Yuzuncu Yil University
Journal of Agricultural Sciences

(Yüzüncü Yıl Üniversitesi Tarım Bilimleri Dergisi)

https://dergipark.org.tr/en/pub/yyutbd

Research Article

Investigations of Some Morphological, Pomological, and Physiological Parameters with Mineral Content of Different *Rosa* L. Taxa Grown under Greenhouse Condition

İbrahim Halil HATİPOĞLU*[1], Bekir Erol AK[2], Birgül DİKMETAŞ[3], Meral DOĞAN[4]

[1,2,3,4] Harran University, Faculty of Agriculture, Department of Horticulture, Şanlıurfa

[1]https://orcid.org/0000-0002-7236-4976, [2]https://orcid.org/0000-0001-6938-942X, [3]https://orcid.org/0000-0001-6227-2579
[4]https://orcid.org/0000-0003-3618-3307

*Corresponding author: ibrahimhhatipoglu@gmail.com

Abstract: Horticulture is a discipline mainly concerned with the cultivation of plant material for food supply, medicinal use, or functional and aesthetic purposes by humans, they are a genetically diverse group and play an important role in the economy of modern society, as well as at the center of the healthy diet of the urban population. In this respect, *Rosa* L. are important plants for traditional pharmacological practices and landscape studies. In this context, within the scope of the research, some morphological, pomological, physiological, and mineral contents of important taxa such as *Rosa alba* L.'Semiplena', *R. banksiae* R.Br. cv 'Alba', *R. canina* L.'Yildiz', *R. centifolia* L., *R. chinensis* Jacq. 'Old Blush', *R. foetida* Herrm., *R. heckeliana* Tratt. subsp. *vanheurckiana* (Boiss. Ö. Nilsson), *R. hemispharica* J.Herrm., *R.* x *odorata* (hort ex. Andrews) Sweet 'Louis XVI', *R. pisiformis* (Christ) Sosn., *R.* x *damascena* Mill., and *R.* x *damascena* Herrm. 'Semperflorens'(Loisel. & Michel) Rowley for landscape design and horticulture were determined. Within the scope of the research, the morphological, physiological, and pomological characteristics and nutrient contents of taxa adapted to semi-arid conditions and different *Rosa* taxa spreading in Anatolia were determined. Principal component analysis and cluster analysis were also used to determine the similarities and differences of these parameters measured in different *Rosa* L. taxa.

1. Introduction

Rosa species are in the *Rosales* order. There are approximately 8000 species of economic and ecological importance, nine families of this order are divided into three main subgroups. Members of the *Rosaceae* family, which is one of these three subgroups, are generally distributed in the area from the temperate regions of the Northern Hemisphere to the subtropical region and contain nearly 100 genera and more than 2000 species throughout the world. There are 58 endemic *Rosa* species in Anatolia and there is an endemism rate of 24% in Turkiye (Nilsson, 1972; Campbell, 2002; Evans, 2002; Heywood et al., 2007; Hurkul and Koroglu, 2019; Altun et al., 2021).

Horticulture is a discipline primarily concerned with the cultivation of plant material by humans for food supply, medicinal use, or functional and aesthetic purposes. They are a genetically diverse group and play an important role in the economy of modern society. They are also central to the healthy diet of the urban population. From this point of view, roses and rosehip plants are extremely important garden plants because they contain these features. Although there is a wide variety of rose taxa in the world today, studies are continuing to determine some characteristics of roses due to the abundance of roses grown and the increasing number of newly bred varieties.

The first systematic description of roses was made by Aristotle's student Theophrastos, and he also included roses in his work known as Historia Plantarum. Theophrastos mentions three types of roses in his work and it is assumed that these are *Rosa canina*, *R. sempervirens,* and *R. centifolia* (Ozcan, 2012). Some roses that were used in ancient times and still exist today; *R.* x *damascena*, *R. moschata*, *R. hemisphaerrica,* and *R.centifolia* species (Baktir, 2015). In addition, natural roses that are sectorally important are *R. canina*, *R. dumalis*, *R. foetida,* and *R. hemisphaerica* (Sahin, 2011; Korkmaz and Ozcelik, 2015). In this context, within the scope of the research, some morphological, pomological, physiological, and mineral contents of important taxa such as *Rosa alba* L.'Semiplena' *R. banksiae, R.* Br. Cv '*Alba*', *R. canina* L.'Yildiz', *R. centifolia* L., *R. chinensis* Jacq. 'Old Blush', *R. foetida* Herrm., *R. heckeliana* Tratt. subsp. *vanheurckiana* (Boiss. Ö. Nilsson) *R. hemispharica* J.Herrm., R.x *odorata* (hort ex.Andrews) Sweet 'Louis XVI', *R. pisiformis* (Christ) Sosn., *R.* x *damascena* Mill. and *R.* x *damascena* Herrm. 'Semperflorens' (Loisel. & Michel) Rowley, for landscape design and horticulture were determined. Within the scope of the research, the morphological, physiological, and pomological characteristics and nutrient contents of taxa adapted to semi-arid conditions and different *Rosa* taxa spreading in Anatolia were determined. These parameters were classified by different statistical evaluations.

2. Material and Methods

2.1. Material

Some of the natural rose species distributed in the Iran-Turanian Phytogeographic Region are the widely used Bengal rose (*R. chinensis* cv. 'Old Blush'), Halfeti rose (*R.* x *odorata* cv. 'Louis XIV'), Rosehip (*R. canina*), white rose (*R. alba* 'Semi Plena'), Van yellow rose (*R. heckeliana* subsp. *vanheurckiana*), Damask rose (*R.* x *damascena*), hedge rose (*R. hemisphaerica*), Banks rose (R. *banksiae* cv. '*Alba*'), *Rosa* de Mai (*R.* x *centifolia*), yellow rose (*R. foetida*), Hosap rose [*R. pisiformis* (Christ) D.] and evergreen rose (*R.* x *damascena* 'Semperflorens') rose species and subspecies of some morphological, pomological, physiological, and mineral contents were determined. Taxa names are written in full at this stage, and in other parts of the manuscript, they are given in a short form without authorization.

2.1.1. Climatic characteristics of the greenhouse

Natural rose species are generally spread at high altitudes. Within the scope of the research, changes in stomatal parameters were determined in relatively warm conditions. In the Southeastern Anatolia Region, very high temperatures are observed in June and July. In this context, leaf samples were collected in these periods in 2020 and 2021. In this process, cooling units were not operated in the greenhouses where the plants were grown. Temperature values were also measured with Onset Computer H21-002 HOBO® Micro station and the averages were transferred to the data compiler. At the time the leaf samples were taken, the average temperature of the greenhouse was 39.8°C and the RH (%) value was determined as 59.8.

2.1.2. Physical and chemical properties of the growing medium

The findings obtained in the analyzes made; the pH of the growing medium in which the study was carried out was 7.14, clayey/loamy structure, and low in organic matter. Lime content was determined as 6.14% and salt content as 0.04%. In Japan, Yamane (1990) reported that the pH of the topsoil in natural stands of *R. rugosa* varied between 5.1 and 7.6. According to unpublished data from the University of Copenhagen Biology Institute; in the regions where *R. rugosa* grows naturally in Denmark, pH values were determined as 4.66-7.74, lime rate 6.26%, and organic matter content 1.20%

(Bruun, 2005). The results of the soil analysis carried out within the scope of the thesis and the aforementioned literature were found to be close to each other.

The chemical properties of the soil used in the greenhouse where the research was carried out, were analyzed. According to the results, the P value was high, the K value was critical, and the Fe, Cu, Zn, Mn, and B values were sufficient. It was determined that the growing environment was generally at sufficient levels in terms of the content of plant nutrients required for rose cultivation, fertilization was not done and the research was carried out in this way.

2.2. Methods

2.2.1. Determination of plant growth characteristics

Plants of different *Rosa* taxa propagated by cuttings were transplanted into 5 L pots in 2019, plant length (cm), plant crown width (cm), and plant crown/height ratio measurements were made in 2021. Growth patterns of 2-year-old plants were determined according to height and crown width. The codes of these parameters were denoted as; PL:plant height, PW:plant grown, PR:the ratio of the crown to the height of the plant.

