International Journal of Agricultural Technology 2022Vol. 18(3):927-938
Available online http://www.ijat-aatsea.com
ISSN 2630-0192 (Online)

Application of *Allium hirtifolium* for the selection process in architecture and environmental sciences

Alp, S.[1], Mohammadi Fallah, A. [1,2] and Najafi, S.[3*]

[1]Department of Landscape Architecture, Faculty of Architecture, Van Yuzuncu Yil University, Van, Turkey; [2] Department of Architecture, Faculty of Architecture, Islamic Azad University, Urmia, Iran; [3]Department of Field Crops, Faculty of Agriculture, Van Yuzuncu Yil University, Van, Turkey.

Alp, S., Mohammadi Fallah, A. and Najafi, S. (2022). Application of *Allium hirtifolium* for the selection process in architecture and environmental sciences. International Journal of Agricultural Technology 18(3):927-938.

Abstract Contrary to the popular belief, green space is not just a plant-covered, tabulated area. It is a symbol of a community's cultural and social thinking. So, its scope does not include just parks. Plants are the most important environmental variables in the landscape architecture and green space. Given the numerous problems in the field of green space, it seems necessary to provide methods for selecting plants with a systemic and holistic perspective. The genus *Allium* is one of the largest world florae. This study analyzed the karyotype and chromosome structure in five populations of *Allium hirtifolium* in different parts of Van, Turkey. Pre-treatment, fixation, hydrolysis and staining were done using root meristem; then microscopic samples were elucidated. The results showed that in all studied cells of each population, the basic chromosome number was 2n=2x=16 and all of them were diploid and X=8. Karyotype analysis of each population. It was also separately conducted and several indices including length of the long arm, length of the short arm, length of satellites, total length of the chromosome, arm ratio and centromere index. The length of chromosomes in all populations was estimated as 12.53 – 18.64 micrometers. Chromosomes 6 and 8 contained a secondary constriction and satellite. Karyotype formula for these populations was seven metacentric one submetacentric.

Keywords: Chromosome, cytogenetic, *Allium* hirtifolium, Architecture, Environment

Introduction

Green space design projects in the world are required to follow certain principles and technical points. To achieve an ideal, beautiful and unique green space design, new ideas must always be used. Plants are the most important environmental variables in the landscape architecture and green space (Taghizadeh, 2016). Urban green space is a part of open urban spaces whose natural or artificial areas are under the establishment of trees, shrubs, flowers, grasses and other plants that are based on human's supervision and

[*] **Corresponding Author:** Najafi, S; **Email:** solmaznajafi@yyu.edu.tr

management, considering the rules, regulations and related specialties for improving the living conditions and welfare of citizens and non-rural population centers. Green space design is a professional specialty that includes areas such as analysis, planning, design, management and monitoring of natural and man-made environments. Specialists in this field, in collaboration with other professions such as architecture, urban planning and civil engineering, can play an important role in supporting the environment and do so by designing and implementing projects to meet human and environmental needs. The important social task of green space design is to create harmony between art and science, in order to plann and design the entire environment and landscape. Today, given the importance of the health and well-being of humans and the environment, achieving sustainable environmental and landscape ability without destroying and reducing the quality of resources is a vital principle in this profession. The main purpose of landscape design is to change the phenomena from the current states to their desired ones. However, human's negligence, potentials and limitations of nature have been affected the whole planet, leading to a quantitative and qualitative decline in living standards and environmental degradation. In order to carry out the process of designing the green space in a logical and purposeful way, it is necessary to have a proper combination of the components of the process of designing the environment and landscape along with planning and, especially, selecting the suitable plant materials for each geographical area. In this regard, access to tangible, objective and lasting designs rtevealed important. Therefore, each design is needed to be the following steps. The first step was to identify the environmental resources and needs as well as reviewing the plans and regulations. The second phase of the analysis was analyzed the resources and needs, and adapting them to the overriding rules, thus leading to the determination of the possible actions. The third step involved in adapting the actions and plans possible to the environmental conditions of the site. The result was the location of each activity.

