Alinteri J. of Agr. Sci. (2020) 35(1): 113-119
e-ISSN: 2587-2249
info@alinteridergisi.com
http://dergipark.gov.tr/alinterizbd
http://www.alinteridergisi.com/
DOI: 10.28955/alinterizbd.697938

Alinteri Journal of Agriculture Sciences

RESEARCH ARTICLE

Some Morphological Characteristics of Gene Pool from the Hybridization of Local Tomato Genotypes and Some Commercial Types

Levent Keskin[1*] • Mustafa Paksoy[2,3] • Önder Türkmen[3]

[1]Batı Akdeniz Agricultural Research Institute, Antalya/Turkey
[2]Selçuk University, Faculty of Agriculture, Department of Horticulture, Konya/Turkey
[3]Kyrgyzstan Turkey Manas University, Faculty of Agriculture, Department of Horticulture, Bishkek/Kyrgyzstan

ARTICLE INFO

Article History:
Received: 03.03.2020
Accepted: 10.04.2020
Available Online: 29.05.2020

Keywords:
Tomato
Landraces
Genotypes
Morphological characteristics

ABSTRACT

Determination of different gene sources is important for plant breeding studies; therefore, local genotypes are of interest. In this study, collected genotypes were hybridizied with commercial genotypes in order to transfer some traits such as disease resistance and long shelf life to local genotypes. After that, obtained genotypes were self pollinated twice and gene pool was created according to some morphological traits. Nine different groups were created from combinations according to result of clustering analysis. Result of principal component analysis (PCA) revealed that total rate of 65.208% variation was observed. As a result of the research, half way materials were acquired that are thought to be used in obtaining qualified variety or varieties.

Please cite this paper as follows:

Keskin, L., Paksoy, M. and Türkmen, Ö. (2020). Some Morphological Characteristics of Gene Pool from the Hybridization of Local Tomato Genotypes and Some Commercial Types. *Alinteri Journal of Agriculture Sciences*, *35*(1): 113-119. doi: 10.28955/alinterizbd.697938

Introduction

Tomato, one of the economically most significant products, has importance not only for economy but also for human diet. It is the one of the most produced vegetables in both Turkey and the world. World tomato production is 177 042 359 tons and China is the biggest producer in the world. It is followed by India, USA and Turkey, respectively. China produces 50 540 000 tons which constitutes 28.54% of world total tomato production. In the year of 2000, Turkey had 8 890 000 tons tomato production whereas, in 2018 with an increase of approximately 40%, this number reached up to 12.15 million tons (Anonymous, 2020) and amounted to 6.86% of world production (Anonymous, 2018). There are many reasons for the increase of tomato production in Turkey. Some of the reasons are breeding studies conducted to develop required quality and standard varieties (Sönmez and Ellialtıoğlu, 2014) and improved culture practices. Many breeding studies are carried out in line with demands of the consumer such as disease resistance and long shelf life. In breeding studies, it is important to obtain and identify local genotypes.

Rodríguez et al. (2019) evaluated the differences in genotypic homogeneity and heterogeneity for three genetically different tomato groups. They studied twenty-four hybrids, seventeen landraces varieties, and six advanced lines (F8). They found significant differences ($p \leq 0.05$) between genetic groups for all variables evaluated. Except for the days

* Corresponding author
E-mail address: lkeskin01@hotmail.com

when the fruits ripen in the fifth branch. Six hybrids, three local varieties and two advanced lines showed remarkable agronomic responses in yield per plant. In another research; Leal et al. (2019) reported that a good germplasm can be achieved by using commercial tomato (*Solanum lycopersicum* L.) hybrids for obtaining new tomato inbred lines. Aim of their study was to investigate the stability of commercial F_1 hybrids in climatic conditions in mountainous regions, to predict genetic parameters, and to evaluate the breeding potential of F_1 hybrids according to the agronomic performance of the F_3 generation. Accordin to their results, while there were significant differences in most F_1 and F_3 generations, only one variable showed significant difference in the F_2 population.

