter of the Node to Which the Cob is Attached PH: Planth Height FEH: First Ear Height, ED: Ear Diameter, EL: Ear Length, RNE: The Row Number of Ear, NGER: The Number of Grain on The Ear Row, NEP: Number of Ears per Plant GY:Grain Yield per Decare, SOT: Silk Out Time, TOT: Tassel Out Time. P<0.05 * P<0.01 **

Conclusion

Gene erosion is increasing in our country as well as all over the world. Therefore, local genotypes are very valuable breeding materials for the supply of lost genetic material. In the study carried out with 17 local popcorn genotypes in second crop conditions in Kahramanmaraş, it was determined that the findings obtained from some local populations were higher than the three commercial popcorn cultivars

used as control in terms of the characteristics examined. This situation reveals the importance of local populations as potential gene sources today. It is of great importance to collect, produce and determine the agricultural characteristics of local varieties. In Kahramanmaraş, the production of local genotypes, which are valuable breeding materials, will be increased by choosing local genotypes instead of commercial varieties under second crop conditions. Increasing the production of local populations and studies to be carried out will guide other researchers for new studies. According to the findings obtained from this study, the importance of local genotypes is understood once again.

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