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Determination on The Number of Roots in Pure Oriental Beech (*Fagus orientalis* Lipsky.) Forests in Karabük-Yenice District of Turkey

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Abstract – This study was carried out in the pure oriental beech forests of Yenice-Kızılkay in the Western Black Sea Region of Turkey, where the changes in the number of side roots and the changes in the height and diameter of the beech trees were examined in three different soil depth gradients. The root profiling was opened underneath beech trees, which were marked for cutting due to road construction studies and in 6 different aspects (north, south, northeast, northwest, southeast and southwest) in the 42 and 43 number divisions. In these root profiles, the cross-sectional surfaces of the side roots were counted and root lengths were measured at 3 different soil depth levels (10-30 cm, 31-50 cm and 51-80 cm) using 2x2m laths. In order to realize these side-root counts and measurements, studies were carried out on root profiles that were opened under 5 trees at each different aspect. In this context, a total of 30 trees in the root zone opened in the root profile, all the work continued. On the other hand, the height (H) and diameter (DBH) measurements were made on 5 sample trees examined in each aspect and these values were used to make comparisons in statistical analyses. The data obtained from the measurements made on these sample trees and root profiles opened on the of these sample trees were subjected to one-way analysis of variance (One Way ANOVA) according to the factors of depth and depth of view by SPSS 22.0 statistical programme. In this context, it has been determined that the mean number of side-root and length of side-root occurred differences significantly from 95% and 99%. According to the results obtained from the Duncan Range Test, the mean number of side roots and mean length of side root of the sample trees in northeast and northwest aspects were found to be higher in the first group. In the study, it was investigated how the mean number of side roots and the mean length of side roots change with respect to the soil depth ranges. As a result of the one-way ANOVA analysis, it was determined that the mean number of side roots and length were significantly different from 99.9% confidence level according to soil depth level. According to the Duncan Range test results conducted at 95% confidence level, it was determined that the first soil depth level covering the depth range of 10-30 cm in terms of both the mean number of side roots and the mean side root length was in the first group. In this research, a multiple correlation analysis was performed to determine the relationship and effect level between all the variables for which measurements and determinations were made. According to the results obtained from the multiple correlation analysis it is found that there are relations between different variables, different trust levels and different effects. Accordingly, an effective relationship was found between the NSR and the ASP variables at 95% confidence level in the positive direction (0.229*). On the other hand, between ASP and H (-0.280**), there were effective relations between NSR and SDG (-0.722**), between LSR and SDG (-0.669**), and between LSR and NSR (-0.789**) with 99% confidence level and negative direction. However, significant correlations were found between DBH and NSR (0.336**), between DBH and LSR (0.389**), between H and LSR (0.361**), and between H and DBH (0.906**) at 99% confidence. According to these results, both NSR and LSR variables and the DBH and H variables were found to have a 99% confidence level and an effective positive correlation. According to this, as NSR and LSR increase, the growth of height and diameter of mature oriental beech trees found in the sample areas is increasing.

Keywords – Oriental Beech, Aspect, Soil Depth Gradient, Number of Side Root, Variation.

I. INTRODUCTION

Forest resources are also damaged, as are all natural resources due to excessive and unplanned exploitation and global climate change. However, reforestation of forests, especially those with significant benefits such as carbon sequestration, climate balancing, recreation and raw material supply, and the transfer of this important resource to future generations by acquiring new forest areas is crucial for the whole world. The forest ecosystems and their ecological balances must be well known and the physiological characteristics of the species or species of forests bringing to the forest should be studied very thoroughly so that the forests can be improved and the yield strengths can be increased to serve humanity again in a healthy way. In order to explain the ecophysiological properties of trees in this respect, root and leaf physiology must first be well known. Because this can change under macro ecological conditions, especially under micro-ecological conditions, it can be very important. In this respect, in order to determine the utilization level of the trees, it is necessary to determine the distribution of the root system according to the depth stages of the soil, in order to determine the level of productivity provided by the conditions of the growing environment [1]. Just as plants are full, there are different root systems in forest trees depending on their genetic properties. Some tree species can create pile root systems that descend very deeply, especially in carstic areas, with lower yield power and water potential possessions, and some tree species also bring about shallow and heart root systems in the rich growth environments they are experiencing and growing optimally [2], [3]. In this case, it is very important in terms of determination of the severity