2.2.2. Morphological analysis

Leaf area was calculated in cm² with the help of ImageJ program and determined according to Klamkowski and Treder (2008). Leaflets were classified as the bottom (1), middle (2), and tip (3), and leaf areas were determined by the same method. The leaves and leaflets of the plants belonging to each taxon were counted one by one, and the average leaf and leaflet measurements per plant were made in cm. In the same way, pedicel lengths were determined. The codes of these parameters were denoted as; LL: leaf length, LWH: leaf width, LA: leaf area, PW: pedicel width, LR: the ratio of the length to the width of the leaf, L1L: tip leaflet length, L1WH: tip leaflet width, L1A: tip leaflet area, L2A: middle leaflet area, L3A: bottom leaflet area.

2.2.3. Pomological analysis

Pomological analyzes were carried out according to the mentioned literature (Ercisli, 1996; Gunes, 2010; Kazankaya et al., 2005; Najda and Buczwoska, 2013; Encu, 2015; Hatipoglu and Ak, 2021; Guler et al., 2021). After the harvest of rosehip/rose fruits that reached harvest maturity, the yields of the samples brought to the laboratory were determined, and the fruits of each taxon were counted and recorded. 10 replications and 30 fruits in each replication were taken from the related taxa and weighed individually with a scale sensitive to 0.01 g and the average values were recorded. 30 fruits were selected from the *Rosa* L. taxa included in the study, and the width and height values of each fruit were determined using a 0.05 mm precision caliper. A vertical line was drawn between the point where the fruit connects to the sepal and the mark of breaking off from the branch, and the horizontal part was recorded as width and the vertical part as height, making an angle of 90 degrees with this line.

From the *Rosa* L. taxa examined in the study, 30 fruits were selected randomly, and after removing the seeds from each fruit, the weight of the fruit was checked. The fruit flesh ratio of taxa was determined by the ratio of the fruit flesh weight to the total fruit weight. Fruit shapes in *Rosa* L. taxa were calculated according to the average aspect ratio of 30 randomly selected fruits in line with the index determined by Ercisli (1996).

The absorbic acid (Vitamin C) content of *Rosa* L. taxa examined within the scope of the research was determined by spectrophotometric method (Cemeroglu, 1992; Karasakal, 2007; Sanlidere Aloglu, 2018). The separated fruit fleshes of the fruits collected in November 2020 from different locations were ground using a blender and sieved. After the fruits were pureed, 5 g of fruit juice was taken into the flasks in 3 repetitions, the fruit sample was weighed, 45 ml of 0.4% oxalic acid was added and filtered with filter paper. 1 ml of the obtained filtrate was taken and 9 ml of dye solution ($C_{12}H_6Cl_2NNaO_2$-H_2O) was added to it and readings were made at 520 nm wavelength. As a standard, a solution in which 9 ml of distilled water was added to 1 ml of filtrate was used (Ozdemir and Dundar, 1998; Aksoy, 2019).

The codes of pomological parameters were denoted as; FW: fruit weight, FL: fruit length, FWH: fruit width, FFR: fruit flesh ratio, FSI: fruit shape index, CV: C vitamin content.

2.2.4. Physiological analysis

The wet weights of the leaf samples taken from the pots in the experiment were determined, and the turgor weight was determined as a result of keeping them in petri dishes containing 100 ml of water for 24 hours. The samples were dried in an oven at 65-70ºC and their dry weights were determined by weighing them on a precision balance. Leaf relative water content was calculated according to Sanchez et al. (2004) (Dogan, 2018; Hatipoglu and Ak, 2021). This parameter is encoded as LRWC.

The amount of chlorophyll in the leaf was determined by the SPAD-502 Plus device with 10 separate measurements made from the bottom, middle, and tip parts of the compound leaflets in 2020 and 2021 (Khan et al., 2004). This parameter is encoded Ch.

In *Rosa* L. species, the leaves are in the form of leaflets; the differences in stomatal characteristics between the tip (A), middle (B), and lower (C) leaflets of the leaves were also investigated. Leaf samples were taken at noon for stomatal counts and measurements. The lower surfaces of the leaves were completely painted with transparent nail polish and left to dry. The tape was attached to the dried nail polished leaves and then removed and attached to the slides. Thus, stomata were examined under the microscope. The number of stomata per unit area (pcs/mm-2) value of the slide molds was photographed under the microscope; the number of stomata displayed in the 0.776 mm² field of view was determined by adapting to 1 mm2 area. (Kara and Ozeker, 1999; Bekisli, 2014; Dikmetas, 2019). For stomata/pore length and width (μm) values, the length and width of 10 stomata in the photographs of stomata/pore patterns were measured in MShot-1.3.10 computer program and measured in μm (Bekisli, 2014). For the stomata width/stomata length ratio, it was obtained by dividing the stomatal width by the stomatal length. The codes of stomata parameters were denoted as; STL: stomata length, SWH: stomata width, SD: stomata density, PRL: pore length, PWH: pore width.

2.2.5. Mineral content analysis

Leaf samples were taken from the middle parts of annual shoots together with their stems, representing the bottom, middle, and end leaflets of each plant. This process was performed with 10 replications for the samples taken. The samples brought to the laboratory were first thoroughly washed with running water and then washed with distilled water. The samples were left to dry for 7 days at room temperature and were mixed 3 times a day to prevent moisture. After these processes, it was dried in an oven and then ground. Nitrogen amount was calculated as % by the Khejdal method (Kacar, 1972; Ozdemir, 2005). Phosphorus in the leaves was determined by the colorimetric determination of the color in the spectrophotometer as a result of the dry burning process (Olsen, 1954). The determination of calcium and potassium in leaves was read in a flame photometer (Kacar, 1972). The determination of magnesium in leaves; after dilution of plant samples prepared by the dry burning method, it was determined by reading with an atomic absorption instrument (Kacar, 1972). 1 ml of sulfuric acid and then 19 ml of ethyl alcohol were added to the leaf samples weighing 1 g. The ash was first burned in the furnace at 250˚C for 2 hours, then at 650˚C for 4 hours, and left to cool. Then 5 ml of HCL (Hydrochloric Acid) has been added to the burnt leaves. Leaf samples were filtered using sterile filter paper, crucibles were filled with distilled water, and the process was repeated 2-3 times. Mn, Cu, Zn, and Fe contents were calculated in ppm units in atomic absorption spectrophotometer (Kacar, 1972; Ryan et al., 2001).

2.2.6. Statistical analysis

Statistical analysis of data for all variables was performed using Minitab 18. program. The difference between applications was determined by the LSD multiple analysis test. Principal component analysis (PCA) and clustering analysis (Dendogram) were performed using the R 4.1.1 package program.

3. Results

3.1. Plant growth characteristics of some *Rosa* L. taxa

In order to determine the differences in the growth characteristics of the plants, the findings related to the plant height (cm), plant crown width (cm), and plant crown/height ratio of 12 taxa are given in Table 1, and the numerical values were found to be statistically significant at the 5% level. In the study, the PLs of the taxa varied between 38.00 cm (*R.* x *damascena* 'Semperflorens') to 138.33 cm

(*R. chinensis* 'Old Blush'). PW values were determined between 46.32 cm (*R. foetida*) – 112.14 cm (R. *heckeliana* subsp. vanheurckiona). *R. hemisphearica* taxa had the most superior PR value (1.47), while *R. alba* 'Semiplena' had the least value (0.70) in terms of this feature (Table 1). In line with this information, a shape index was created for the growth characteristics of rose species. According to this shape index, if the crown/height ratio of plants grown (PR) under the same conditions and at the same age is between 0.70 and 0.95, the plant is erect; 0.96-1.24, the plant is broad/erect; bigger than 1.24, the plant is broad. According to PR; *R. alba* 'Semiplena', *R. canina* 'Yildiz', *R. centifolia*, *R. foetida*, *R. odorata* 'Louis XIV' and *R. pisiformis* taxa are 'erect'; *R. banksiae* 'Alba', *R. chinensis* 'Old Blush', *R. chinensis* 'Viridflora' and *R.* x *damascena*taxa are 'broad/erect'; *R. heckellana* subsp. vanheurckiona, *R. hemispharica,* and *R.* x *damascena* 'Semperflorens' taxa are 'broad'. This classification is similar to the evaluations of Koca (2014).