Qaryouti et al. (2007) performed the characterization of 44 landrace tomato populations collected from Jordan according to IPGRI criteria. They determined that there was a high variation among tomatoes in terms of vegetative, yield and fruit characteristics.

In Argentina, Hu et al. (2012) examined 67 different tomato samples in terms of morphology and genetic diversity. They stated that according to cluster analysis 3 groups were formed both morphologically and molecularly and the populations collected before 1960 showed more variation than those collected later. In another research, Osei et al. (2014) reported that a total of 216 tomato accessions obtained from Ghana, Korea, Taiwan and Burkino Faso were examined for 18 morphological features. At the end of the study, it was stated that there were 10 factor groups and 58.09% cumulative variation occurred in PCA analysis. In the clustering analysis, it was reported that the samples were divided into two groups with a similarity ratio of 0.86. Henareh et al. (2015) examined morphological characteristics of 97 different tomato populations collected from Iğdır province of Turkey and from different parts of Iran. In principal components analysis, they determined that the variation of the first three main component among samples was 71.6%. The first principal component constituted 50% of the total variation and the yield value showed a high correlation with this component, therefore, they stated that breeders can use the characteristics of this component as selection criteria. On the other hand, Bhattarai et al. (2016) studied 71 tomato samples. According to their clustering analysis, it was stated that 6 different groups were formed and 5 main components explained more than 92% of the variation in the principal component analysis. In another study, comparison of quality characteristics between three tomato hybrids and their six maternal and paternal individuals were conducted. Accoring to results, it was stated that by hybridization studies, a variation can be created in quality properties such as lycopene content, sugar composition and color. Although their taste, smell and aroma properties are good, local varieties are not preferred for commercial production due to their low yields, short shelf life, low disease resistance and deformed fruit shape. It is thought that local tomato varieties can gain a place in the market if their undesirable characteristics get eliminated. For this reason, it was aimed to collect and identify local tomato genotypes as well as to create a gene pool by hybridization of local tomato genotypes, and to utilize this gene pool in breeding programs.

Materials and Methods

Material

Plant material of this study consist of 136 Genotypes that reached to S_2 stage and are obtained by hybridiziation of 11 local and 6 commercial tomato varieties collected from different regions of Turkey.

Method

Seedlings belonging to genotypes were planted to greenhouse in February 2013. Some morphological characterization measurements and observations were performed according to UPOV criteria. Measurements and observations are given in Table 1. Means of all observations and measurements obtained in this study are presented and interpreted as tables. To determine the relationship between the genotypes and investigated properties, all data obtained were analyzed using the Ward method in the JMP computer program for clustering analysis. Principal Component Analysis (PCA) and factor analysis were also performed with the same program.

Table 1. Some morphological characteristics of tomato genotypes

Morphological Features	Group	Scoring		S_2	
				Genotype	Percentage (%)
Anthocyanin formation in seedlings	Absent	1		6	4.41
	Present	9		130	96.29
Plant growth type	Determinate	1		90	66.7
	Indeterminate	9		46	33.82
Plant growth power	Few	3		0	0
	Medium	5		120	88.97
	Many	7		16	11.02
Stem internode length	Short	3	5 cm≤	32	23.52
	Medium	5	6-10	102	75.55
	Large	7	11≥	2	1.48
Stem internode thickness	Thin	3	5 mm≤	15	11.82
	Medium	5	6-10 mm	41	30.37
	Thick	7	11 mm≥	80	59.25

Table 1. (continued)