and time of the silvicultural operations to be carried out at the stand determined to determine the side root numbers that fulfill different functions within different root systems and to associate these numbers with the parameters indicating the development performance such as the size and diameter of the tree [4], [5]. On the other hand, the number of roots in the physiological activities, nutrition and development of trees is not a single effective factor in terms of root physiology. At the same time, the length of the side roots spreading in different soil depths must be known and detected. In this case, it is possible to obtain more realistic information about the growth of root physiology under the influence of dominant site conditions within a certain geographical area of the tree [6], [7]. In addition to this, whichever of the trees have root systems, the width of the area covered by all root systems in all the root systems, the high soil depth they can reach, and the large number of absorbent fur that they have are more important in removing water and minerals, which are important for the development of trees, they are performing a duty [8].

In this study carried out in the pure oriental beech (*Fagus orientalis* Lipsky.) forests of Yenice-Kızılkaya region, there are 6 different tectonics (north, south, northeast, northwest, southeast and southwest) and 3 different soil depths (10-30 cm, 31-50 cm and 51-80 cm) and also the relationships between the number and length of side roots and the growth of the total height (H) and diameter of height breast (DBH) of the trees were tried to be determined.

II. Materials and Method

A. Material

This study was carried out in the pure oriental beech forests of Yenice-Kızılkay in the Western Black Sea Region of Turkey, where the changes in the number of side roots and the changes in the height and diameter of the beech trees were examined in three different soil depth gradients. Average annual temperature is 13.8°C, average annual precipitation is 603 mm, dominant wind direction is northwest, vegetation period is 6 months, snow covered period is 7 months and period length is 4 months in the Yenice-Kızılkaya region located in the Western Black Sea subeuxin forest zone. In the research area, soil sandy-loam is in heavy texture and deep soil conditions are dominant. In addition, there is a structure structure with a cracked structure in the field. The elevation is 1120m in the study area and the general conditions are north and northwest. In the study area, all the stalks in which the trees are examined are pure beech stalks and the stands types are Knd_2 and Knd_1. These stalls, where the survey is carried out, are generally located on the middle slope. The land slope varies between 25-48% [9].

B.Method

In this research carried out in the pure-oriental beech forests of Yenice-Kızılkaya, root profiling was opened underneath beech trees, which were marked for cutting due to road construction studies and in 6 different aspects (north, south, northeast, northwest, southeast and southwest) in the 42 and 43 number divisions. In these root profiles, the cross-sectional surfaces of the side roots were counted and root lengths were measured at 3 different soil depth levels (10-30 cm, 31-50 cm and 51-80 cm) using 2x2m laths. In order to realize these side-root counts and measurements, studies were carried out on root profiles that were opened under 5 trees at each different aspect. In this context, a total of 30 trees in the root zone opened in the root profile, all the work continued (Table 1). On the other hand, the height (H) and diameter (DBH) measurements were made on 5 sample trees examined in each aspect and these values were used to make comparisons in statistical analyses. Height and diameter measurements of the trees taken from the core of the core are taken from the core of each of these trees have no neighborly relations with each other and there are no free growth conditions. Hence, sample trees that have normal growth performance and best represent the conditions of the stands in which they are located are selected and all measurements and determinations are made on these trees. All measurements and determinations made on specimen trees were made after the vegetation season

Table 1. Distribution of sample trees according to aspect and soil depth gradient

Aspect	Depth Gradient of Soil (cm)	Number of Sample Trees (item)
North	10-30	5
	31-50	5
	51-80	5
South	10-30	5
	31-50	5
	51-80	5
Northeast	10-30	5
	31-50	5
	51-80	5
Northwest	10-30	5
	31-50	5
	51-80	5
Southeast	10-30	5
	31-50	5
	51-80	5
Southwest	10-30	5
	31-50	5
	51-80	5

C.Statistic Analysis

One-way analysis of variance (One Way ANOVA) was used in comparison of the number of side roots and lengths in the survey and the comparison of the depths of soil and soil depths and the determination of the differences. The Duncan RangeTest was used to make groupings. Multiple correlation analysis was performed to examine the relationship between the number and length of side roots and the length and diameter development of trees together. All of these analyzes were performed in the SPSS 22.0 version packet statistics program.