Most people consider trees and flowers to be part of the urban landscape. The fame and characteristics of many cities are due to the vegetation in them, serving an important role in the urban landscape. The use of trees and ornamental flowers in urban spaces may not play a decisive role in the human's livelihood, but many people find living next to trees a pleasure. This shows the strong desire of the human to return to nature. On the other hand, the effect of trees and flowers on reducing the density of the environment and the uniformity of the landscape is one of the factors making people feel to be the need for the presence of trees and flowers in cities. Flowers and plants of green space in cities, in addition, it is being reminiscent of the natural environment and providing special spatial structures for humans which are important in modifying some environmental factors. These environmental factors include the following, decrease of air pollution, reduction of noise pollution, soil erosion control and stabilization, light reflection control and control of auto climatic conditions including control of sunlight and temperature, wind and control.

Expanding the scope of human civilization and the rule of industry is based on new technologies and the tendency towards machine life along with the destructive effects and destruction of natural resources and vegetation. It has turned the farmlands and orchards into buildings, along with the population growth in cities. Environmental pollution has not only disrupted the ecological system and the welfare system, but also created difficult conditions for the human’s life. Green spaces can be used to detoxify and created peace of mind and body in urban environments. However, the construction of any type of green space helps to beautiul environment. Despite, taking advantage of this function requires careful planning. In order to human-oriented city, it is necessary to pay attention to the necessity of leisure planning in the case of distribution and expansion of green space. Flowers and plants have architectural features that can be used in the design and space of cities. It can be used to design and space of cities. Flowers and plants are used as the main materials in the landscape architecture. Plants and flowers can be used as architectural elements in landscaping. Genetic and cytogenetic study, and analysis of plants to select the appropriate genus and species in each region can be regarded as one of the most important and valuable steps for a beautiful design in architecture. The genus *Allium* is one of the largest world florae. Approximately 750 *Allium* species can be found in the northern hemisphere from Europe and Asia, to the shores of the Pacific Ocean in northwestern America (Fritsch and Friesen, 2002; Friesen *et al*., 2006; Gen ç and Özhatay, 2014; İpek *et al*., 2014). Botanically, *Allium* is an herbaceous, perennial plant with stems having the height of 20 to 40 cm; its underground part is swollen and composed of 3 to 12 pieces, being enclosed in thin and delicate membranes of white-gray color, with narrow green striped leaves. Dark small pink flowers appear as an umbrella at the end of the stem. It is a long day plant that needs day and temperature to form cloves (Baghalian *et al.,* 2004). Taxonomic studies in the past have largely led to improve the classification of *Allium* and a better understanding of each species in different regions (Friesen *et al*., 2006).

This genus is characterized by bulbs with membranous coatings, which are sometimes fibrous (tufts); the leaves are loose or almost free, and a semi-basal cream is often subginobase. The predominant chromosome number of this genus is x=7 and x=8. Species can be identified which based on a set of characteristics including chromosome number, karyotype formula, chromosome length, and position of satellites on specific chromosomes. *Allium* is classified into 5 subtypes and more than 50 sections (Karimzadeh and Paknia, 2010). Studies in Central Asia have significantly contributed to this development with the description of more than 30 new *Allium* species (Fritsch and Khassanov, 2008). In the present study, chromosomal analysis of endemic *Allium* masses in the Van region, Turkey, was performed.