Morphological Features	Group	Scoring		S_2	
				Genotype	Percentage (%)
Stem pubescence	Absent	1		0	0
	Few	3		0	0
	Medium	5		120	88.23
	Intensive	7		16	11.85
	Very intensive	9		0	0
Leaf attitude of petiole of leaflet in relation to main axis	Semi- erect	3		45	33.08
	Horizontal	5		91	66.91
	Semi- drooping	7		0	0
Leaf length	Short	3	10 cm ≤	42	30.88
	Medium	5	10-15 cm	90	66.6
	Long	7	15 cm ≥	4	2.96
Leaf width	Narrow	3	5 cm≤	52	38.23
	Medium	5	5-10 cm	83	61.48
	Broad	7	10 cm≥	1	0.74
Green color intensity of leaf;	Light	3		13	9.55
	Medium	5		93	68.38
	Dark	7		30	22.05
Flower color	Yellow	1		136	100
	Orange	9		0	0
Peduncle length	Short	3	1cm ≤	0	0
	Medium	5	1-2 cm	128	94.11
	Long	7	2cm≥	8	5.88
Inflorescence type	Simple	1		104	76.47
	Mixed	2		32	23.53
	multiple	3		0	0
Flower pubescence	None or very little	1		3	2.20
	Present	9		133	97.80
Fruit weight		1	35gr <	2	1.47
		2	35-70gr	26	19.11
		3	70-105gr	43	31.61
		4	105-140gr	34	25
		5	140-175gr	22	16.17
		6	175gr>	9	6.61
Fruit height		1	15 mm≤	0	0
		2	15-30 mm	2	1.47
		3	30-45 mm	70	51.47
		4	45-60 mm	52	38.23
		5	60-75 mm	10	7.35
		6	75-90 mm	2	1.47
		7	90 mm≥	0	0
Fruit width		1	15 mm≤	0	
		2	15-30 mm	0	
		3	30-45 mm	48	35.29
		4	45-60 mm	45	33.08
		5	60-75 mm	20	14.70
		6	75-90 mm	21	15.44
		7	90 mm≥	2	1.47
Fruit shape in longitudinal section	Flattened	1		38	27.94
	Slightly flattened	2		78	55.14
	Circular	3		13	9.55
	Rectangular	4			
	Cylindrical	5		0	0
	Elliptic	6		0	0
	Heart-shaped	7		0	0
	Ovate	8		7	5.14
	Pear-shaped	9		0	0
Fruit color (at maturity)	Light red	3		37	27.20
	Red	5		96	70.58
	Pink	7		3	2.20

Results and Discussion

136 genotypes were measured and observed at S_2 stage and the results were indicated below.