III. Results

The descriptive statistical results of the findings obtained after the measurements, counts and determinations made on the root profiles opened to include three different depths of soil on the sample trees determined at 5 replications at the 6 different aspects in the study area and at the bottom of the sample trees are given in Table 2.

Table 2. Descriptive statistics of variables

Variables	N	Min.	Max.	Mean	Std.Dev.
The Number of side root (**NSR**)	90	45.56	2765.98	824.05	1022.42
The Length of side root (**LSR**)	90	2.25	29.56	11.02	6.14
Height Breast Diameter (**DBH**)	90	18.63	27.48	22.47	3.05
Total Height (**H**)	90	9.28	15.23	12.44	2.16

The result of the one-way analysis of variance applied to the data obtained with respect to the side factor and side root length variables according to the aspect factor were given Table 3.

Table 3. Results of One Way ANOVA according to aspect factor

Source of Variation		Sum of Squares	df	Mean Square	F	Sig.
NSR	BG	16635316.2	5	3327063.2	3.658	0.005
	WG	76400589.7	84	909530.8		
	T	93035905.9	89			
LSR	BG	762.8	5	152.5	4.926	0.001
	WG	2601.6	84	30.9		
	T	3364.5	89			

BG: Between Group, **WG:** Within Group, **T:** Total

When the results of analysis of variance included in Table 3 were given, statistically significant differences were found at 95% confidence level for the number of side roots and 99.9% confidence level for the length of side roots. In this context Duncan Range Test was performed within 95% confidence level to group the side roots in terms of number and length variables and the results are given in Table 4.

Table 4. Results of Duncan Range Test according to aspect factor

Aspect	Mean NSR (item)	Mean LSR (cm)
North	147.33^{c}	10.04^{bc}
South	527.05^{bc}	11.66^{bc}
Northeast	1216.87^{ab}	12.84^{ab}
Northwest	1415.42^{a}	16.03^{a}
Southeast	647.36^{bc}	7.51^{c}
Southwest	990.23^{ab}	8.06^{c}

When the results of Duncan Test given in Table 4 were examined, both the mean number of side roots and the mean length of side root were found in the first group.

The One-way variance analysis (One Way ANOVA) was performed in order to find out the changes in the mean number of side root and the mean length of side root in terms of soil depth gradient factor in the research and the results of One Way ANOVA are shown in Table 5.

Table 5. Results of One Way ANOVA according to soil depth gradient factor

Source of Variation		Sum of Squares	df	Mean Square	F	Sig.
NSR	BG	54194469.4	2	27097234.7	60.694	0.00
	WG	38841436.5	87	446453.2		
	T	93035905.9	89			
LSR	BG		2	753.9	35.332	0.00
	WG		87	21.3		
	T		89			

BG: Between Group, **WG:** Within Group, **T:** Total

According to the results in Table 5, it was determined that there is a statistically significant difference in the mean number of side root and the mean length of side root of 99.9% confidence level according to the soil depth gradient factor. In this context Duncan Range Test was performed within 95% confidence level to group the side roots in terms of number and length variables and the results are given in Table 6.

Table 6. Results of Duncan Range Test according to soil depth gradient factor

Soil Depth Gradient (cm)	Mean NSR (item)	Mean LSR (cm)
I (10-30cm)	1901.13^{a}	15.90^{a}
II (31-50cm)	467.60^{b}	11.28^{b}
III (51-80cm)	103.41^{c}	5.89^{c}

According to the Duncan Range Test results in Table 6, both the mean number of side roots and the mean length of side root at 95% confidence level were collected in 3 different groups, and the first soil depth step covering 10-30 cm depth was in the first group in both variables.

