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The study of structural characteristics of *Zelkova carpinifolia* (Pall.) trees in the Educational – Research forest of Darabkola, Mazandaran

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Abstract

In this study, the structural properties of *Zelkova Carpinifolia* trees were compared in pure and mixed stands of educational -Research forest of Darabkola. The inventory was performed selectivelyin 16 circular plots (1000 m²). In each sample plot, characteristics such as height, diameter at breast height, basal area, total volume, number of trees per hectare were recorded. Although, the study results did not show a significant difference between measured characteristics in pure and mixed stands at 95% level but the average of total height, diameter at breast height, basal area and volume in mixed stands was more than pure stand. While the average of tree number per hectare in pure stands was greater than the mixed stands. In addition, for the studied *Zelkova carpinifolia* trees in the stands the same above conditions were observed. The scatter plot of diameter classes for both pure and mixed stands and also *Zelkova Carpinifolia* trees represented an unbalanced even aged structure. The findings of this study confirmed that *Zelkova Carpinifolia* trees in both pure and mixed modes had the same conditions in terms of structure.

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Introduction

The vital importance of forests in today's world is not only their economic value but also their irreplaceable environmental values (Poorbabaei and Abedi, 2008). Forests of northern Iran with different types of trees and shrubs are a priceless resource, which we should try to maintain it. Lack of awareness of the importance of tree species and the subsequent destruction of the forest and timber smuggling, grazing, lack of information about their environment as well as previous management programs based on intensive harvest had caused some trees and shrubs get in endanger (Espahbodi *Et al*, 2007). Obviously, the most important way to achieve an appropriate management model and silviculture method for stands managing is the determination of structure and planning based on their current state (Eslami and Sagheb Taleb, 2007). Generally, the study of forest structure is the study of its two properties: identifying the component of stand and its relationship with other components. In practice, if the frequency of characteristics including basal area, standing volume, number of trees, height and canopy in diameter classes, age or height profile (stories) associated with type and contribution of each factor are examined, then the structure has been studied (Amini *Et al*, 2010).

The extent of vegetation variation as well as climate variability had formed one of the most important genetic storages of the world with lots of exclusive species (Kialashki *Et al*, 2012). One of the most valuable species in composition and vegetation diversity and also in danger is *Zelkova carpinifolia* (Pall.) of *Ulmaceae* family (Jalili & Jamazade, 2000). This species is native to Iran and parts of Turkey, Georgia, Azerbaijan and Armenia (Yazdian,1995) remained from Tertiary geology era, which is referred as a living fossil. In the past, this species had constituted some large pure populations in plain forests of northern Iran. Unfortunately, in recent decades its expanse have been declined due to habitat destruction and intense harvesting (Kvavadze &

Connor, 2005). Many studies have been done about the structure of different species in the country Eslami and Sagheb Taleb (2007), Poorbabaei *Et al* (2010), Mahdiani *Et al* (2012), Rostamikia and Zobeiri (2012), Mohammadi *Et al*, (2014). But no researches have been performed about the structure of pure and mixed stands of *Zelkova carpinifolia* in the country. Therefore, the aim of this study was to evaluate the structural characteristics of *Zelkova carpinifolia* trees in similar conditions of pure and mixed stands in educational research forest of Darabkola, to achieve a suitable silviculture method and ideal management plan according to the stands structure by a better understanding.

Materials and methods

Research area

This study was conducted in educational research forest of Darabkola, Sari, watershed of 74 and parcels of 24 and 29 have an area of 52 and 76 ha. The Alborz Mountains is placed in 15 km from east of Sari and between 36° 23′ to 36° 33′ north latitude and 52° 20′ to 52° 31′ east longitude on lower altitudes of northern edge. The minimum and maximum heights of the series are 160 and 710 m above sea level, respectively. These forests are limited to Darabkola village in north, to forest of Neka-Zalemrod sector 5 in south, to Neka-choob sector 1 in east and to Darabkola series 2 in west. Based on conducted studies in forestry plan, this area has limestone bedrock and marl with calcareous sandstone.

Study methods

After initial and general recognition of the study area, to determine the structure of *Zelkova carpinifolia* stands, 16 circular sample plots (1000 m²) (in parcels of 24 and 29) were considered, which 10 plots were in pure stands and 6 plots were in mixed stands. Characteristics such as total height, diameter at breast height, basal area at breast height, volume and number of trees per hectare were measured in each plot.

First, comparisons were performed for growth characteristics of pure and mixed stands and next the characteristics of *Zelkova carpinifolia* trees in these stands were investigated. To analyze the data obtained from forest areas, the paired t-test was used and was done in the form of data files in SPSS 16 and Excel software.

Results

Statistical characteristics of pure and mixed stands

As shown in Table 2, the comparison of pure and mixed stands and non-paired t-test had shown no significant differences between measured variables at 95% level.

Table 1. Comparison of statistical characteristics of pure and mixed stands of *Zelkova carpinifolia* in the study area.

Variable	Stand	Mean ± SD	Significant level
total height (m)	Pure	15.66± 4.41	Ns
	Mixed	16.47±4.53	Ns
Diameter at breast height (cm)	Pure	42.93. ± 23.55	Ns
	Mixed	47.15 ± 18.67	Ns
Basal area at Breast height (m²)	Pure	0.19 ± 2.12	Ns
	Mixed	0.2 ± 1.44	Ns

ns shows no significantly different.

Statistical characteristics of Zelkova carpinifolia trees in pure and mixed stands

As shown in Table 1, the comparison of *Zelkova carpinifolia* trees in pure and mixed stands and non-paired t-test had indicated no significant differences between measured variables at 95% level.

Table 2. Statistical comparison of *Zelkova carpinifolia* trees in pure and mixed stands.

Variable	Stand	Mean ± SD	Significant level
total height (m)	Pure	15.61± 4.14	Ns
	Mixed	18.09 ± 4.17	Ns
Diameter at breast height (cm)	Pure	40.91± 20.45	Ns
	Mixed	52.44 ±13.73	Ns
Basal area at Breast height (m²)	Pure	-0.16 ± 0.17	Ns
	Mixed	-0.22 ± -0.9	Ns
Volume (m³)	Pure	1.52 ± 1.87	Ns
	Mixed	2.26 ± 1.21	Ns

ns shows no significantly different

Species frequency in pure and mixed stands

The number and percentage of *Zelkova carpinifolia* trees in pure and mixed stands are shown in Table 3, which the number and percentage of *Zelkova carpinifolia* trees in mixed stands were 730 trees per hectare and 53.68%, respectively, and the rest were from other species. While the mixture percent of

Zelkova carpinifolia in mixed stands was 15.79%, which had assigned the third grade.

Table 3. Frequency of trees (trees per hectare) in pure and mixed stands in the study area.

Species	Stand	Number per hectare	Percent
Zelkova carpinifolia	Pure	730	53.68
	Mixed	90	15.79
Carpinus betulus	Pure	250	18.38
	Mixed	310	54.39
Quercus castaneifolia	Pure	190	13.97
	Mixed	40	7.02
Parrotia persica	Pure	170	12.5
	Mixed	110	19.3
Acer velutinum	Pure	20	1.47
	Mixed	10	1.75
Fagus orientalis	Pure	0	0
	Mixed	10	1.75
Total per hectar	Pure	1360	100
	Mixed	570	100

Tree number distribution in diameter classes for pure and mixed stands and Zelkova carpinifolia trees in both stand

The scatter plot of tree number in in diameter classes for pure and mixed stands as well as the *Zelkova carpinifolia* trees in both stands indicated an unbalanced age structure (Fig. 1 to 4).
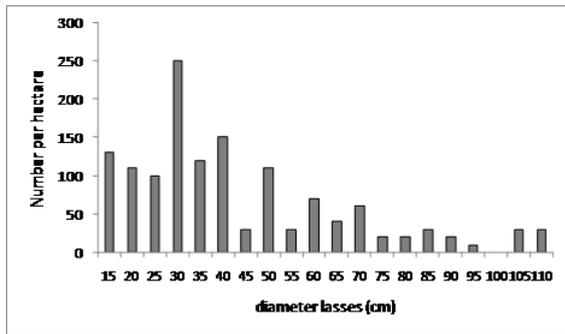
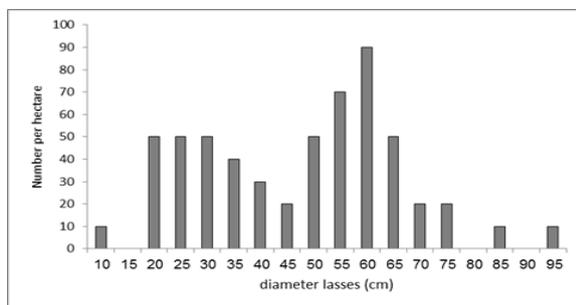**Fig. 1**. The graph of number in diameter classes in pure stands.

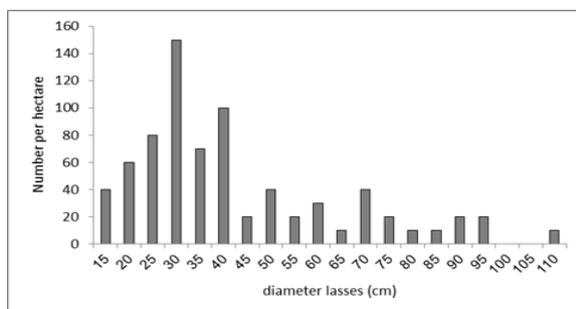**Fig. 2.** The graph of number in diameter classes in mixed stands.

Fig. 3. The graph of *Zelkova carpinifolia* tree number in diameter classes in pure stands.
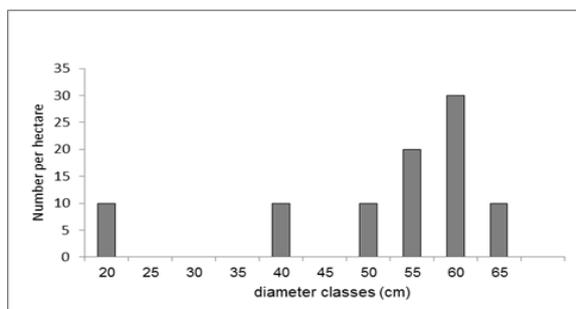

Fig. 4. The graph of *Zelkova carpinifolia* tree number in diameter classes in mixed stands.

Discussion

The results of the study showed that the pure and mixed stands of *Zelkova carpinifolia* were similar in structure in same ecological conditions. The statistical comparison between the measured variables including total height, diameter at breast height, basal area at breast height and volume of *Zelkova carpinifolia* pure and mixed stands indicated that there were no significant differences at 95% level and these variables were higher in mixed stands. Similar to our research, Memarian *et al*, (2006) have shown that the basal area and stability of mixed stand of picea – pine was higher than pure stand of picea. In contrast, Kialashki *et al*, (2011) in a study in *Zelkova carpinifolia* pure and mixed stands in Gormaras forest, Neka as well as Eslami and Sagheb Taleb, (2007) in a study in beech pure and mixed stands in Neka –Zalemrod forests showed contrary results and also they had shown no significant difference between variables.

In fact, *Zelkova carpinifolia* trees in the same habitat conditions would not be affected by mixture condition with other species. Similarly, Kabiri Koupaei *et al* (2009) in a study about both pure and mixed stands of beech showed that the beech trees in both stands had no significant difference ($\alpha=0.05$) and qualitative and quantitative variables were the same in both stands. In this study, the tree number per hectare in pure stands (1360 trees) was greater than the mixed stands (570 trees), which the frequency of *Zelkova carpinifolia* trees in pure and mixed stands were 53.68 and 15.79%, respectively. The diameter distribution and tree number per hectare in pure stands was higher than the mixed. In conclusion, it can be stated that the pure stands of *Zelkova carpinifolia* and *Zelkova carpinifolia* trees in pure stands were higher in age than the mixed stands. The scatter plot in diameter classes of *Zelkova carpinifolia* trees and the whole tress in pure and mixed stands showed an unbalanced even aged condition.

In general, according to the results of this study it could be concluded that the vegetative characteristics of *Zelkova carpinifolia* trees in pure and mixed stands had a uniform habitat condition and these characteristics in mixed stands were in better situation, in fact *Zelkova carpinifolia* trees were not influenced by mixture conditions.

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