Table 1. Growth characteristics of some *Rosa* L. taxa

Taxa	Plant growth characteristics		
	PL	PW	PR
R. alba **'Semiplena'**	91.33±3.50cd	64.62±3.04f	0.70±0.01g
R. banksiae **'Alba'**	96.33±2.66bc	95.32±3.42c	0.98±0.01d
R. canina **'Yildiz'**	83.67±2.07e	68.81±4.09e	0.81±0.01f
R. centifolia	100.04±3.53ab	94.02±4.19c	0.94±0.01de
R. chinensis **'Old Blush'**	103.33±3.32a	107.33±4.20b	1.05±0.01c
R. foetida	57.66±3.78f	46.32±3.21i	0.80±0.01f
R. heckeliana **subsp.** *vanheurckiona*	89.30±3.01de	112.14±4.51a	1.25±0.01b
R. hemispharica	62.60±2.64f	91.64±3.05d	1.47±0.01a
R. odorata **'Louis XIV'**	61.33±4.33f	52.34±2.51g	0.77±0.01f
R. pisiformis	84.31 ±2.51e	68.63±3.51e	0.81±0.01f
R. x *damascena*	56.67±4.72f	50.31±5.50h	0.89±0.01e
R. x *damascena* **'Semperflorens'**	38.00±3.00g	49.00±3.78h	1.29±0.01b
Average	**77.05**	**75.04**	**0.98**
LSD (%5)	**6.626**	**1.731**	**0.060**

*: The differences between the averages with different letters in the same column are statistically significant. (P <0.05). **: It is the average of 10 repetitions. PL:plant height, PW:plant grown, PR:the ratio of the crown to the height of the plant.

3.2. Morphological parameters of some *Rosa* L. taxa

Morphological parameters of some *Rosa* L. taxa are given in Table 2. *R. foetida*taxa had the lowest values in LWH, LL, LA, and PW parameters. The highest values were obtained by R. *alba* 'Semiplena' (7.50 cm) in LWH, *R. pisiformis* (7.15 cm) in LL, *R. centifolia* (43.31 cm2) in LA, *R. centifolia* (2.41 cm) in PW, and *R. heckeliana* (1.13 cm) in LR. In the leaflet measurement parameters, *R. centifolia* taxa had the highest values. Similarly, *R. foetida* taxa generally had the lowest values in leaflet measurement parameters (Table 2 and 3.).

Table 2. Morphological parameters of leaves

Taxa	Leaf Characteristic				
	LWH	LL	LA	PW	LR
R. alba 'Semiplena'	7.50±0.90a	6.82±1.19a	33.85±1.17b	1.53±0.51d	1.10±0.06e
R. banksiae 'Alba'	5.72±0.09f	6.16±0.61 cd	12.83±0.53g	1.46±0.10e	0.93±0.08e
R. canina 'Yildiz'	6.06±0.37d	5.57±0.36f	18.67±1.58d	1.53±0.25d	1.08±0.02b
R. centifolia	7.30±0.20b	6.47±0.28b	43.31±0.71a	2.41±0.10a	1.12±0.05a
R. chinensis 'Old Blush'	6.32±0.88c	6.02±0.47de	13.05±1.47g	1.29±0.22f	1.04±0.07c
R. foetida	2.89±0.09h	2.77±0.18h	4.35±0.40h	1.01±1.10g	1.04±0.09c
R. heckeliana subsp. vanheurckiona	6.27±0.57c	5.54±0.51f	17.42±1.07e	1.28±0.29f	1.13±0.01a
R. hemispharica	6.29±1.19c	6.22±1.16c	20.72±1.05c	1.76±0.07b	1.01±0.01d
R. odorata 'Louis XIV'	5.69±0.34f	6.40±0.35b	18.61±0.96d	0.96±0.28g	0.88±0.05f
R. pisiformis	5.94±0.86e	7.15±0.97a	36.98±0.81de	2.20±0.52e	0.85±0.03g
R. x *damascena*	5.48±0.35g	5.06±0.28g	14.26±1.41f	1.46±0.46e	1.08±0.05b
R. x *damascena* 'Semperflorens'	6.10±0.43d	5.87±0.25e	18.53±0.57d	1.68±0.24c	1.03±0.04cd
Average	**5.96**	**5.82**	**19.47**	**1.48**	**1.01**
LSD (%5)	**0.119**	**0.152**	**0.713**	**0.062**	**0.098**

*: The difference between the averages with different letters on the same column is statistically significant. (P <0.05). LL: leaf length, LWH: leaf width, LA: leaf area, PW: pedicel width, LR: the ratio of the length to the width of the leaf,

Table 3. Morphological parameters of leaflets

Taxa	Leaflet Characteristic				
	L1L	L1WH	L1A	L2A	L3A
R. alba 'Semiplena'	4.02±0.32a	2.25±0.24ab	7.39±1.41b	6.38±10.29bc	2.26±0.76bc
R. banksiae 'Alba'	3.46±0.25abc	1.18±0.10de	2.80±0.32ef	1.92±0.14ef	1.16±0.38cd
R. canina 'Yildiz'	3.22±0.24bc	2.23±0.11ab	5.39±0.48cd	4.22±0.15c	2.13±0.41bc
R. centifolia	4.14±0.17a	2.60±0.26a	11.92±0.16a	8.68±1.00a	5.80±1.18a
R. chinensis 'Old Blush'	4.03±0.39a	1.65±0.10cd	4.41±0.78de	2.63±0.65de	1.35±0.69cd
R. foetida	1.27±.0.19d	1.01±0.07e	1.14±0.02f	0.90±0.14f	0.66±0.08d
R. heckeliana subsp. vanheurckiona	3.23±0.40bc	1.87±0.29bc	3.94±1.01de	3.69±0.68cd	1.30±0.53cd
R. hemispharica	3.46±0.58abc	2.14±0.65ab	5.23±2.46cd	3.87±2.04cd	1.72±0.58bcd
R. odorata 'Louis XIV'	4.13±0.90a	2.41±0.53a	6.83±2.20bc	4.00±0.31cd	0.70±0.23d
R. pisiformis	3.95±0.18a	2.50±0.10a	6.96±0.61bc	6.04±0.37b	2.73±1.18b
R. x *damascena*	2.88±0.34c	1.63±0.11cd	3.46±0.51de	3.00±0.17 cde	1.14±0.77cd
R. x *damascena* 'Semperflorens'	3.67±0.15ab	2.18±0.22ab	5.38±0.97cd	3.90±0.83cd	1.57±0.67 bcd
Average	**3.46**	**1.98**	**5.40**	**4.09**	**1.88**
LSD (%5)	**0.683**	**0.495**	**1.983**	**1.497**	**1.187**

*: The difference between the averages with different letters on the same column is statistically significant. (P <0.05). L1L: tip leaflet length, L1WH: tip leaflet width, L1A: tip leaflet area, L2A: middle leaflet area, L3A: bottom leaflet area.

3.3. Pomological parameters of some *Rosa* L. taxa

Pomological parameters were determined as a result of fruit measurements and ascorbic acid analysis in *Rosa* L. taxa. In the study, FWs of taxa varied between 0.19 g (*R. banksiae* '*Alba*') to 4.44 g (*R. centifolia*), and FL values were between 8.82 – 23.18 mm (Table 4.). FWH values were determined between 6.65–21.24 mm in *R. banksiae* '*Alba*' and *R. centifolia*, respectively. *R. pisiformis* had the least FWH (0.06 mm), while *R. centifolia* had the most superior value (3.33 mm) in terms of this feature. FFRs varied by 58.64% (*R. pisiformis*) to 89.32% (*R. chinensis* 'Old Blush'), and FSI values were recorded between 0.95-1.70 (Table 3). It can be said that the fruit characteristics of rose hips vary according to the species, growing region, climate, and ecological conditions. In this context, the aforementioned data of the fruits collected from the regions to which they are adapted show significant differences. The findings are similar to the pomological data determined in the literature (Kovacs et al., 2005; Celik et al., 2005; Kizilci, 2005; Savir, 2008; Gunes, 2010; Ozcelik, 2013; Akkus, 2016; Ipek and Balta, 2020; Tomlijenovic et al., 2021; Guler et al.,2021).

However, vitamin C values vary widely in studies. As a result of the analyzes made to determine the amount of vitamin C; 12.04-43.77 mg/100 g (Turkben et al., 2010), 1074 mg/100 g, and 2962 mg/100 g (Ercisli et al. 2001), 282.70-1173.40 mg/100 g (Gunes and Sen, 2001), 73-987 mg/100 g (Kazankaya et al., 2001), 1074-2557 mg/100 g (Ercisli and Esitken, 2004), 301-1183 mg/100 g (Kazankaya et al.

2005), 65.75 to 136.14 mg/100 g (Celik et al., 2006), 575.48-1369.89 mg/100 g (Savir, 2008), 2200 mg/100 g (Kazaz et al., 2009), 517-1032 mg/100 mL (Celik et al., 2009), 108.57- 908.57 mg/100 g (Gunes and Dolek, 2010), 575.48-1369.89 mg/100 g (Ekincialp and Kazankaya, 2012), values such as 332.47-1603.53 mg/100 g (Ozen, 2013). In the study, the CVs of the taxa varied between 36.34 to 1101.36 mg/100 g. As a result of the vitamin C analysis; *R. pisiformis* (1101.36 mg/100 g), *R. alba* 'Semiplena' (1041.85 mg/100 g) had high values.

Table 4. Pomological parameters of some *Rosa* L. taxa

Taxa	Pomological Parameters						
	FW	FL	FWH	FSI	FFW	FFR	CV
R. alba 'Semiplena'	3.48±0.54b	23.18±1.68a	18.72±1.54b	R(1.27e)	2.62±0.75b	77.82±1.60bcd	1041.85±2.05a
R. banksiae 'Alba'	0.19±0.05j	8.82±0.62f	6.65±0.70g	R(1.32c)	0.12±0.03i	61.81±1.78f	506.56±1.50d
R. canina 'Yildiz'	1.65±0.34d	22.17±1.59ab	15.09±1.59c	O(1.58b)	1.14±0.41cde	72.05±1.76e	99.85±2.13f
R. centifolia	4.44±0.75a	20.31±1.25b	21.24±1.80a	Fr(0.95i)	3.33±0.68a	72.40±1.10e	401.06±1.75e
R. chinensis 'Old Blush'	1.60±0.18de	17.49±1.25c	13.45±0.80e	R(1.30d)	1.43±0.16cd	89.32±0.58a	30.79±1.58g
R. foetida	0.61±0.14hi	13.73±1.20e	12.38±1.41ef	Fr(1.11g)	0.49±0.13ghi	81.09±1.95b	40.17±0.94g
R. heckeliana	0.35±0.08ij	13.89±1.18de	8.18±1.21g	C(1.70a)	0.25±0.08hi	80.21±1.92bc	592.61±2.39bc
R. hemispharica	0.74±0.19gh	13.94±1.00de	13.42±1.32e	Fr(1.04h)	0.62±0.18fgh	82.11±2.01b	75.77±1.17fg
R. odorata 'Louis XVI'	1.00±0.09fg	12.80±1.40e	11.65±0.62f	Fr(1.10g)	0.85±0.10efg	87.99±1.87a	36.34±1.39g
R. pisiformis	0.11±0.03j	7.35±0.71f	7.14±0.66g	Fr(1.03h)	0.06±0.01i	58.64±1.79f	1101.36±1.45a
R. x *damascena*	1.31±0.39ef	16.16±2.11c	13.66±1.47cd	Fr(1.18f)	1.01±0.29def	75.37±2.23cde	632.87±0.23b
R. x *damascena* 'Semperflorens'	1.99±0.55c	15.70±1.50cd	15.20±1.69c	Fr(1.03h)	1.55±0.50c	74.55±1.76de	577.34±1.55c
Average	1.46	15.47	13.07	1.21	1.12	76.11	420.55
LSD (%5)	0.331	1.878	1.580	0.017	0.450	5.402	50.962

[*]Fr: Flat Round, R: Round, O: Oval, C: Conical**: The difference between the averages with different letters on the same column is statistically significant. (P <0.05). ***: It is the average of 30 repetitions. FW: fruit weight, FL: fruit length, FWH: fruit width, FFR: fruit flesh ratio, FSI: fruit shape index, CV: C vitamin content.

3.4. Physiological parameters of some *Rosa* L. taxa

Physiological parameters of some *Rosa* L. taxa are given in Table 5. The values determined on the change of the LRWC according to the taxa were found to be statistically significant (p<0.05). As a result of the research; the highest LRWC were *R. chinensis* 'Viridflora', *R. canina* 'Yildiz, *R. foetida* and R. *chinensis* 'Old Blush; the lowest LRWC were determined in R. *heckeliana* and R. pisiformis taxa. Bucsa and Zamfirce (2017) found the highest LRWC values in R. nitidula, R. rubiginosa and R. *canina* taxa in their study, and they stated that there were statistically significant differences in LRWC rates between different taxa. In the study, it was concluded that these values varied during the vegetative and flowering periods in *Rosa* L. taxa. In studies conducted on different plant species, it has been stated that stress applications reduce the proportional water content of the leaves (Cekic, 2004; Irfan et al., 2014; Semida et al., 2015; Dogan, 2018). In woody landscape and ornamental plants; It is stated that determining physiological data such as leaf proportional water content will provide sustainable plant use in many application areas such as determining the tolerance of the plant against stress conditions such as water, temperature and drought, and determining ozone damage.

Ch values in leaves of different taxa were found to be statistically significant. According to the results of the research, the lowest chlorophyll content was obtained from *R. banksiae* 'Alba' (28.13), and the highest chlorophyll content was obtained from plants belonging to R. *chinensis* 'Old Blush' (44.39) and *R. odorata* 'Louis XIV' (42.99) taxa. On the other hand, it was determined that the chlorophyll content of the taxa commonly used in semi-arid conditions had higher leaf chlorophyll content than the taxa brought from different ecologies. In studies conducted on different plants, it has been stated that the amount of chlorophyll in the leaves of plants that are under stress conditions and have adaptation problems to the ecology it is in, decreases, and it has been reported that this low value causes problems in photosynthesis and carbon fixation (Cekic, 2004; Hassan et al., 2005; Krantev et al., 2008; Liu et al., 2015; Semida et al., 2015; Piršelová et al., 2016).

The stomatal parameters of the leaflets at the tip (A), middle (B), and lower (C) ends of the leaves taken from 2 different directions of the rose taxa used as plant material in the study were determined. When the mean stomatal length values of the taxa were examined, the highest value was *R. odorata* 'Louis XIV' (36.99 µm); the lowest values were found in the R.*canina* 'Yildiz' taxa (23.81 µm). In all taxa, the stomatal length parameter was found to be statistically significant in all four groups.

Descriptive statistics and comparison results for stomatal width in six taxa are given in Table 2. As seen in Table 2; The highest stomatal width value was determined as 25.65μm in R.*odorata* 'Louis XIV'. The lowest stomatal width value was determined in *R.* x *damascena* (17.55 μm) and R. *canina* 'Yildiz' (17.82 μm). While the variation in A-B-C leaflet values was five in stoma width values, four variations were detected in the two-year general average values. As a result of its adaptation to semi-arid conditions, *R. odorata* 'Louis XIV' received a geographical indication in 2021 in order to contribute to rural tourism and the rural population to turn to different business areas (TURKPATENT, 2022). It is important to compare the parameters of these two taxa with rose species grown in Anatolia.

Zarinkamar (2007), Orcen el. (2013) and Alp et al. (2016) stated in their study that the number of stomata per unit area (mm²) tends to increase as stoma sizes decrease. Kalariya et al.(2017) explain this by reducing the stomatal density and osmotic stress caused by drought, disrupting normal stomatal motility, and forming more adjacent stomatal clusters in the leaf epidermis. The research gives similar results to that study. These results confirm that the size of the stomata decreases as the water content in the leaf decreases (Xu and Zhou, 2008). However, the surface area parameter in the leaf did not change which provides a linear proportion with these two parameters. Due to anthropogenic effects, nature is adversely affected in many ways during the rapid change process on earth and deterioration in the ecological balance occurs. In this context, studies on the health of plants affected by these effects and their sustainable use in landscape planning studies have gained importance. Determination of data such as chlorophyll content, stomatal parameters, and leaf proportional water content in woody landscape and ornamental plants can be used in many application areas such as the determination of plant water stress, cold/drought tolerance, and ozone damage. For this reason, it is thought that sustainability in plant uses will be ensured as a result of studies aimed at revealing this situation and determining the different characteristics of plants. The research focused on the identification of stress resistant species in roses, an important species for landscape planning studies. It is thought that the research will contribute to the cultivation and promotion of high temperature resistant species and also to urban plant planning by determining the relationship between the relevant parameters.

Table 5. Physiological parameters of some *Rosa* L. taxa

Taxa	Physiological Parameters						
	LRWC	Ch	STL	SWH	SD	PRL	PRWH
R. alba 'Semiplena'	41.19±1.65d	34.87±3.23e	30.57±2.33bc	15.34±2.31g	156.20±6.93i	19.57±3.01g	7.76±0.98i
R. banksiae 'Alba'	39.50±1.93e	28.13±1.40i	27.73±3.13c	19.73±2.53bc	169.40±7.54h	20.63±2.41e	10.99±1.21c
R. canina 'Yildiz'	74.33±5.25a	38.85±1.64d	23.81±4.66g	15.51±3.03fg	202.76±8.11d	19.02±3.93h	8.53±1.02h
R. centifolia	30.44±0.71h	32.94±2.00g	31.14±6.06b	18.16±2.63d	148.04±6.43j	24.03±1.97c	10.70±1.31cd
R. chinensis 'Old Blush'	73.41±5.69b	44.39±1.82a	26.90±5.08e	21.26±4.03a	199.47±6.21e	21.93±2.22d	14.90±1.10a
R. foetida	73.99±5.80ab	35.69±1.75e	27.51±5.01c	16.15±3.93ef	212.30±8.24b	20.20±3.05f	10.34±1.24de
R. heckeliana	24.06±0.93j	33.30±1.75fg	27.76±3.03c	18.77±3.33d	213.40±7.06a	17.42±1.98j	10.73±1.46cd
R. hemispharica	55.00±5.00c	29.79±3.49h	29.90±3.31c	19.60±2.33c	188.10±4.88f	22.24±1.46d	10.13±1.46ef
R. odorata 'Louis XVI'	38.23±2.93f	42.99±3.53ab	36.99±6.60a	21.51±2.33a	133.20±3.44k	30.12±2.15a	13.46±1.05b
R. pisiformis	25.49±0.84i	34.69±2.55ef	26.59±5.01ef	15.45±2.33fg	173.80±7.83g	17.90±1.85i	9.42±1.96g
R. x damascena	31.30±5.78g	42.34±1.65a	25.62±5.09f	16.68±2.33b	203.50±3.95c	18.17±2.53i	9.67±1.46fg
R. x damascena 'Semperflorens'	41.60±5.13g	40.99±3.23c	31.81±4.08b	17.79±2.33e	124.30±5.20l	26.14±2.16b	10.17±1.64ef
Average	**45.70**	**36.59**	**28.33**	**18.22**	**177.04**	**21.45**	**10.57**
LSD (%5)	**0.844**	**1.414**	**0.970**	**0.763**	**0.490**	**0.417**	**0.514**

*: The difference between the averages with different letters on the same column is statistically significant. (P <0.05). **: It is the average of 20 repetitions. LRWC: leaf relative water content Ch: chlorophyll content STL: stomata lenght, SWH: stomata width, SD: stomata density, PRL: pore lenght, PWH: pore width.

3.5. Mineral contents of some *Rosa* L. taxa

The macro and micro nutrient elements examined in the samples taken from *Rosa* L. taxa are given in Table 6. It was determined that nitrogen (N), phosphorus (P), potassium (K) and calcium (Ca), magnesium (Mg) contents of macronutrients analyzed in the samples taken from *Rosa* L. taxa differed statistically from each other. Accordingly, the highest nitrogen content (1.63%) was R. x *damascena*; the lowest nitrogen content (1.00%) was determined in the leaves of the *R. pisiformis* taxa. The average phosphorus (P) content of the leaf samples of the *Rosa* L. taxa in the study was the highest in the R.

heckeliana (0.36%) taxa. According to Kacar and Katkat (1998), potassium, one of the mobile elements, passes from old leaves to young leaves in plants. For this reason, it is stated that the potassium content of young leaves is higher than that of old leaves. According to the analysis results of the leaf samples taken from *Rosa* L. taxa, the mean potassium (K) content was the lowest in *R. pisiformis* (0.68%), and the highest value was found in the leaves of the *R. banksiae* 'Alba' (1.1.82%) taxa (Table 6.).

It was determined that the contents of iron (Fe), copper (Cu), zinc (Zn), and boron (B) examined in the samples taken from *Rosa* L. taxa differed statistically from each other (Table 7.). When the average micronutrient content of the leaf samples taken from the middle parts of the annual shoots of *Rosa* L. taxa were compared, it was determined that the accumulation of all the nutrients examined in the leaves differed according to the species and subspecies, except for the Mg element. Looking at the results of the analysis, *R. x damascena* (Damask rose), which has the highest nitrogen content, draws attention to its low copper and boron content. It has been concluded that the taxon *R. odorata* 'Louis XIV' has generally lower contents than other taxa in terms of both macro and micro nutrients.

Table 6. Macro mineral contents in leaves of *Rosa* L. taxa

Taxa	N (%)	P (%)	K (%)	Mg (%)
R. alba 'Semiplena'	1.13±0.00g	0.17±0.00e	1.54±0.01e	0.27±0.01f
R. banksiae '*Alba*'	1.16±0.01f	0.14±0.00f	1.82±0.02a	0.27±0.01f
R. canina 'Yildiz'	1.09±0.00h	0.32±0.00b	1.75±0.01b	0.34±0.00d
R. centifolia	1.19±0.01f	0.13±0.00g	1.58±0.02d	0.27±0.00f
R. chinensis 'Old Blush'	1.34±0.00d	0.23±0.00d	1.67±0.01c	0.27±0.01f
R. foetida	1.52±0.02b	0.10±0.00h	1.49±0.01f	0.36±0.01c
R. heckeliana subsp*. vanheurckiana*	1.36±0.05d	0.36±0.00a	1.03±0.01h	0.42±0.01b
R. hemispharica	1.24±0.01e	0.17±0.00e	1.59±0.02d	0.33±0.00d
R. odorata 'Louis XVI'	1.47±0.01c	0.09±0.00i	1.68±0.02c	0.28±0.01f
R. pisiformis	1.00±0.00i	0.10±0.00h	0.68±0.01i	0.43±0.01a
R. x damascena	1.63±0.05a	0.25±0.00c	1.50±0.02f	0.29±0.01e
R. x damascena 'Semperflorens'	1.03±0.01i	0.10±0.00 h	1.35±0.01 g	0.34±0.01d
Average	**1.26**	**0.18**	**1.48**	**0.32**
LSD (%5)	**0.030**	**0.009**	**0.030**	**0.013**

*: The difference between the averages with different letters on the same column is statistically significant. (P <0.05).

Table 7. Micro nutrient contents in leaves of *Rosa* L. taxa

Taxa	Fe (ppm)	Cu (ppm)	Zn (ppm)	Mn (ppm)	B (ppm)
R. alba 'Semiplena'	120.51±1.44d	12.01±0.97d	27.32±1.30h	73.37±1.18d	114.72±1.34d
R. banksiae 'Alba'	92.91±1.35i	13.00±0.22c	25.50±0.21i	32.30±0.40j	91.84±1.84h
R. canina 'Yildiz'	119.28±1.44d	13.54±0.32b	37.62±0.66b	43.18±0.49i	101.50±1.60f
R. centifolia	112.60±1.79e	13.02±0.18c	45.89±0.81a	60.98±0.92f	104.15±1.06e
R. chinensis 'Old Blush'	125.77±1.70c	11.55±0.08e	28.49±0.28f	49.24±0.73g	164.99±1.88b
R. foetida	138.01±1.79b	10.58±0.41fg	27.47±0.17gh	76.89±1.08c	90.41±1.88h
R. heckeliana subsp*. vanheurckiana*	157.14±1.80a	11.58±0.18e	31.27±0.38d	64.94±1.06e	69.89±1.42j
R. hemispharica	106.39±1.37f	12.01±0.32d	28.31±0.51fg	78.13±1.38c	139.07±1.71c
R. odorata 'Louis XVI'	78.68±1.01j	10.27±0.20g	25.10±0.24i	74.49±1.09d	94.36±1.10g
R. pisiformis	119.95±1.80d	10.76±0.19f	33.72±0.24c	92.77±0.95b	85.34±1.30i
R. x damascena	96.15±1.33h	14.24±0.31a	30.66±0.23de	45.08±0.99h	56.30±1.39k
R. x damascena 'Semperflorens'	102.97±1.71g	10.40±0.31fg	29.86±0.38e	111.33±0.98a	168.22±0.38a
Average	**114.01**	**11.91**	**30.93**	**66.88**	**106.74**
LSD (%5)	**2.735**	**0.423**	**0.930**	**1.687**	**2.479**

*: The difference between the averages with different letters on the same column is statistically significant. (P <0.05).

3.6. Cluster and principal component analyses

Cluster analysis, which is one of the multivariate statistical analysis methods, is a method used to divide individuals into groups according to their similarities. As a result of cluster analysis, plants within the same group are more similar in terms of characteristics than plants between other groups (Polumackanycz et al., 2020; Guler et al., 2021). The purpose of using cluster analysis in our research is to distinguish plants that are similar in terms of morphological, physiological, pomological, and

biochemical characteristics from those that are different. The advantage of applying a dendogram for the interpretation of the results is that it divides the data into groups, taking into account all the data variability, without the need for any generalization.

In our study, a dendogram tree was formed as a result of 37 different parameters examined in 12 different rose taxa, and as a result, 4 different groups were formed in the dendogram graph (Figure 1). In group 1, *R. foetida* took place alone. In the taxa under the 2nd group in the dendogram tree, *R. canina* 'Yildiz' and R. *damascena* are more similar to each other, and *R. banksiae* 'Alba' and *R. chinensis* 'Old Bush' are also similar to each other, and also in the 2nd group of *R. heckeliana*. *R. alba* 'Semiplena' and R. *centifolia* were under group 3 in the dendogram and were found to be similar in line with the parameters examined. *R.* pisiformis, *R. odorata* 'Louis XVI' clustered in group 4 in the dendogram graph. In *R. hemispharica* and *R. damascena* 'Semperflorens' were found to be more similar compared to the others.
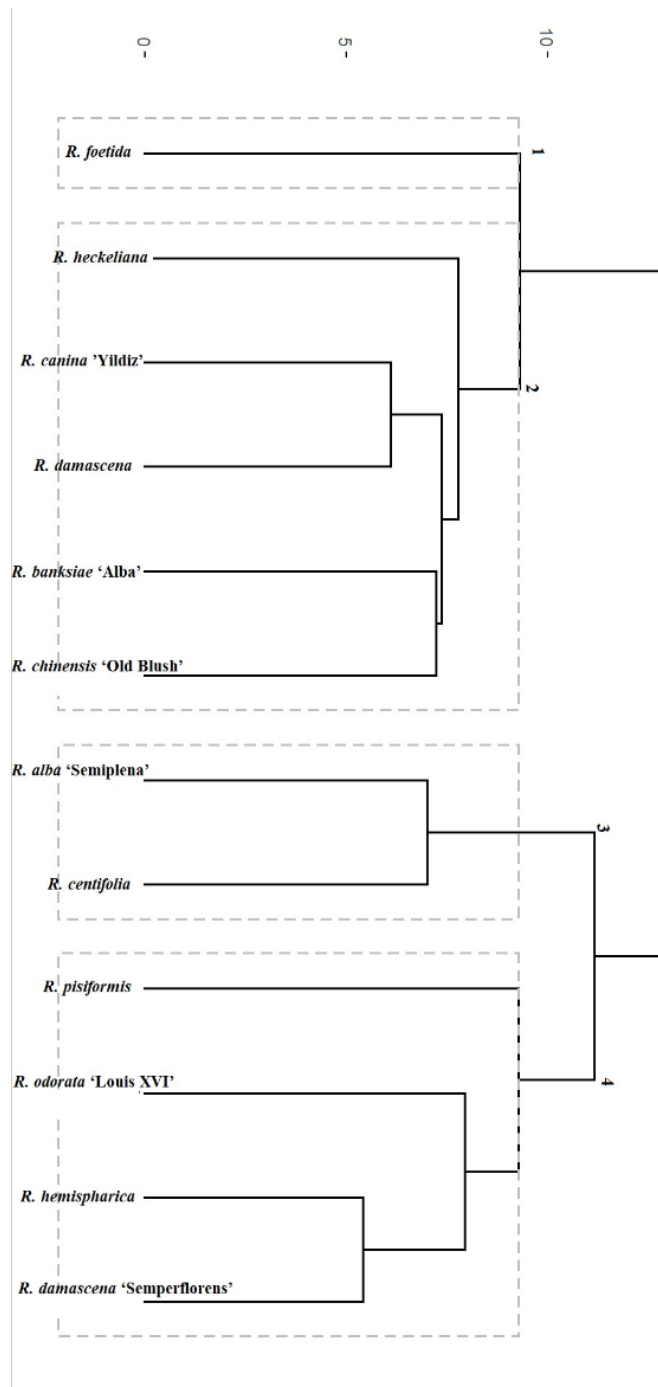

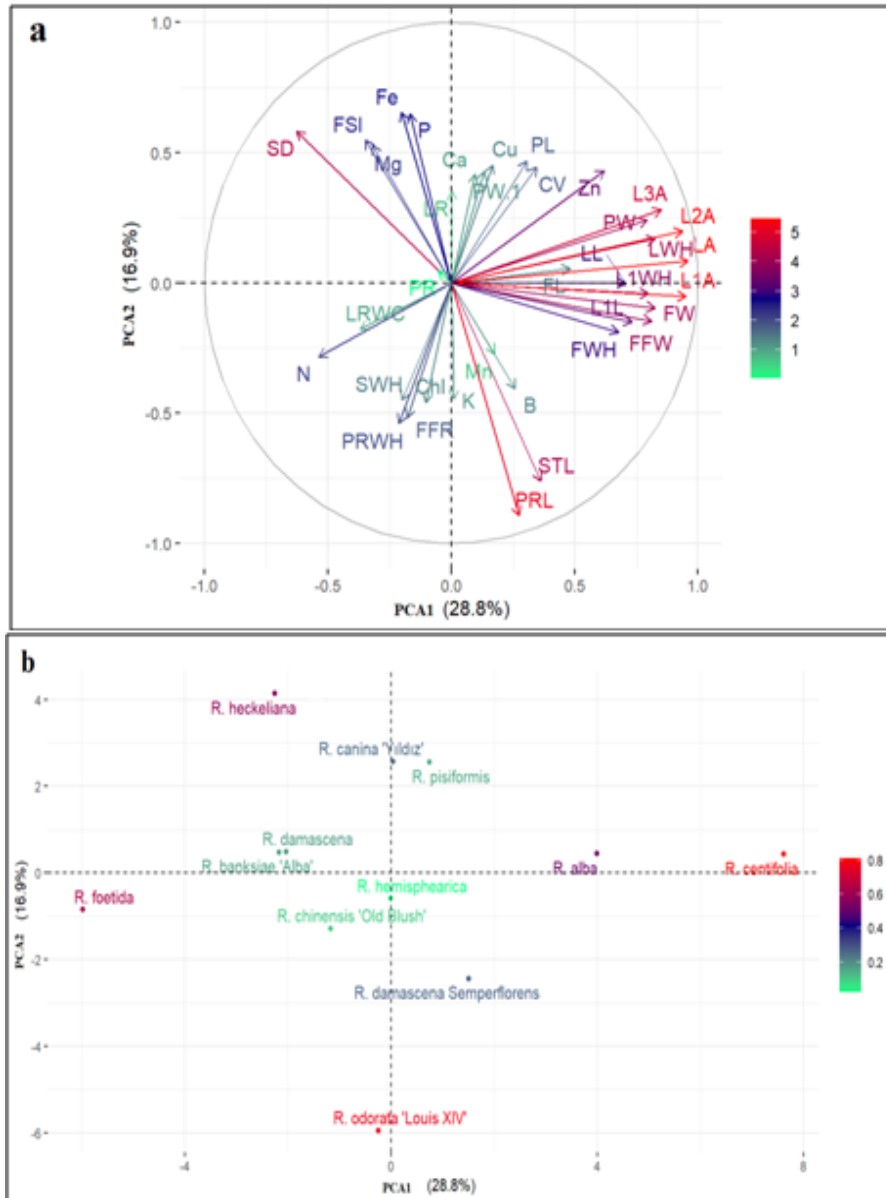Figure 1. Comparative dendogram plot of some *Rosa* L. taxa.

Figure 2. Comparative dendogram plot of some *Rosa* L. taxa.

PCA analysis is a statistical technique that is used to define the data in a smaller area by finding the general features in the multidimensional data, reducing the number of dimensions, and compressing the data. This method combines highly correlated variables to create a smaller set of artificial variables, called 'principal components', that generate the most variation in the data. The data obtained by PCA analyzes are reduced to smaller sizes and the differences and similarities between the applications are visually defined (Bozhuyuk et al., 2021; Guler et al., 2021). In our study, which we conducted to examine the morphological, physiological, pomological, and biochemical properties of different rose taxa, similarities and differences between 12 different rose taxa were determined. As seen in Figure 2 (a,b), the 12 rose taxa used in the study, which have similar characteristics, are located in the same place. The main logic of these groupings is shown in Figure 2 (a). The arrows in the graph show the values of the different parameters examined, that is, these values increase as you move toward the arrow direction.

4. Discussion

Within the scope of the research, 12 different *Rosa* L. taxa were studied. As a result of the research, in terms of plant growth parameters, *R. chinensis* 'Old Blush' and *R. centifolia*; in terms of

morphological features, *R. alba* 'Semiplena'*, R. centifolia* and *R. pisiformis*; in terms of pomological properties, *R. centifolia*, *R. alba* 'Semiplena' and *R. odorata* 'Louis XIV' were found to have high values. It was concluded that *R. pisiformis* and *R. alba* 'Semiplena' species contain high levels of vitamin C. In addition, *R. rugosa*, *R.* x *damascena*, *R.* x *damascena* 'Semperflorens', *R. banksiae* '*Alba*', *R. heckeliana* subsp. *vanheurckiana* and *R. montana* subsp. *woronovii* 'Gercekcioglu' were determined to be promising species in terms of vitamin C content. The vitamin C contents of the fruits of *R. chinensis* and *R. odorata* species, which are used extensively in urban landscape studies, were found to be low. In addition, it is thought that the *R. alba* species, which has higher values compared to other species in parameters such as weight, width and height in fruit and starts to bear fruit early, can be considered as an alternative agricultural product apart from its landscape feature. *R. canina* 'Yildiz', *R. chinensis* 'Old Blush', *R. odorata* 'Louis XIV', *R. heckeliana* stand out in photosynthetic parameters. It was determined that the contents of macro and micro nutrients examined in the samples taken from *Rosa* L. taxa differed statistically from each other. Principal component analysis and cluster analysis were also used to determine the similarities and differences of these parameters measured in different *Rosa* L. taxa.

Conclusion

Roses that adapt to the ecological conditions they are in can be used with their aesthetic appearance and functional effects (erosion prevention, landscape restoration works, etc.). It can be used in slope areas, especially on intercity roads. If a visuality is provided with the fruits of the rose taxa studied and the value of the fruits is understood, the local people adopt these plants and a sustainable use can be achieved. The data obtained in the determination of physiological characteristics are the values reached under greenhouse conditions. In this respect, it is important to carry out pomological analyzes in the same ecology and to evaluate the plants in question as genetic materials.

Acknowledgements

References

Akkus, E. (2016). *Morphological identification of naturally growing rosehip genotypes (Rosa spp.) in the Hamur (Ağrı) Region.* (Master Thesis). ODU Institute of Science and Technology, Department of Horticulture, Ordu, Turkiye.

Aksoy, E. (2019). *Effects of humic acid on plant growth, yield, some quality biochemical properties in tomatoes grown in salty conditions*. (Master Thesis). Harran University, Graduate School of Natural and Applied Sciences, Department of Horticulture, Sanliurfa, Turkiye.

Alp, S., Celik, F., & Keskin, N. (2016). Determination of stoma characteristics and density by image analysis method in some rose and rosehip species (*Rosa* ssp.). *Harran Journal of Agricultural and Food Sciences*, 20(3), 159-165. https://doi.org/10.29050/harranziraat.259107

Altun, B., Boyacı, S., & Kazankaya, A. (2021). Kuşburnunda (*Rosa canina* L.) Tohum Çıkışı ve Çöğür Gelişimi Üzerine Farklı Katlama Ortamlarının ve Sıcaklık Uygulamalarının Etkisi . Yuzuncu Yıl University Journal of Agricultural Sciences, 31 (2), 330-336. https://doi.org/10.29133/yyutbd.846822

TURKPATENT, (2022). *Origin Name: Halfeti Karagül/Halfeti Black Rose*. Registrant; Halfeti Municipality, Registration date: 01.03.2021, Registration No: 684, T.C. Ministry of Industry and Technology, Turkish Patent Institute, Ankara.

Baktir, I. (2015). *All aspects of roses and rose cultivation*. Hasad Publishing and Advertising Agriculture Industry. Ltd. Sti., Istanbul.

Bruun, H.H. (2005). *Rosa rugosa* Thunb. ex Murray. *Journal of Ecology*, 63, 335–344. https://doi.org/10.1111/j.1365-2745.2005.01002.x

Bucsa, C., & Zamfirache, M.M. (2017). *Variations in photosynthetic and transpiration rates in five spontaneous Rosa L. taxa from Suceava County, Romania*. First International Congress of

Danube Region Botanical Gardens (IC-DRBG) - Transdisciplinarity in Plant Science. September 7-9, 2017, Arad - Macea, Romania.

Campbell, S.C. (2002). *Rosales* / Rose (Chapter). Wiley Online Library, DOI: 10.1038/npg.els.0003722.

Celik, F., Dogan, A., Oguz, H. I., Kazankaya, A., & Ekincialp, A. (2006). *Effects of different altitudes on vitamin c content in rosehip (Rosa spp.) types.* Paper presented at the II. National Symposium on Berries, 14-16 September, Tokat, Turkiye.

Celik, F., Kazankaya, A., Dogan, A., Gundogdu, M., & Cangi, R. (2005). *Some pomological and biochemical properties of rose hip (Rosa spp.) germplasm.* Paper presented at the 3rd IS on Pomegranate and Minor Mediterranean Fruits, ISHS 2015 ActaHort. 1089: 287-292.

Celik, F., Kazankaya, A., & Ercisli, S. (2009). Fruit characteristics of some selected promising rose hip (*Rosa* spp.) genotypes from Van region of Turkey. *African Journal Of Agricultural Research*, 4 (3), 236-240.

Cemeroglu, B. (1992). *Fundamental analysis methods in fruit and vegetable industry*. Biltav University Books Series, , Ankara, Turkiye.

Dogan, M. (2018). *Investigation of humic acid and silicon effects on plants under cadmium toxicity in strawberry.* (Master Thesis). Harran University Institute of Science and Technology, Sanliurfa, Turkiye.

Ekincialp, A., Kazankaya, A., Eyduran, E., Dogan, A. & Celik, F. (2007). *Factors affecting some pomological characteristics of roseship plants grown in Hakkari City Center.* Paper presented at the Turkey V. National Horticultural Congress, 04-07 September, Erzurum, Turkiye.

Encu, T. (2015). *Determination of pomological and some biochemical characteristics of rosehip (Rosa canina L.) fruits from some locations of Eastern Anatolia Region (Van-Hakkari-Şırnak).* (Master Thesis). Yuzuncuyil University, Graduate School of Natural and Applied Sciences, Department of Horticulture, Van, Turkiye.

Ercisli, S. (1996). *A study on the selection breeding and propagation opportunities of naturally growing rosehips (Rosa spp.) in Gümüşhane and its districts*. (PhD Thesis). Ataturk University, Institute of Science, Erzurum, Turkiye.

Ercisli, S., & Esitken, A. (2004). Fruit characteristics of native rose hip (*Rosa* spp.) selections from the Erzurum Province of Turkey. *New Zealand Journal of Crop and Horticultural Science*, 32, 52–53. https://doi.10.1080/01140671.2004.9514279

Ercisli, S., Esitken, A., & Guleryuz, M. (2001). A study on the breeding of naturally growing rosehips (*Rosa* spp.) by selection in Erzurum (Central District), Tortum, Pazaryolu and Pasinler Districts. *Bahce* 29(1/2): 39-44.

Evans, W.C. (2002). *Pharmacognosy*. 5th edition, Saunders, 25-26.

Guler, E., Bak, T., Karadeniz T., & Muradoglu F., (2021). Relationships of fruit characteristics of rosehips (*Rosa canina* L.) grown in Bolu City Center. *Journal of the Institute of Science and Technology*, 11(2), 831-838. https://doi. 10.21597/jist.824742.

Gunes, M. Dolek, U. (2010). Fruit characteristics of promising native rose hip genotypes grown in Mid-North Anatolia Region of Turkey. *Journal of Food, Agriculture & Environment*, 8 (2), 460-463.