In this research, multiple correlation analysis was applied to see the effect and level of the relationship among all variables. The results obtained from the multiple correlation analysis are given in Table 7.

Tablo 7. Results of multiple correlation analysis.

Vrbs	*ASP*	*SDG*	*NSR*	*LSR*	*DBH*	*H*
ASP	**1.00**					
SDG	0.000	**1.00**				
NSR	0.229*	-0.722**	**1.00**			
LSR	-0.153	-0.669**	-0.789**	**1.00**		
DBH	0.058	0.000	0.336**	0.389**	**1.00**	
H	-0.280**	0.000	0.203	0.361**	0.906**	**1.00**

Vrbs: Variables
ASP: Aspect
SDG: Soil Depth Gradient (cm)
NSR: Mean Number of Side Root (item)
LSR: Mean Length of Side Root (cm)
DBH: Height Breast Diameter (cm)
H : Total Tree Height (m)

When the results of the multiple correlation analysis in Table 7 are examined, it is found that there are relations between different variables, different trust levels and different effects. Accordingly, an effective relationship was found between the NSR and the ASP variables at 95% confidence level in the positive direction (0.229*). On the other hand, between ASP and H (-0.280**), there were effective relations between NSR and SDG (-0.722**), between LSR and SDG (-0.669**), and between LSR and NSR (-0.789**) with 99% confidence level and negative direction. However, significant correlations were found

between DBH and NSR (0.336**), between DBH and LSR (0.389**), between H and LSR (0.361**), and between H and DBH (0.906**) at 99% confidence (Table 7). According to these results, both NSR and LSR variables and the DBH and H variables were found to have a 99% confidence level and an effective positive correlation. According to this, as NSR and LSR increase, the development of height and diameter of mature beech trees found in the sample areas is increasing. This can be explained by the fact that the trees are used at a higher level than the water and nutrients in the soil (Table 7).

IV. DISCUSSION

This research was carried out on pure oriental beech stands in the divisions 42 and 43 of Yenice-Kızılkaya trading unit under 6 different aspect conditions. Diameter and height measurements were made on 5 sample trees which were marked to be cut for road construction, and root cross sections were counted according to 3 different soil depth gradients in the root profiles of these 5 sample trees and tried to determine the number and length of side roots. In this context totally 30 samples were identified on the tree and root profiles were opened (Table 1). The descriptive statistical values of the obtained data for the variables as a result of measurements made in the field are given in Table 2. The data obtained from the measurements made on these sample trees and root profiles opened on the of these sample trees were subjected to one-way analysis of variance (One Way ANOVA) according to the factors of depth and depth of view by SPSS 22.0 statistical programme. In this context, it has been determined that the mean number of side-root and length of side-root occurred differences significantly from 95% and 99% (Table 3). In this regard, a Duncan Range Test with a 95% confidence level was used to group the mean number of side roots and length of side root according to the aspect factor (Table 4). According to the results obtained from the Duncan Range Test, the mean number of side roots and mean length of side root of the sample trees in northeast and northwest aspects were found to be higher in the first group (Table 4). As a matter of fact that, the results obtained from another research carried out on similar conditions in the field of natural rejuvenation of oriental beech in the Bartın and Devrek regions revealed that the beech has the best roots and stem growth in the north, northeast and northwest aspects [10]. This finding is supported by the findings on the mean number and length of side roots from this research carried out in the Yenice-Kızılkaya region. As a matter of fact, there is a high correlation between the diameter and height values determined in the sample trees and this growth is higher in the values compared to the other aspects in the north, northwest and northeast, as in the number and length of side roots. In the study, it was investigated how the mean number of side roots and the mean length of side roots change with respect to the soil depth ranges. As a result of the one-way ANOVA analysis, it was determined that the mean number of side roots and length were significantly different from 99.9% confidence level according to soil depth level (Table 5). In this direction Duncan Range Test was applied in order to group the depths of the soil in terms of mean number of side roots and length (Table 6). According to the Duncan Range test results conducted at 95% confidence level, it was determined that the first soil depth level covering the depth range of 10-30 cm in terms of both the mean number of side roots and the mean side root length was in the first group (Table 6). It has been determined in many studies conducted on this subject that broad-leaved species have established and maintained more root systems in the upper stages of the soil until reaching the age of maturity after many years from the moment they arrived. The reason for this situation is the presence of the organic matter that can be used immediately by the side roots in the upper soil conditions and the positive effect of the humus layer in the rotten form on the soil organisms and the aeration conditions in the upper soil layer are shown to be optimum for many years [11].

