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Research article/Araştırma makalesi

Phenological and visual evaluations of some roadside deciduous trees in urban area

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Abstract

Landscape has been referred to ecologically as a patch-corridor-matrix. Road corridors are not only significant in contributing to the urban landscape, but are also of great importance from an ecological point of view. Under pressure from increasing urban population, the density of urban open green areas is diminishing. In urban spaces, plantings along roadside corridors provide a very important positive effect on this density. The main objectives of this study were to identify the morphological changes in some deciduous roadside trees, and to use images of urban roadside plantings of different species, ages and seasonal change potential to identify the visual effects they had on urban motorists. In order to realize these aims, firstly, a number of deciduous trees were observed over a six-year period to determine their morphological changes. Secondly, seasonal changes of *Platanus orientalis* L. (oriental plane), *Aesculus hippocastanum* L. (horse chestnut), *Liriodendron tulipifera* L. (tulip poplar) and *Acer negundo* L. (boxelder maple) along urban roadsides were photographed over each of the six years. These images were then subjected to a preliminary survey in order to evaluate the questionnaire. The survey itself was conducted in two stages. In the first stage, the images of the trees were evaluated according to the years in order to determine visual preference levels. In the second stage, they were assessed according to seasonal changes in order to define visual quality levels. Consequently, the preference and visual quality levels of the images of the roadside trees as they affected urban motorists were identified and the phenological changes of the trees were determined.

Key words: plant phenology, visual determinations, roadside plantings, deciduous trees

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Kentsel alanlardaki yaprak döken bazı yol ağaçlarının fenolojik ve görsel açıdan değerlendirilmesi

Özet

Peyzaj ekolojik olarak leke-matris-koridor kavramalarının referansı ile ifade edilir. Yol koridorları kentsel ortamların sadece ekoljik değil aynı zamanda görsel durumun da katkı sağlayan önemli kentsel yapılardır. Kentler artan nüfüs bakımından açık ve yeşil alanların sıklığı yönünden baskı altındadır. Yol kenarı bitkilendirmeleri bu sıklık üzerinde olumlu yönde önemli katılar sağlamaktadır. Bu çalışmanın temel amacı; yol kenarındaki bazı yaprak döken bitkilerin morfolojik değişimlerinin neler olduklarını belirlemek ve bu ağaçların yolu kullananlar üzerindeki görsel etkilerini mevsimsel değişim ve yaşlara göre değişim yönünden ele almaktır. Bu amaçların gerçekleştirilmesi için; ilk aşamada morfolojik değişimlerini belirlemek için bu ağaçlar altı yıl boyunca gözlemlenmiştir. Ikici aşamada altı yıl boyunca ve mevsimsel değişimleri fotoğraflanan bu ağaçlar (*Platanus orientalis* L., *Aesculus hippocastanum* L., *Liriodendron tulipifera* L. and *Acer negundo* L.) yol kenarı boyunca fotoğraflanmıştır. Daha sonra, fotoğraflar ankette değerlendirmek için ön elemeye tabi tutulmuştur. Anket çalışması iki aşamada gerçekleştirilmiştir. Ilk aşamasında fotoğrafların yıllara göre beğeni düzeylerini belirlemek için yapılırken, ikinci aşamasında ise mevsimsel değişimlerin görsel tercih ve kalite düzeylerini belirlemek üzere değerlendirmeler yapılmıştır. Sonuç olarak bu çalışma ile, yol kenarında bulunan bazı yaprak döken ağaçların görsel kalite ve beğeni durumları ve ağaçalrın fenolojik değişimleri belirlenmiştir.

Anahtar kelimeler: bitki fenolojisi, görsel tanımlamalar, yol kenarı bitkilendirmeleri, yaprak döken ağaç

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1. Introduction

Most trees in cities or along roadsides are planted to provide beauty or shade. People derive various benefits from plants in urban areas (Ulrich, 1984; Kaplan, 1992; Ulrich and Parsons, 1992). In addition to these excellent benefits, woody plants serve many other purposes, including contributions to health (Ulrich, 1984) and psychological well-being (Hull, 1992; Radley, 1997; Stoneham, 1997).