Materials and methods

Five ecotypes of the native *Allium* of Van province were collected. After disinfecting the *Allium* tubers with Sodium hypochlorite %2 for 5 minutes, *Allium* cloves were separated for rooting and placed on water-containing erlenes; so, the roots were part of the crown with water. When the roots reached a length of one to two centimeters, from 8 to 10 in the morning, they were separated from the cloves. To study mitosis in dividing cells, colchicine pretreatment with a concentration of 0.1% at room temperature was used for 4 hours (Farsi *et al*., 2011). After removing the roots from the pretreatment stage, they were washed and dried using filter paper. In order to stabilize the cell division, the roots were immersed in a Karnoy solution (3 parts of ethyl alcohol: 1 part of glacial acetic acid) for 4 hours at 4 ° C. Hydrolysis was performed with a solution of normal hydrochloric acid in an oven at 60 °C for 12 minutes. After hydrolysis, the roots were washed with distilled water for 30 minutes and stained with 1% Aceto-Carmine at 25 ° C for three hours. After preparing the slide by the squash method, microscopic observations by Olympus microscope were performed. The cells were identified with an objective lens of 100X microscopes; after obtaining the appropriate metaphase cells, the cells were photographed using a camera attached to the mentioned microscopes. Five clear images of each ecotype were then selected to be transferred to Karyotype Analysis 1.5 for measurement and software analysis. The arms of the chromosomes were measured and the location of the centromere was determined. Other karyotype indices along with the ideogram of each ecotype were calculated in the Excel software; all data were analyzed in SPSS. The length of short and long arms, the ratio of long to short arms and the total length of chromosomes, along with other indicators, were then calculated (Kumari *et al*., 2011).

Standard karyotype was prepared using selective metaphase and chromosome parameters including the length of long arm (L), the length of short arm(S), the length of satellites, the total length of chromosomes (TL), arm ratio (AR) and centromere index (CI); these were calculated for chromosomes.

The volume of each chromosome was measured by assuming that it is made of two cylinders corresponding to two sister chromatids. The chromosomes were assigned into different categories on the basis of arms ratio, following Levan *et al.* (1964) (M=1.0, m=1.0 -1.7, sm=1.7-3.0, st=3.0-7.0) (Figure1). Also, the ideogram of each population was based on the length of short and long arms using the Excel software. The arrangement of chromosomes in the ideogram was considered from left to right, as well as from the largest to the smallest total chromosomes length (TL) as seen in Figure 1.

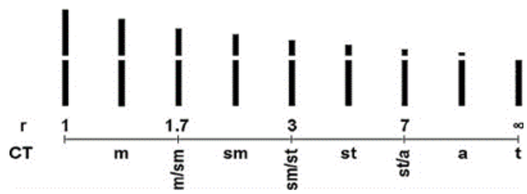

Figure 1. Chromosomes categories on the basis of arms ratio, according to Levan *et al.* (1964).

Results

Results of the mitotic metaphase plates in the studied populations and the karyotype ideogram showed that in all examined cells in each population, the basic chromosome number was x=12 and all were diploid 2n=2x=16. Karyotype analysis was conducted separately for each population.

The karyotype formula was 7m+1sm in all studied populations (Tables 1-6 and Figures 2-8). The chromosomes type in all populations included seven metacentric, one submetacentric and two satellites in chromosomes six and eight. The length of chromosomes in all populations was calculated to be 12.53 to 18.64 micrometers. The longest chromosome was observed in the chromosome 1 from population Edremit 3, which was 18.64 micrometers, and the shortest one was related to the chromosome 8 from population Edremit 4, which was 1.55 micrometers.

In population Edremit 1, which belongs to the northern parts of Edremit in the city of Van, total chromosomes length varies from 13.05 to 18.59 micrometers. The longest arm was 11.29 µm, while the shortest arm was 4.21 µm. Centromere of all chromosomes was at the median region, except the chromosome eight, which was submetacentric. Two satellites were observed in the karyotypic of this population. Arm Ratio (L/S) varied from 1.10 to 2.05. The karyotype of this population consisted of seven pairs of median regions (m) chromosomes and one submetacentric (sm) chromosomes, as well as two satellites in chromosomes six and eight (Table 2). Somatic metaphase and haploid ideogram in the population number 1 can be seen in Figure 2. All experiments were shown in Tables 1-6.