In this research, a multiple correlation analysis was performed to determine the relationship and effect level between all the variables for which measurements and determinations were made. The results obtained from this study are given in Table 7. According to the results obtained from the multiple correlation analysis it is found that there are relations between different variables, different trust levels and different effects. Accordingly, an effective relationship was found between the NSR and the ASP variables at 95% confidence level in the positive direction (0.229*). On the other hand, between ASP and H (-0.280**), there were effective relations between NSR and SDG (-0.722**), between LSR and SDG (-0.669**), and between LSR and NSR (-0.789**) with 99% confidence level and negative direction. However, significant correlations were found between DBH and NSR (0.336**), between DBH and LSR (0.389**), between H and LSR (0.361**), and between H and DBH (0.906**) at 99% confidence (Table 7). According to these results, both NSR and LSR variables and the DBH and H variables were found to have a 99% confidence level and an effective positive correlation. According to this, as NSR and LSR increase, the growth of height and diameter of mature oriental beech trees found in the sample areas is increasing. This can be explained by the fact that the trees are used at a higher level than the water and nutrients in the soil (Table 7). When the relations between all the variables are examined, the mean number of side roots and length variables which show significant differences according to the depth of view and the depth of the soil, directly and indirectly affect all the growth activities of the oriental beech trees in the stand conditions. It has been extensively determined in this study that there are considerable influences on the positivity of growth of diameter and height of side roots, especially in the upper soil layer of shaded aspects. Indeed, in a study of the root physiology and chemical effects of forest litter coverings, it has been shown that the use of the amount of organic matter caused by the litter cover layer in the species with a high number of side roots intensifies the amount of photosynthesis reaching the saturation point in a shorter time and thus the cell division. This affects positively the height, diameter and volumetric growth of the trees to the extent that limiting factors such as those in all plants allow.

V. CONCLUSION

According to the findings and results obtained from this research, it is possible to indicate that the activity of the root physiology in the pure oriental beech forests in the Yenice-Kızılkaya region, especially in shady-looking and medium slope conditions, at elevation conditions of 1120m, shows a positive tendency under the influence of existing ecological conditions (soil conditions). This situation directly and

indirectly positively affects the growth performance of the oriental beech trees. For this reason, in order to be able to perform silvicultural activities such as successful natural regeneration and maintenance work in the future in the local conditions, the aspects in the research area and similar structures should be well looked after and protected. On the other hand, the life processes involving the activities of specific organs, such as root physiology, leaf physiology, can be closely monitored and more accurate information about the general growth status of the stand can be obtained. For this reason, the root physiology of the trees in the vicinity should be closely monitored. For this purpose, sample trees to be kept under constant control should be determined and even more detailed studies should be carried out to reveal the physical and chemical changes in the organic matter and mineral layers of the changes and differentiations of the side and main root structure. Thus, according to age, height, diameter, photosynthesis rate and other quantitative characters, the real cut-off age or transition between the ages of growth must be determined more realistically by determining the availability and quantities of the trees at the real level of the water and mineral nutrients in the soil. Furthermore, by expanding the scope of the studies in this area, the relationships between changes in root physiology and the seed characteristics and seed holding capacities of trees should be examined and the possibilities of benefiting from developments in root physiology should be determined when the years of rich seeds related to the complete nutrient cycle of trees are determined.

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REFERENCES

[1] D. Atkinson. Plant Root Growth, Blackwell, London, 1991.
[2] T.T. Kozlowski. Flooding and Plant Growth, