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CONTENTS

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Research Article

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AMPELOGRAPHIC CHARACTERIZATION OF TURKISH INDIGENOUS GRAPE ACCESSIONS AND EUROPEAN CULTIVARS (*Vitis vinifera* L.)

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ABSTRACT

A total of 35 grape accessions and 3 reference cultivars were used to investigate the genetic polymorphism and relationships among Turkey and other European grape accessions by ampelographic characterization. Total of 74 ampelographic characteristics were identified for 38 genotypes. Ampelographic data were collected two vegetation periods. The characteristics of the vines were defined and measured according to OIV descriptors. In this study, three synonym varieties (100% similarity) were identified: 'Cabernet Sauvignon' and 'Cabernet Franch'; standard grape variety 'Merlot' and no.12 genotype (Merlot), and 'Sèmillion' analyzed as a standard grape variety and no. 1 'Sèmillion' genotype. Based on similarity rate of grape varieties, highest similarity ratios were found between 'Yuvarlak Razakı-Siyah Gemre' with 93%, 'Yuvarlak Razakı-Siyah Gemre' and 'Şika' with 91%, 'Moiseylative-Hafızali' with 90% and 'Kırmızı Şam-Pembe Gemre' genotypes with 89%. In principal component analyses graph, 'Müşküle', 'Buca Razakı', 'Moiseylative', 'Kırmızı Şam', 'Cardinal', 'Yuvarlak Razakı', 'Hafızali', 'Siyah Gemre' and 'Şika' were grouped together.

Keywords: *Vitis vinifera* L., Ampelography, Characterization, Grape Accessions

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INTRODUCTION

Anatolia has a long history of viticulture and a wide diversity of grape cultivars. Grapevines (*Vitis vinifera* L.) are one of the oldest domesticated crop plants and economically the most important cultivated fruit crops in the world. Turkey, one of the countries where *Vitis vinifera* L. was first cultivated, has a rich grapevine gene potential. According to Oraman and Ağaoğlu, 1969 [1], Turkey has a history of viticulture dating back to 3500 B.C. Grapes have an important place among agricultural products as table grapes, wine grapes, raisin and with their various local uses.

Ampelographic studies have been undertaken for many years to present the grapevine gene potential in Turkey. As in many parts of the world, heterozygotic hereditary structure of the grapevine has resulted in the generation of a wide variety, type and species in Turkey, a country regarded as the homeland of viticulture for *Vitis vinifera* L. Investigation of genetic relationship is very import for germplasm conservation, evaluation and utilization for future grape breeding programs considering the present need of cultivar improvement. The objectives of the present study are to investigate the genetic relationships among Turkey grape accessions which include main local grape varieties in Turkey and some European cultivars were investigated for ampelographic observations of a total of 38 grape accessions (*Vitis vinifera* L.) including the 35 grape accessions and 3 reference cultivars. Scientific studies undertaken to identify the grapevine gene potential in Turkey and to prepare a catalog for this potential to validate it in international contexts are crucial.

MATERIALS AND METHODS

Plant Material

Thirty five grapevine cultivars (*Vitis vinifera* L.) were analyzed to determine their ampelographic relationships. The representative vines of cultivars were grown in implementation area at Horticulture Department, Agriculture Faculty, Ege University. The locations of the vineyards: $38^{0}27'32''$ N, $27^{0}13'21''$ E. Nine vines per cultivar were selected for study. The vines were 12 years old and cultivated under the same growing conditions using rootstock 41B (Vinifera x Berlandieri) with the spaces 2,5 x 3 m.

Three reference cultivars, *Vitis vinifera* L. cv. 'Cabernet Sauvignon', *Vitis vinifera* L. cv. 'Merlot' and Vitis vinifera L. cv. 'Sémillon' were considered as reference cultivars, as they were recently characterized in detail using SSR primers of core set, VVS2, VVMD5, VVMD7, VVMD27, VrZAG62 and VrZAG79 [2], they were grown at Manisa Viticulture Research and implementation area (Manisa/Turkey). Basic ampelographic characteristics of grape varieties and reference cultivars used in this study is listed in Table 1.

Ampelografic Evaluation

Ampelographic characterization of 38 grapevine genotypes was conducted using the descriptions in the Descriptors for Grapevine (*Vitis* spp.) (GENRES 081 1997) and the Office International de la Vigne et du Vin (OIV) Descriptor List for Grape Varieties and *Vitis* species [3, 4]. Descriptors used in this study and their OIV-IPGRI codes are presented in Table 2. In total, 75 different descriptors were used.

Ampelographic observations were carried out during two consecutive vegetation periods. The characteristics of the vines were defined and measured according to OIV descriptors. The characters of representing vines were investigated/measured following the specifications of vine growth stages indicated by OIV. The shoot tips were investigated when they were approximately 10 to 30 cm in height, and the first four distal leaves of young leaves were evaluated.

Mature leaf descriptions were obtained between berry set and beginning of berry maturity and were conducted on leaves above the cluster within the middle of the shoot. The clusters were measured at maturity and berry characteristics were obtained from ripe berries located in the middle of the bunch.

On average, ten canes per variety were analyzed after leaf fall. The mean values obtained over two years were transformed to numerical scales according to international descriptors. The resulting raw data were analyzed in NTSYSpc 2.0 software [5] using a distance matrix. The clustering dendrogram was based on the un-weighted pair group of the arithmetic mean (UPGMA) [3]. A principal component analysis (PCA) graph was also constructed.

Ampelografic Analysis Evaluation

For analysis, dendrograms for genotypes according to UPGMA (Unweighted pair-group method arithmetic average) grouping were obtained by using NTSYS-version 2.0 (Numerical Taxonomy and Multivariate Analysis System) [5] statistical package program.

RESULTS AND DISCUSSION

Ampelografic studies are utilized to identify existing and new breeds in all the countries where viticulture is common. Identification of the ampelografic characteristics of grapevine accessions and varieties is crucial for identification and classification. It is important to know grape accession qualities to determine the best adapted varieties and to plan breeding work. In this study, ampelografic observations were carried out by investigating 73 features in 38 grape accessions based on "Descriptors for Grape".

According to ampelografic observation results presented in Table 2, all grape accessions in the study were identified as *Vitis vinifera* L. since their shoot types (OIV 001) were "open=7" and sequencing of tendrils (OIV 16) were "discontinuous=1" i.e. "2 or less".

Density of anthocyan on the tip of shoots (OIV 003) was not observed in 'Müşküle', 'Moiseylative', 'Pek Üzümü', 'İtalia', 'Siyah Gemre', 'Colombard', 'Abiguş' and 'Kırmızı Şam' grape varieties (0=absent), it was found to be medium in 'Cabernet Sauvignon' and 'Cabernet Franc' 'Şam' grape varieties (5=medium) and it was weak (3=weak) in other grape varieties.

Examination of OIV 244 descriptor (seed: tranversal ridges on side) shows that lack of tranversal ridges on side of the seed (absent=0) validates the variety as belonging to *Vitis vinifera* L.

Examination of flower types (OIV 151) shows that all grape acccessions had hermaphrodite (hermaphrodite=3) structure.

It is very important to examine mature leaf characteristics in ampelografic definitions. Based on “Mature leaf: number of lobes” (OIV 068) descriptor, 'Yuvarlak Razakı' and 'Çeşme Pembesi' grape varieties were found to have 3 lobes “three=2” while the others had five lobes five=3” (Table 2). Definitions relevant to mature leaves have been generally approved as powerful way of identifying grapevine genotypes [6, 7]. In a similar studies, Ecevit and Kelen 1999, [8] and Ateş et al., 2011 [9] also reported the leaves with five lobes as a major type among some Turkish grapes.

All grape accessions in this study were determined to be “both sides convex=3” based on mature leaf: shape of teeth (OIV 076) descriptor. Differences were observed between varieties in terms of “Mature leaf: length” (OIV 066) and “mature leaf: shape of base of petiole sinus” (OIV 080) descriptors. 'Tarsus Pembesi' and 'Granache' varieties were in “short=3” group in terms of leaf size whereas other varieties were in “very short=1” group.

According to “Mature leaf: general shape of petiole sinus” (OIV 079) descriptor, 'İtalia', 'Sémillon' and 'Çeşme Pembesi' grape varieties were found to be “wide open=2” and the others were identified to be “open=3”.

Differences were identified among grape accessions in terms of cluster characteristics. Three separate groups were identified among the varieties with “Bunch: length” (OIV 203) descriptor. The majority of the grape varieties were included in “very short (< 11 cm)” classification group while 'Kırmızı Şam' and 'Moiseylative' varieties were in “long (24-26 cm)” group. 'Öküzgözü', 'Kozak Gemresi', 'Çeşme Pembesi', 'Cardinal', 'Ohannes', 'Siyah Gemre' and 'Yuvarlak Razakı' grape varieties were in “short (14-16 cm)” group. As stated by Marasali, 1986 [10] and Demir, 1987 [11], cluster lengths can differ based on whether the variety is situated in its own ecology or its adaptation to the ecology it is situated in.

Evaluation of results obtained from “Berry: uniformity of size” (OIV 222) descriptor shows differences among varieties and it was found that berries were generally uniform in clusters.

According to “Berry: shape” based on OIV 223 descriptor: The majority of the grape varieties were found to have round, while 'Şika' and 'Çeşme Pembesi' ovate, 'Delbele' obovate, 'Öküzgözü', 'Sémillon' and 'Alicante Boushet' slightly flat, 'Pek Üzümü', 'Hafızali', 'Conlonbart' and 'Moiseylative' obtuse-ovate, 'Cinsaut' and 'Buca Razakısı' were found to have long eliptic shape.

In terms of “Berry: classification of flavor” (OIV 237) descriptor, 'Cardinal', 'Merlot' and 'Harsleleh' grape varieties were found to have unique flavors and were included in “little flavor=2” classification group.

The UPGMA dendrogram, constructed on the basis of ampelographic scoring (0 to 9) using a distance matrix, is shown in Figure 1. Average similarity ratio of genotypes is 84%. Genotypes have shown various types of branching in ampelographic dendrogram. In the first differentiation of the dendrogram, 'Abiguş' grape cultivar generated a different group from other varieties. In the second differentiation of the dendrogram, 'Öküzgözü', 'Grenache Noir', 'Italia', 'Kozak Gemresi', 'Kırmızı Şam', 'Pembe Gemre', 'Yuvarlak Razakı', 'Siyah Gemre', 'Şika', 'Cardinal', 'Moiseylative', 'Hafızali', 'Buca Razakı', 'Pek Üzümü', 'Çeşme Pembesi', 'Mahrabaşı', 'Tarsus Pembesi', 'Beyaz Şam', 'Ohannes', 'Müşküle' genotypes created sub groups and were distributed along the dendrogram. In the third differentiation point, some groups of two or three were found to be generated from the three reference varieties and 14 genotypes.

As can be seen in the dendrogram, three synonym varieties (100% similarity) were identified: 'Cabernet' and 'Cabernet Franch', standard grape variety 'Merlot' and no.12 genotype (Merlot) and 'Sèmillion' analyzed as a standard grape variety and no. 1 'Sèmillion' genotype.

Based on similarity rate of grape varieties, highest similarity ratios were found between 'Yuvarlak Razakı-Siyah Gemre' with 93%, 'Yuvarlak Razakı-Siyah Gemre' and 'Şika' with 91%, 'Moiseylative-Hafızali' with 90% and 'Kırmızı Şam-Pembe Gemre' genotypes with 89%. As seen in principal component analyses graph, 'Müşküle', 'Buca Razakı', 'Moiseylative', 'Kırmızı Şam', 'Cardinal', 'Yuvarlak Razakı', 'Hafızali', 'Siyah Gemre' and 'Şika' were grouped together. No links were found with being local or universal varieties (Figure 1, Figure 2).

Prevalence of homonym and synonym groups were also presented in studies implemented with Turkish grape accessions [12, 13, 14, 15, 16, 17, 18, 19, 20, 21]. Development of viticulture in

Turkey will be possible when scientific studies that will allow the identification and preservation of our rich grapevine gene potential and provide resources for new breeding studies will be given the required importance. It is imperative to test the ampelographic characteristics of grape varieties and their relationships at genetic levels through modern methods that have international levels of reliability in order to conserve grape varieties in Turkey and select high quality varieties from among them. It is crucial to identify the genotypes via exact identification since some genotypes are names the same. In addition, the present study provided particular knowledge on some autochthonous grapevine cultivars, most of which are today on the verge of extinction. This study would therefore help to prevent disappearing local cultivars and to preserve such germplasm collection for the future studies. It is hoped that this study will enlighten similar studies in the field in the future.

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Table 1. Basic ampelographic characteristics of the grape cultivars used in this study.

Cultivar	Cluster Form	Berry Form	Berry Colour	Flavor	Seed
CabernetSauvignon	Very dense	Round	Blue-black	Little flavour	Present
Merlot	Very dense	Round	Blue-black	Little aromatic	Present
Sémillon	Dense	Round	Green-yellow	Neutral	Present
Sémillon	Dense	Round	Green-yellow	Neutral	Present
Marsleleh	Dense	Long elliptic	Dark red-violet	Neutral	Present
Conlonbart	Medium	Obtuse-ovate	Green-yellow	Neutral	Present
Grenache Noir	Dense	Round	Dark red-violet	Neutral	Present
Cinsaut	Dense	Long elliptic	Blue-black	Neutral	Present
Cabernet Franc	Dense	Round	Blue-black	Neutral	Present
CabernetSauvignon	Very dense	Round	Blue-black	Little flavour	Present
Papazkarası	Very dense	Round	Red	Little flavour	Absent
Öküzgözü	Loose	Slightly flat	Rose	Little flavour	Present
Petit Syrah	Dense	Round	Blue-black	Neutral	Present
Foça Karası	Very dense	Round	Blue-black	Neutral	Present
Merlot	Very dense	Round	Blue-black	Little aromatic	Present
Alicante Boushet	Very dense	Slightly flat	Blue-black	Little flavour	Present
Delbele	Medium	Obovate	Blue-black	Neutral	Present
Grenache	Medium	Round	Blue-black	Little flavour	Present
Malbee	Dense	Round	Blue-black	Neutral	Present
Çeşme Pembesi	Loose	Ovate	Rose	Neutral	Present
Kozak Gemresi	Loose	Round	Red	Neutral	Present
Abiguş	Loose	Round	Red	Neutral	Present
Kırmızı Şam	Very loose	Round	Red	Little flavour	Present
Mahrabaşı	Loose	Round	Dark red-violet	Neutral	Present
Yuvarlak Razakı	Loose	Round	Green-yellow	Neutral	Present
Siyah Gemre	Loose	Round	Red	Neutral	Present
Pembe Gemre	Loose	Round	Rose	Neutral	Present
Cardinal	Loose	Round	Blue-black	Little aromatic	Present
Beyaz Şam	Loose	Round	Green-yellow	Neutral	Present
Italia	Loose	Round	Red	Little flavour	Present
Ohannes	Loose	Round	Green-yellow	Little flavour	Present
Pek Üzümü	Medium	Obtuse-ovate	Blue-black	Little flavour	Present
Şika	Loose	Ovate	Dark red-violet	Neutral	Present
Müşküle	Loose	Round	Dark red-violet	Neutral	Present
Moiseylative	Medium	Obtuse-ovate	Blue-black	Little flavour	Present
Buca Razakısı	Loose	Long elliptic	Green-yellow	Little flavour	Present
Tarsus Pembesi	Loose	Round	Rose	Neutral	Present
Hafızali	Loose	Obtuse-ovate	Blue-black	Neutral	Absent

Table 2. Ampelographic characteristics of grape cultivars used in this study.

OIV Cod Number	Tarsus Pembesi*	Buca Razakısı	Moiseylative	Müşküle	Hafızali	Şika	Pek Üzümü
001	Open	Half-open	Half-open	Half-open	Half-open	Half-open	Half-open
003	Very weak	Very weak	Absent	Absent	Very weak	Very weak	Absent
004	Sparse	Very sparse	Sparse	Very sparse	Very sparse	Very sparse	Very sparse
005	None	None	None	None	None	None	None
006	Semi-erect	Semi-erect	Semi-erect	Semi-erect	Semi-erect	Horizontal	Semi-erect
007	Green	G with r.s	G with r.s	G with r.s	Green	Green	G with r.s
008	G with r.s	G with r.s	G with r.s	G with r.s	Green	Green	G with r.s
009	G with r.s	Green	G with r.s	G with r.s	G with r.s	G with r.s	G with r.s
010	G with r.s	G with r.s	G with r.s	G with r.s	G with r.s	G with r.s	G with r.s
011	None	None	None	None	None	None	None
012	None	None	None	None	None	None	None
013	Very sparse	None	None	None	None	None	None
014	None	None	None	None	None	None	None
015	Very weak	Absent	Absent	Very weak	Absent	Very weak	Weak
016	Dis. cont.	Dis. cont.	Dis. cont.	Dis. cont.	Dis. cont.	Dis. cont.	Dis. cont.
017	Short	Short	Very short	Short	Very short	Short	Very short
051	Green with b.s.	Green with b.s.	Green with b.s.	Green with b.s.	Green with b.s.	Green with b.s.	Green with b.s.
052	None	None	Very weak	Weak	None	None	None
053	Dense	None	None	None	Very sparse	Very sparse	Very sparse
054	Sparse	None	None	None	None	None	None
055	Sparse	None	None	None	None	None	None
056	None	Very sparse	Very sparse	None	None	Very sparse	None
065	Small	Very small	Very small	Very small	Very small	Very small	Very small
066	Short	Short	Very short	Very short	Short	Short	Short
067	Pentagonal	Pentagonal	Pentagonal	Pentagonal	Pentagonal	Pentagonal	Pentagonal
068	Five	Five	Five	Five	Five	Five	Five
069	Medium green	Medium green	Dark green	Pale green	Dark green	Dark green	Dark green
070	Absent	Absent	Very weak	Absent	Absent	Absent	Absent
071	Absent	Absent	Absent	Absent	Absent	Absent	Absent
076	B. s. straight	B. s. straight	B. s. straight	B. s. straight	B. s. straight	B. s. straight	B. s. straight
077	Very long	Long	Long	Long	Medium	Very long	Long
078	Long	Long	Long	Long	Long	Long	Medium
079	Wide open	Open	Open	Open	Open	Wide open	Open
080	U shape	V shape	V shape	V shape	U shape	U shape	V shape
081	None	None	None	None	None	None	None
082	Closed	Open	L. s. overlap.	L. s. overlap.	Open	Open	Open
083	V shape	V shape	V shape	U shape	V shape	U shape	V shape
084	None	None	None	None	None	None	None
085	None	None	None	None	None	None	None
086	None	None	Very sparse	None	None	None	Sparse
087	None	Very sparse	None	None	None	None	None
088	Absent	Absent	Absent	Absent	Absent	Absent	Absent
089	Absent	Absent	Absent	Absent	Absent	Absent	Absent
090	None	None	None	None	None	None	None
091	None	None	None	None	None	None	None
092	Very short	Very short	Very short	Very short	Very short	Very short	Very short
093	Shorter	Shorter	Shorter	Longer	Shorter	Shorter	Shorter
151	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite
153	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses

Table 2. Ampelographic characteristics of grape cultivars used in this study (continued).

OIV Cod Number	Tarsus Pembesi*	Buca Razakısı	Moiseylative	Müşküle	Hafızali	Şika	Pek Üzümü
154		Long	Very long	Long	Medium	Very long	Medium
203		Short	Long	Short	Short	Short	Medium
204		Loose	Medium	Loose	Loose	Loose	Medium
205		Very few	Medium	Few	Very few	Few	Few
206		Very long	Very long	Very long	Very long	Very long	Very long
207		Weak	Medium	Strong	Weak	Weak	Weak
221		Long	Long	Medium	Long	Medium	Medium
222		Not uniform	Not uniform	Not uniform	Not uniform	Uniform	Uniform
223		Long elliptic	Obtuseovate	Round	Obtuseovate	Ovate	Obtuseovate
224		Not circular	Not circular	Circular	Circular	Circular	Circular
225		Green-yellow	Blue-black	Dark red-violet	Blue-black	Dark red-violet	Blue-black
226		Not uniform	Not uniform	Not uniform	Not uniform	Not uniform	Not uniform
230-231		Not coloured	Not coloured	Not coloured	Not coloured	Not coloured	Not coloured
233		Medium	Medium	Medium	Medium	Little	Medium
237		Little flavour	Little flavour	Neutral	Neutral	Neutral	Little flavour
238		Medium	Short	Short	Short	Short	Short
239		Medim	Medim	Easy	Medim	Medim	Medim
241		Present	Present	Present	Absent	Present	Present
301	Late	Late	Late	Medium	Late	Medium	Very early
305	Medium	Medium	Early	Early	Early	Medium	Early
306	Yellow	Yellow	Red-violet	Dark red	Reddish	Reddish	Reddish

Table 2. Ampelographic characteristics of grape cultivars used in this study (continued).

OIV Cod Number	Beyaz Şam*	Italia	Ohannes	Cardinal	Pembe Gemre*	Siyah Gemre	Yuvarlak Razakı
001	Half-open	Half-open	Half-open	Half-open	Half-open	Half-open	Half-open
003	Weak	Absent	Very weak	Very weak	Very weak	Absent	Very weak
004	Medium	Dense	Sparse	Very sparse	Medium	Very sparse	Very sparse
005	None	None	None	None	None	None	None
006	Horizontal	Semi-erect	Horizontal	Semi-erect	Semi-erect	Semi-erect	Semi-erect
007	G with r.s	G with r.s	Green	G with r.s	G with r.s	G with r.s	Green
008	G with r.s	Green	G with r.s	G with r.s	G with r.s	G with r.s	Green
009	G with r.s	G with r.s	G with r.s	G with r.s	G with r.s	G with r.s	Green
010	G with r.s	Green	G with r.s	G with r.s	G with r.s	G with r.s	Green
011	None	None	None	None	None	None	None
012	None	None	None	None	None	None	None
013	None	None	None	None	None	None	None
014	None	None	None	None	None	None	None
015	Absent	Absent	Weak	Very weak	Absent	Very weak	Absent
016	Dis. cont.	Dis. cont.	Dis. cont.	Dis. cont.	Dis. cont.	Dis. cont.	Dis. cont.
017	Very short	Very short	Short	Short	Very short	Short	Very short
051	Green with b.s.	Green	Green with b.s.	Green with b.s.	Green with b.s.	Green with b.s.	Green with b.s.
052	Very weak	None	None	None	None	None	None
053	Very sparse	Medium	Sparse	Sparse	Medium	Very sparse	Çok seyrek
054	None	None	None	None	None	None	None
055	Very sparse	Sparse	None	None	None	None	None
056	Sparse	Sparse	Very sparse	None	Very sparse	None	None
065	Very small	Very small	Very small	Very small	Very small	Very small	Very small
066	Short	Very short	Very short	Short	Short	Short	Short
067	Pentagonal	Pentagonal	Pentagonal	Pentagonal	Pentagonal	Pentagonal	Pentagonal
068	Five	Five	Five	Five	Five	Five	Three
069	Medium green	Pale green	Pale green	Dark green	Medium green	Dark green	Medium green
070	Absent	Absent	Absent	Absent	Absent	Absent	Absent
071	Absent	Absent	Absent	Absent	Absent	Absent	Absent
076	B. s. straight	B. s. straight	B. s. straight	B. s. straight	B. s. straight	B. s. straight	B. s. straight
077	Long	Short	Long	Medium	Very long	Medium	Long
078	Very long	Short	Long	Long	Very long	Long	Long
079	Open	Wide open	Open	Open	Open	Open	Open
080	V shape	V shape	V shape	U shape	V shape	U shape	U shape
081	None	None	None	None	None	None	None
082	Open	Open	Open	L. s. overlap.	Open	Open	Open
083	U shape	U shape	V shape	U shape	V shape	V shape	U shape
084	None	None	None	None	None	None	None
085	None	Very weak	None	None	None	None	None
086	Very sparse	Very sparse	None	None	Very sparse	Very sparse	Very sparse
087	None	None	None	None	None	None	None
088	Absent	Absent	Absent	Absent	Absent	Absent	Absent
089	Absent	Absent	Absent	Absent	Absent	Absent	Absent
089	Absent	Absent	Absent	Absent	Absent	Absent	Absent
090	None	None	None	None	None	None	None
091	None	None	None	None	None	None	None
092	Very short	Very short	Very short	Very short	Very short	Very short	Very short
093	Shorter	Shorter	Very much shorter	Shorter	Shorter	Shorter	Shorter
151	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite
153	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 3 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses

Table 2. Ampelographic characteristics of grape cultivars used in this study (continued).

OIV Cod Number	Beyaz Şam*	Italia	Ohannes	Cardinal	Pembe Gemre*	Siyah Gemre	Yuvarlak Razakı
154	Short	Short	Short	Very long	Long	Long	Very long
203		Very short	Short	Short		Short	Short
204		Loose	Loose	Loose		Loose	Loose
205		Very few	Few	Few		Very few	Very few
206		Very long	Very long	Very long		Very long	Very long
207		Strong	Medium	Weak		Weak	Weak
221		Long	Medium	Long		Medium	Medium
222		Uniform	Not uniform	Not uniform		Not uniform	Not uniform
223		Round	Round	Round		Round	Round
224		Not circular	Not circular	Circular		Circular	Circular
225		Red	Green-yellow	Blue-black		Red	Green-yellow
226		Not uniform	Uniform	Uniform		Not uniform	Not uniform
230-231		Not coloured	Slightly coloured	Slightly coloured		Not coloured	Not coloured
233		Medium	Little	Medium		Medium	Little
237		Little flavour	Little flavour	Little aromatic		Neutral	Neutral
238		Short	Short	Short		Short	Short
239		Medim	Medim	Medim		Medim	Difficult
241		Present	Present	Present		Present	Present
301	Medium	Late	Medium	Late	Early	Early	Medium
305	Medium	Medium	Medium	Late	Medium	Early	Medium
306	Yellow	Yellow	Yellow	Yellow	Yellow	Dark red	Red

Table 2. Ampelographic characteristics of grape cultivars used in this study (continued).

OIV Cod Number	Mahrabaşı*	Kırmızı Şam	Kozak Gemresi	Çeşme Pembesi	Malbee	Grenache	Delbele
001	Half-open	Half-open	Half-open	Half-open	Half-open	Half-open	Half-open
003	Very weak	Absent	Very weak	Very weak	Very weak	Very weak	Very weak
004	Medium	Sparse	Sparse	Medium	Dense	Dense	Dense
005	None	None	None	None	None	None	None
006	Semi- erect	Semi- erect	Horizontal	Semi- erect	Erect	Erect	Erect
007	Green	G with r.s	Green	G with r.s	G with r.s	G with r.s	Green
008	Green	G with r.s	G with r.s	G with r.s	Red	G with r.s	Green
009	Green	G with r.s	Green	G with r.s	G with r.s	Green	Green
010	Green	Green	G with r.s	Green	G with r.s	Green	Green
011	None	None	None	None	Sparse	Sparse	Sparse
012	None	None	None	None	None	Very sparse	Very sparse
013	None	None	None	None	None	Very sparse	None
014	None	None	None	None	Very sparse	Sparse	Very sparse
015	Very weak	Very weak	Absent	Absent	Weak	Weak	Weak
016	Dis. cont.	Dis. cont.	Dis. cont.	Dis. cont.	Sub. or cont.	Dis. cont.	Dis. cont.
017	Very short	Very short	Very short	Short	Very short	Very short	Very short
051	Green with b.s.	Green with b.s.	Green with b.s.	Green	Green with b.s	Green	Yellow
052	None	None	None	Very weak	Weak	None	None
053	Sparse	Very sparse	Very sparse	Dense	Very dense	Dense	Dense
054	None	None	None	None	None	None	None
055	None	None	None	None	None	None	None
056	Sparse	Sparse	None	Sparse	Very sparse	Very sparse	Very sparse
065	Very small	Very small	Very small	Very small	Very small	Small	Very small
066	Short	Short	Short	Short	Very short	Short	Very short
067	Pentagonal	Pentagonal	Wedgeshaped	Pentagonal	Pentagonal	Pentagonal	Pentagonal
068	Five	Five	Five	Three	Five	Five	Five
069	Medium green	Pale green	Medium green	Medium green	Medium green	Dark green	Dark green
070	Absent	Absent	Absent	Absent	Absent	Absent	Absent
071	Very weak	Absent	Absent	Absent	Absent	Absent	Absent
076	B. s. straight	B. s. straight	B. s. straight	B. s. straight	B. s. straight	B. s. straight	B. s. straight
077	Medium	Long	Medium	Very long	Medium	Long	Long
078	Short	Long	Short	Long	Medium	Long	Very long
079	Open	Open	Open	Wide open	Open	Open	Open
080	V shape	U shape	V shape	U shape	U shape	V shape	U shape
081	None	None	None	None	None	None	None
082	Open	Open	Closed	L. s. overlap.	Open	Open	Open
083	V shape	V shape	V shape	V shape	U shape	U shape	V shape
084	None	None	None	Sparse	None	Medium	Very sparse
085	None	None	None	None	None	None	None
086	None	None	None	Sparse	Sprase	Medium	None
087	None	None	None	Very sparse	None	None	Sparse
088	Absent	Absent	Absent	Absent	Absent	Present	Absent
089	Absent	Absent	Absent	Absent	Absent	Present	Absent
089	Absent	Absent	Absent	Absent	Absent	Present	Absent
090	None	None	None	None	Very sparse	Sparse	None
091	None	None	None	None	None	None	None
092	Very short	Very short	Very short	Very short	Very short	Very short	Very short
093	Shorter	Shorter	Shorter	Shorter	Shorter	Shorter	Shorter
151	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite

Table 2. Ampelographic characteristics of grape cultivars used in this study (continued).

OIV Cod Number	Mahrabaşı*	Kırmızı Şam	Kozak Gemresi	Çeşme Pembesi	Malbee	Grenache	Delbele
153	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	Up ot 1 inflorescence	1.1 to 3 inflorescenses	1.1 to 2 inflorescenses
154	Medium	Very long	Long	Medium	Short	Medium	Short
203		Long	Short	Short	Very short	Very short	Very short
204		Very loose	Loose	Loose	Dense	Medium	Medium
205		Few	Few	Few	Very few	Very few	Very few
206		Very long	Very long	Very long	Long	Very long	Very long
207		Medium	Weak	Weak	Weak	Weak	Weak
221		Medium	Short	Long	Short	Short	Short
222		Uniform	Not uniform	Not uniform	Uniform	Uniform	Not uniform
223		Round	Round	Ovate	Round	Round	Obovate
224		Not circular	Circular	Not circular	Circular	Circular	Circular
225		Red	Red	Rose	Blue-black	Blue-black	Blue-black
226		Not uniform	Not uniform	Not uniform	Uniform	Not uniform	Not uniform
230-231		Not coloured	Very slightly coloured	Not coloured	Very slightly coloured	Not coloured	Not coloured
233		Medium	Little	Medium	Medium	Medium	Medium
237		Little flavour	Neutral	Neutral	Neutral	Little flavour	Neutral
238		Short	Short	Short	Very short	Short	Short
239		Medim	Medim	Easy	Medim	Medim	Medim
241		Present	Present	Present	Present	Present	Present
301	Medium	Medium	Early	Medium	Very early	Very early	Medium
305	Early	Medium	Late	Early	Early	Early	Medium
306	Yellow	Yellow	Red-violet	Reddish	Dark red	Dark red	Yellow

Table 2. Ampelographic characteristics of grape cultivars used in this study (continued).

OIV Cod Number	Alicante Boushet	Merlot	Foça Karası	Petit Syrah	Öküzgözü	Papaz Karası	Cabarnet Sauvignon*
001	Half-open	Half-open	Half-open	Half-open	Half-open	Half-open	Half-open
003	Weak	Very weak	Very weak	Very weak	Very weak	Very weak	Medium
004	Dense	Dense	Seyrek	Dense	Medium	Dense	Dense
005	None	None	None	None	None	None	None
006	Semi- erect	Erect	Semi- erect	Semi- erect	Horizontal	Semi- erect	Semi- erect
007	G with r.s	G with r.s	Green	G with r.s	G with r.s	G with r.s	G with r.s
008	G with r.s	G with r.s	G with r.s	Green	G with r.s	G with r.s	G with r.s
009	G with r.s	G with r.s	G with r.s	G with r.s	G with r.s	G with r.s	G with r.s
010	G with r.s	G with r.s	Green	G with r.s	G with r.s	Green	Red
011	None	None	None	None	None	Sparse	None
012	Very sparse	None	None	None	None	None	None
013	None	Very sparse	None	None	None	Sparse	Sparse
014	Very sparse	Very sparse	None	None	None	Sparse	Sparse
015	Very weak	Very weak	Absent	Absent	Absent	Absent	Very weak
016	Dis. cont.	Dis. cont.	Dis. cont.	Dis. cont.	Dis. cont	Dis. cont.	Dis. cont.
017	Very short	Short	Very short	Very short	Very short	Very short	Short
051	Green with b.s.	Yellow	Green with b.s.	Green with b.s.	Green with b.s.	Yellow	Green with b.s.
052	None	None	None	None	Weak	None	None
053	Very dense	Very dense	Sparse	Very dense	Very sparse	Very dense	Dense
054	None	None	None	None	None	None	None
055	None	None	None	None	Very sparse	Medium	None
056	Sparse	Sparse	Sparse	Very sparse	None	Very sparse	Very sparse
065	Very small	Very small	Very small	Very small	Very small	Very small	Very small
066	Short	Short	Very short	Very short	Short	Short	Very short
067	Wedgeshaped	Pentagonal	Pentagonal	Pentagonal	Pentagonal	Pentagonal	Pentagonal
068	Five	Five	Five	Five	Five	Five	Five
069	Dark green	Dark green	Medium green	Medium green	Medium green	Dark green	Dark green
070	Medium	Absent	Absent	Absent	Very weak	Absent	Absent
071	Weak	Absent	Absent	Absent	Very weak	Absent	Absent
076	B. s. straight	B. s. straight	B. s. straight	B. s. straight	O. s. c, o. s. c.	B. s. straight	B. s. straight
077	Long	Long	Medium	Medium	Short	Long	Long
078	Medium	Long	Long	Medium	Long	Long	Long
079	Open	Open	Open	Open	Open	Open	Open
080	V shape	U shape	V shape	V shape	V shape	V shape	U shape
081	None	None	None	None	None	None	None
082	Open	Open	Open	Open	Open	Open	L. s. overlap.
083	V shape	U shape	V shape	V shape	U shape	U shape	U shape
084	Dense	Sparse	None	Medium	None	Dense	Sparse
085	None	None	None	None	None	None	None
086	Sprase	Very sprase	None	Medium	None	Sparse	None
087	None	None	None	None	None	None	Very sparse
088	Absent	Present	Absent	Absent	Absent	Present	Absent
089	Absent	Absent	Absent	Absent	Absent	Absent	Absent
089	Absent	Absent	Absent	Absent	Absent	Absent	Absent
090	None	None	None	None	None	None	None
091	Very sparse	None	None	None	None	None	None
092	Very short	Very short	Very short	Very short	Very short	Very short	Very short
093	Shorter	Shorter	Shorter	Shorter	Shorter	Shorter	Shorter
151	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite
153	1.1 to 2 inflorescenses	Up to 1 inflorescence	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	Up to 1 inflorescence

Table 2. Ampelographic characteristics of grape cultivars used in this study (continued).

OIV Cod Number	Alicante Boushet	Merlot	Foça Karası	Petit Syrah	Öküzgözü	Papaz Karası	Cabarnet Sauvignon*
153	1.1 to 2 inflorescenses	Up to 1 inflorescence	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	Up to 1 inflorescence
154	Long	Medium	Medium	Medium	Medium	Medium	Medium
203	Very short	Very short	Very short		Short	Medium	
204	Very dense	Very dense	Very dense		Loose	Very dense	
205	Very few	Medium	Medium		Very few	Medium	
206	Very long	Short		Short	Very short	Very long	
207	Weak	Weak	Weak	Medium	Medium	Weak	
221	Short	Short		Short	Medium	Short	
222	Not uniform	Uniform		Uniform	Not uniform	Not uniform	
223	Slightly flat	Round		Round	Slightly flat	Round	
224	Not circular	Circular		Circular	Circular	Circular	
225	Blue-black	Blue-black		Blue-black	Rose	Red	
226	Not uniform	Uniform		Not uniform	Uniform	Uniform	
230-231	Very strong coloured	Very slightly		Not coloured	Very slightly	Not coloured	
233	Medium	Medium		Medium	Medium	Medium	
237	Little flavour	Little aromatic		Neutral	Little flavour	Little flavour	
238	Short	Very short		Short	Short	Short	
239	Medium	Medium		Medium	Medium	Easy	
241	Present	Present		Present	Present	Absent	
301	Medium	Çok erken	Medium	Very early	Medium	Medium	Early
305	Early	Early	Medium	Very early	Medium	Medium	Early
306	Red-violet	Red	Yellow	Red-violet	Yellow	Red	Red-violet

Table 2. Ampelographic characteristics of grape cultivars used in this study (continued).

OIV Cod Number	Cabarnet Franc*	Cınsaut	Grenache Noir*	Colombard	Harsleleh	Semillion	Abiguş*
001	Half-open	Half-open	Half-open	Half-open	Half-open	Half-open	Half-open
003	Medium	Weak	Very weak	Absent	Very weak	Weak	Absent
004	Medium	Dense	Sparse	Dense	Dense	Medium	Very sparse
005	None	None	None	None	None	None	None
006	Erect	Semi- erect	Erect	Semi- erect	Semi- erect	Semi- erect	
007	G with r.s	Green	Green	G with r.s	G with r.s	Green	
008	Red	Green	Green	G with r.s	G with r.s	G with r.s	
009	Red	G with r.s	Green	G with r.s	G with r.s	Green	
010	Red	G with r.s	Green	G with r.s	G with r.s	G with r.s	
011	None	None	None	None	None	None	
012	Very sparse	None	None	None	None	None	
013	None	None	None	None	None	None	
014	Very sparse	None	None	Sparse	Very sparse	None	
015	Very weak	Absent	Absent	Medium	Absent	Very weak	
016	Dis. cont.	Dis. cont.	Dis. cont.	Dis. cont.	Dis. cont.	Dis. cont.	
017	Very short	Very short	Very short	Very short	Very short	Very short	
051	Reddish	Reddish	Green	Green	Yellow	Green with b.s.	Green
052	Weak	None	None	None	None	Very weak	
053	Very dense	Dense	Very sparse	Very dense	Very dense	Dense	Very sparse
054	None	None	None	None	None	None	
055	None	Very sparse	None	Sparse	Medium	Sparse	
056	Very sparse	Sparse	Sparse	None	Sparse	Very sparse	None
065	Very small	Very small	Very small	Very small	Very small	Very small	
066	Very short	Very short	Very short	Short	Short	Very short	
067	Pentagonal	Pentagonal	Pentagonal	Pentagonal	Cordate	Pentagonal	
068	Five	Five	Five	Five	Five	Five	
069	Dark green	Medium green	Pale green	Dark green	Medium green	Açık yeşil	
070	Very weak	Absent	Absent	Absent	Absent	Absent	
071	Very weak	Absent	Absent	Absent	Absent	Absent	
076	B. s. straight	B. s. straight	B. s. straight	B. s. straight	B. s. straight	B. s. straight	
077	Medium	Long	Medium	Medium	Medium	Long	
078	Long	Short	Short	Short	Short	Medium	
079	Open	Open	Open	Open	Open	Wide open	
080	U shape	V shape	V shape	V shape	U shape	U shape	
081	None	None	None	None	None	None	
082	Open	Open	L. s. overlap.	Open	Open	L. s. overlap.	
083	U shape	V shape	V shape	U shape	V shape	U shape	
084	Sprase	Very sprase	None	Medium	Medium	Very sprase	
085	None	Very weak	None	Weak	None	None	
086	None	None	Very sparse	None	Sprase	Very sprase	
087	None	Very sparse	None	Sparse	None	None	
088	Present	Absent	Absent	Absent	Absent	Absent	
089	Absent	Absent	Absent	Absent	Absent	Absent	
090	None	Very sparse	None	None	None	None	
091	Very sparse	None	None	None	Sparse	Very dense	
092	Very short	Very short	Very short	Very short	Very short	Very short	
093	Shorter	Shorter	Shorter	Shorter	Shorter	Shorter	
151	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	Hermaphrodite	
153	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	1.1 to 2 inflorescenses	

Table 2. Ampelographic characteristics of grape cultivars used in this study (continued).

OIV Cod Number	Cabarnet Franc*	Cınsaut	Grenache Noir*	Colombard	Harsleleh	Semillion	Abiguş*
154	Short	Medium	Medium	Short	Medium	Medium	
203		Very short		Very short	Very short	Very short	
204		Dense		Medium	Loose	Dense	
205		Very few		Few	Medium	Few	
206		Long		Long	Long	Long	
207		Medium		Weak	Weak	Weak	
221		Short		Short	Short	Short	
222		Uniform		Not uniform	Not uniform	Uniform	
223		Long elliptic		Obtuseovate	Round	Slightly flat	
224		Circular		Not circular	Circular	Not circular	
225		Blue-black		Green-yellow	Rose	Rose	
226		Not uniform		Not uniform	Not uniform	Not uniform	
230-231		Not coloured		Not coloured	Not coloured	Not coloured	
233		Medium		Medium	Medium	Medium	
237		Neutral		Neutral	Little aromatic	Neutral	
238		Short		Short	Short	Short	
239		Difficult		Easy	Easy	Medium	
241		Present		Present	Present	Absent	
301	Early	Very early	Late	Very early	Medium	Early	
305	Early	Very early	Medium	Early	Medium	Medium	
306	Dark red	Red-violet	Yellow	Yellow	Yellow	Yellow	

G with r.s: Green with red stripes; Dis. cont.: Discontinuous (2 or less); Sub. or cont.: Subcontinuous or continuous (3 or more); Green with b.s.: Green with bronze spots; B. s. straight: Both sides straight; O. s. c, o. s. c.: One side concave, one side convex; L. s. overlap.: Lobes slightly overlapping.
Tarsus Pembesi*; Cabernet Franc*; Abiguş*; Cabernet Sauvignon*; Beyaz Şam*; Pembe Gemre*; Mahrabaşı*; Granache Noir*: Grape varieties that could not be observed in their maturity due to lack of sufficient number of clusters that could be analyzed.

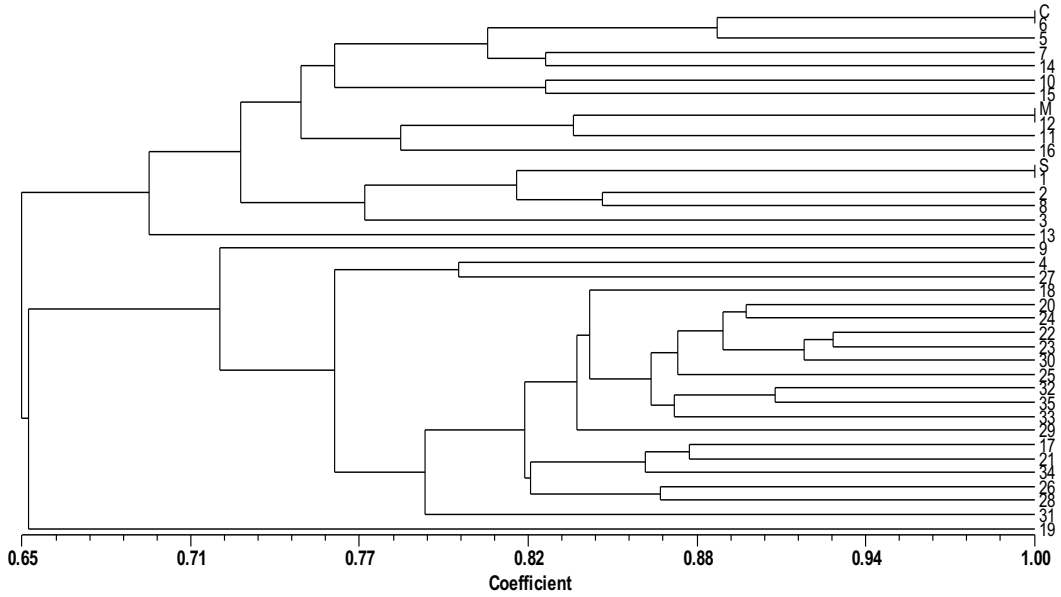

Figure 1. Dendrogram showing the relationships of 38 grapevine cultivars used in this study based on UPGMA cluster analysis of 73 features in "Descriptors for Grape"

C: Cabernet Sauvignon, M: Merlot, S: Sémillon, 1: Sémillon, 2: Marsleleh, 3: Conlonbart, 4: Grenache Noir, 5: Cinsaut, 6: Cabernet Franc, 7: Cabernet Sauvignon, 8: Papazkarası, 9: Öküzgözü, 10: Petit Syrah, 11: Foça Karası, 12: Merlot, 13: Alicante Boushet, 14: Delbele, 15: Grenache, 16: Malbee, 17: Çeşme Pembesi, 18: Kozak Gemresi 19: Abiguş, 20: Kırmızı Şam, 21: Mahrabaşı, 22: Yuvarlak Razakı, 23: Siyah Gemre, 24: Pembe Gemre, 25: Cardinal, 26: Beyaz Şam,27: Italia, 28: Ohannes, 29: Pek Üzümü, 30: Şika, 31: Müşküle, 32: Moiseylative, 33: Buca Razakısı, 34: Tarsus Pembesi, 35: Hafızali

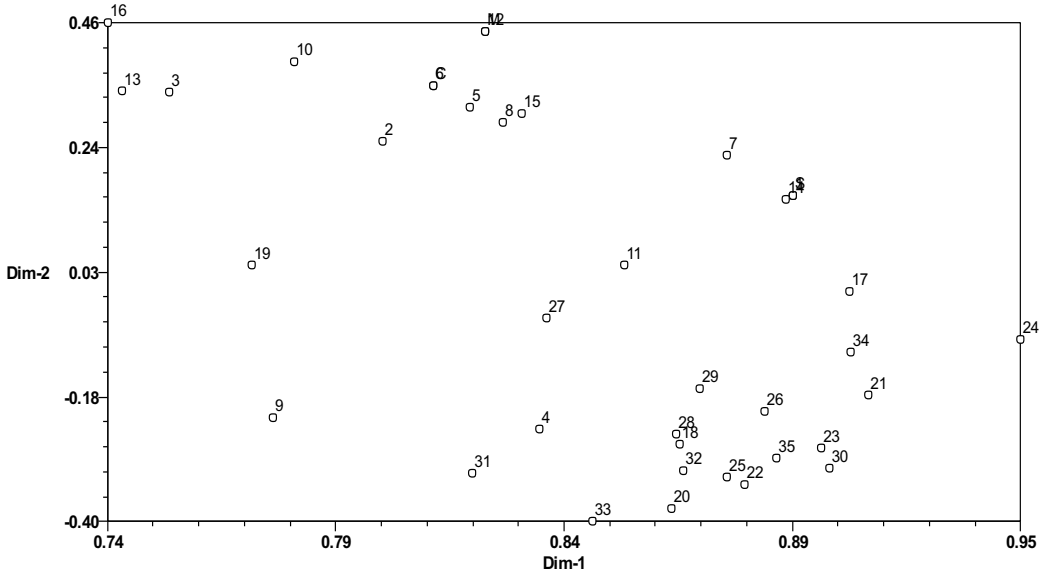

Figure 2. Principal component analyses of 38 grapevine cultivars used in this study based on 73 ampelographic characteristics

C: Cabernet Sauvignon, M: Merlot, S: Sémillon, 1: Sémillon, 2: Marsleleh, 3: Conlonbart, 4: Grenache Noir, 5: Cinsaut, 6: Cabernet Franc, 7: Cabernet Sauvignon, 8: Papazkarası, 9: Öküzgözü, 10: Petit Syrah, 11: Foça Karası, 12: Merlot, 13: Alicante Boushet, 14: Delbele, 15: Grenache, 16: Malbee, 17: Çeşme Pembesi, 18: Kozak Gemresi 19: Abiguş, 20: Kırmızı Şam, 21: Mahrabaşı, 22: Yuvarlak Razakı, 23: Siyah Gemre, 24: Pembe Gemre, 25: Cardinal, 26: Beyaz Şam,27: Italia, 28: Ohannes, 29: Pek Üzümü, 30: Şika, 31: Müşküle, 32: Moiseylative, 33: Buca Razakısı, 34: Tarsus Pembesi, 35: Hafızali

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ADDITIONAL NOTES ON DELPHACIDAE, TETTIGOMETRIDAE AND CIXIDAE [AUCHENORRHYNCHA (INSECTA: HEMIPTERA)] FAUNA IN EAST AND SOUTHEAST ANATOLIA REGION OF TURKEY

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ABSTRACT

This study was carried out to contribute the Delphacidae, Tettigometridae and Cixiidae (Hemiptera) fauna in the East and Southeast Anatolia Region of Turkey. Specimens were collected from different locations of the study area, in 2007, 2008, 2014 and 2015, and prepared according to standard methods. 7 species belonging to 6 genera from 3 families were determined: *Hyalesthes obsoletus*, *Pentastiridius leporinus*, *Laodelphax striatellus*, *Sogatella vibix, Toya propinqua*, *Tettigometra atra* and *Tettigometra macrocephala*. Number of examined specimens, host plants and distribution of species in Turkey have been given. In these species; *P. leporinus, L. striatellus T. atra, T. macrocephala* were new records in these regions.

Keywords: Delphacidae, Tettigometridae, Cixiidae, New Regional Record, Turkey

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INTRODUCTION

Auchenorrhyncha is a suborder of the Hemiptera (true bugs). The hemipteran suborder Auchenorrhyncha includes planthoppers, leafhoppers, treehoppers, spittlebugs and cicadas. Members of the suborder Auchenorrhyncha occur in all major zoogeographic regions apart from Antarctica. The species rich in the tropics, the suborder includes a major component of the phytophagous fauna in privately many terrestrial ecosystem [1] In Turkey; many studies have carried out in 20. century. In the recent times; many studies have been carried out with on Auchenorrhyncha in the Eastern and Southeastern Anatolia, but these studies are limited [2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18]. These studies were carried out in non-agricultural and intra-agricultural areas. They are important in terms of interactions with plant and insect species in habitats for detailed studies at future. Additionally; They are important out of their direct damage due to some of this species are vectors of viruses and phytoplasmic diseases that. The results of this study are contribute to biodiversity.

MATERIALS AND METHODS

Several sampling methods were used for collecting Auchnorrhycha species, differing on the activity patterns of the different species. The species were captured individually using net trap during the morning period. One light trap on the ground was used at each area from the mid July to the mid October season. A 20 watt Philips energy that saver white day light bulb was used at each trap and traps were cleared at two weeks interval. The collected material was deposited in Suluova Vocational School, of Amasya University.

RESULTS AND DISCUSSION

Family Cixidae

Hyalesthes obsoletus Signoret,1865

Host Plant Area: Cherry, Vineyard

Material examined: 2♀, 5♂, 22.07.2014, Elazığ, Doğukent, 38° 40' 53.7564" N, 39° 16' 5.0376' E. Totally: 7 species.

Distribution in Turkey: Adana, Ankara, Adapazarı, Adıyaman, Ağrı, Ankara, Antalya, Aydın, Balıkesir, Bursa, Çanakkale, Çorum, Diyarbakır, Elazığ, Erzincan, Erzurum, Eskişehir, Gaziantep, Giresun, Hakkari, İstanbul, İçel, Kars, Konya, Manisa, Mardin, Muğla, Sinop, Sivas, Tokat, Trabzon, Urfa, Van, [10, 19]

***Pentastiridius leporinus* Linné, 1761**

Host Plant Area: Pistachio, Cotton

Material examined: 2♀, 5♂, 11.08.2007, Siirt, Aydınlar, 37° 57' 30.7908" N, 42° 2' 39.3720 E. 5♂, 01.06.2015 Şırnak, Silopi, 37° 7′ 35. 9724" N, 42° 25′ 25. 3704" E. **Totally:** 12 species

Distribution in Turkey: Adana, Antalya, Ağrı, Ankara, Aydın, Bitlis, Diyarbakır, Hatay, Kahramanmaraş, Mardin, Mersin, Niğde [20].

Family Delphacidae

***Laodelphax striatellus* Fallen, 1826**

Host Plant Area: Cherry, Vineyard, Pistachio, Cotton

Material examined: 3♀, 12♂, 01.08.2014, Elazığ, Doğukent, 38° 40' 53.7564" N, 39° 16' 5.0376,' E 11♀,12♂, 12,07.2007, Siirt, Aydınlar, 37° 57' 30. 7908" N, 42° 2' 39.3720 E, 22♀,13♂, 01.06.2015, Şırnak, Silopi, 37° 7′ 35. 9724" N, 42° 25′ 25. 3704" E. **Totally:** 73 species

Distribution in Turkey: Adana, Adıyaman, Amasya, Ankara, Antalya, Bilecik, Bitlis, Çorum, Diyarbakır, Erzincan, Erzurum, Eskişehir, Iğdır, İçel, İzmir, Kahramanmaraş, Kars, Malatya, Mersin, Muğla, Niğde, Ordu, Rize, Samsun, Siirt, Sinop, Tokat [2, 3, 9, 12, 13, 16, 18, 21]

***Sogatella vibix* Haupt, 1927**

Host Plant Area: Cherry, Vineyard, Pistachio, Cotton

Material examined: 2♀, 5♂, 01.08.2014, Doğukent, Elazığ, 38° 40' 53.7564" N, 39° 16' 5.0376' E, 6♀, 7♂, 12,07.2007, Siirt, Aydınlar, 37° 57' 30.7908" N, 42° 2' 39.3720 E 11♀, 8♂, 15.08.2015, Şırnak (Silopi, 37° 7′ 35.9724" N, 42° 25′ 25.3704" E. **Totally:** 39 species.

Distribution in Turkey: Adıyaman, Amasya, Bitlis, Diyarbakır, Elazığ, Erzurum, Gaziantep, İçel, İzmir, Konya, Mardin, Nevşehir, Samsun, Siirt, Şanlıurfa, Tokat, Van [4, 9, 12,13, 18, 21, 21].

***Toya propinqua* Fieber,1866**

Host Plant Area: Cotton
Material examined: 11♀, 8♂, 08, 08,2015, Şırnak, Silopi, 37° 7′ 35. 9724" N, 42° 25′ 25.3704" E. **Totally:** 19 species
Distribution in Turkey: Adana, Afyon, Amasya, Ankara, Antalya, Aydın, Çanakkale, Çorum, Denizli, Diyarbakır, Erzurum, Gaziantep, Hatay, Isparta, İçel, İskenderun, İzmir, Kastamonu, Mardin, Muğla, Ordu, Samsun, Siirt, Sinop, Şırnak, Tokat [2, 3, 9, 12, 13,20].

Tettigometridae

***Tettigometra atra* Hagenbach, 1825**
Host Plant Area: Pistachio
Material examined: 2♀, 2♂, 22,09.2007, Siirt, Aydınlar, 37° 57' 30.7908" N, 42° 2' 39.3720 E. **Totally:** 4 species
Distribution in Turkey: Ankara, Mardin, Mersin [16, 22, 23].

***Tettigometra macrocephala* Fieber,1865**
Host Plant Area: Pistachio
Material examined: 5♂, 22,08.2008, Siirt, Aydınlar, 37° 57' 30.7908" N, 42° 2' 39.3720 E. **Totally:** 5 species
Distribution in Turkey: Kocaeli, Van [23]

In total, 7 Auchenorrhyncha species from three families (Cixiidae, Delphacidae, Tettigometridae) were recorded in these provinces. The distribution of collected species in each province varied greatly; these were in total, 3 species from two families recorded at one sampling locations in Elazığ, 5 species from three families recorded at two sampling locations in Siirt, 3 species from three families at two sampling locations in Şırnak respectively.

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CHANGES IN LEAF AND SHOOT WATER STATUTES OF GRAPEVINES IN RESPONSE TO CONTRASTING WATER AVAILABILITY AND GLYCINE BETAINE PULVERIZATION

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ABSTRACT

Drought is one of the most widespread stress factors adversely affecting plant growth, crop yield and quality. In Subtropical region, on the face of global warming, temperature extremes aggravate the negative effects of drought. Increased resistance to stress has been achieved in several plants by exogenous application of various organic osmoprotectants. In this study, the role of glycine betaine (GB) as exogenous application, is aimed to investigate for increasing grapevine stress tolerance to drought. The grapevines of Alphonse Lavallée' cultivar, grafted on the rootstock 41 B, were subjected to four different applications; (1) full irrigation (FI) as control (irrigation at field capacity level), (2) deficit irrigation (DI, 50% of FI), (3) DI plus 5000 ppm GB pulverization, and (4) DI plus 10000 ppm GB pulverization in a pot experiment under glasshouse condition. Leaf fresh weight of vines subjected to DI was 31.8% lower than those of FI vines. GB appeared to exert an influence on leaf water statute, slightly alleviating the leaf water loss resulting from water shortage. GB treatments, regardless of the concentration, slightly increased the fresh weight of the leaves (22.2% lower than FI). Investigations on leaf turgid weight and dry weight were also similar to those of fresh weight in that the highest and the lowest values were determined in FI and DI applications, respectively. Reduction in shoot water content in response to water deficit was closely related to the decrease in leaf water content.

Keywords: Drought, Grapevine, Organic Osmoprotectants, Glycine Betaine

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INTRODUCTION

Environmental stress factors such as drought, temperature extremes, salinity, nutrient imbalances adversely affect plant growth, crop yield and quality. Less than 10% of the world's arable lands is estimated to be free of such major environmental stresses [1]. Drought and salinity stresses are the most widespread stress factors [2, 3]. Around 45% of the world agricultural lands are subject to continuous or frequent drought [4]. Low precipitation, high surface evaporation, using saline water in irrigation and improper cultural practices are among the major contributors to the decreasing yield.

Temperature extremes aggravate the negative effects of other stresses, including drought and salinity, on agricultural production and quality of commodities. Fischer and Byerlee [5], for instance, indicated that heat stress adversely affects grain yield and quality in 40% of the irrigated wheat growing area of the world. On the other hand, global warming is an increasing environmental issue with its differential effects on plants according to the regions. It is envisaged that developing countries will be affected to a greater extent, thereby resulting in increased food insecurity therein [6].

Plant tolerance to abiotic stresses is a complex physiology due to the complexity of interactions between stress factors and various molecular, biochemical and physiological phenomena affecting plant growth. Development of plants tolerant to environmental stresses is proven as a promising approach, which may aid to satisfy growing food demands of the world. Such challenge necessitates knowledge of the genetic controls and physiological mechanisms of the contributing traits at certain developmental stages of plant. Stress factors may provoke osmotic stress and protein denaturation in plants, leading to cellular adaptive responses such as accumulation of compatible solutes and induction of stress proteins [7].

Over synthesis of organic solutes to protect plants from stress, is one of the most common stress responses in plants [8]. These solutes, referred to osmoprotectants, protect cellular components from dehydration injury. These protectants include proline, polyols, sucrose, trehalose and quaternary ammonium compounds such as glycine betaine, alaninebetaine, prolinebetaine, choline *O*-sulfate, hydroxyprolinebetaine, and pipecolatebetaine [9].

Increased resistance to abiotic stresses has been achieved in several plants by exogenous application of various organic osmoprotectants. In spite of this fact, however, this approach in viticulture has not received sufficient consideration in the literature [10]. For this reason, in this study, the role of glycine betaine as exogenous application, is aimed to investigate for increasing grapevine stress tolerance, in particular in response to drought.

MATERIALS AND METHODS

Study Design

The study was performed in the controlled glasshouse of Selcuk University, Konya, Turkey. The vines of 'Alphonse Lavallée' table grapevine cultivar was grown on the rootstock 41 B in pots containing equal mixture of peat and perlite. The experiment consisted of four different applications; (1) full irrigation (FI) as control (irrigation at field capacity level), (2) deficit irrigation (DI, 50% of FI), (3) DI plus 5000 ppm glycine betaine (GB) treatment, and (4) DI plus 10000 ppm glycine betaine (GB) treatment. The experimental vines were spur pruned to leave 4 or 5 cane with a total of 8 or 10 buds per vine. The shoots were tied with thread to wires 2.3 m above the pots to let plants grow on a perpendicular position to ensure similar cultural practices [11]. The vines received the same annual amount of fertilizer (approx. 30 g N, 18 g P, 30 kg K, and micro elements per vine) from April to August.

Experimental Condition

To determine the required volume of irrigation water, similar pots filled with growth medium were placed in large plastic buckets and irrigated with a known volume of water, and then kept for seven hours to attain field capacity. Afterwards, the drained water was measured and subtracted from the total volume of water applied. The value obtained (mean of three pots) was considered as optimum to keep the soil moisture at field capacity. Each pot-grown vine was given 0.8-1.5 L every day [12]. This amount was considered as the volume of the irrigation water that has to be used to attain 100% field capacity (FI). Fifty percentage amount of FI was considered as DI [13]. Irrigations were regulated according to soil water matric potential (Ψm) levels using tensiometers (The Irrometer Company, Riverside, CA) placed at a depth of 20 cm (about rooting depth) and approximately 12 cm from the trunk and were applied from bud break (early March) to the end of vegetation period (beginning of October). Soil tensiometers (irrometer) were employed for a more realistic expression of soil water depletion in terms of Ψm following the slightly modified procedure described by Myburgh and van der Walt [14]. Changes in Ψm were continuously monitored with daily readings at around 13:00 pm as well as before and after irrigations [15]. To ensure the uniformity, the water was applied via drip systems. Repeated readings during several days showed that the tensiometers readings at midday (13.00 pm) were constantly around 0.8–14 cb and 30–38 cb for FI and DI conditions, respectively. For DI, irrigation was started around 32-34 cb and was terminated when the calculated amount of water was applied. The start value of irrigation system for FI group vines were adjusted to around 10±2 cb to ensure that the full water amount of field capacity is provided. Relatively higher air temperature in the glasshouse was also performed to simulate the typical semi-arid Mediterranean climate. During vegetation periods (March-October) for two experimental years, daily air temperature and relative humidity, recorded using data logger (Ebro EBI 20 TH1) inside the glasshouse, were 22–40°C and 28–65%, respectively. During the hot and dry summers for both years (from the beginning of June to September), excessive heat accumulation in glasshouse was avoided by opening the roof and sidewall windows as well as slight whitewash painting (providing approx. 15-20% natural light reflection) to keep clusters and young leaves from burning.

Leaf Mass and Leaf Relative Water Content (LRWC)

LRWC were investigated on fully expanded leaves of experimental grapevines of each treatment [16]. Fifteen sun-exposed transpiring leaves per treatment were sampled early in the morning and immediately weighed to obtain fresh weight. To investigate the relative water content (RWC) of the mature leaves, the freshly sampled leaves were rehydrated by submerging in

deionized water for 24 h in dark to obtain turgid weight [17]. Measurements were performed after gently wiping the water from the leaf surface with soft tissue paper. At the end of rehydration period, leaf samples were weighed to obtain final turgid mass (TM) and then placed in an oven at 70°C for 48 h in order to found the dry mass (DM). All the mass measurements were made using an analytical scale, with precision of 0.001 g. Values of FM, TM, and DM were used to calculate RWC, using the equation suggested for leaf by Weatherley [18]:

$$LRWC\,(\%) = [(FM - DM)/(TM - DM)] * 100$$

Summer Shoot Features

Summer shoot features such as shoot relative water content (SRWC), shoot and pith diameters were investigated in the late summer period when the shoot growth was approaching to cessation. Shoot features was determined using a total of fifteen samples per a plot consisted of shoot pieces from upper, middle and lower parts by cutting ca. 50 mm shoot lengths with a bud in its center. Mean value of upper, middle and lower shoot parts was calculated. Fresh and dry masses of each pieces were attained using the same procedure followed in the leaves. SRWC was calculated as the percentage water loss using the following equation suggested for leaf by Myburgh and van der Walt [14];

$$SRWC\,(\%) = [(FM - DM)/(TM - DM)] * 100.$$

Statistical Analysis

Data were subjected to the variance analyses using SPSS 13.0 for Windows (SPSS Inc., Chicago, IL, USA) at $P<0.05$ level. The mean values of three of each treatment were compared using the least significant difference (LSD) test.

RESULTS AND DISCUSSION

In order to investigate the effects of irrigation applications at different levels and leaf glycine betaine (GB) treatments, leaf and summer shoot characteristics such as fresh weight, turgid weight, dry weight and relative water content were determined.

Changes in Leaf Mass and Leaf Relative Water Content (LRWC)

The highest leaf fresh weight was obtained from FI application while, on the other hand, the lowest value was recorded from DI. Leaf fresh weight of vines subjected to DI was 31.8% lower than those of FI vines. GB treatments, regardless of the concentration, slightly increased the fresh weight of the leaves (22.2% lower than FI). Investigations on leaf turgid weight and dry weight were also similar to those of fresh weight in that the highest and the lowest values were determined in FI and DI applications, respectively. As known, vine water status depends on many factors such as soil texture, percentage of stones, rooting depth, rainfall, evapotranspiration, and leaf area (16, 19). In the present study water deficit impaired the leaf weight and relative water content features of 'Alphonse Lavallée' grapevine. GB treatment had no remarkable alleviating effect on leaf water statute.

Table 1. Differences in leaf characteristics in response to water applications and glycine betaine treatments.

Treatments	Leaf fresh weight (g)	Leaf turgid weight (g)	Leaf dry weight (g)
FI	2.79±0.04 a	3.35±0.06 a	0.67±0.04 a
DI	1.90±0.05 c	2.60±0.07 c	0.58±0.03 b
DI+5000 ppm GB	2.17±0.03 b	2.97±0.07 b	0.60±0.03 b
DI+10000 ppm GB	2.17±0.02 b	3.01±0.08 b	0.61±0.01 b
LSD (%5)	0.59	0.10	0.04

FI: Full irrigation, DI: Deficit irrigation. Mean values indicated by different letters identify significantly different groups ($P<0.05$). (n = 15).

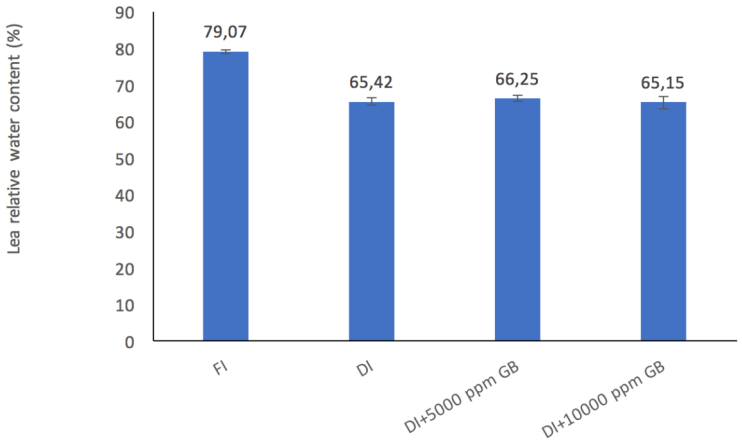

Figure 1. Differences in leaf relative water content (LRWC, %) as affected by irrigation level (FI: full irrigation, DI: deficit irrigation) and GB treatments (5000 and 10000 ppm). Values of bars indicated by different letters identify significantly different groups (P<0.05, LSD).

Considering the findings on the leaf features of the present study, it is evident that the water statute of mature leaves is a sensitive indicator for grapevine response to water deficit as stated by Sabir [20]. However, a lower relative water content of the leaf does not necessarily indicate that the physiological capacity of the vine is low. As stated by Dry and Loveys [21] the capacity of a vine may be closely related to the total grape yield rather than to the activity rate such as total vegetative growth. Also, grapevines, like many other plants, have developed long- and short-term acclimation strategies to cope with water stress, such as modifying the leaf anatomy [19]. Studying on the effect of different levels of salinity on seedless grape cultivars 'Askari' and 'Yaghuti', Alirezanezhad et al. [22] found that leaf LRWC decreased with increasing salinity in both cultivars, in different magnitudes depending on acclimation strategy aptitude of the studied cultivars.

LRWC response of grapevines to various treatments has been depicted in Fig 1. Analysis of variance showed that LRWC of the grapevines received FI application was significantly higher than all the other treatments. GB treatments in both concentrations had no significant effect on RLWC, because they were in the same statistical group with DI application. Ability to maintain a high LRWC at a low water availability may display greater strength of the cell wall and its capability to withstand against the water loss [23].

Changes in Summer Shoot Quality Features

Relative Water ontent (CRWC)

Certain shoot parameters regarding to cane quality have been shown in Table 2. Summer shoot diameter and pith diameter presented slight non-significant variation among the treatments.

Table 2. Differences in summer shoot hardiness features in response to water applications and glycine betaine treatments.

Treatments	Shoot diameter (mm)	Pith diameter (mm)	Shoot/pith diameter
FI	4.15	2.09	1.98±0.05 c
DI	4.13	2.00	2.07±0.25 b
DI+5000 ppm GB	4.13	1.91	2.16±0.06 a
DI+10000 ppm GB	4.21	2.13	1.98±0.17 c
LSD (%5)	ns	ns	0.07

FI: Full irrigation, DI: Deficit irrigation, ns: nonsignificant. Mean values indicated by different letters identify significantly different groups (P<0.05). (n = 15).

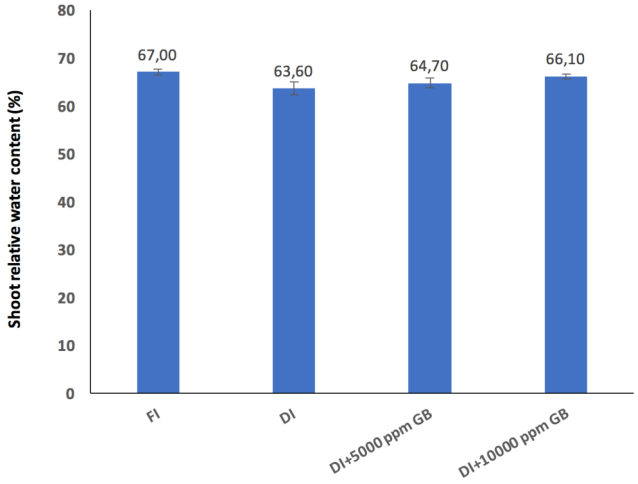

Figure 2. Differences in summer shoot relative water content (LRWC, %) as affected by irrigation level (FI: full irrigation, DI: deficit irrigation) and GB treatments (5000 and 10000 ppm). Values of bars indicated by different letters identify significantly different groups (P<0.05, LSD).

Nonetheless treating the grapevines with DI plus 10000 ppm GB resulted in the highest shoot and pith diameters. Bu the magnitude of the treatments were not as high as those observed for leaf investigations. On the other hand, shoot/pith value, as a better measurement for evaluating shoot hardiness, significantly varied according to the treatments. The highest shoot/pith value was obtained from DI plus 5000 ppm GB treatment (2.16) while the lowest value was recorded from FI and DI plus 10000 ppm GB (with the same value of 1.98). Lower pith diameter and higher shoot/pith value means higher xylem and phloem tissue ring formation in response to 5000 ppm GB. It is well known that quality of a shoot is positively correlated with the ratio of shoot width/pith [24, 25]. Studies revealed that pith diameter diminishes with the higher carbohydrate accumulation in xylem and phloem, and consequently freezing tolerance of the cane and bud cells increase [26, 27].

DI slightly but significantly reduced the SRWC determined as the mean value of basal, middle, and upper pieces with a node lengthwise of the summer shoots of each plant (Figure 2). Considering the mean values the highest SRWC was determined in FI vines (67.0%) while the lowest value (63.6%) was found in DI. SRWC of vines in response to 10000 ppm concentration (66.1%) was higher than those of DI.

Correlation between SRWC and LRWC was illustrated in Fig 3. The pooled data on the water content parameters revealed that there was significant positive correlation between leaf and cane water statutes. Reduction in SRWC in response to water deficit was closely associated with decrease in LRWC.

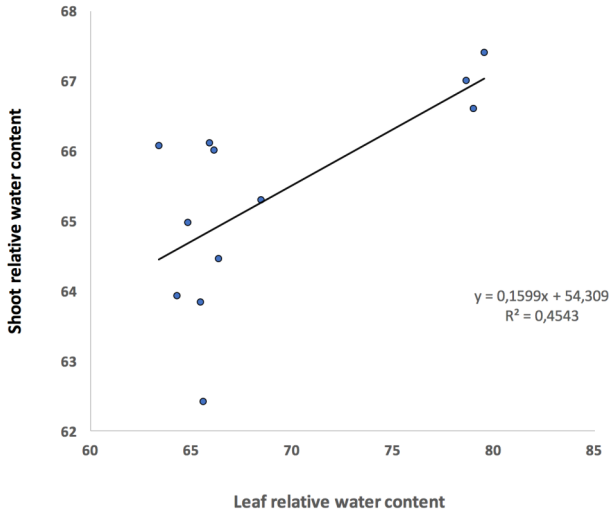

Figure 3. Correlation between summer shoot relative water content and leaf relative water content

CONCLUSION

Climate change, resulting higher temperatures and more frequent water deficits in agricultural areas, is a major challenge for viticulture in the coming decades. If the climate change tendency proceeds, grape quality and yield will be negatively affected in the near future. Hence, growers need to implement adaptive strategies to ensure production of economically high-quality grapes at acceptable yields in a dryer climate. Among various options, the use of adapted plant materials and plant protectants are better tools, because of their advantages of being environmentally friendly and cost effective. Certain solutes, referred to osmoprotectants, protect cellular components from dehydration injury. Glycine betaine, in the present study, appeared to exert an influence on leaf water statute, slightly alleviating the leaf water loss resulting from water shortage. Glycine betaine treatments, regardless of the concentration, increased the fresh and dry weights of the leaves of grapevines subjected to deficit irrigation. Therefore, glycine betaine pulverization might be one of environmentally friendly cultural strategy to alleviate negative effects of drought in viticulture.

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EFFECT OF DIFFERENT THAWING TECHNIQUES ON COLOR OF BLACK SEA TROUT (*Salmo labrax* PALLAS, 1814) FILLETS

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ABSTRACT

In this research, effect of different thawing techniques on the meat color of Black Sea trout (*Salmo labrax*) was evaluated. The commonly using fish thawing methods by the consumers were applied to frozen fish fillets and the color losses were determined. For this purpose, 70 individuals of Black Sea trout were used. First of all, trouts were washed, cleaned and filleted before the freezing stage. In the latter, fillets were kept at -20 ºC for 7 days in deep-freezer and frozen fillets were thawed with 4 different thawing techniques such as thawing in room temperature (+25ºC), immersion in water (+15 ºC), in refrigerator (+4 ºC) and in microwave (defrost option). Finally, color characteristics of thawed fillets were determined. According to the results, while the most similar color profile to fresh Black Sea trout meat was detected on thawed in refrigerator at +4ºC, most color loss was observed in microwaved ones. In view of the results and considering food safety, thawing of frozen fish fillets in refrigerator (+4ºC) is more convenient.

Keywords: Thawing, Color, *Salmo* trutta *labrax*, Quality Loss, Fish Fillet, Freezing

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INTRODUCTION

In Europe, some Salmonidae species especially Atlantic Salmon is cultured extensively for a long time [1,2]. Black Sea trout, *Salmo labrax* (accepted) or *Salmo trutta labrax* (synonym) [3] is an endemic species of Salmonidae and it is distributing naturally in the northeastern rivers of Turkey and the Black Sea [4]. Also, culture of Black Sea trout being widespread recent years in Turkey [5]. Despite expanding aquaculture, scientific researches about meat quality of this species are not enough. Black Sea trout as a rich nutrient source in terms of protein and essential fatty acids for human beings must be well preserved to avoid from microbial, oxidative and enzymatic spoilages before delivering to the consumers.

As well known, one of the preservation methods is freezing. Quality of frozen fish is dependent not only on the freezing itself but also on processing during catching, slaughtering, cold storage with the initial quality of fresh fish [6–8]. The implementation of freezing meat and meat products to prolong the shelf-life has been practiced for thousands of years. Frozen storage is an important preservation method for fish and fish products where it can affect the quality [9]. Fish commonly preferred for its health improving properties which is very sensitive to thawing process due to their low connective tissue content causes rapid spoilage. Freezing and thawing mainly influence the water fraction of fish fillets where the growth of ice crystals causes osmotic removal of water, denaturation of protein and mechanical damage. Enzymes and other components like color pigments are released. That's why one of the most obvious quality changes caused by thawing is in color [10, 11].

Chemical properties with conformational stability and biochemical features in biological systems depend on interaction of their constituent groups with the surrounding medium [12]. Freezing and frozen storage contribute to textural changes [13, 14]. Once the water freezes, the concentration of the remaining materials like proteins, lipids, vitamins and minerals increases [15]. The shelf-life of fish is mainly related to microbial activity and nutritive value where the appearance, texture, color and flavor are also [10, 16]. Flavor which is originated from lipid and peptide components in the muscle is the most

difficult to measure [15]. Two main parameters are pointed in conventional thawing processes which are the surface heat transfer coefficient and the surrounding medium temperature [17, 18]. Rapid thawing at low temperatures may prolong the shelf life of fish by preventing the soluent losses and microbial and chemical changes [19]. This is a certain challenge for traditional thawing processes, where the lower temperature used remains between the frozen sample and the ambient, which is the principal driving power for the thawing process [17].

In this research, effect of different thawing techniques on the meat color of Black Sea trout was evaluated. For this reason, commonly used thawing methods by the consumers were applied on frozen fish fillets and color losses were determined.

MATERIALS AND METHODS

Fish Material

In this study, 70 individuals of cultured Black Sea trout approximately 2 kg each of them were used. First of all, cultured Black Sea trouts were obtained from marine cages unit in Central Fisheries Research Institute and bring to the laboratory with cold storage. In the latter, trouts were washed, cleaned their internal organs, removed their fins and filleted with a sharp fillet knife for the main study. Black sea trout individuals and fillets were shown in Figure 1.

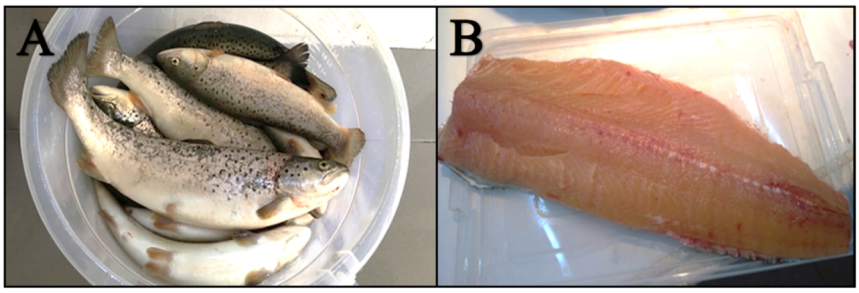

Figure 1. Black Sea trout individuals which are 2 kg each approximately (A), fillet of Black Sea trouts were used in main study (B).

Freezing Procedure

The fillets were divided into five different groups according to the thawing techniques to be applied in further. First group was not frozen with the aim of determination to color properties of fresh Black Sea trout meat and color measurements were carried out immediately. Rest of all were stored in zipper-bags which they placed in foam plates and frozen in -20°C via deep-freezer for 7 days.

Implementation of Thawing Techniques

After the storage period, different thawing techniques were used. All techniques were carried out till the all groups completely thawed. During thawing process, fillets were kept in zipper-bags except microwaved ones in order that minimizing external factors. In the first technique, frozen fillets were kept at room temperature (+25ºC) for 2 hours. In the second, frozen fillets were kept in refrigerator at +4 ºC for 12 hours. In the third one, frozen fillets were immersed in water-bath stabilized at +15ºC for 4 hours. Finally, last group of frozen fillets was thawed in Kenwood digital microwave oven (model: MV577, 900 watts) at defrost option (30% power) for 6 minutes. All thawing techniques and conditions of techniques were shown in Figure 2 and Table 1.

Figure 2. Thawing techniques applied to frozen trout fillets: thawing in room temperature at +25ºC (A), thawing in refrigerator at +4 ºC (B), thawing with immersion in water at +15ºC (C), thawing in microwave with defrost

Table 1. Thawing conditions.

Thawing Techniques	Freezing Temp.	Storage Period	Thawing Temp.	Thawing Duration
In room temp.	-20	7 days	+25ºC	2 h
In refrigerator	-20	7 days	+4ºC	12 h
In water (immersion)	-20	7 days	+15ºC	4 h
In microwave (defrost)*	-20	7 days	+25ºC	6 min

*Defrost option (30% power) was set as automatically in microwave.

Determination of Color Characteristics

Color characteristics of thawed fillets and fresh meat were specified according to Minolta (1994) [20] by Konica Minolta CR-410 colorimeter with silicone photo cell detector and pulsed xenon lamb light source (Figure 3). In analysis, values of luminance (L), a and b (color-opponent dimensions) were specified. According to L*a*b* color chart; while the L value show lightness, a value indicates axis from green to red and b value ranges from blue to yellow in a similar vein. Color differences (ΔE) were calculated with an equation mentioned by Zhu et al. (2004) [21]. This equation was given below:

$$\Delta E = \sqrt{(\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2}$$

(ΔL, Δa and Δb were differences on L*, a* and b* values between fresh meat and thawing technique).

Finally, obtained data were calculated by Color Data Software CM-S100w Spectra Magic^{tm} NX Lite and SPSS 21 statistic program. Differences between groups were determined by one-way analysis of variance ANOVA using Tukey's multiple comparison tests [22].

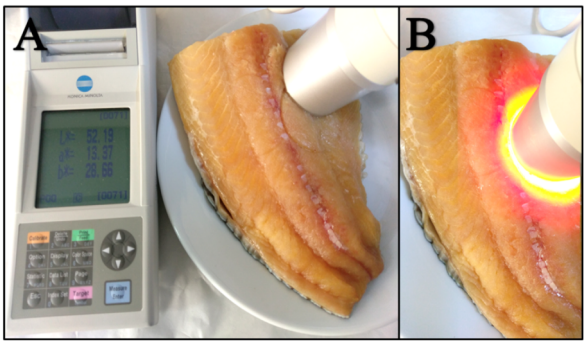

Figure 3. Determination of color characteristics: Conica Minolta CR-410 colorimeter (A) and using in measurements of color with with silicone photo cell detector and pulsed xenon lamb light source (B).

RESULTS AND DISCUSSION

The meat color is one of the most important quality parameters in Salmonid species [23]. According to Steine et al. (2004) consumers want pink-red salmon meat [24]. In salmonids, carotenoids are responsible for the characteristic pink color of meat [25, 26]. Wild salmons contained approximately 10 times higher carotenoids than cultured ones [27]. Thus, with low carotenoid contents, color losses in cultured salmon become important. The color loss of trout meat mostly associated with oxidation of carotenoids, enzyme activity and temperature especially in frozen fish [28]. Freezing procedure is not responsible one of the significant factors which cause color changes in thawed fillets [21]. However, several thawing methods effects color of fish meat [11, 29, 30]. According to our results; color profile of fresh meat was found as 57.35±0.49 (L*), 8.83±0.26 (a*) and 9.25±0.52 (b*). These results show that meat of Black Sea trout is light colored than the Atlantic Salmon [23,31]. The highest L value was specified in room temperature at +25ºC, a value was specified in microwave and b value was specified in microwave and room temperature at +25ºC. The lowest L value was observed in microwaved ones, whereas a and b values were specified in refrigerator thawing. The color profiles of thawed fillets were shown in Table 2.

According to calculations of color differences; the most similar color profile to fresh trout meat was detected thawed in +4ºC ones. It can be related to low enzyme activity and slightly water loss in the surface area of fillets caused low temperature of refrigerator conditions than the other techniques. Second most similar color profile was observed in immersing thawing in similar vein. However, thawing in room temperature and thawing in microwave caused more color loss than the other two techniques.

Table 2. Color profile of Black Sea trout' fillets

Thawing Techniques	L*	a*	b*	Color Differences (ΔE)
Fresh meat	57.35±0.49^{b}	8.83±0.26^{c}	9.25±0.52^{c}	-
In room temp.	59.99±1.67^{a}	9.80±0.69^{c}	22.71±1.48^{a}	13.74±0.47^{b}
In refrigerator	56.08±1.02^{b}	7.63±0.55^{d}	10.58±0.92^{c}	2.20±0.15^{d}
In water (immersion)	57.42±0.92^{b}	12.30±0.85^{b}	18.66±1.10^{b}	10.03±0.22^{c}
In microwave (defrost)	49.19±0.82^{c}	14.02±0.69^{a}	21.09±0.60^{a}	15.29±0.51^{a}

Values are expressed as mean ±SD (n = 3), mean values in column with different superscripts were significantly different (P <0.05).

Especially, analyze results show that microwaved fillets have extreme L, a and b values among groups along with the most total color changes (ΔE). Fish fillets were exposed to different thawing temperatures due to the using technique in this study. Also, except the samples thawed in microwave, the others were all packed in same conditions to avoid surrounding environments' effects. The samples thawed at lower temperatures in refrigerator conditions unsurprisingly defrosted latter. In contrast to higher defrost period and exposing to the surrounding oxygen, discoloration is the lowest in samples thawed in refrigerator comparing the other samples. That's why loss of carotenoids which are responsible for pink color in trout fillets is more effective in discoloration than increasing enzyme activity by increasing the temperature and autoxidation because of surrounding oxygen. Thus, thawing at lower temperatures with lower oxygen levels contribute a better color profile in fish fillets. The total color changes of thawed fillets were shown in Table 2.

CONCLUSION

In view of the results, thawing of frozen fish fillets in refrigerator (+4ºC) is more preferable by the reason of their minimum color loss. Also, thawing in refrigerator is more reliable than other techniques considering food safety as well as more practical. Our findings will be contributed to the future work and these results attract all researchers.

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Research Article

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THE DROUGHT EFFECT ON SEED GERMINATION AND SEEDLING GROWTH IN BREAD WHEAT (*Triticum aestivum* L.)

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ABSTRACT

Drought is a major abiotic stress that threating the producing and survival of many crops such as cereal. Wheat is grown on arid lands and drought often causes serious problem in wheat production on these fields. In this study, it was determined that the effect of five different drought stress (0, -0.3, -0.6, -0.9, -1.2 MPa, by using PEG 6000 solution) on the germination of 4 different bread wheat cultivars (Tekin, Pehlivan, DZT13-1 and DZT13-2). The study was carried out according to completely randomized design in factorial arrangement with four replications. In the present study, important growth parameters like germination rate (%), seedling vigor (%), coleoptile length (cm), root length (cm) and shoot length (cm) were observed. Results showed when dose of PEG increased, seedling growth was significantly affected. Increasing drought stress was resulted with a decrease on germination rate, seedling vigor, coleoptile length, root length and shoot length.

Keywords: Germination, PEG-6000, Wheat, Drought Tolerance

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INTRODUCTION

Wheat one of the most important cereal crops in the world, is grown in wide range of environmental conditions. Wheat yield is reduced by abiotic stresses such as salinity, drought and heat. Drought stress is probably the most important limiting factor to crop production worldwide, especially in many developing counties in arid and semi-arid regions [1]. In the limitations of world crop production drought stress has the highest percentage with 26% when the usable areas on the earth are classified in view of stress factors. Wheat often experiences drought stress at various growth stages especially during germination, tillering and early grain filling with corresponding depressions in biomass production and grain yield under rainfed conditions. Seed germination and seedling growth are critical stages in the life cycle of a plant, especially under adverse abiotic stresses. Germination percentage and seedling traits reduce with a high drought stress. Some researchers had reviewed the effects of drought on germination and seedling development in crops such as wheat [2], corn [3] and barley [4]. Polyethylene glycol (PEG) causes osmotic stress and could be used as a drought simulator [5,6]. It was evaluated four bread wheat varieties for their tolerance to drought stress at germination and seedling at changing stress level.

MATERIALS AND METHODS

The experiment was conducted at growth chamber in laboratory of Horticulture, Faculty of Agriculture, Sirnak University, Turkey. Two commercial bread wheat genotypes (Pehlivan and Tekin) and two advanced genotype were used against drought stress at germination and seedling stage under laboratory. It was laid out as completely randomized design (CRD) in factorial arrangement with five treatments (0, -0.3, -0.6, -0.9, -1.2 MPa, by using PEG 6000 solution) and four replicates.

Day and night lengths were 14/10 h, with ±25°C. Seeds were surface sterilized with 10% sodium hypochlorite solution for 10 minutes and then washed four times with distilled water. Twenty seeds of each wheat genotype were planted in each petri dishes containing filter paper. Germination rate, seedling vigor, coleoptile length, root length and shoot length determined following the method of Yildirim et al. [7].

Analysis of variance was performed using the Genstat statistic package. Means were compared according to LSD test at 0.05 probability levels.

RESULTS

The result obtained from analysis of variance revealed significant differences among different levels of drought stress (Table 1). There was decrease in germination and seedling growth with increase in drought stress.

Germination rate decreased significantly in all cultivars. The decreases were more apparent at -0.9 and -1.2 concentrations. In -0.3 MPa treatment maximum germination rate was executed by Pehlivan (75%), whereas DZT13-2 showed minimum germination rates (55%). Tekin had the highest germination rate (55%) and DZT13-2 exhibited lowest germination rate (27.5%) at -06 MPa treatment. While none of the seeds was able to germinate at-1.2 MPa of PEG. All genotypes exhibited decreases in seedling vigor as osmotic potential was decreased from 0 to -1.2 MPa (Table1). The highest seedling vigor was determined by genotype Pehlivan (90%) in control, whereas DZT13-2 showed minimum germination (11.2%) at -1.2 MPa PEG solution.

Significant reduction in coleoptile length was observed in drought stress in all genotypes. There was a slight decrease in coleoptile length associated with the -0.3 MPa and -0.6 MPa treatments. Tekin had maximum shoot length with 18.9% and 24.1% reduction as compare to control at -0.3 MPa and -0.6 MPa treatments respectively (Figure 1).The shoot length was decreased significantly with increasing of drought stress levels. The decreases were very high at -0.9 MPa and -1.2 MPa. DZT13-1 had maximum shoot length (82.34 mm) with 35% reduction as compare to control at -0.3MPa PEG stress. While it has maximum reduction (99%) was given by all genotypes under -0.9 and -1.2 PEG stress (Figure 2).An increase in PEG concentrations over -0.9 and - 1.2 MPa significantly reduced the length of root compared to control. The maximum root length was observed in control and minimum values observed in -1.2 MPa (Figure 3).

DISCUSSIONS

Our data shows that germination rate, seedling vigor, coleoptile length, shoot length and root length of all wheat genotypes decreased significantly under drought stress. Drought is considered one of the most devastating among the environmental stresses [8]. All agricultural regions will experience drought and some areas experience predictable dry seasons as some others exposed to unpredictable drought periods. Drought stress decreases the crop quality and yield up to 50% or more [9]. Due to the need of developing and identifying drought tolerant crop lines, understanding the functioning capacity of drought tolerant plants under water deficit conditions is inevitable [10].

Under drought stress, growth inhibition observed in all cultivars. The increases in the growth inhibition of the plants become more significant at high PEG concentration. Van den Bergand Zeng [4] reported that drought plays an important role not only in determining germination rates, but also influences seedling development. Significant reduction in coleoptile, shoot and root length at higher concentrations of PEG was observed as compare to control. The reason for low shoot and root length may be due to increase in osmotic potential by increasing drought, which leads to dehydration, ionic imbalance in transpiring leaves that caused reduction in meristem activity and cell elongation, consequently inhibit the growth of wheat plant [11,12,13]. Bartels and Sunkar [14] concluded that growth arrest might allow plants to preserve carbohydrates for prolonged energy supply and for sustained metabolism the reduction in the root length under drought stress. Root length is a very important trait for the plants to cope with drought environments. In this study has shown that the results are in agreement with the study Dranda et al.[15] who noticed the significant decline in the germination and seedling growth.

It is pointless to use -0.9 and -1.2 PEG stress because of the loss of the genotypic difference and almost all of the plants are died in PEG conditions in bread wheats. In this study, the drought tolerance of the varieties changed according to the severity of the drought and the traits investigated.

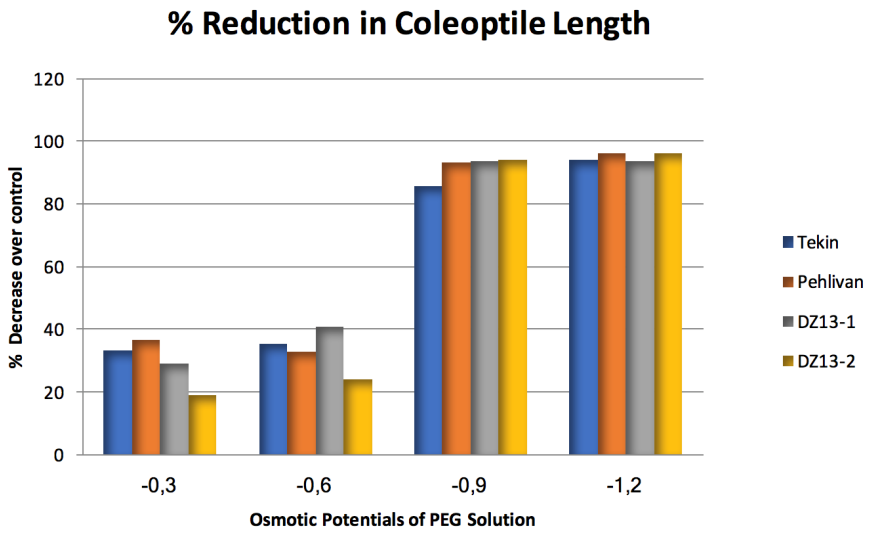

Figure 1. Percent reduction in coleoptile length of wheat genotypes at -0.3, -0.6, -0.9 and -1.2 MPa PEG stress.

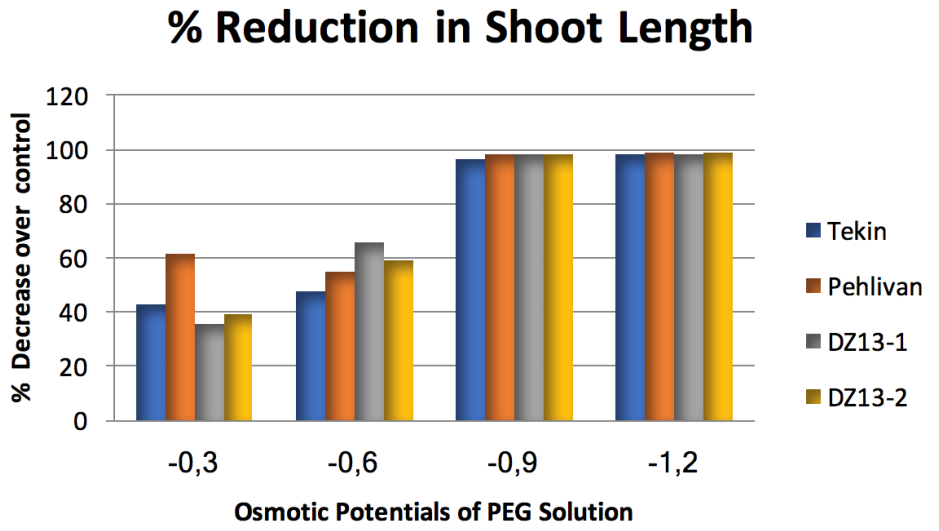

Figure 2. Percent reduction in shoot length of wheat genotypes at -0.3, -0.6, -0.9 and -1.2 MPa PEG stress.

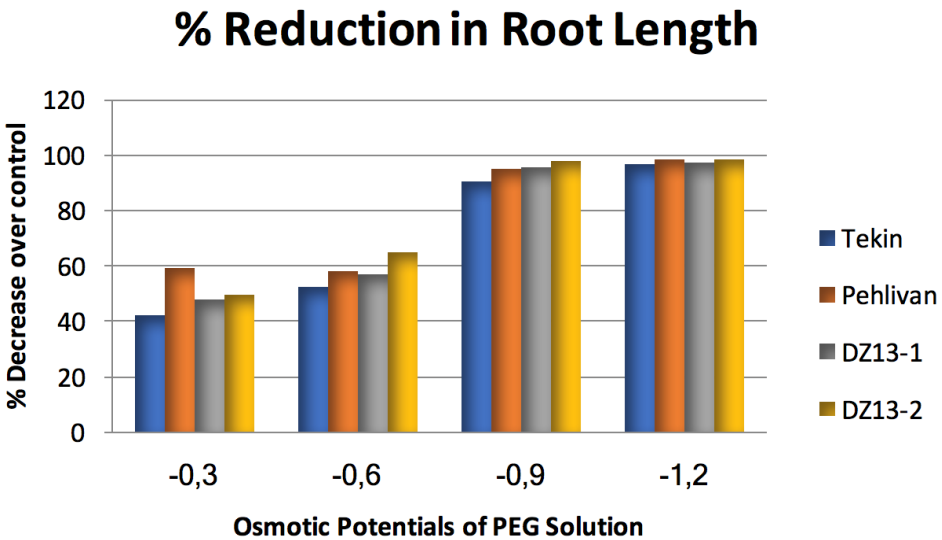

Figure 3. Percent reduction in root length of wheat genotypes at -0.3, -0.6, -0.9 and -1.2 MPa PEG stress.

Table 1. Growth responses of bread wheat genotypes under control and PEG treatments.

Treatments	Varieties	Germination Rate (%)	Seedling Vigor (%)	Coleoptile Length (cm)	Root Length(cm)	Shoot Length (cm)
0 (Control)	Tekin	67.5	88.8	2.718	11.14	10.75
	Pehlivan	75.0	90.0	3.901	14.93	14.49
	DZT13-1	62.5	85.0	3.090	13.63	12.83
	DZT13-2	60.0	78.8	3.736	16.13	14.54
-0.3 MPa	Tekin	62.5	77.5	1.811	6.46	6.15
	Pehlivan	51.2	75.0	2.478	6.12	5.62
	DZT13-1	62.5	73.8	2.187	7.14	8.23
	DZT13-2	55.0	68.8	3.030	8.09	8.81
-0.6 MPa	Tekin	55.0	70.0	1.750	5.28	5.64
	Pehlivan	50.0	62.5	2.611	6.22	6.55
	DZT13-1	42.5	62.5	1.823	5.83	4.38
	DZT13-2	27.5	56.2	2.835	5.63	5.95
-0.9 MPa	Tekin	17.5	46.2	0.390	1.07	0.39
	Pehlivan	15.0	45.0	0.260	0.77	0.26
	DZT13-1	10.0	42.5	0.193	0.61	0.19
	DZT13-2	0	41.2	0.223	0.37	0.22
-1.2 MPa	Tekin	0	21.2	0.171	0.34	0.17
	Pehlivan	0	26.2	0.149	0.22	0.16
	DZT13-1	0	18.8	0.191	0.40	0.19
	DZT13-2	0	11.2	0.146	0.24	0.15
	$Lsd_{0.05}$ stress levels	6.63	6.37	0.166	1.141	0.85
	$Lsd_{0.05}$ genotypes	5.93	5.70	0.149	1.020	0.76
Mean Square	Stress levels	13561.25***	10899.69***	31.74487***	494.947***	468.247***
Mean Square	genotypes	542.81***	276.15*	1.79517***	5.229	5.963**

*, **, *** Significant at 0.05, 0.01 and 0.001 probability levels, respectively.

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Review

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THE SCOPE AND TYPES OF ENVIRONMENTAL HUMAN RIGHTS

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ABSTRACT

Environmental human rights (EHRs) have received greater worldwide attention over the years since first recognized by the 1972 Stockholm Declaration. Approximately 100 countries currently recognize and guarantee EHRs within their national constitutions. EHRs have been also used by such diverse groups as academics, social activists, international organizations, political parties, NGOs, etc. EHRs, however, are still a long way from being clear as a concept, or may at best be considered vague. This may be because different scholars have defined EHRs in different ways. In order to broaden and deepen our understanding of EHRs, this conceptual paper will attempt to explain the scope and types of EHRs through a critical analysis of the related literature by addressing the following research questions: (1) What is the scope of environmental human rights? and (2) What types of environmental human rights are there? It concludes with four main types of EHRs, including the right to environment, civil and political rights, and the constitutional and procedural rights that are the rights of individuals to preserve the environment in which they live.

Keywords: Human Rights, The Environment, Environmental Law, Environmental Human Rights

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INTRODUCTION

Environmental human rights (EHRs) have been referenced by different groups, particularly scholars, activists, NGOs and international organizations (e.g. the United Nations) since their recognition at the international level by the 1972 Stockholm Declaration, which proclaimed that "*Both aspects of man's environment, the natural and the man-made, are essential to his well-being and to the enjoyment of basic human rights the right to life itself*". This clearly implies that there is a direct connection between a safe environment and the enjoyment of human rights, which is the core argument of EHRs, but the term is still currently vague and unclear, as the literature does not provide any single, explicit definition, and which has thus been interpreted in different ways by different scholars depending on their values and priorities.

Another indeterminate point is related to the types of environmental human rights. It is still somewhat unclear to, or under debate by, scholars as to what types of environmental human rights there actually are, or should be, and how they are linked to each other. There is no recognition of environmental human rights by hard law at the international level, but there are many countries' constitutions, international soft law documents, and regional hard law declarations, which clearly recognize different types of environmental human rights. This raises the following question: what types of EHRs are there?

In light of the above discussions, this paper aims to achieve two fundamental goals. The first section attempts to determine the true scope of environmental human rights, or how we can define EHRs. The second section attempts to consider what types of environmental human rights exist at the international and national levels, and how these rights are connected with each other. By doing so, this paper intends to clarify the direct relationship between the environment and human rights.

1. DEFINING "ENVIRONMENTAL HUMAN RIGHTS"

Human rights are moral principles or norms, which are believed to belong to every person, and in whose exercise a government may not interfere. There are three overarching types of human rights norms: civil-political, socio-economic, and collective-developmental.

Kotzé [1] describes the manifestation of human rights in an environmental context, and cites three common instances: (1) environmental rights; (2) environmental human rights; (3) human rights and the environment. He concludes that 'human rights and the environment' is the best definition, as the term allows for a decidedly holistic consideration of the relationship between all human rights.

The main reason for any conceptual uncertainty is the fact that EHRs do not have a rooted history [2], which means that they still need time to mature before they can be defined in a more definite way. It seems that there is no significant conceptual difference between these three terms, but it would be more appropriate to use the terms 'environmental human rights', as the first term implies that environmental rights refer to rights of the environment and the third term that human rights and environment-oriented rights refer to two different fields, when it is commonly accepted by scholars that the environment and human rights are directly related and cannot be discussed separately [3, 4]). In contrast, environmental human rights refer to rights of humans related to the environment, which is what they essentially are.

On the other hand, the scope of EHRs is still far from being clear [3, 5]. This may be because various scholars have defined EHRs in many ways [6, 7]. One commonality amongst these definitions is that environmental human rights are described as an expansion or reformulation of existing human rights and responsibilities in the specific context of environmental protection [4, 8]). According to this definition, the object of environmental human rights encompasses a reinterpretation of human rights laws; a new substantive right to be protected by state institutions; and the protection of the environment by state institutions and individuals.

Environmental human rights are, more specifically, not rights belonging to the environment [9], but the rights of humans to various environmental protections as they mainly derive from a reinterpretation of recognised human rights. The right to education, for example, does not seem directly relevant to environmental protection as it implies that education shall be equally accessible to all on the basis of merit, but as Boyle and Anderson [5] argue, it can be interpreted that education is a powerful means of informing people about environmental matters and informing people through the enjoyment of the right to education can result in better environmental decisions in favour of the natural world than uninformed ones. This approach links the right to education with environmental protection, which is defined as EHR. On this basis, EHRs depend on how people interpret human rights in relation to the environment.

On the other hand, saying that EHRs belong to people does not mean that humans can use the environment to satisfy their own needs as they wish; they have no direct right to an object (the environment), but to the action that allows them to protect their environment. EHRs make explicit reference to the protection of the environment itself, or to the protection of individuals from harm originating within the environment [10], which requires that a government has an obligation to protect those resources on behalf of its citizens and future generations. Therefore, it can be seen that the main goal of EHRs is to ensure the preservation of natural resources rather than the sovereignty of humans, the latter of which allows for the exploitation of the environment as humans see fit.

Hiskes [11] categorises EHRs as emergent rights, observing that they arise in response to threats to human dignity, a concept which underlies all "basic" human rights. It is unsurprising, therefore, that this definition and categorisation is agreed upon by many scholars [2, 12, 13]. However, it can be argued that this perspective is anthropocentric, in that it regards humankind as the central or most important actor [9], and ignores the inherent value of nature [14], as well as how humans affect or damage their habitat, impair ecosystems, and change the climate [15]. Indeed, it can be argued that regarding pollution as a threat to only human dignity makes the environment “guilty” and human beings “innocent”, which is an extremely narrow approach. It is possible to take an alternative stance, which may reflect a more ecocentric perspective, according to which, in contrast to Hiskes [11]'s definition, environmental human rights are emergent in that they arise in response to threats to the environment caused by human activities that affect all subjects of that ecosystem, humans and non-humans [16, 17].

Lercher [18] develops a further and less common argument over the scope of EHRs. He states that environmental human rights against contamination are individual rights, rather than group rights.

While individual rights are held by a single person, group rights are held by the group itself rather than by its individual members. The right to environment, constitutional rights, civil and political rights, and procedural rights are mainly held by individuals. The same argument is proposed by [19], that environment related rights are 'individual rights' that emerge as an extension, by way of interpretation, from other expressly recognised human rights – such as the right to life and health. It seems reasonable to categorise EHRs as individual rights due to the fact that they recognise the liberties of individuals and award them the right to life in a safe environment. Secondly, any disproportionate impact to the environment is, equally, an effect on an individual and his or her rights. Fukushima nuclear accident in 2011, for example, poses risks to residents' rights to life, health, property, and access to safe food and water in the region. In addition, traditionally, one of the main purposes of the doctrine of human rights has been to protect individuals from the power of groups, such as states [20]. Human rights are strongly associated with the concept of individualism. Thus, environmental human rights can be viewed as an effective tool for individuals to use against any state policy that threatens the environment on which they are physically dependent.

Conversely, the individualistic form of environmental human rights is not without exception. it would be arguably wrong to view environmental human rights as truly individual, as they can sometimes only be held by groups [11]. Arguments in favour of this view have been proposed by Boyle [21] who states that as environmental quality is a collective or solidarity right, environmental human rights can give communities, or "peoples", rather than individuals, the right to determine how the environment and natural resources should be protected and managed. It does not seem wrong that a safe environment is a collective purpose that people would like to achieve by exercising their environmental human rights, but this does not change the fact that environmental human rights that aim to protect the common home of people – the environment – are held by all individuals rather than a group. Cullet [12] take thus argument further, suggesting that the right to environment is an individual right not only for existing people but that one must also consider the rights of future generations, whose interests must be similarly taken into account. As we cannot, he argues, identify whose individual members, then the right is given to a group, the so-called future generations, but he ignores the fact that the term addresses neither existing people nor future generations as rights holders. They are merely used to define the time period that rights holders live or will live. EHRs are, therefore, rights of individuals rather than groups.

2. TYPES OF ENVIRONMENTAL HUMAN RIGHTS

There is no specific right to environmental protection guaranteed by law at the international level [22]. However, this idea is not far away, and it is interesting that a distinct substantive right to environmental protection may be established as part of international law in the near future, as EHRs are increasingly being recognised by international, local and domestic law, such as the 1972 Stockholm Declaration and 1992 Rio Declaration [4, 23]. The literature illustrates four main approaches to EHRs, which are not entirely mutually exclusive [24, 25]: first, mobilising civil and political rights to achieve environmental ends; secondly, reinterpretation of existing human rights (constitutional rights); thirdly, procedural rights, and lastly, creating new rights explicit to the environment [5], all of which largely remain an issue of philosophical debate.

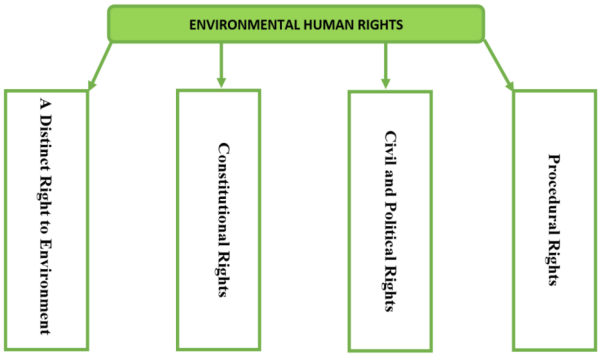

Figure 1. Types of Environmental Human Rights

a) A Distinct Right to Environment

A right to environment implies that a safe environment is one of the basic human rights to which all human beings are entitled because the environment is accepted as a basic human need; a provider of the air, water and food that are essential for human survival. That is, all people depend on the environment in which we live.

A safe environment has been increasingly recognised as a human right by countries all over the world. At the national level, over 90 countries (such as Brazil, South Africa, Canada and India) guarantee a distinct right to environment in their own constitutions, obligating countries to preserve ecology, and giving citizens the opportunity to enjoy a healthy environment [3], but this does not mean that people fully realise this right. In terms of recognition, it appears that the right to a clean and healthy environment is assuming a higher degree of relevance. There is, however, no legally enforceable right to the environment at the international level. As the environment is everyone's home [25], and environmental issues such as major nuclear accidents have transboundary impacts on both people and the non-human world, the debate in the literature revolves around whether we should have a right to the environment that can be realised on a global scale [5, 12]. As a right to the environment has both advantages and disadvantages, this can be considered either negatively or positively depending upon how a given scholar might perceive and weigh its weaknesses and strengths.

The discussion over a distinct right to environment is not without controversy, as there are both advantages and disadvantages. Advocates of the argument, for example Hayward [26] in the book "*Constitutional Environmental Rights*", argue that the right to an adequate environment is a genuine and ecologically sound right that should be provided in the constitution of any modern democratic state. The latest developments are in favour of Hayward [26]'s suggestion that over 90 countries, which can be found in their own constitution or the African Charter (which is a binding regional human rights document) guarantee the right to a safe and/or clean environment. Mann [27] takes a universal view and states that an internationally applied right to environment is needed to reduce the increasing number of environmental issues. Hancock [6] develops a more specific approach and suggests that the recognition of two particular rights, the right to an environment free from toxic pollution and ownership of natural resources, would protect human beings from harm to the environment. Thorme [28] agrees, but takes a highly pessimistic view that if this new right is not soon guaranteed, the Earth will ultimately become uninhabitable and people would disappear. Of course, recognition of such rights would bring some advantages to environmental protection. However, as Boyle and Anderson [5] argue, this does not mean that a right to environment is the only way to preserve both nature and human existence; well-protected civil and political human rights, for example, can also be effectively used to address environmental issues. As a rebuttal to this point, Thorme [28] ignores the fact that the planet, historically speaking, exists and was habitable for millions of years without new – indeed, any –distinct right to environment. Additionally, procedural and civil and political rights can also be effectively used in environmental matters without recourse to a distinct right to environment. A right to environment is, therefore, not the only way to achieve environmental protection.

The main advantage of the right to environment is that a distinct right to environment, Gellers [4] argues, could be effectively used to address environmental issues affecting human life. The opposing view is also compelling. Pevato [29] discusses how if the ultimate goal of a right to environment is to give moral rights to concerned groups to raise only their concerns about environmental issues, then this can in fact be encouraged without any expressly recognised right to environment. Boyle [21] takes this argument further and claims that the right to expression, for example, is a far more effective way of enabling victims of environmental matters to raise their objections than a right to environment. A right to environment, however, may have more effective advantages in favour of nature. A rights-based approach to environmental protection would place states under the obligation to secure a clean environment for their citizens because this would demand positive state action to guarantee minimum standards towards protecting the right to environment [30]. Being in favour of the latter argument, Eacott [31] emphasizes on that recognition and enforcement of a right to environment would necessitate the creation and implementation of stronger, more comprehensive national and international laws of environmental protection.

Ziemer [32] takes the strong anthropocentric perspective that linking human rights to the environment creates a rights-based approach to environmental protection that places the people harmed by environmental degradation at the centre of the issue. Indeed, a right to environment may oblige states to conserve and protect nature

because responsibility to protect human rights resides first and foremost with the states themselves. According to the International Law Commission, working on responsibility of states for internationally wrongful act and in conjunction with the implementation of the international Covenant on Economic, Social and Cultural rights, states have a threefold responsibility; (1) States must take positive action to facilitate the enjoyment of basic human rights; (2) States must refrain from interfering with or curtailing the enjoyment of human rights (3) States must protect individuals and groups against human rights abuses. This right becomes a legal weapon of concerned citizens to force their states to secure minimum standard to enjoy a right to environment; this clearly may serve in favour of environmental protection.

On the other hand, such an approach is not without problems, in particular with respect to implementation of such a right in a practical sense. A distinct substantive right to environment seems unenforceable [21, 33]. Some scholars, such as Boyle and Anderson [5], argue that a right to environment should be added to internationally recognised rights, as environmental issues are transboundary. They are partly correct insofar that major environmental issues such as nuclear accidents have worldwide implications. Their suggestion is, however, not convincing because opponents mainly argue that the practical implementation of a global substantive right to environment is highly challenging as it is not clear how the right to environment can be measured, protected, audited, and judged at the international level. This does not seem achievable as daily activities, directly or indirectly, contaminate the environment on an ongoing basis e.g., smoking, which is purported to cause 600,000 deaths amongst non-smokers annually [34]; using transportation which burns most of the world's petroleum [35]; the growing use of plastic products and increased global meat consumption. These are some regular, common activities performed by people in the modern world. If people have the right to a healthy environment, and if these and similar activities pollute nature, then unarguably the next step would be to discuss how to stop them. It seems utopian, but in practice the right to a healthy environment requires the need for action that protects it from any human activities that pollute nature. This is a theme taken up by Shelton [33], who states that, "*no justiciable standards can be developed to enforce the right, because of the inherent variability of environmental conditions"*. Thus, the boundaries of the right to a healthy environment are undefined and vague, while its actual implementation appears to be challenging and complex at an international level. This may be the main reason why there is still no distinct right to a healthy environment at the international level.

Secondly, it is argued that cultural relativism would be an obstacle to achieve a distinct right to environment at the international level. Handl [36] argues the right to environment on epistemological grounds, claiming that cultural relativism would be an obstacle to the implementation of substantive components of the expansive right to environment at the international level. The notion of cultural relativism was developed by Franz Boas in 1911, which emphasises that no moral principles can be formed that will apply to all cultures because human rights are themselves culturally dependent [37]. Donnelly [38] claims that cultural relativism is an undeniable fact; that is, culture is an important source of the validity of a moral human right. The opposing viewpoint is universalism, which regards human rights as a single universal concept. The modern system of the international human rights framework is indeed based on the concept of universalism, which means that human rights are an entitlement of all human beings regardless of their culture, religion, age, gender, etc. [39], but this is still under debate. Zechenter [40], for example, argues that universalism is merely an uncritical, ethnocentric Western conspiracy designed to undermine non-Western cultures. Similarly, Perusek [41] defines universalism as Western traditionalism that ignores the diversity of cultures worldwide. It appears true that the UDHR Universal Declaration, for example, is rooted in political landmarks in Western history, such as the Magna Carta of the United Kingdom (1215), the French Revolution (1789) and the American Bill of Rights (1791). Nevertheless, the right to environment is not recognised by the UDHR [42]. Additionally, the first binding regional document recognising a right to environment is the African Charter; the origins of EHRs may not be rooted purely in Western culture.

b) Reinterpretation of Existing Human Rights: Constitutional Rights

Some scholars argue that EHRs should be

added to internationally recognised human rights to protect human rights, wellbeing and dignity from environmental harm. While Thorme [28] suggests the recognition of a right to a healthy environment, Hancock [6] offers the right to an environment free from toxic pollution and ownership of natural resources as a solution to the issue. As Woods [25] points out, the key argument is not recognition of these rights as they are already implicit in internationally recognised human rights. On the basis of this argument, there is no need for separate EHRs because well-established and legally enforceable human rights require a safe environment. They are also referred to as the constitutional rights to a healthy/clean environment [43].

There are a great number of supporters of this argument. Olawuyi [44] and Alfredsson and Ovsiouk [45], for example, argue that the realisation of certain well-established substantive human rights, such as those relating to life, food, health, is inherently dependent on the successful management of the environment. Nickel [46] explains the reasoning behind this argument and states that it is not possible to protect human rights without a safe environment because the most severe effects of pollution, toxic wastes, and inadequately processed sewage result in the sicknesses and deaths that undermine recognised rights. This is a relatively narrow perspective because some environmental issues – particularly nuclear accidents – significantly affect the lives of individuals. Pathak [47] applies basic needs theory in that the lack of good quality air, water and food as provided by the environment is the greatest obstacle to the fulfilment of the right to life and health. He also acknowledges the trap that it would be narrow-minded to limit any impact to the environment to purely those of life and health, as any such impact would also pose risks to the right to food and water.

It seems that this approach does not attempt to set out any new vision for the relationship between the two, but instead merely touches on the interconnection between the protection of the environment and the fulfilment of human rights, which have in any case been recognised since the 1972 Stockholm Declaration. The advantage of this argument, however, is, as Thorme [28] argues, that it demands positive state action in order to guarantee minimum environmental standards for human rights because it is the responsibility of states to take essential steps to protect constitutional rights such as the right to life. For example, Article 27b of the Constitution of Uganda states that: "*The State shall ensure that ...all Ugandans enjoy rights and opportunities and access to education, health services, clean and safe water, decent shelter, adequate clothing, food, security and pension and retirements benefits*" [43]. In this sense, environmental protection becomes a legal, rather than moral, obligation for states in order to protect constitutional human rights such as the right to water, food, health, property, etc. Similarly, Ziemer [32] argues that linking human rights to environment issues creates a rights-based approach to environmental protection that enables citizens to force their governments to preserve nature in order to realise enjoyment of recognised substantive human rights. If enforcement bodies [5] explicitly recognise such a relationship, then environmental criteria may be directly incorporated into the monitoring and enforcement of human rights. His argument seems correct in that this may arguably depend on values or environmental awareness of judges who may, or may not, link the two. In other words, there is no guarantee that enforcement bodies may not link the two, although others maybe will. Environmental human rights, therefore, are implicit to the constitutional rights that states are obliged to protect and provide minimum standards for environment, which does not pose an obstacle to the enjoyment of substantive human rights.

c) Civil and Political Rights

Whilst less common than the other approaches mentioned above, a few scholars claim that we have internationally well-established civil and political rights that can be strong vehicles for addressing environmental issues and that, in particular, they can foster an environmentally-friendly political order at the domestic level [8, 22]. Civil and political rights, very briefly, can be defined as a class of human rights that protect individuals' freedoms from infringement by governments, social organisations, and other private individuals [48, 49]. They restrict the powers of central or local governments regarding actions that might affect individuals and their rights/liberties [50]. The International Covenant on Civil and Political Rights (ICCPR) is the core of the legally binding human rights treaty, providing a range of protections for civil and political rights at the international level, and

is signed by 168 state parties [51]. Civil and political rights may vary from country to country, but the most common ones include freedom to worship, freedom of thought and expression, the right to vote, to take part in political life, and to have freedom of assembly and association [52].

It seems that civil and political rights are not directly linked with EHRs or environmental protection, but as Boyle and Anderson [5] argue, the realisation of such rights, particularly the right to expression, association and political participation, may enable concerned citizens to raise their objection to environmental harm and policies. These rights are not limited to individuals; they may also include legal personality or organisations. In this sense, Boyle [21] points out that their importance lies in their ability to give individuals, groups and non-governmental organisations (NGOs), who are affected or threatened by environmental degradation, the opportunity to voice their objections. Controversially, Dias [53] touches upon an important issue through his claim that environmental protection via civil and political rights is not an easy process in practice because they may be vulnerable to governmental control, which means autocratic regimes would be an obstacle to the enjoyment of civil and political rights. Indeed, this issue might be considered more obvious in Middle Eastern, Latin American, and Asian countries which suffer from the lack of a healthy democracy, and well-developed and protected human rights [54], which ultimately results in autocratic regimes representing the greatest obstacle to the enjoyment of civil and political rights for the protection of the environment. Sachs [55] underlines another issue, in that civil and political rights cannot be effective in isolation because they can only create a duty to refrain from certain actions that are harmful to the environment. He implies that they are negative rights that usually oblige inaction on the part of the government. However, arguably, he falls into the trap of ignoring the fact that, sometimes, the effective enjoyment of certain civil and political rights may also force government to take action through the allocation of appropriate resources; for example, if the majority of citizens exercise their rights against NPPs, then they may force their governments to invest in renewable energy sources instead.

d) Procedural Rights

Procedural rights are based on three pillars: a right to information, a right to participation, and a right to access to justice. The 1992 Rio Declaration is the first international document that defines and fosters procedural rights which have been commonly conceived as being more transparent, inclusive, and accountable in the decision-making progress concerning matters affecting the environment that people are dependent upon. Principle 10 states that:

"Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided"

Anton and Shelton [3] argues that each procedural right is a piece of the puzzle in building good environmental governance. That is, they are closely integrated with each other and may be ineffective in the absence of one or another of them; for example, if public authorities do not proactively make environmental information available, meaning that members of the public cannot exercise their right to information, the right to participation in decision-making processes may be rendered meaningless or ineffective, as uninformed or ill-informed citizens are not able to reflect on their thoughts in the absence of relevant information, and poor knowledge may affect people's decisions and awareness in a negative way [56]. From this perspective, it is reasonable to assert that the right to information is a prerequisite for effective participation. Similarly, access to justice is, inter alia, required to enforce the rights to access to information and participation [57].

Procedural rights, including participation in decision-making processes, access to information and access to justice are essentially recognised as civil and political rights by many international human rights documents. Article 25 of International Covenant on Civil and Political Rights, which is a multilateral treaty adopted by the United Nations General Assembly in 1966, states that: "*Every citizen shall have the right and the opportunity to take part in the conduct of*

public affairs, directly or through freely chosen representatives." Similarly, article 21 of the Universal Declaration of Human Rights, which is the first time that countries agreed on a comprehensive statement of inalienable human rights, states that: "*Everyone has the right to take part in the government of his country, directly or through freely chosen representatives*." Not only public participation but also access to information can be categorised as one of civil and political human rights. It is generally accepted that access to information is necessary for the realization of the basic rights to freedom of opinion and expression; and public participation in governmental activities that are guaranteed in the United Nations Declaration on Human Rights. Article 13 of American Convention on Human Rights, which an international human rights instrument adopted in 1969, states that: "*Everyone has the right to freedom of thought and expression. This right includes freedom to seek, receive, and impart information and ideas of all kinds, regardless of frontiers, either orally, in writing, in print, in the form of art, or through any other medium of one's choice.*". Similarly, access to justice is recognised by many constitutions including Brazil, Bolivia, Portugal, Kenya, and so on, as a fundamental right. Article 42 of the Constitution of Russia states that: "*Everyone shall have the right to* . . . compensation for the damage caused to his or her health or property by ecological violations" [56]. Their adoption into environmental governance had been achieved by principle 10 of the 1992 Rio Declaration, which states that: "*Environmental issues are best handled with the participation of all concerned citizens ..... each individual shall have appropriate access to information concerning the environment*." Procedural rights are, therefore, human rights recognised by international treaties and national constitutionals.

Why are procedural rights important for environmental protection? Boyle and Anderson [5] states that procedural rights promise environmental protection essentially by way of democratic environmental governance because, as May [56] explains, they promote democratisation and concomitant rights to assemble, speak, and participate in governance. Lynn [57] highlights the importance of public participation in that ensuring public involvement is essential to defining the parameters of a problem, framing the questions that need to be answered, deciding what information needs to be generated, interpreting such information, and choosing among available public policy options and means of implementation. This results in, as Sax [58] argues, the most environmentally friendly decisions possible as the process enables concerned citizens to choose "what quality and quantity of natural resources we should be entitled to access". This remains a quite optimistic perspective, in that enjoyment of procedural rights may not always guarantee the most rational decisions in favour of the environment; ultimately, people may not perceive environmental benefits or benefit and cost of the decisions in a same way. For example, advocates of nuclear energy claim that NPPs are an environmentally friendly energy source due to negligible gas emissions in comparison to fossil fuel-fired power stations. In contrast, opponents claim that NPPs are the most dangerous form energy to the environment due to the generation of radioactive wastes. So, the question remains: what is the most environmentally-friendly decision for NPPs? Each decision can be disappointing or not environmentally-friendly for some groups, as depends on their particular set of values.

On the other hand, limiting participatory governance to only concerned citizens seem an overly narrow practice. As Rose-Ackerman and Halpaap [59] point out, a decision in participatory governance is taken by such diverse groups as citizens, NGOs, scientists and other experts. There is no lack in the controversy that surrounds this in particular due to issues of time management. If participants have diverse social, political and environmental goals or different environmental values, this would represent a considerable obstacle to making any rapid or immediate decisions on any given matter.

However, some environmental issues, such as nuclear accidents, require immediate action and quick response as radioactive contamination poses such a serious – indeed, potentially fatal – risk to human health. Another issue is that there is no fixed rule as to what extent, or at what level, the public should ideally be engaged. Public participation in each single decision can be financially costly and highly time consuming [57].

Another advantage of procedural rights is, Gellers and Jeffords [60] argue, that marginalised groups who face an unequal burden of environmental harm can forward their environmental and health concerns to other

people, organisations, and officials through active participation in environmental decision-making, which is taken such as diverse groups, and indeed this can act as an early warning system for public concerns. The literature commonly addresses the fact that procedural rights enable even the most disadvantaged groups within a society, who face distributive justice issues, to give voice to their concerns, to effectively monitor and hold their government to account, and to enter into informed dialogue regarding public authority decisions [61, 62]. In a similar sense, Lawrence et al. [63] states that procedural rights are a useful vehicle to reduce dissatisfaction with unfavourable decisions that result in distributive injustice. Indeed, distributive injustice is a visible moral issue in environmental matters, particularly nuclear incidents. All citizens benefit from the electricity generated by nuclear stations equally but those who live close to the station are always more vulnerable to a potential nuclear accident than people who live further away. They may, however, stay insufficient in addressing ecological and intergenerational justice issues as procedural rights do not guarantee any right to the non-human world and future generations that might also be at risk from the long-term consequences of nuclear accidents.

CONCLUSION

This paper has focussed on the scope and types of environmental human rights through an analysis of the related literature. Firstly, as has been reported above, environmental human rights are based on the connection between the environment and human rights. This relationship can be conceived in two different ways: the first, and most common, is that the environment has been considered a precondition of the realisation and enjoyment of human rights since the 1972 Stockholm Declaration; the second, and more recent, is that human rights are accepted as an effective means of addressing environmental issues that people suffer/witness, thus forcing public authorities to implement more sustainable environmental policies and to affect environmental decisions in favour of nature. From this perspective, it seems reasonable to say that EHRs are not the right to the environment for its own sake; rather, they are fundamental human rights of individuals (like the right to life and health) to environmental protection.

The second conclusion is that EHRs are of four different types, which include the right to the environment, constitutional rights, civil and political rights, and procedural rights. The right to the environment, which is guaranteed by more than 100 countries worldwide, implies that people have a fundamental right to a clean/safe/healthy environment. The second argument is that there is no need for a separate right to the environment because this is already a prerequisite of well-established and recognised human rights, such as the right to life and health; these are called constitutional EHRs. The third argument states that civil and political rights, such as the right to expression and protest, enable citizens to affect decision-making processes in an eco-friendly way. Lastly, procedural rights, which include the right to participation in decision-making processes, the right to have access to information, and the right to justice, can be an effective means of achieving the environmental protection that is essential to the realisation of human rights. These three types are, however, not alternatives to each other; rather, they are pieces of a puzzle whose ultimate aim is one of a truly safe environment.

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EFFECTS OF THIAMETHOXAM ON *VESPULA GERMANICA* (F.) (HYMENOPTERA: VESPIDAE)

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ABSTRACT

Damage of pesticides used in agriculture on non-target organisms (except honey bees) is not sufficiently considered and neglected. Studies showed that wild bees, like honey bees, were also affected by pesticides. Wild bee species should also be protected because of their importance in pollination and biological control and also in order to protect biodiversity. Effects of pesticides on wild bees should be investigated without delay and precautions should be taken to protect the generations of wildlife. In addition, while increasing the agricultural areas, habitat for wild pollinators should be established.

In this study, effect of Thiamethoxam, an agriculturally active agent in the neonicotinoid group, commonly used in agriculture fields, on the European wasp (*Vespula germanica*) was investigated. For this purpose, 2 molar carnation-flavored syrup in a petri dish was placed in a field where wild bees are frequent, and wild bees had got accustomed there. Trial doses were prepared with thiamethoxam dose commonly used in agricultural areas (15 ml/100 L water) and 50% dilutions of this dose (15.00, 7.50, 3.75, 1.87, 0.93, 0.46, 0.23, 0.12, 0.06 ml/100 L water) and fed in 2 molar syrup. Those who returned to the carnation petri dish after feeding were recorded at the 1st, 4th and 24th hours.

At the end of the study, bees fed with 15.00, 7.50, and 3.75 ml / 100 L doses of the pesticide all died. One hour after pesticide ingestion, 84.73% of the control group and 13.33% of the bees fed with 1.87 ml / 100L dose, were alive and returned to the syrup petri dish.

Keywords: Pesticide, Neonicotinoids, Thiamethoxam, *Vespula germanica*

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INTRODUCTION

Insects are important pollinators of wild flowers and cultivated plants [1, 2, 3]. The decline of pollinators, which are effective in crop production, in recent years has caused a concern in the field of international agricultural production due to the economic contribution and services they provide [4]. Without sufficient pollination, the source of many nutrients and critical food in the ecosystem will soon disappear [5]. In many countries, the diversity and number of wild pollinators in agriculture has decreased [6]. With the increase in agricultural and urban areas, the reduction of natural habitats and nutrient sources of wild bees is the biggest impact on the worldwide decrease of the wildlife population [7]. The living area of the wild pollinators is neglected while the agricultural land is increasing [8].

Pesticides are used to protect cultivated plants, but sometimes affecting off-target insects [9] and causing beneficial insects to be damaged and populations to be reduced [10]. In recent years, neonicotinoids are the most commonly used insecticides [11] and have become one of the causes of bee death worldwide at the onset of their use in agriculture [12].

Neonicotinoid insecticides have been identified in underground waters, off-target plants and bee products [13, 14]. Neonicotinoid residues in nectar and pollen areas are indicated as one of the potential factors that cause the decrease of bee populations [15]. It has been found that the bee populations exposed to thiamethoxam are more susceptible to decrease and disappear [16].

Almost all of the investigations on the toxicity of neonicotinoids on bees were carried out on the honey bee, *Apis mellifera* [17], because honey bees are frequently exposed to neonicotinoids [18].

It has been determined that other bee species are more susceptible to selective pesticides than *Apis mellifera* [19].

Very little information is available on the effects of neonicotinoids on predator insects which has an important role in the functioning and biological balance of the ecosystem [20]. In this study, effect of thiamethoxam, a widely used insecticide in the control of agricultural pests, on the European wasp (*Vespula germanica*) [21, 22], which is one of the most common wasps in Turkey and important for biodiversity were investigated.

MATERIALS AND METHODS

The main materials of the study were *Vespula germanica* and insecticide Thiamethoxam, belonging to neonicotinoid group, commonly used in agriculture fields [23]. Doses (15.00, 7.50, 3.75, 1.87, 0.93, 0.46, 0.23, 0.12, 0.06 ml/100 L water) were prepared by diluting 50% of the thiamethoxam dose (15.00 ml/100 L water) commonly used in agriculture, and were given to bees in 2 molar syrups.

Two molar carnation-flavored syrup was placed in a petri dish in an area where the wasps are frequent and the wasps were accustomed to it. Thorax and abdomen of the bees were marked with different water-insoluble colors [24].

Marked bees were collected in small plastic boxes, and healthy bees were separated after one hour. The bees were then fed with 5 microliters of 2M syrups with the different doses of the insecticide and were marked with different colors. The bees were kept in the dark and in the light each for 15 minutes and then they were released to the area where the petri dishes with the carnation fragrant syrups were kept. Observations were made after 1, 4 and 24 hours and the bees returning to the petri dishes were noted. Each observation lasted 30 minutes. By this way, the number of the visits of the bees fed with different doses and controls were recorded. Experiments were established in 3 replicates for each dose, with 15 bees per dose, with a total of 150 bees.

As a result of the experiments, the responses of the bees to different insecticide doses were determined by regression analysis.

RESULTS AND DISCUSSION

All the bees fed with the 15.00, 7.50, 3.75 ml / 100 L water doses of the pesticide died, so regression analyses were made with the results obtained with the other doses.

Relationship Between Dose and Return

After 1 hour of feeding with the pesticide, only 13.33% of the bees fed with the 1.87 ml / 100L water dose returned, while 86.67% of the bees in the control group returned. The regression graph of the relationship between the insecticide doses and returning bees is given in Figure 1.

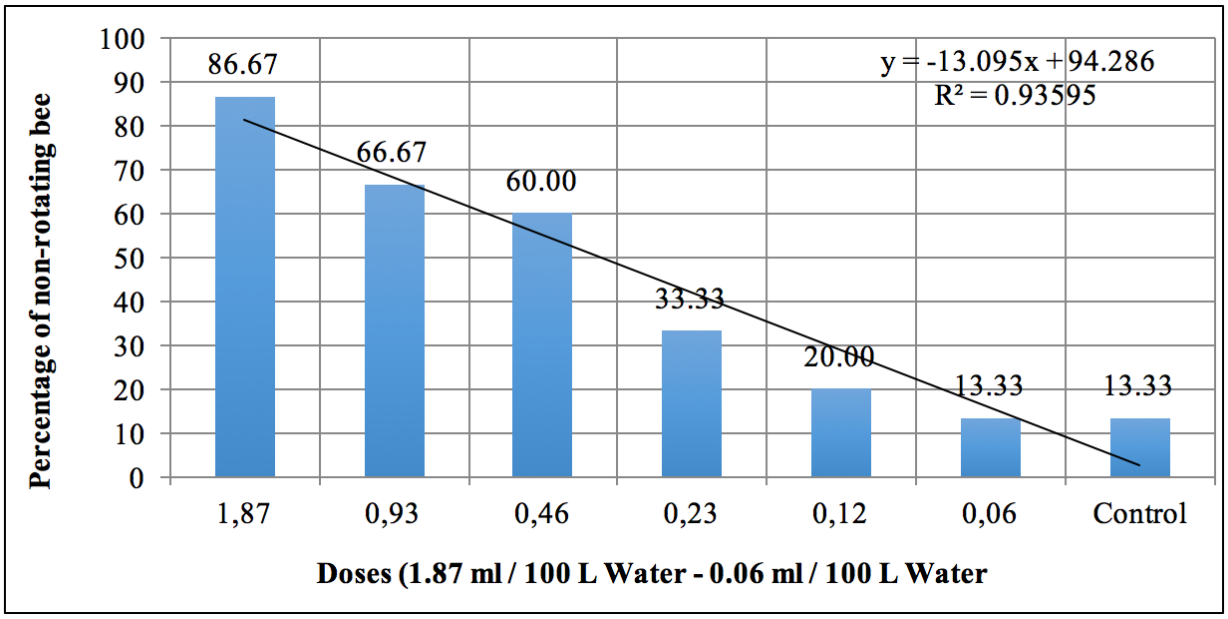

Figure 1. Relationship between the insecticide doses and rate of the bees which did not return one hour after feeding with the different doses of Thiamethoxam.

As can be seen in Figure 1, observations made at the end of the first hour showed a high correlation between the different doses of the chemical and the rates of the returning bees. The rate of the bees returned decreased with the increasing doses. The relationship was determined as $R^2 = 0.936$.

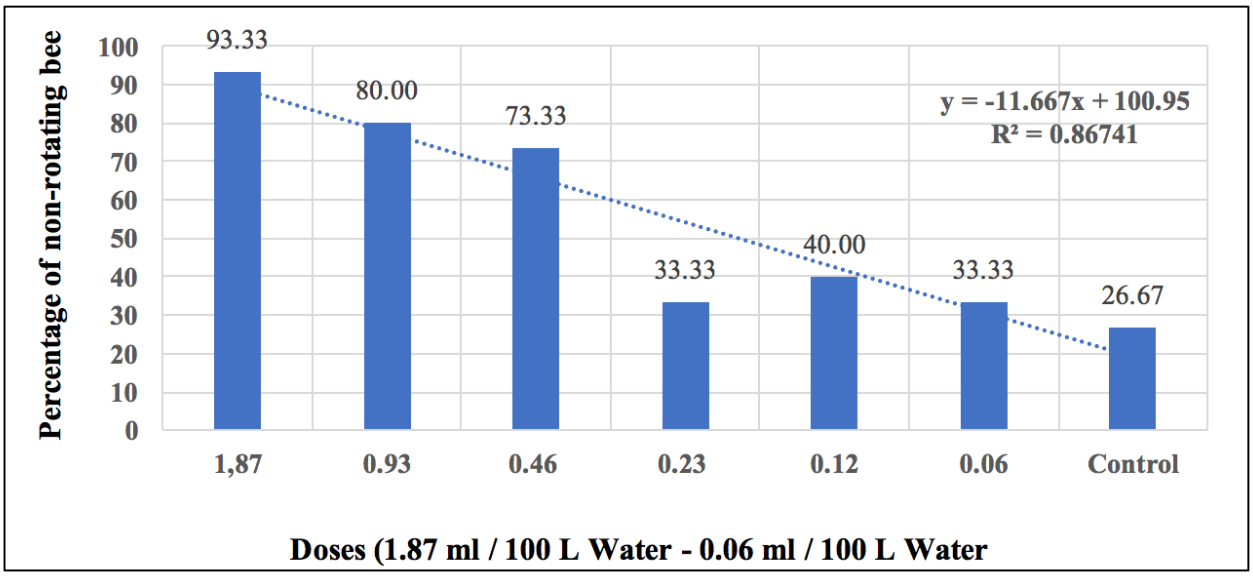

Figure 2. After 4 hour percentage of non-returning bees and regression graph.

In Figure 2, at the end of 4 hours, in Figure 3 at the end of 24 hours, graphs of the relationship between doses and percentage of non-returning bees were given.

At the end of 4 hours, 26.67% of the bees in control group and 93.33% of those fed with 1,87 ml/100 L water dose did not return. As the dose increased, the rates of returning bees decreased and the percent of the relationship was found to be $R^2 = 0.8674$.

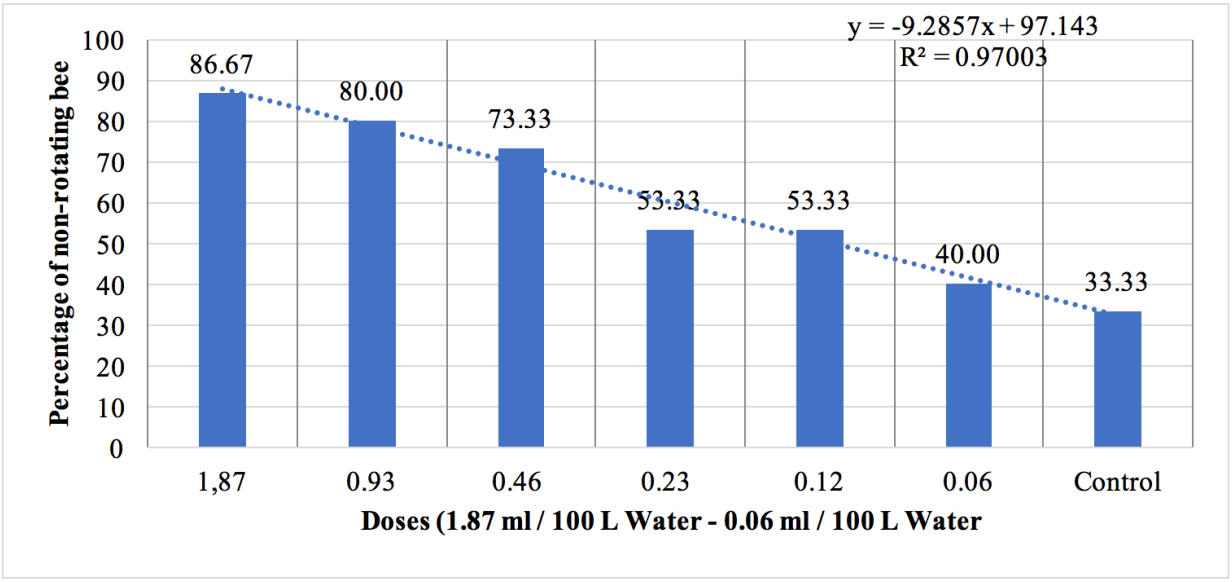

Figure 3. After 24 hour percentage of non-returning bees and regression graph.

As seen in Figure 3, at the end of 24 hours, 33.33% of the bees in control group and 86.67% of those fed with 1.87 ml / 100 L water dose of the pesticide did not return. The relationship between the rates of bees which did not return and insecticide doses was found to be quite high ($R^2 = 0.97$).

Relationship Between Dose and Number of Visits

In Figure 4, averages of the visits of the bees per half-hour observation period to the petri dishes containing carnation-flavored syrup were given. The number of visits of the bees fed with 1.87 and 0.93 ml / 100 l water doses of Thiamethoxam were rather low, while those of the bees fed with lower doses were similar with the ones in control group.

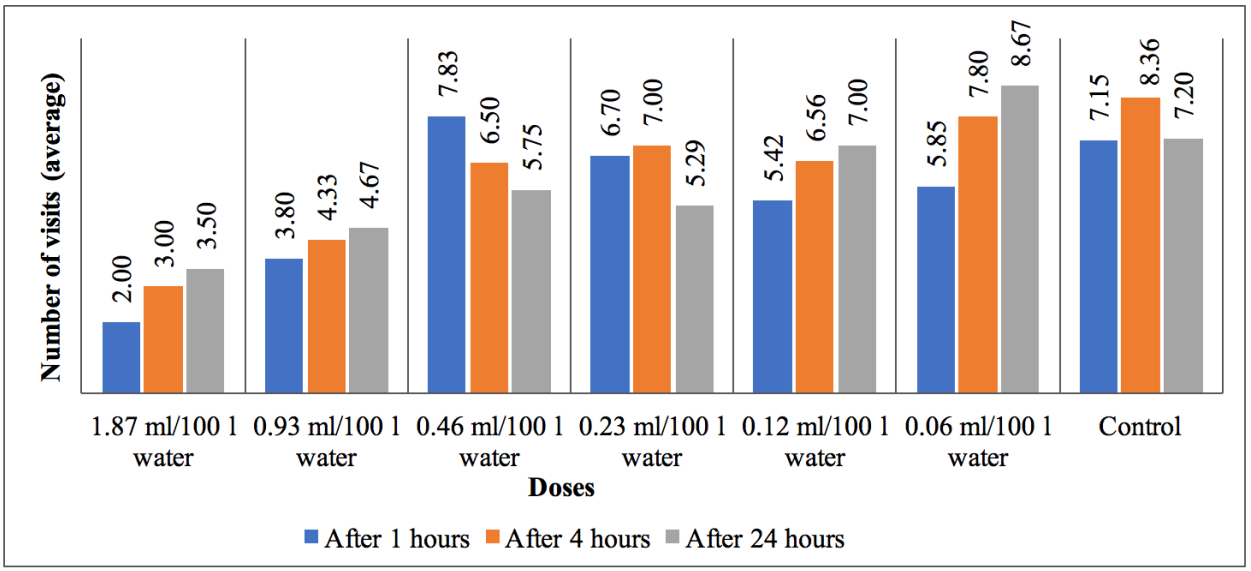

Figure 4. Depending on the dose number of visits (average).

Figure 5 shows the mean numbers of the visits to the petri dish, depending on the doses, at all observation times.

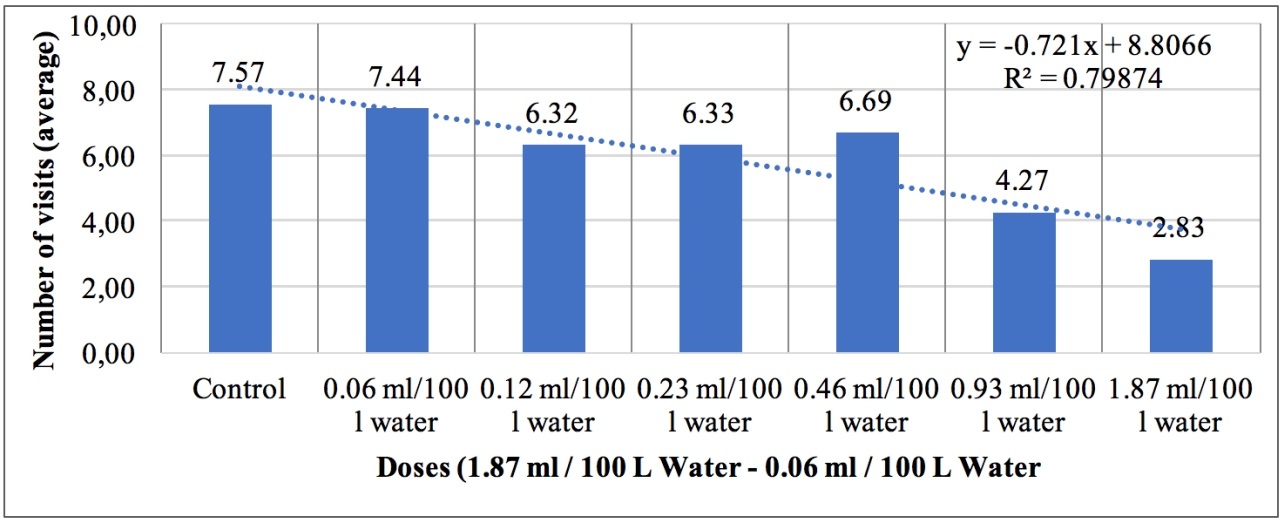

Figure 5. Average number of visits of the bees fed with different doses of Thiamethoxam.

The control group visited the petri dish by an average of 7.57 times, while those fed with the lowest dose of the pesticide (0.06 ml / 100 L water) visited the petri dish 7.44 times. The number of visits decreased as the dose increased except 0.23 ml / 100 L water and 0.46 ml / 100 L water.

CONCLUSION

All of the bees fed with the syrups prepared with the doses 15.00, 7.50, 3.75 ml / 100 L water of the thiamethoxam active ingredient which is commonly used in agriculture, died. The rates of the bees returning to the petri dish and the number of visits varied after 1, 4 and 24 hours, in the other doses. The rates of returning bees showed a linear decline depending on the insecticide dose and the wild bees were found to be affected from thiamethoxam even with the lower doses used in pest control. Similarly, when all observation times were evaluated together, the number of syrup visits of the bees showed a similar pattern.

Since there was no similar study on *Vespa germanica*, the literature information of other bees was taken into consideration in the discussions. In recent years there is an increasing concern about the possible effects of neonicotinoid pesticides on non-target species [25]. In a study investigating neonicotinoid residues in 198 honey samples collected all around the world, it was found that 75% of the samples contained at least 1, 45% of at least 2 and 10% of them contained 4 or 5 different neonicotinoid residues [26]. In a study conducted in 2016, the field where the neonicotinoid medicated oilseed crops were cultivated and the 45 plant species around this area were examined and an average of 10 ng / g neonicotinoid residue was found. Among the concentrations determined, the highest level belongs to thiamethoxam in *Cirsium vulgare* with 106 ng / g. [27]. It can be mentioned as a result that wild bees or pollinators are very likely to meet with pesticide residues, and that bees and other pollinators take pesticide residues together with food, like human.

Nowadays, the importance of natural pollinators has become more and more evident. As the decrease in pollinators means a decrease in product yields, there is concern that this may lead to a "pollination crisis" [28].

Vespa germanica, a species of natural predator and also a wild pollinator [29, 30], is found in almost all regions of our country [31, 32, 33, 34]. Both the findings of our research and the literature on similar topics suggested that frequent and widespread use of neonicotinoid agrochemicals may lead to environmental pollution as well as an important ecological and economic problem.

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Research Article

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INTEGRATED ASSESSMENT OF IRRIGATION WATER QUALITY BASED ON HARRINGTON'S DESIRABILITY FUNCTION

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ABSTRACT

It was proposed the integrated approach to the irrigation water assessment as its quality index IWQI. This criteria is united the quantitative assessment of different risks such as soil sodicity, plant toxicity, biofilm formation in drippers of irrigation systems etc. It is proposed to combine agronomic, ecological and technological requirements to the irrigation water using a generalized Harrington's desirability function (HDF). Within the framework of this concept, it was developed the scales of particular HDF for physico-chemical indicators, SAR values, and the Stebler's irrigation coefficient. IWQI was determined for the assessment of water quality for irrigation purpose on the examples of 3 dug wells located on the Agronomic Experimental station of National University of Life and Environmental Sciences of Ukraine (Pshenichne village, Kiev region). It is shown that water quality varies considerably (from 56 till 85%).

Keywords: Irrigation, Water Quality Index (IWQI), Harrington's Desirability Function, Physical-Chemical Parameters

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INTRODUCTION

Global climate change requires reviewing the approaches to irrigated agriculture using. In particular, irrigation is assessed as a mitigation factor potentially reduced the impacts of climate change on agriculture by about 40% [1]. Therefore, the environmental and land reclamation assessment of natural waters should be comprehensive, taking into account the soil-climatic conditions of the irrigation zone, the physiological features of agricultural crops and the requirements of the functioning of the technical means of the irrigation system.

The concept of the generalized water quality assessment in the form of so-called Water Quality Index (WQI) has been proposed by R. Horton in 1965 [2]. During last decades this idea was significantly improved and expanded [3-6]. WQI modifications has been accepted as regional or state standards of complex water assessment in the Great Britain, USA, Canada, India, Poland. The comprehensive review of the WQI concepts, its application included classification, analysis of methodological collisions, applied computer software, and WQI using for monitoring and simulation of water resource quality dynamics for the sustainable development was made by Abassi and Abassi [7]. Simsek and Gunduz [8] proposed GIS-integrated irrigation water assessment in the form multi-parametric irrigation water index IWQ. Authors used the linear combination of the parameters determined the different kinds of irrigation risks for soils and plants and subdivided the water quality into three groups. Sutadian et al. [3] pointed on the methodological problems of WQI using as a water assessment technique: (i) there is no unified step-by-step strategy of WQI development; (ii) most WQIs are designed for a specific region or separated biocenosis (objects with an individual set of hydro-chemical, hydrological characteristics); (iii) random choice of parameters, their weighting factors, procedure of sub-indices generating, etc.

Agronomic, soil, environmental requirements to irrigation water quality and, as a result, the demand to irrigation projects are a subject of intensive discussions [9, 10]. Thus, agronomic criteria focus on indicators that should ensure the quantitative and qualitative composition of the

crop and not cause soil degradation (salinity, sodicity, infiltration, gas disruption, oxidation-reduction potential). To do this, it is necessary to monitor water temperature, the pH, the electrical conductivity, the total mineralization, mineral matrix composition (Na^+, K^+, Mg^{2+}, Ca^{2+}, HCO_3^- + CO_3^{2-}, Cl^-, SO_4^{2-}), the nutrient elements contents (NH_4^+, NO_3^-, NO_2^-, PO_4^{3-}, C_{org}, P_{org}), trace elements and toxicants (B, Cu, Zn, Mo, F, Co).

MATERIALS AND METHODS

Water Sources

Mainly, the rural areas in Ukraine are supplied of local water sources for human and animal consumption, and irrigation [11]. Three boreholes situated on the territory adjoining to the Agronomic Experimental station of National University of Life and Environmental Sciences of Ukraine (Pshenichnoe village, Kiev region) were determined for experimental assessment of its water quality for irrigation purposes:

Object # 1 – 50°05′45.8′′N, 30°12′22.4′′E (50.096043, 30.206210);

Object # 2 – 50°05′43.2′′N, 30°12′25.9′′E (50.095322, 30.207190);

Object # 3 – 50°05′30.2′′N, 30°12′29.8′′E (50.091724, 30.208282).

Sampling was done in September, 2017. Monitoring design was made due to the EPA recommendations [12].

Chemical Analysis

The water quality parameters were measured in the Measuring laboratory of surface, underground waters and wastes of Analytical and Bio-inorganic Chemistry & Water Quality Department, which is the structural subdivision of Ukrainian Laboratory of Quality and Safety of AIS Products of National University of Life and Environmental Sciences of Ukraine (certificate of approval No TÜB Lab-01).

RESULTS AND DISCUSSION

It is proposed to combine agronomic, ecological and technological requirements to the irrigation water using a generalized Harrington's desirability function (HDF) [13]. On our opinion, this conception is very similar to the WQIs, but more flexible and may be adapted to any kind of water consumption/nature of water sources (surface, underground).

Within the framework of this concept, it was developed the scales of particular HDF d_i for physico-chemical indicators, SAR values, and the Stebler's irrigation coefficient (Table 1).

In accordance with recognized procedures [9, 14] it was calculated SAR coefficient (Table 2) and Stebler's irrigation coefficient (Table 3).

Table 1. Scale for particular d_i assessment

i	Parameters	Units	Values of particular d_i				
			1,00…0,80 Very good	0,80…0,63 Good	0,63…0,37 Satisfactorily	0,37…0,20 Badly	0,20…0,00 Very badly
1	Salinity	mg/L	320-480	481-1000 150-319	1001-3500 100-149	3501-5000 80-99	5001-10000 0-79
2	Temperature	Celsius degree, ºC	21-16	12-15 22-24	9-11 25-28	7-9 29-31	0-8 32-45
3	pH	pH units	6,9-7,0	6,5-6,8 7,1-7,5	6,1-6,4 7,6-8,5	5,5-6,0 8,6-9,0	3,5-5,4 9,1-11,0
4	Iron total	mg/L	0-0,05	0,06-0,20	0,21-1,00	1,01-5,00	5,01-90,000
5	Turbidity	NTU	0-5	6-10	11-50	52-200	201-5000
6	SAR	-	2,0-3,0	1,5-1,9 3,1-6,0	1,2-1,4 6,1-12,0	0,9-1,1 12,1-20,0	0,1-0,8 20,0-40,0
7	Stebler's irrigation coefficient K_C	-	25,0-18,0	17,9-6,0	5,9-4,0	3,9-1,2	1,1-0,2
8	Boron	mg/L	0-0,4	0,4-1,0	1,1-2,0	2,1-5,0	5,0-30,0
9	Nitrogen nitrates, N-NO_3	mg/L	0-4	5-15	16-20	21-30	30-1000

Table 2. SAR calculation

# object	Total hardness (Ca+Mg), mmol/L	Ionic composition, mmol/L					Salinity, mg/L	PK_2-PK_0	P(Ca+Mg)	P_{Alk}	pH_c	SAR
		Na^+	Cl^-	SO_4^{2-}	HCO_3^-	$Ca^{2+}+Mg^{2+}+Na^+$						
1	29,30	1,56	9,35	1,52	19,99	30,86	2039	2,41	1,90	2,70	6,01	1,38
2	12,37	2,03	3,22	0,18	11,00	14,40	917	2,31	2,20	1,95	6,46	2,40
3	10,81	2,64	0,96	0,13	12,36	13,45	618	2,30	2,30	1,90	6,20	3,63

Table 3. Stebler's irrigation coefficient calculation

# object	Ionic composition, mmol/L			Relation between rNa, rCl, and rSO_4	Formula of Stebler's irrigation coefficient K_C	K_C
	Na^+	Cl^-	SO_4^{2-}			
1	1,56	9,35	1,52	$rNa < rCl$	$288/5rCl$	14,1
2	2,03	3,22	0,18	$rNa < rCl$	$288/5rCl$	6,2
3	2,64	0,96	0,13	$rNa > (rCl+rSO_4)$	$288/(10rNa - 5rCl - 9rSO_4)$	17,9

The procedure of mathematical transformation of measured natural parameters into d_i [13], is made as for the parameters of so-called "one-side" limitation:

$d_i = \exp(-\exp(-x_i))$, $0 \le d_i \le 1$,

where x_i is coded value of i-parameter (i=4, 5, 7, 8, 9, Table 1). These parameters are limiting as "less is better", or having "maximum permissible concentration" (MPC).

If executing parameter is limited as optimum field (having "two-side" limitation), it is transformed as:

$d_i = \exp[-(x_i)^n]$, where n – any positive figure $(0 < n < \infty)$ (i=1, 2, 3, 6, Table 1).

This scale permits to transform any physical parameter in dimensionless entity expressed in psychophysical terms – "very good", "good", "satisfactorily", "badly", and "very badly".

So, the physical values of measured parameter are translated as the functions to a common scale [0, 1] (Table 4), combine them using the geometric mean (generalized HDF d_Σ): $d_\Sigma = \sqrt[9]{\prod_1^9 d_i}$.

So, results of integrated assessment of water quality for irrigation purposes demonstrate the significant variability – from 56,61 % - "satisfactorily" (object #1) till 85,17 % - "very good" (object #3). It means that the underground waters have different degree of suitability. Analyzing particular d_i, it is clear that the critical parameter dramatically decreasing water quality of object #1 is the nitrates pollution.

Table 4. Transformation of measured parameters into particular d_i and generalized HDF d_Σ

# water source	Measured values of water quality parameters									Generalized HDF d_Σ
	Salinity, mg/L	Temperature, °C	pH, units	Iron total, mg/L	Turbidity, NTU	SAR	Stebler's irrigation coefficient K_C	Boron, mg/L	Nitrogen nitrates, N-NO_3, mg/L	
1	2039	21	7,25	0,049	1	1,38	14,1	< 0,05	35,3	
2	917	20	7,30	0,075	1	2,40	6,2	< 0,05	3,8	
3	618	18	6,95	0,060	1	3,63	17,9	< 0,05	4,8	
	Values of particular d_i									
1	0,3902	1,0000	0,7920	0,8010	0,9845	0,3805	0,7437	0,9998	0,1530	0,5661
2	0,6480	0,9998	0,7837	0,7528	0,9845	0,9162	0,6506	0,9998	0,8137	0,8085
3	0,7425	1,0000	0,9892	0,8000	0,9845	0,7480	0,8000	0,9998	0,8000	0,8517

CONCLUSION

Analysis of the assessment principles of water quality for irrigation was done. It was shown that there is no standardized method because existing approaches evaluate the risks of different nature – for plants, soils, or the water supply network. It was proposed to unite agronomic, environmental, and technician requirements to water quality in the form of the united Harrington's desirability function. In the framework of this conception it was developed the scales of the partial desirabilities for physical-chemical parameters, values of sodium-absorption ratio SAR, Stebler's irrigation coefficient. On the example of the three dug wells which are situated near Agronomic Research station (Pshenychne Village, Kyiv Oblast) use of the developed method was demonstrated. It has been established that water quality varied significantly within the study area. The quantitative assessment ranged from 56 till 85 % in terms on requirements of irrigation. The same methodology should be developed for water, which is used for foliar dressing, which often takes place simultaneously with irrigation.

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