Table 1. Chromosome characteristics in *Allium hirtifolium* (Population Edremit 1)

Pair No	L(μm)	S(μm)	Sat.(μm)	TL(μm)	AR	CI (%)	Chromosome type (Levan)
1	11.29	7.3	0	18.59	1.55	39.27	M
2	9.63	7.41	0	17.04	1.30	43.49	M
3	8.96	7.36	0	16.32	1.22	45.10	M
4	9.8	5.39	0	15.19	1.82	35.48	M
5	9.21	5.34	0	14.55	1.72	36.70	M
6	8.35	5.51	0.21	14.07	1.52	39.75	M
7	7.23	6.6	0	13.83	1.10	47.72	M
8	8.62	4.21	0.22	13.05	2.05	32.81	sm
Total	73.09	49.12	0.43	122.64	-	-	-

L: Long arm, S: Short arm, Sat: Satelite, TL: Total chromosome length, AR: Arm Ratio, (μm), CI: Centromere Index, M: metacentric, sm: Submetacentric.

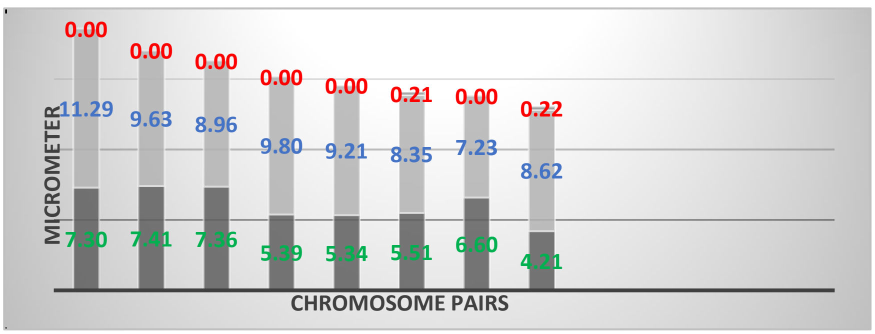

Figure 2. Somatic haploid ideogram in *Allium hirtifolium* (Population Edremit1)

Table 2. Chromosome characteristics in *A. hirtifolium* (Population Edremit 2)

Pair No	L(μm)	S(μm)	Sat. (μm)	TL (μm)	AR	CI (%)	Chromosome type (Levan)
1	10.55	7.36	0	17.91	1.43	41.09	M
2	9.26	7.05	0	16.31	1.31	43.23	M
3	8.65	7.08	0	15.73	1.22	45.01	M
4	9.51	4.56	0	14.07	2.09	32.41	sm
5	7.19	6.43	0	13.62	1.12	47.21	M
6	7.21	5.65	0.35	13.21	1.28	43.93	M
7	7.35	5.84	0	13.19	1.26	44.28	M
8	8.87	3.69	0.29	12.85	2.40	29.38	sm
Total	68.59	47.66	0.64	116.89	-	-	-

L: Long arm, S: Short arm, Sat: Satelite, TL: Total chromosome length, AR: Arm Ratio, CI: Centromere Index, M: metacentric, sm: Submetacentric.

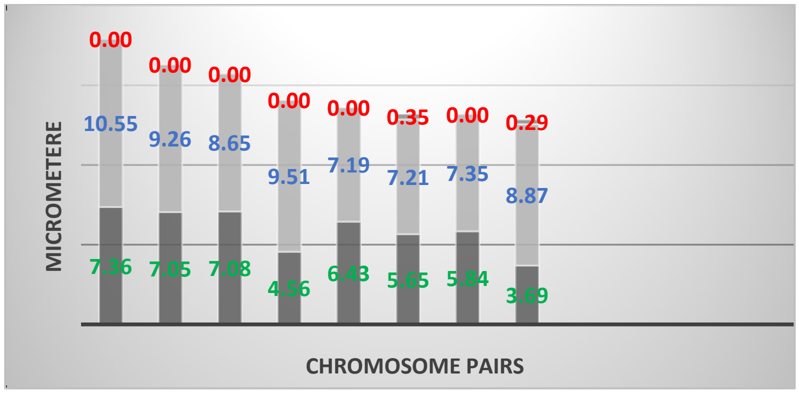

Figure 3. Somatic haploid ideogram in *Allium hirtifolium* (Population Edremit2)

Table 3. Chromosome characteristics in *A. hirtifolium* (Population Edremit 3)

Pair No	L(µm)	S(µm)	Sat.(µm)	TL (µm)	AR	CI (%)	Chromosome type (Levan)
1	11.08	7.56	0	18.64	1.47	40.56	M
2	10.15	7.97	0	18.12	1.27	43.98	m
3	9.83	7.68	0	17.51	1.28	43.86	M
4	9.81	6.96	0	16.77	1.41	41.50	M
5	8.67	6.94	0	15.61	1.25	44.46	M
6	8.37	5.63	0.19	14.19	1.49	40.21	M
7	7.59	5.59	0	13.18	1.36	42.41	M
8	9.32	3.24	0.25	12.81	2.88	25.80	sm
Total	74.82	51.57	0.44	126.83	-	-	-

L: Long arm, S: Short arm, Sat: Satelite, TL: Total chromosome length, AR: Arm Ratio, CI: Centromere Index, M: metacentric, sm: Submetacentric.

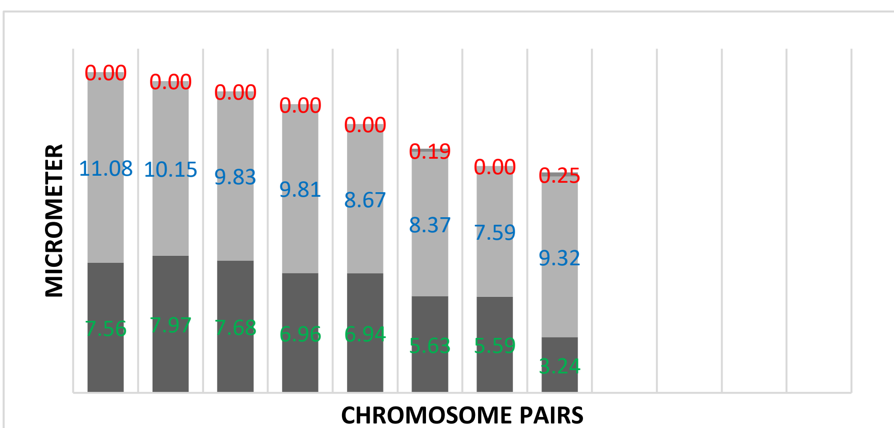

Figure 4. Somatic haploid ideogram in *Allium hirtifolium* (Population Edremit3)

Table 4. Chromosome characteristics in *A. hirtifolium* (Population Edremit 4)

Pair No	L(µm)	S(µm)	Sat. (µm)	TL (µm)	AR	CI (%)	Chromosome type (Levan)
1	10.45	6.46	0	16.91	1.62	38.20	M
2	8.96	7.37	0	16.33	1.22	45.13	M
3	8.51	6.7	0	15.21	1.27	44.05	M
4	9.74	5.13	0	14.87	1.90	34.50	M
5	8.55	5.56	0	14.11	1.54	39.40	M
6	8.59	4.49	0.37	13.45	1.91	34.33	M
7	7.46	5.46	0	12.92	1.37	42.26	M
8	8.05	4.17	0.31	12.53	1.93	34.12	M
Total	70.31	45.34	0.68	116.33	-	-	-

L: Long arm, S: Short arm, Sat: Satelite, TL: Total chromosome length, AR: Arm Ratio, CI: Centromere Index, M: metacentric, sm: Submetacentric.

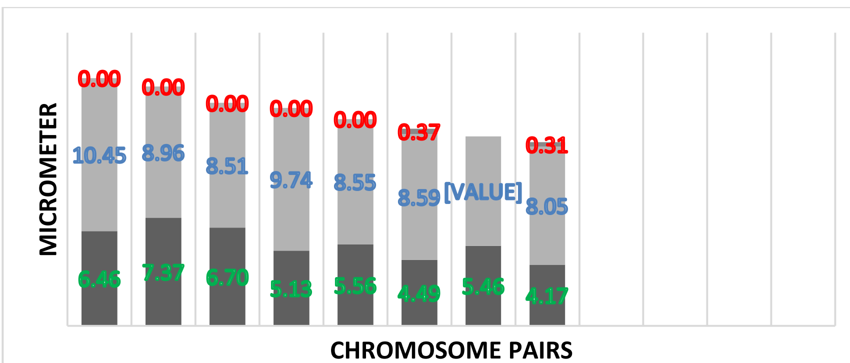

Figure 5. Somatic haploid ideogram in *Allium hirtifolium* (Population Edremit4)

Table 5. Chromosome characteristics in *A. hirtifolium* (Population Edremit 5)

Pair No	L(µm)	S(µm)	Sat.(µm)	TL (µm)	AR	CI (%)	Chromosome type (Levan)
1	9.77	7.78	0	17.55	1.26	44.33	M
2	9.52	7.19	0	16.71	1.32	43.03	M
3	8.81	6.81	0	15.62	1.29	43.60	M
4	9.34	4.97	0	14.31	1.88	34.73	M
5	8	6.01	0	14.01	1.33	42.90	M
6	8.07	4.93	0.22	13.22	1.64	37.92	M
7	7.46	5.47	0	12.93	1.36	42.30	M
8	8.4	4.02	0.19	12.61	2.09	32.37	sm
Total	69.37	47.18	0.41	116.96	-	-	-

L: Long arm, S: Short arm, Sat: Satelite, TL: Total chromosome length, AR: Arm Ratio, CI: Centromere Index, M: metacentric, sm: Submetacentric.

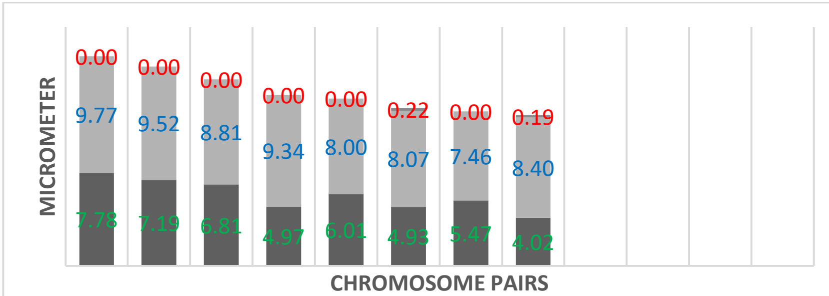

Figure 6. Somatic haploid ideogram in *Allium hirtifolium* (Population Edremit 6)

Table 6. Mean values of Chromosome characteristics in *A. hirtifolium* (Van-Edremit ecotypes)

Pair	L±Se (µm)	S±Se(µm)	Sat±Se(µm)	TL±Se(µm)	AR±Se	CI±Se(%)	Chromosome type (Levan)
1	10.63±0.6	7.29±0.5	0.00	17.92±0.73	1.46±0.14	40.69±0.2.33	M
2	9.50±0.44	7.40±0.35	0.00	16.90±0.74	1.29±0.04	43.77±0.84	M
3	8.95±0.52	7.13±0.4	0.00	16.08±0.89	1.26±0.03	44.32±0.69	M
4	9.64±0.21	5.40±0.92	0.00	15.04±1.06	1.82±0.25	35.73±3.43	M
5	8.32±0.77	6.06±0.65	0.00	14.38±0.76	1.39±0.24	42.13±4.14	M
6	8.12±0.54	5.24±0.51	0.27±0.08	13.63±0.47	1.57±0.23	39.23±3.50	M
7	7.42±0.14	5.79±0.48	0.00	13.21±0.37	1.29±0.12	43.80±2.35	M
8	8.65±0.48	3.87±0.41	0.25±0.05	12.77±0.21	2.27±0.38	30.90±3.34	sm

Karyotype Formula (KF): 7m+1sm
Se:Standard error, L: Long Arm, S: Short arm, SAT: Satelite, TL: Total chromosome length, AR: Arm Ratio, KF: karyotype formula, M: metacentric, sm: Submetacentric.

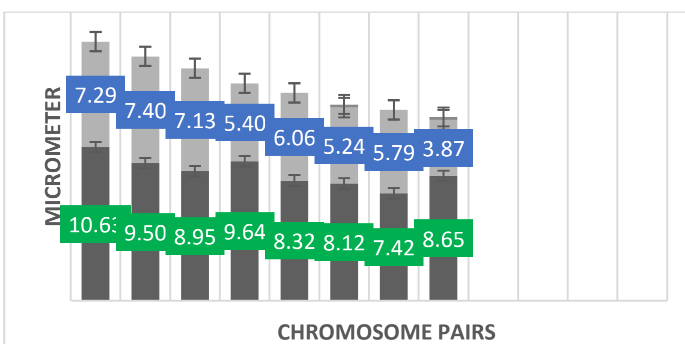

Figure 7. Somatic haploid ideogram in *Allium hirtifolium* (Van-Edremit ecotypes)

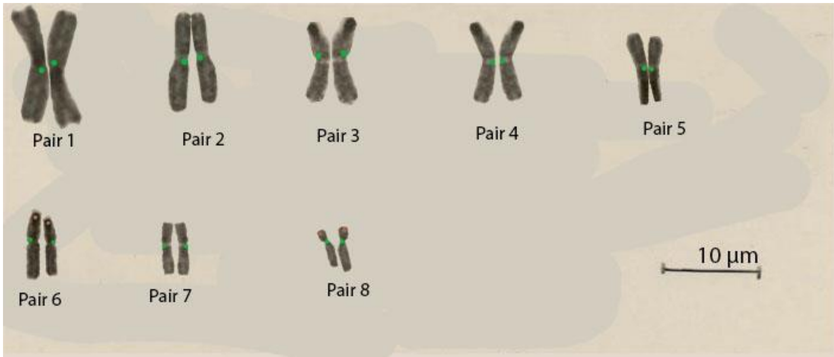

Figure 8. Somatic haploid Karyogram in *Allium hirtifolium* (Van-Edremit ecotypes)

Discussion

The karyotype formula showed 7m+1sm in all populations. The chromosomes type included seven metacentric, one submetacentric and two satellites in chromosomes six and eight. The length of chromosomes in all populations was 12.53 to 18.64 micrometers. The longest chromosome was chromosome 1 from population Edremit 3, which 18.64 micrometers. The shortest one related to chromosome 8 from population Edremit 4, which 1.55 micrometers. The population Edremit 1 from the northern parts of Edremit showed that total chromosomes length varied from 13.05 - 18.59 micrometers. The longest arm was 11.29 µm, while the shortest arm was 4.21 µm. Centromere in chromosomes was at the median region, except the chromosome 8, that was submetacentric. Two satellites observed in the karyotypic. Arm Ratio (L/S) varied from 1.10 - 2.05. The karyotype consisted of seven pairs of median region chromosomes, one submetacentric chromosomes and two satellites in chromosomes 6 and 8. Yaghoobi (2016) reported similasrv result in a study conducted on *Allium*, it was observed that chromosomes 1-5 in the karyotype of the studied *Allium*s were metacentric and chromosomes 6, 7 and 8 were submetacentric.

In the current study, the length of chromosomes was calculated to be 12.53 to 18.64 micrometers, while Yuzbasioglu and Unal (2004) found that the range of chromosomes in this plant was 7.32-12.20 micrometers. Also, Ünal and Duman (2012) found that the range of chromosomes in *Allium* was 4.62-11.15 micrometers. In one other study performed on *Allium* chromosomes, Oroji *et al*. (2017) found that karyotype formula in all accessions in *Allium*s was 3m+5sm, but the karyotype formula in the current study was 7m+1sm. Further, Guetat *et al.* (2015) showed that there were several ploidy levels in *Allium* from Lithuania. Results indicated that *A. hirtifolium* was a diploid species with predominantly metacentric chromosomes and a symmetric karyotype; each of the two chromosome pairs, VI and VIII, contained a secondary constriction and a small satellite as also reported by Panahandeh and Mahna (2012).

References

Baghalian, K., Ziaee, A., Naghavi, M. and Naghdibady, H. S. (2004). Evaluation of *Allium* ecotypes Iranian culture allicin content and botanical characteristics. Medicinal plant journal, 4:50-59.

Farsi, M., Ghabooli, M. and Mahmoodnia, M. (2011). Plant cytogenetics. Mashhad University Press, Mashhsd, Iran.

Friesen, N., Fritsch, R. M. and Blattner, F. R. (2006). Phylogeny and new intrageneric classification of *Allium* (*Alliaceae*) based on nuclear ribosomal DNA ITS sequences, Aliso, 22:372-395.

Fritsch, R. M. and Friesen, N. (2002). Evolution, domestication, and taxonomy. In: Rabinowitch HD, Currah L, editors. *Allium* Crop Science. Recent Advances. Wallingford, UK: CABI Publishing, pp.5-30.

Fritsch, R. M. and Khassanov, F. O. (2008). New taxa of *Allium* L. subg. *Allium* (Alliaceae) from Tajikistan and Uzbekistan. Feddes Reportorium, 119:625-633.

Genç, I. and Özhatay, F. N. (2014). *Allium efeae* (*Amaryllidaceae*), a new species from northwest Anatolia, Turkey. Turkish Journal of Botany, 38:1022-1025.

Guetat, A., Rosato, M., Rosselló, J. A. and Boussaid, M. (2015). Karyotype analysis in *Allium* roseum L. (Alliaceae) using fluorescent in situ hybridization of rDNA sites and conventional staining. Turkish Journal of Botany, 39:796-807.

Ipek, M., Ipek, A. and Simon, P. W. (2014). Testing the utility of matK and ITS DNA regions for discrimination of *Allium* species. Turkish Journal of Botany, 38:203-212.

Karimzadeh, G. and Paknia, R. (2010). Karyotypic study in some Iranian local Onion populations. Journal of plant physiology and breeding, 1:49-56.

Kumari, G., Gunjan, B. and Krishna, R. (2010). Karyotype studies in dominant species of *Aloe* from eastern India. Center of Advanced Study in Botany, Banaras Hindu University, Varanasi- 221005, India. Journal of Caryologia, 63:41-49.

Oroji Salmasi, K., Javadi, H. and Miri, S. M. (2017). Cytogenetic study of five species of *Allium* L. Conference on agriculture and sustainable natural resources, 1-7.

Panahandeh, J. and Mahna, N. (2012). The Karyomorphology of *Allium* hirtifolium Bioss., a Less Known Edible. Species from Ira Journal of Plant Physiology and Breeding, 1:53-57.

Taghizadeh, K. and Minaee, A. (2016). How to choose plants in the planning and architecture of urban green spaces. Human Geography Research, 44:127-140.

Ünal, F. and Duman, H. (2012). Cytotaxonomic studies on four *Allium* L. (Alliaceae) species endemic to Turkey. Caryologia, 55:175-180.

Yaghoobi, E. Malekzadeh-Shafaroudi, S. (2016). Genetic variation of Iranian ecotypes of Garlic (Allium sp.) using karyotypenalysis. Modern Genetics, 8:411-422.
Yuzbasioglu, D. and Unal, F. (2004). Karyotiping, C-and Nor banding of *Allium sativum* in Turkey. Pakistan Journal of Botany, 36:343-349.

(Received: 10 January 2022, accepted: 20 March 2022)