Much of the time, the physical benefits of roadside trees (Givoni, 1991; Scott et al., 1999) encourage social interaction between nature and people (Coley et al., 1997). Human response to trees goes well beyond simply observing their beauty. There is a feeling of serenity, peacefulness, restfulness, and tranquillity in a grove of trees. This study has shown that areas with greener surroundings draw residents to interact with nature. A view of trees from the car gives drivers a greater sense of well-being and satisfaction with their surroundings. People even tend to drive more slowly on tree-lined streets; thus, driver behaviour is positively influenced. The soothing effect of nearby trees and urban green can significantly reduce workplace stress levels and fatigue, and calm down traffic. Recent research has shown that the visual beauty and sensual enhancement of trees elevate moods and improve mental and physical health.

Several authors have reported that vegetation receives priority in the list of qualities and positive effects of naturalistic roadways, with greater appreciation expressed for freeway roadsides which have trees (Antupit et al., 1996; Kent, 1993; Parsons et al., 1998; Wolf, 2003). In addition, plant species, and especially trees, have contributed to the goal of urban biodiversity, which is to realize the variety and sustainability of the ecological framework for urban environments (Gürcan and Düşen, 2015).

With the ever increasing use of roads for transportation in modern life, roadside vegetation has become one of the major elements of the roadside environment. Trees can be used to provide several aesthetic functions for motorists, including providing visual accents, complementing the architectural style of the buildings, and providing visual delight by means of attractive forms, texture, and colours.

This study presents the results of a questionnaire survey of motorists on their opinions of roadside vegetation over the four seasons of a six-year period and on their perceptions of the scenic value of roadside vegetation.

For the integration of scenic beauty into roadside vegetation management programs, it is necessary to record the opinions and preferences of the motorists who are the actual targets in all roadside beautification plans. This information would be helpful in analysing the status in the public eye of roadside vegetation over the different seasons in order to achieve its effective application and management. The basic objective setup for this study was to assess the scenic value of roadside plantings in Düzce, Turkey, by collecting and analysing the views of motorists, and to learn what kind of vegetation they would like to see on the roadsides.

This study had the following objectives.

- To observe morphological changes on diameter at breast height (DBH), height and canopies of deciduous trees.
- To identify the visual effects of roadside trees according to their ages, species and seasonal changes.
- To determine the effects of participant demographic characteristics on their visual preferences and perception of the roadside plantings of Düzce.

To understand the relation between phenological and visual assessment of trees.

2. Materials and methods

1.1. Study area

The study was carried out on the main roadsides around the city of Düzce. The province of Düzce, is located between the 400 40′ – 400 47′ north altitude and 310 21′ – 310 26′ east longitudes, and is situated in north-western Turkey in the Black Sea Region (Eroğlu et al., 2012) (Figure 1).