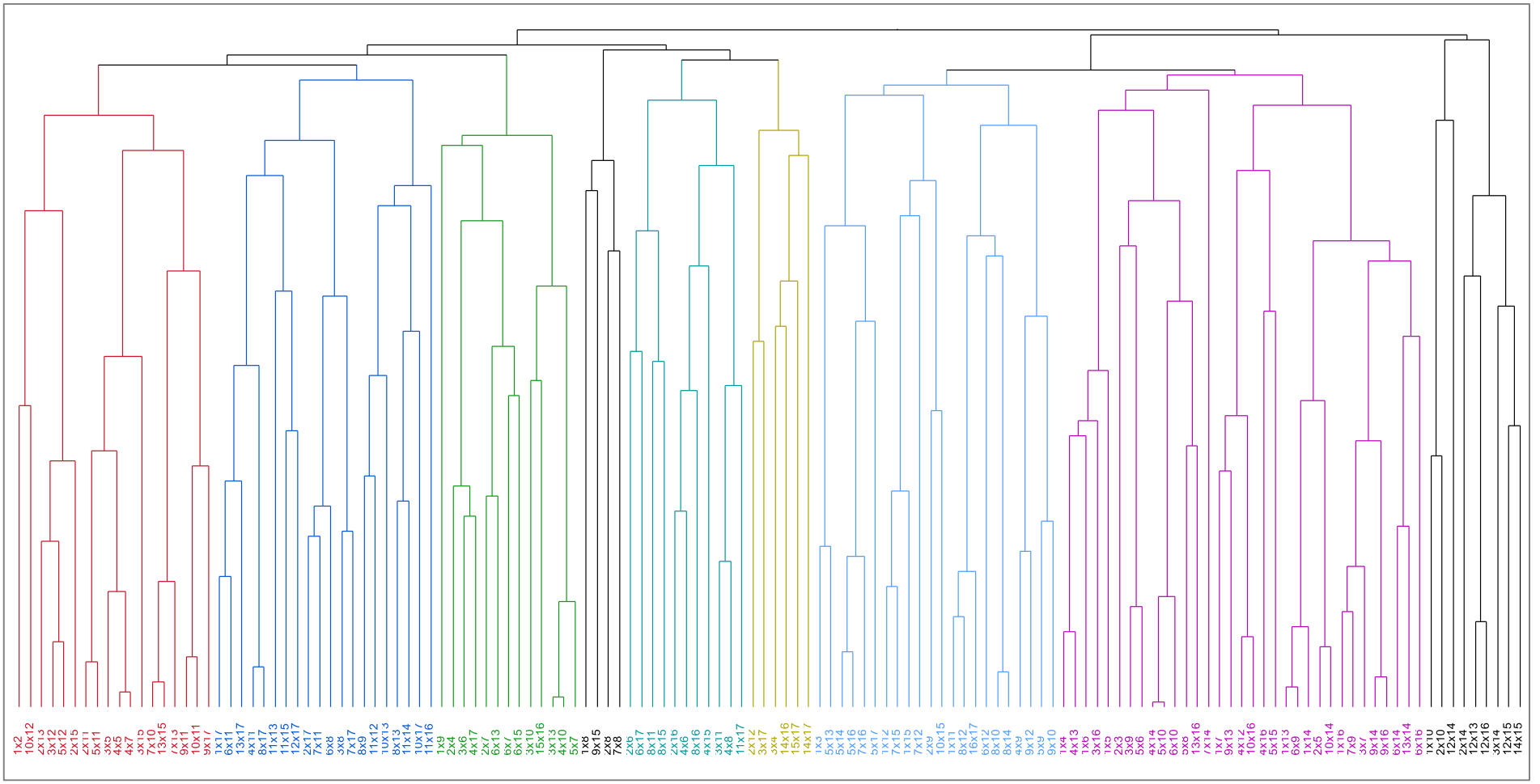

Figure 1. Dendogram of hybrids

Anthocyanin formation in seedlings: There was no anthocyanin formation in 6 (4.41%) of 136 genotypes, while it was present in 130 genotypes (96.29%). The absence of anthocyanin formation can be used as an indicator of resistance to some disease factors such as male infertility and fusarium (Masuda et al. 2000). Plant growth power: 120 genotypes (88.97%) out of 136 were observed to have "moderate" plant growth power whereas, it was "high" in other 16 genotypes (11.02%). Criteria such as plant growth power and stem thickness are considered to be important elements in endurance of the plant against environmental factors (Peralta and Spooner, 2005). We obtained supporting measuring data. Plant growth type were observed as "indeterminate" in 46 genotypes (33.82 %) and "determinate" in 90 genotypes (66.17 %) out of 136 genotypes. In another study, Oğuz (2010) observed 32 "determinate" and 56 "indeterminate" genotypes in 88 genotypes. Stem Internode length were measured to be short for 32 genotypes (23.52%), "medium" for 102 genotypes (75.55%) and "large" for 2 genotypes (1.48%) out of 136 genotypes. Stem Internode thickness of the 136 genotypes were classified as "thin" for 15 genotypes (11.82%), "medium" for 41 genotypes (30.37%), and "thick" for 80 genotypes (59.25%). In plants; internode thickness and plant growth power are important criteria in evaluation of effective resistance of the genotype to environmental factors (Peralta and Spooner 2005).