Gunes, M. (2010). Pomological and phenological characteristics of promising rose hip (*Rosa*) genotypes. *African Journal of Biotechnology*, 9(38), 6301-6306.

Gunes, M., & Sen, S.M. (2001). A study on the breeding of naturally growing rosehips (*Rosa* spp.) in Tokat Region by selection. *Bahce*, 30 (1-2), 9-16.

Hatipoglu, İ.H., & Ak, B.E. (2021). Some pomological and physiological characteristics of Halfeti Rose (*Rosa odorata* 'Louis XIV') and different rose taxa. *Harran Journal of Agricultural and Food Sciences*, 25(4), 457-468. https://doi.10.29050/harranziraat.980733

Heywood, V.H., Brummit, R.K., Culham, A., & Seberg, O. (2007). *Flowering Plants families of the world*. Firefly Books Ltd., New York., 280-283.

Hurkul, M.M., & Koroglu, A. (2019). A ethnobotanical review: The subfamily Amygdaloideae (Rosaceae). *FABAD J. Pharm. Sci.*, 44(1), 35-46.

Ipek, P., & Balta, F. (2020). Fruit properties of rose hip (*Rosa* spp.) genotypes selected from Akkuş, Ordu Province. *Yuzuncu Yil University Journal of Agricultural Science*, 30(2), 338-344. https://doi.10.29133/yyutbd.680453

Kacar, B. (1972). *Chemical analysis of plant and soil: ii plant analysis*. Ankara University Faculty of Agriculture Publication, Ankara, 464p.

Kacar, B., & Katkat, A.V. (2009). *Plant nutrition* (4th Edition). Nobel Publications, Ankara, 659s.

Kalariya K.A, Mehta D., Goswami N., Singh A.L., Chakraborty K., Mahatma M.K., Zala P.V., & Patel C.B. (2017). Stomatal clustering pattern in *Arachis hypogaee* L. under water deficit stress. *Indian Journal of Experimental Biology*, 55 (12), 880-883.

Kara, S., & Ozeker, E. (1999). Studies on leaf characteristics and stoma distribution of round seedless grape grape grapes grafted on different rootstocks. *Journal of AARI*, 9(1), 76-85.

Karaksakal, A. (2007). *Determination of ascorbic acid in rosehip plant by spectrophotometric method.* (Master Thesis). Istanbul University Graduate School of Sciences, Department of Chemistry, Chemistry Program, Istanbul, Turkiye.

Kazankaya, A., Turkoglu, N., Yilmaz, M., & Balta, M.F. (2005). Pomological description of *Rosa canina* selections from Eastern Anatolia, Turkey. *Int.J. Botany*. 1 (11), 100- 102.

Kazankaya, A., Yilmaz, H., & Yilmaz, M. (2001). Selection of naturally growing rosehips in Adilcevaz Region. *YYU. Journal of Agr.Fac*, 11(2), 29–34.

Kazaz, S., Baydar, H., & Erbas, S. (2009). Variaitions in chemical compositions of *Rosa damascena* Mill. and *Rosa canina* L. fruits. *Czech. J. Food. Sci*, 27 (3), 178-184. https://doi.10.17221/5/2009-CJFS

Kızılcı, G. (2005). *Adaptation of some valuable Rosehip (Rosa spp.) types in Erzincan ecological conditions (Selection II).* (Master Thesis). GOP Uni. Graduate School of Natural and Applied Sciences, Master Thesis, Tokat, Turkiye.

Koca, A. (2014). *Studies on landscape roses (Rosa L. spp.) of Turkey.* (Master Thesis). T. C. Süleyman Demirel University, Graduate School of Natural and Applied Sciences, Department of Biology, Isparta, Turkiye.

Korkmaz, M., Ozcelik, H. (2015). Local names of Turkey roses (*Rosa* L.) and growing regions. *Journal of Suleyman Demirel University Institute of Science*, 19 (1), 75-82.

Kovacs, S., Fascar, G., Udvardy, L., & Toth, M. (2005). *Phenological, morphological and pomological characteristics of some rose species found in Hungary*. Paper presented at the 1st Int. Rose Hip Conf. Eds. H. Nybom and K. Rumpunen, ISHS 2005, Acta Hort. 690: 71-76.

Liu, X., & Pijut, P.M. (2008). Plant regeneration from *in vitro* leaves of mature black cherry (*Prunus serotina*). *Plant Cell Tissue Organ Culture*, 94, 113-123.

Najda, A., & Buczkowska, H. (2013). Morphological and chemical characteristics of fruits of selected *Rosa* sp. *Modern Phytomorphology*, 3, 99–103, https://doi.0.5281/zenodo.161996

Nilsson, O. (1972). *Rosa* L. in: Davis, P.H. (ed.). Flora of Turkey and the East Aegean Islands. 4, 106-128, Edinburgh University Press.

Odabasıoglu, M.İ. (2020). *Investigation of yield, quality and seed traits and stoma morphology of table grape varieties grown on different rootstocks in semi-arid conditions*. (PhD Thesis). Harran University Institute of Science and Technology, Sanliurfa, Turkiye.

Orchen, N., Nazarian, G., & Gharibkhani, M. (2013). The responses of stomatal parameters and SPAD Value in Asian Tobacco exposed to chromium. *Polish Journal of Environmental Studies* 22(5), 1441-1447.

Ozcan, F. (2012). The rose in the Greek and Roman world. *Suleyman Demirel University Journal of Social Sciences Institute*, 2012/2, 16, 1-29.

Ozcelik, S. (2013). *Studies on rose (Rosa L.) species important for fruit rose growing in Turkey*. (Master Thesis). Süleyman Demirel University Institute of Science and Technology, Isparta, Turkiye.

Ozdemir, E., & Dundar, O. (1998). *Effect of different postharvest application on storage of Kozan and Valencia late oranges*. Paper presented at the XXV. Int. Hort. Con. 2-7 August 1998 Brussels, Belgium.

Ozdemir, G. (2005). *Morphological and physiological investigation of the effects of different applications on Fe uptake in vine genotypes grown in soils with different lime content.* (PhD Thesis). Çukurova University, Institute of Science and Technology, Adana, Turkiye.

Pirselova, B. (2021). Impact of cadmium Toxicity on leaf area and stomatal characteristics in faba bean. *Journal of Microbiology, Biotechnology and Food Sciences*, 11(2), https://doi.10.15414/jmbfs.3718

Polumackanycz, M., Kaszuba, M., Konopacka, A., Marzec-Wróblewska, U., Wesolowski, M., Waleron K., Buci ´nski, A., & Viapiana A. (2021). Phenolic composition and biological

properties of wild and commercial dog rose fruits and leaves. *Molecules*, 25, 5272. https://doi:10.3390/molecules25225272

Ryan, J., Estafan, G., & Rashid, A. (2001). *Soil and plant analysis laboratory manual* (2nd edit.). ICARDA and NARS, Aleppo- Syria, 135-140.

Sanchez, F.J., Andres, E.F., Tenorio, J.L., & Ayerbe, L. (2004). Growth of epicotyls, turgor maintenance and osmotic adjustment in pea plants (*Pisum sativa* L.). *Field Crops Research*, 86, 81-90.

Sanlidere Aloglu, H., Gokgoz, Y., & Bayraktar, M. (2018). *Arbutus unedo* L. fruit ice cream production, investigation in terms of physical, chemical and sensory parameters. *Food Technology Association Food Journal*, 43(6), 1030-1039.

Semida, W.M., Rady, M.M., Abdelmageed, T.A., Howladar, S.M., & Abdelhamid, M.T. (2015). Alleviation of cadmium toxicity in common bean (*Phaseolus vulgaris* L.) plants by the exogenous application of salicylic acid. *Journal of Horticultural Science and Biotechnology*, 90(1), 83-91.

Tomlijenovic, N., Jemrit, T., & Vukovic, M. (2021). Variability in pomological traits of dog rose (*Rosa canina* L.) under the ecological conditions of the Republic of Croatia. *Acta Agriculturae Serbica*, 26 (51), 41–47. https://doi.10.5937/AASer2151041T

Turkben C., Uylaser V., İncedayi B., & Celikkol I. (2010). Effects of different maturity periods and processes on nutritional components of rosehip (*Rosa canina* L.) *Journal of Food, Agriculture & Environment*, 8 (1), p26-30.

Yamane, M. (1990). A case study on indigenous population of *Rugosa* Rose in Western Japan. *Sand Dune Research*, 37, 23–35.