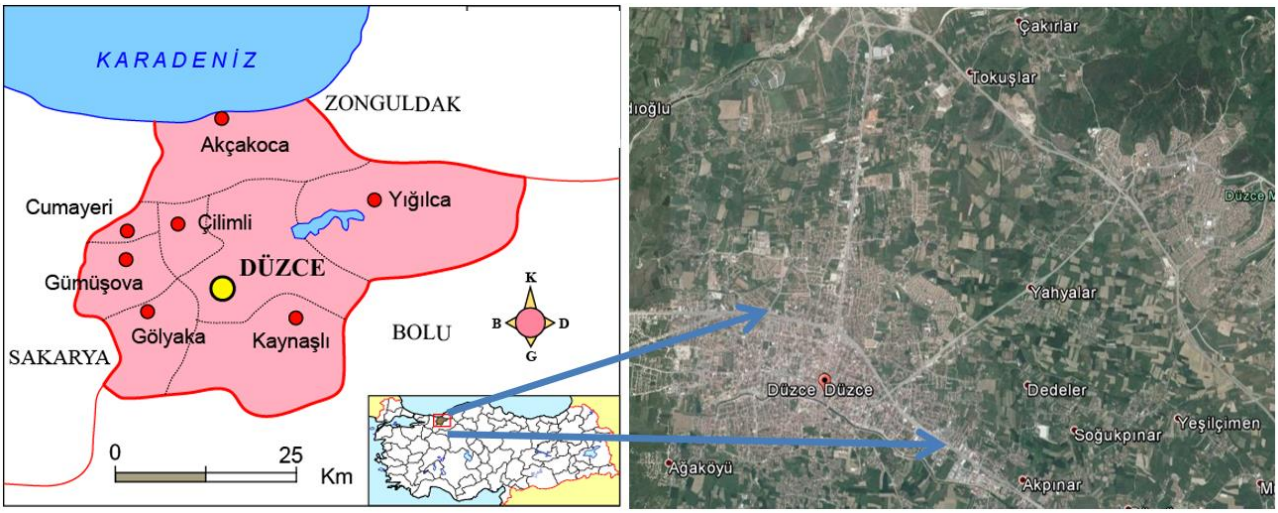

Figure 1. Study area

1.2. Materials

The trees along the main road of Düzce comprised the chief material of the study. The main road runs for about 5 km between the old area and the new residential area constructed after the 1999 earthquake. The repetition method of solitary plantings was used along the road corridor. The trees observed on the roadside were all the same age at the start of the study. The photographs of trees used as the questionnaire material included *Acer negundo* L. (photo nos. 1-6 in Figure 2 and nos. 1, 5, 9, and 13 in Figure 3), *Aesculus hippocastanum* L. (photo nos. 7-12 in Figure 2 and nos. 2, 6, 10, and 14 in Figure 3), *Platanus orientalis* L. (photo nos. 13-18 in Figure 2 and nos. 3, 7, 11, and 15 in Figure 3), and *Liriodendron tulipifera* L. (photo nos. 18-24 in Figure 2 and photo nos. 4, 8, 12, and 16 in Figure 3).

1.3. Phenological observations of the morphological changes of the species:

Plant phenology is a main indicator of climate change, as well as a driver of global climate via changes in the carbon, energy and water cycles (D' Odorico, et al., 2015). In this study, plant phenology dealt with the contributions of the visual assessment of trees. In order to achieve this, deciduous trees were observed over a 6-year period between 2009 and 2014 wıth regard to their morphological changes (Rutishauser et al., 2008; Orsenigo et al., 2014) including those of height, canopy and diameter.

1.4. Visual assessment of the species:

This study consisted of a two-stage method. The survey was carried out at each stage by using tree photos (Eroğlu et al., 2012; Acar et al., 2007; Müderrisoğlu et al., 2006; Müderrisoğlu and Eroğlu, 2006). In the first stage (Survey 1), the photos showing trees of different ages and representing all species including *Platanus orientalis* L. (oriental plane), *Acer negundo* L. (boxelder maple), *Liriodendron tulipifera* L. (tulip poplar), and *Aesculus hippocastanum* L. (horse chestnut) were used to determine the most effective visual quality for the age of each tree (Figure 2). In the second stage, those trees identified as the most visually effective were evaluated (Survey 2) with regard to their seasonal changes (Figure 3).