Stem pubescence were determined as "medium" in 120 genotypes (88.23%) and "intensive" in 16 genotypes (11.85%) out of 136 genotypes. Çukadar and Dursun (2012) observed as "few" in 24 genotypes, "medium" in 23 genotypes and 'intensive" in 1 genotype. Leaf attitude of petiole of leaflet in relation to main axis was identified as "semi-erect" in 45 genotypes (33.08 %) and "horizontal" in 91 genotypes (66.91%). Leaf length were measured as "short" (30.88 %) for 42 genotypes, "medium" for 90 genotypes (66.6%) and "long" for 4 genotypes (2.96 %). On the other hand, in their study, Çukadar and Dursun (2012) measured 3 genotypes as "short", 24 genotypes as "medium" and 21 genotypes as "long". Their results support our findings. Green color intensity of leaf was classified as "light" in 13 genotypes (9.55 %), "medium" in 93 genotypes (68.38 %) and "dark" in 30 genotypes (22.05%). Peduncle length were measured as "medium" in 128 genotypes (94.11%) and "long" in 8 genotypes (5.88 %). Inflorescence type was classified as "simple" for 104 genotypes (76.47%) and "mixed" for 32 genotypes (23.53%). Similarly, Oğuz (2010) described 52 genotypes as "simple" and 35 genotypes as "mixed". Flower pubescence was classified as "none or very little" in 3 genotypes (2.20 %) and "present" in 133 genotypes (97.80 %).

Fruit weight was observed as 35g ≤ in 2 genotypes (1.47 %), 35-70g in 26 genotypes (19.11%), 70-105 g in 43 genotypes, (31.61%) 105-140 g in 34 genotypes (25 %), 140-175g in 22 genotypes (16.17%) and 175g ≥ in 9 genotypes (6.61%).
Fruit height was measured as 15-30 mm for 2 genotypes (1.47 %), 30-45 mm for 70 genotypes (51.47 %), 45-60 mm for 52 genotypes (38.23%), 60-75 mm for 10 genotypes (7.35 %) and 75-90 mm for 2 genotypes (1.47 %). Fruit width was measured as 30-45 mm in 48 genotypes (35.29%), 45-60 mm in 45 genotypes (33.08 %), 60-75 mm in 20 genotypes (14.70 %) and 75-90 mm in 2 genotypes (1.47%).

Fruit shape in longitudinal section was classified as "flattened" in 38 genotypes (27.94%), "slightly flattened" in 78 genotypes (55.14 %), "circular" in 13 genotypes (9.55%) and "ovate" in 7 genotypes (5.14%). Fruit color (at maturity) was identified as "light red" for 37 genotypes (27.20%), "red" for 96 genotypes (70.58 %) and "pink" for 3 genotypes (2.20%). The amount of water-soluble dry matter of 136 genotypes ranged from 2.6 to 4.8. Gölükçü et al. (2010) found that the amount of water-soluble dry matter ratio was between 3.65-7.20%.

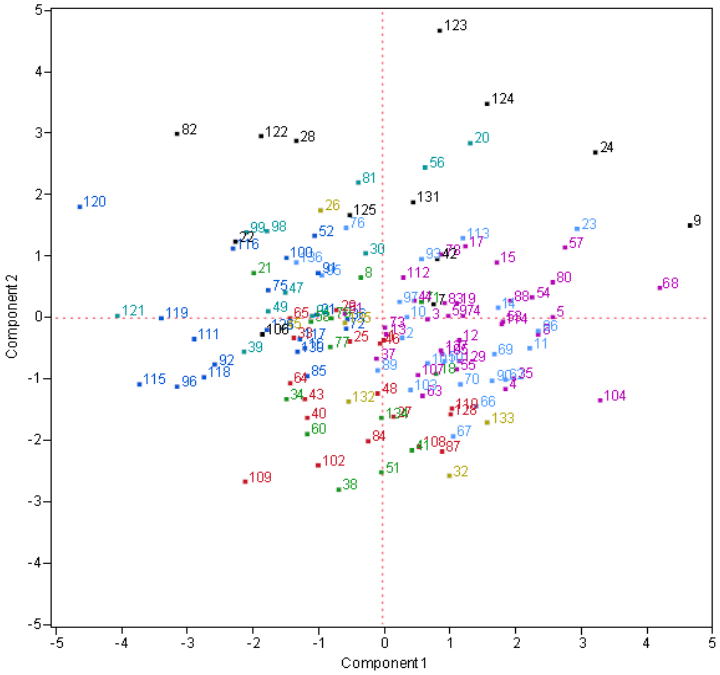

Figure 2. Discriminant analysis between tomato genotypes on the basis of morphological characters