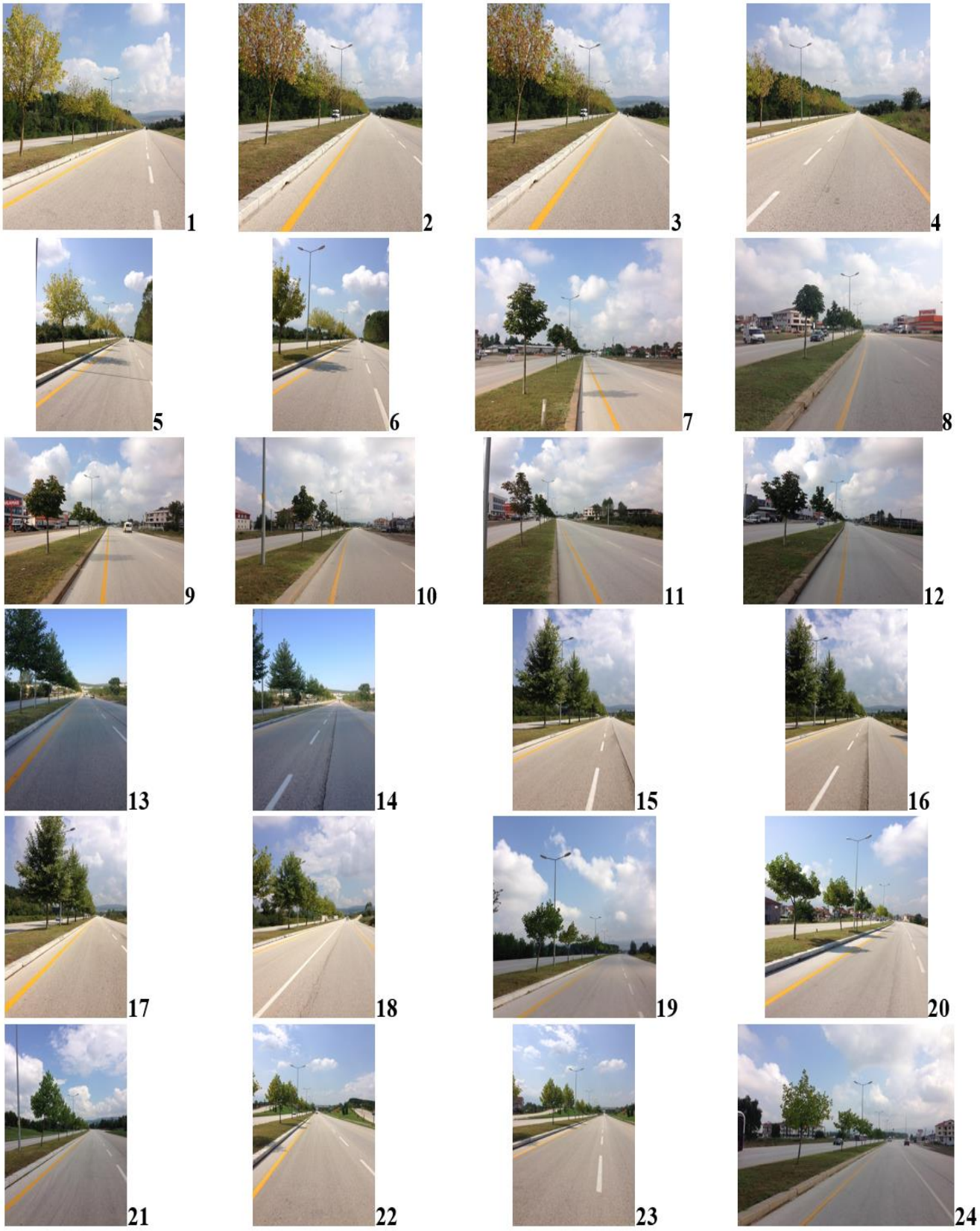

Figure 2. Tree photos used in survey 1.

Figure 3. Tree photos used in survey 2.

In each questionnaire, determining adjective pairs were given to the subjects for the evaluation (Acar et al., 2003). These adjective pairs were selected in a way to indicate the differences between the ages and the seasonal changes in the trees. They included "depressing-refreshing", "ordinary-interesting", "nondescript-eye-catching", "inadequate-adequate", "unpretentious-ostentatious", "simple-complex", "boring-soothing", "disturbing-reassuring" and "unaesthetic-aesthetic". In the questionnaire, each determined adjective pair was evaluated on a 5-point scale as -2,-1, 0, 1, 2. In order to simplify the process, the data were entered into the computer as values of 1, 2, 3, 4, and 5 (Eroğlu et al., 2012). For instance, if a photo received a score of (-2) for "simple-complex", it meant that this photo was perceived more as "simple".

In the statistical analysis, correlation analysis was used in the seasonal evaluation of the adjectives and in the determination of the socio-economic differentiation. In addition, descriptive statistics were produced to determine the demographic and utilisation values of the road according to the tree photos.

3. Results

1.1. Phenological results of the morphological changes of the species

According to Table 1, the DBH of *Aesculus hippocastanum* increased by about 2.3 times over the six years and its canopy grew about 2.6 times larger, while its height rose from 324.15 cm to 347.06 cm during this time. The DBH of *Acer negundo* increased by about 2.4 times during the six years and its canopy grew about 3.9 times larger, while its height rose from 350.22 cm to 410.36 cm. The DBH of *Liriodendron tulipifera* increased by about 3.01 times during the six years and its canopy grew about 4.03 times larger, while its height rose from 302.75 cm to 329.12 cm. The DBH of *Platanus orientalis* increased by about 3.66 times over the sıx years and its canopy grew about 4.15 times larger, while its height increased from 549.51 cm to 649.86 cm.

Table 1. The morphological changes of the species

Aesculus hippocastanum	**Mean (cm)**		**Mean (cm)**		**Mean (cm)**
2009- DBH	3,75	2009-Canopy	79,21	2009-Size	324,15
2010- DBH	4,13	2010-Canopy	92,46	2010-Size	326,42
2011- DBH	4,66	2011-Canopy	111,92	2011-Size	328,75
2012- DBH	5,33	2012-Canopy	135,50	2012-Size	330,21
2013- DBH	6,09	2013-Canopy	161,83	2013-Size	332,79
2014- DBH	8,78	2014-Canopy	205,64	2014-Size	347,06
Acer negundo					
2009- DBH	3,92	2009-Canopy	73,36	2009-Size	350,22
2010- DBH	4,56	2010-Canopy	94,15	2010-Size	355,11
2011- DBH	5,43	2011-Canopy	124,82	2011-Size	363,07
2012- DBH	6,53	2012-Canopy	160,43	2012-Size	371,38
2013- DBH	8,06	2013-Canopy	212,62	2013-Size	383,96
2014- DBH	9,56	2014-Canopy	283,95	2014-Size	410,36
Liriodendron tulipifera					
2009- DBH	2,57	2009-Canopy	60,17	2009-Size	302,75
2010- DBH	3,21	2010-Canopy	81,01	2010-Size	303,43
2011- DBH	4,05	2011-Canopy	105,28	2011-Size	305,63
2012- DBH	5,04	2012-Canopy	137,43	2012-Size	313,51
2013- DBH	6,53	2013-Canopy	182,50	2013-Size	317,36
2014- DBH	7,76	2014-Canopy	242,69	2014-Size	329,12
Platanus orientalis					
2009- DBH	3,65	2009-Canopy	85,61	2009-Size	549,51
2010- DBH	4,65	2010-Canopy	116,16	2010-Size	559,12
2011- DBH	5,96	2011-Canopy	153,84	2011-Size	571,38
2012- DBH	7,71	2012-Canopy	205,47	2012-Size	577,76
2013- DBH	10,44	2013-Canopy	266,78	2013-Size	600,93
2014- DBH	13,39	2014-Canopy	353,68	2014-Size	649,86

1.2. Survey 1

The demographic statistics of the survey participants are shown in Table 2. According to this, 53.9% of the participants were male and 46.1% female, and they were aged 18-27 (24.1%), 25-34 (27.9%), 35-44 (20%), 45-54 (14%) and 55+ (14%). In addition, 40% of the participants were single and 60% married. Their education levels were reported as graduates of elementary school (20%), high school (40%) and university or faculty (40%). Their employment data included those who were unemployed (16%), officers (31.9%), labourers (14.0%), students (10.1%), self-employed (6.0%), homemakers (8.0%) and retired (14.0%).

Scores for photos used for Survey 1 are shown in Table 3. According to the high and low scores, photos were selected from these for Survey 2. Thanks to the arithmetic means of the visual values of the roadside tree photos, the second step of the survey was realised by using the high scores of the visual values.

Table 2. Descriptive statistics of participants in survey 1

	(%)		**(%)**		**(%)**
Gender		**Occupation**		**Education**	
Male	53,9	Unemployed	16,0	Illiterate	-
Female	46,1	Officer	31,9	Literate-no education	-
Age		Laborer	14,0	Elementary school	20,0
18-27	24,1	Student	10,1	High school	40,0
25-34	27,9	Self-employed	6,0	College or faculty graduate	40,0
35-44	20,0	Homemaker	8,0	**Marital status**	
45-54	14,0	Retired	14,0	Single	40,0
55+	14,0	Farmer	-	Married	60,0
		Other	-		

Table 3. Means of the adjective pairs according to photo numbers in survey 1

Photo number	depressing-refreshing	ordinary-interesting	nondescript -eye-catching	inadequate-adequate	umpretentious-ostentatious	simple-complex	boring- soothing	disturbing-reassuring	unaesthetic-aesthetic
1	3,76	3,68	3,90	2,92	2,92	2,22	2,64	2,78	2,96
2	3,08	2,30	2,98	2,92	3,04	2,66	2,80	2,94	3,04
3	3,88	3,04	3,02	2,90	3,04	2,68	2,82	3,76	3,06
4	3,82	3,76	3,80	3,68	3,84	3,46	3,74	3,66	3,82
5	3,24	3,12	3,16	3,78	3,84	3,38	3,78	3,82	3,82
6	3,84	3,82	**4,68**	3,72	**4,62**	3,40	4,06	3,94	3,98
7	2,82	**2,12**	**2,16**	**2,16**	2,20	**1,84**	2,24	**2,14**	2,22
8	2,88	2,18	3,04	**2,16**	2,22	2,16	**2,18**	3,00	2,28
9	**2,18**	2,98	2,96	2,84	2,20	1,94	2,22	2,98	**2,20**
10	2,26	2,96	3,76	2,18	2,94	2,68	2,94	3,08	3,02
11	2,34	3,84	3,78	2,94	3,00	2,56	3,10	3,82	3,04
12	3,06	3,78	2,54	3,00	3,72	2,80	3,08	4,02	3,96
13	4,42	3,06	3,02	2,90	3,00	2,40	3,48	3,30	3,02
14	**4,48**	3,12	3,04	3,02	3,02	2,80	3,04	3,50	3,22
15	3,88	3,12	3,12	2,28	3,10	2,78	3,26	3,48	3,90
16	3,94	3,90	3,94	4,62	3,90	3,36	3,80	4,02	4,00
17	3,28	3,88	3,94	3,76	3,90	3,40	**4,42**	4,10	4,62
18	3,98	**4,64**	**4,68**	**4,64**	3,94	**3,48**	**4,42**	**4,62**	4,54
19	2,94	2,26	3,00	2,18	2,20	1,88	2,24	2,38	2,50
20	3,84	3,08	2,22	**2,16**	**2,16**	2,14	3,00	2,42	3,18
21	3,88	3,04	2,98	2,98	2,18	2,08	2,96	2,42	3,20
22	3,88	3,08	2,20	2,92	2,96	2,68	3,12	3,10	3,96
23	3,92	3,88	3,10	3,74	3,06	2,84	3,44	3,08	4,06
24	3,84	3,86	3,16	3,82	3,22	2,98	4,28	3,44	**4,64**

1.3. Survey 2

In Table 4, the demographic statistics of the survey participants are shown. According to this, 56% of the participants were male and 44% female, and they were aged 18-27 (22%), 25-34 (26%), 35-44 (18%), 45-54 (18%) and 55+ (16%). In addition, 42% were single and 58% married. Their education levels included elementary school (16%), high school (42%) and college or faculty (42%) graduates. Employment data included those who were unemployed (18%), officers (28%), labourers (14%), students (16.1%), self-employed (4%), homemakers (6%), and retired (13.9%). In addition, the frequency of the road use of the participants was reported as everyday (36.1%), 2-3 times a week (41.9%), 2-3 times a month (21.6%) and 2-3 times a year (0.4%).

Table 4. Descriptive statistics of participants in survey 2.

	(%)		(%)		
Gender		**Occupation**		**Education**	
Male	56,0	Unemployed	18,0	Illiterate	-
Female	44,0	Officer	28,0	Literate-no education	-
Age		Laborer	14,0	Elementary school	16,0
18-27	22,0	Student	16,1	High school	42,0
25-34	26,0	Self-employed	4,0	College or faculty graduate	42,0
35-44	18,0	Homemaker	6,0	**Frequency of the road using**	
45-54	18,0	Retired	13,9	Everyday	36,1
55+	16,0	Farmer	-	2-3 times a week	41,9
Marital status				2-3 times a month	21,6
Single	42,0			2-3 times a year	0,4
Married	58,0				

As shown the Table 5, all of the photos of the roadside trees in the study area had positive effects on motorists. While the highest "refreshing" score was for tree photo no. 3, the highest "interesting" one was for no. 12. Number 12 also had the highest "eye-catching" and "soothing" scores. Furthermore, no. 15 had the highest "aesthetic" score, while no. 9 had the least. Number 9 also had the least "reassuring", "ostentatious", "eye-catching" and "refreshing" scores.

Table 5. Means of the adjective pairs according to photo numbers in survey 2

Photo number	depressing-refreshing	ordinary-interesting	nondescript-eye-catching	inadequate-adequate	unpretentious-ostentatious	simple-complex	boring- soothing	disturbing-reassuring	unaesthetic-aesthetic
1	3,88	3,74	3,72	3,44	3,34	2,56	3,72	3,40	3,36
2	4,02	3,20	4,60	3,48	3,44	1,58	4,48	3,44	3,34
3	**4,36**	3,62	4,56	3,60	3,60	2,34	4,50	**3,98**	3,68
4	3,84	3,80	3,80	3,88	3,78	1,80	4,30	3,72	3,76
5	3,48	3,26	3,36	3,72	3,72	1,94	4,16	3,64	3,58
6	3,68	3,60	3,82	3,84	**4,18**	1,90	3,70	3,74	3,76
7	3,78	2,94	4,50	2,90	2,92	2,54	4,44	3,00	2,82
8	3,50	**2,78**	4,12	2,76	2,76	1,66	4,58	3,24	2,84
9	**2,64**	3,02	**3,06**	2,86	**2,50**	2,16	3,68	**2,94**	**2,36**
10	2,84	2,84	**3,06**	**2,44**	2,96	1,98	**3,58**	3,04	2,90
11	3,18	3,86	4,20	3,12	3,16	**2,78**	4,42	3,48	2,92
12	3,94	**4,10**	**4,70**	3,38	3,78	1,44	**4,86**	3,90	3,68
13	4,20	3,34	3,24	3,48	3,50	2,32	4,36	3,86	3,58
14	3,86	3,12	3,12	3,38	3,30	1,98	3,68	3,78	3,66
15	4,12	3,52	3,90	3,00	3,58	**1,28**	4,44	3,92	**3,96**
16	3,62	3,68	3,52	**4,34**	3,78	1,46	4,10	3,90	3,90

According to correlation analysis (p<0.01 and p<0.05) between demographic makeup and adjective pairs in Table 5, education level and occupation were related to the frequency of road use. Gender, age and marital status were related to adjective pairs. As shown in Table 6, males found tree photos more "aesthetic" and "interesting" than females (p<0.01). As education levels of the participant increased, the values of "aesthetic", "reassuring", "ostentatious" and "interesting" of the tree photos decreased. The frequency of road use decreased as well. Older participants found tree photos more "aesthetic" and "complex".

Table 6. Correlations between demographic structure and adjective pairs in survey 2

	frequency of road use	depressing-refreshing	ordinary-interesting	nondescript-eye-catching	Inadequate-adequate	unpretentious-ostentatious	simple-complex	boring- soothing	disturbing-reassuring	unaesthetic-aesthetic
gender	-,052	-,032	**,095****	-,043	,045	,034	-,018	-,029	,046	**,091****
age	-,055	,043	,052	-,006	-,013	-,031	**,101****	-,039	-,022	**,079***
marital status	,069	,013	,059	**-,080***	-,051	,066	,006	,033	-,011	,052
education	**-,195****	,058	**-,152****	,026	,000	**-,153****	-,026	,025	**-,124****	**-,164****
work	**,220****	-,009	,061	,027	-,028	**,075***	,016	-,031	-,007	,048

** Correlation is significant at the 0.01 level (2-tailed).* Correlation is significant at the 0.05 level (2-tailed).

In the correlations ($p < 0.01$ and $p < 0.05$) between seasonal changes and adjective pairs in Table 7, the relationships between adjectives pairs and seasonal changes can be seen. One of the most important was the seasons change from spring to winter, when tree photos were perceived more often as "simple". On the other hand, seasonal changes of the trees were perceived more often as "refreshing", "interesting", "eye-catching", "ostentatious", "soothing", "reassuring" and "aesthetic".

Table 7. Correlations between seasonal changes and adjective pairs in survey 2

	frequency of road use	**depressing-refreshing**	**ordinary-interesting**	**nondescript-eye-catching**	**Inadequate-adequate**	**unpretentious-ostentatious**	**simple-complex**	**boring- soothing**	**disturbing-reassuring**	**unaesthetic-aesthetic**
seasons	-,003	**,095****	**,134****	**,393****	,062	**,077***	**-,214****	**,128****	**,105****	**,115****

** Correlation is significant at the 0.01 level (2-tailed).* Correlation is significant at the 0.05 level (2-tailed).

Table 8 shows that the most effective season was spring according to "refreshing", "interesting", "eye-catching", "ostentatious" and "soothing". Winter was found most often to be a "reassuring" season, and autumn was seen most often as a "complex" season according to visual preferences.

Table 8. Means of the adjective pairs according to seasonal changes in survey 2

seasons	**depressing-refreshing**	**ordinary-interesting**	**nondescript - eye-catching**	**Inadequate-adequate**	**unpretentious-ostentatious**	**simple-complex**	**boring-soothing**	**disturbing-reassuring**	**unaesthetic-aesthetic**
spring	**4,03**	**3,59**	**4,17**	3,60	**3,54**	2,07	**4,25**	3,64	3,54
summer	3,61	**3,15**	3,95	3,31	3,40	2,01	4,22	3,41	3,25
autumn	**3,15**	3,46	3,76	2,95	**3,10**	**2,09**	**4,14**	**3,34**	**2,97**
winter	3,95	3,42	**3,45**	3,55	3,53	**1,76**	4,15	**3,87**	**3,78**

4. Conclusions and discussion

This study showed that one of the important elements in landscape evaluation is the assessment of visual material representing the landscape such as photographs, simulations, etc. (Corner, 1990; Brown, 1993; Dee, 2002; Müderrisoğlu et al, 2006; Müderrsioğlu and Eroğlu, 2006; Deming and Swaffield, 2011). In this study as well, roadside trees were evaluated through the use of photos in order to determine visual preferences.

Serpa and Muhar (1999) stated that demographic variations and social origins affect the way in which plants are perceived. In addition, the gender, age, habitat and experiences of an individual also affect his visual preferences (Strumse, 1996). As shown in the results of the present study, the visual preferences for deciduous trees were also related to demographic differences. There were negative relations between education level and visual aesthetics. The main reason may be that as the quality and level of their education increase, people become more selective, especially in their visual preferences. Moreover, Acar et al. (2003) claimed that changes in visual preferences are inversely proportional to the rise in educational level.

A number of studies (Akbar et al., 2003; Wolf, 2003; Mader and Neubert-Mader, 2004; Bulut and Yilmaz, 2008; Eroğlu et al. 2012, Fathi and Masnavi, 2014) have shown that in roadside and corridor plantings, visually identifiable elements of plants such as variations in species, age size, and proximity to the road as well as seasonal changes are quite effective predictors in the evaluation of visual preferences and visual quality. In this study, plant size and seasonal changes, in particular, were the most effective components of the visual preferences.

According to Eroğlu et al. (2012) seasonal changes of plants and their composition are very important for visual preferences, and they stated that autumn was found to be the most desirable season. In this study, autumn was also observed to be a very effective season in terms of "complex"," reassuring", "aesthetic" and "soothing" qualities.

When sizes of plants and their visual preferences were considered together, the most preferred pictures usually had a larger canopy and greater height and DBH. Thus, according to results of this study, the differences in height and DBH of the trees were related to the visual preferences. Fathi and Masnavi (2014) claimed that plants which are greater in size have the highest visual preference scores, regardless of whether they are trees, shrubs or groundcover. Moreover,

the phonological results of the study supported the fact that the preferred trees are both aesthetically and ecologically suitable for Düzce.

This study aimed to identify the visual effects of roadside trees based on the work carried out in this context. The results of the study are especially important for structured roadside plantings. For example, the results of this study can be utilised to achieve more visually aesthetic roads. Findings obtained by this study include the following:

- Demographic composition is an important determining element in the visual perception of roadside deciduous trees.
- Features of seasonal change, age and plant species are effective in identifying visual preferences for roadside deciduous trees.
- There are positive effects between plant phonological changes and visual preferences, especially with respect to height and canopy changes.
- To determine the visual preferences and visual quality of roadside deciduous plants, adjective pairs can be used as effective components of the visual landscape.
- For roadside planting, and especially for more effective visual perception of motorists, *Platanus orientalis* L., *Aesculus hippocastanum* L., *Liriodendron tulipifera* L. and *Acer negundo* L. are suitable because they have received high visual preference scores from the motorists. Moreover, these trees have more ecological adaptation potential for Düzce due to their advantageous environmental demands.
- While *Platanus orientalis* L. trees were perceived as more "aesthetic" and "reassuring", *Liriodendron tulipifera* L. trees had the highest visually "interesting", "soothing" and "eye-catching" scores.

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