Table 2. Some morphological characteristics of tomato genotypes

Factor	1	2	3	4	5	6	7	8	9
Essence value	2.7807	1.7526	1.5504	1.2943	1.1929	1.1772	1.1485	1.1120	1.0330
Cumulative variation	13.907	22.666	30.419	36.890	42.855	48.741	54.483	60.043	65.208
Anthocyanin formation in seedlings	0.1126	0.5375	-0.3016	-0.3503	-0.2033	0.1419	-0.0263	0.2580	-0.0989
Plant growth power	-0.0007	0.3029	0.2325	0.5953	-0.1463	0.1749	0.1552	-0.1396	-0.0681
Plant growth type	-0.3526	0.6736	0.1053	0.0188	0.0555	0.1771	-0.1039	-0.1645	0.0483
Stem internode length	0.0388	-0.0728	-0.1433	0.6204	0.2386	-0.0336	0.0092	0.1783	-0.0835
Stem internode thickness	0.3326	-0.1459	0.0344	-0.2487	0.3603	0.1302	0.2428	-0.0116	0.5116
Stem pubescence	-0.1279	0.1716	-0.1902	-0.3558	0.1400	-0.5102	0.4391	-0.0434	-0.2502
Leaf length	-0.1141	0.1543	0.7047	-0.0363	0.0788	-0.1570	-0.0951	-0.1202	-0.0691
Leaf width	0.0202	0.0162	0.7903	0.0109	-0.0224	0.0268	0.0460	0.1281	0.0781
Leaf attitude of petiole of leaflet in relation to main axis	-0.0356	0.0287	0.1365	-0.4220	0.0076	0.5026	0.2093	0.2049	-0.2948
Green color intensity of leaf	-0.0466	0.1627	-0.0401	0.1232	0.7399	-0.0741	-0.2085	0.2062	-0.0172
Inflorescence type	0.0509	0.7372	0.1837	0.1155	-0.0136	-0.0759	0.0602	-0.0789	0.1248
Flower pubescence	0.1455	-0.2526	0.1336	0.0257	0.6175	0.1054	0.0664	-0.2464	-0.0117
Peduncle length	-0.0275	0.1079	-0.1231	0.0612	0.0619	0.5773	0.0687	0.0294	-0.0295
Fruit weight	0.8691	0.0256	-0.0507	-0.1109	0.0937	0.0893	-0.1058	-0.1054	-0.0395
Fruit width	0.8387	-0.0646	-0.0228	-0.0150	0.1661	-0.0352	-0.0055	0.1777	-0.1066
Fruit height	0.7766	-0.0666	-0.0343	0.1694	-0.1536	-0.0211	-0.0364	0.0175	0.0508
Fruit shape in longitudinal section	-0.1673	0.1706	0.0146	-0.0102	-0.0824	-0.0893	-0.0004	0.0621	0.8265
Fruit color (at maturity)	-0.0873	-0.0345	-0.0105	0.0820	-0.1203	0.0741	0.8574	-0.0071	0.0745
Water soluble dry matter	-0.1644	0.1270	0.2980	0.2020	0.1540	-0.4320	0.2414	0.3530	-0.0226

In Figure 1, it can be seen that 9 different clusters are formed according to classification made in accordance with 21 characteristics examined of 136 genotypes as S_2 stage. When we examined the figure, it was observed that 1x2-1x3 (14.20) combination was in the farthest distance from these genotypes. In addition, 1x3 combination was found to be at a far distance (12.45) from 1x10 combination. The closest distance was obtained from the combination of 4x14-5x10 (1.26). Combinations of other genotypes were found to be between these two extreme values. As all of the combinations of flower color yielded the same result, it was excluded from factor analysis. Data obtained from remaining 20 properties revealed that genotypes are grouped in 9 factors. As a result of Principal Component Analysis (PCA) of investigated characteristics from combinations, there was a variation at the rate of 65.208%.

Conclusion

One of the most important stages in intensive and long-term breeding studies is to determine suitable parents to the purpose. In this study, local varieties were hybridized with commercial varieties that are highly appreciated by consumers in terms of taste, smell and aroma. In conclusion, a gene pool that can be potentially evaluated in terms of breeding was obtained.

References

Anonymous, 2018. www.fao.org. Erişim tarihi: 02.01.2020.

Anonymous, 2020. www.tuik. gov.tr. Erişim tarihi: 03.01.2020

Bhattarai C., Louws F. J., Williamson J.D. and Panthee D.R., 2016, Diversity analysis of tomato genotypes based on morphological traits with commercial breeding significance for fresh market production in eastern USA, Australian Journal of Crop Science (AJCS) 10(8):1098-1103pp.

Çukadar, K., Dursun, A., 2012. Morphological Characterization of Tomato Genotypes of Erzincan Province. 9th National Vegetable Symposium, p: 116-124, Konya.

Gölükçü, M., Kabaş, A., Yeğin., A.B., Vuran., F. A., Yüksel., K, Tanır, A., 2018. Change of some physical and chemical quality properties of tomato by hybridization. 2018/35(2): 152- 160 doi: 10.16882/derim.2018.427755.

Henareh M., Dursun A. and Mandoulakani B. A., 2015. Genetic diversity in tomato landraces collected from Turkey and Iran. Acta Sci. Pol. Hortorum Cultus, 14(2):87-96pp.

Hu, X., Wang H., Chen J. and Yang W., 2012, Genetic diversity of Argentina tomato varieties revealed by morphological traits, simple sequence repeat, and sıngle nucleotide polymorphism markers, Park.J.Bot.,44(2): 485-492 pp.

Leal E. H., Ortiz R. L., Zavala J.J.G., Bautista A. H., López D. R., Barrientos O.B., (2019). Stability and breeding potential of tomato hybrids, Chilean journal of agricultural research, Chil. j. agric. res. vol.79

Masuda, M., Uchida, K., Kato, K. And Agong, S.G. 2000, Restotarion of Male Sterility in Seonally Depent Mae Sterilemutant Tomato, Lycopersicum esculentum cv. First.J. Japon Soc. Hort.Sci., 69(5),557-562.

Oğuz, A. 2010. Investigation of resistance and genetic variations in tomato spotted wilt virus (TSMV) using different methods in some local tomato genotypes.

Doctoral Thesis. Ankara University Faculty of Agriculture, Department of Horticulture. Ankara.

Osei M. K., Bonsul K. O., Agyeman A. and Choi H. S., 2014, Genetic diversity of tomato germplasm in Ghana using morphological characters, International Journal of Plant & Soil Science 3(3):220-231s.

Peralta, I. E. And Spooner, D.M.2005, Morphological characterization and relationships of wild tomatoes. (Solanum L. Section Lycopersicon). Monograph Syst Bot. Mıssoure Bot Gard. 104:227-257.

Qaryouti M. M., Hamdan H.H., Edwan M. A., Hurani O. M. and Al-Dabbas M. A., 2007. Evaluation and characterization of Jordanian tomato landraces, Dirasat, Agricultural Sciences, 34 (1-2):44-57pp

Rodríguez J.C.C., Chávez –Servia J.L.C., Ortiz R.L., and Segovia C.P., (2019). Generation and evaluation of heterogeneous genotypes of tomato for small - scale farmers, Journal of Plant Breeding and Crop Science, Vol. 11(3), pp. 91-99,

Sönmez, K., & Ellialtıoğlu, Ş.Ş. (2014). A review on tomatoes, carotenoids and the factors affecting them. Derim, 31(2):107-130.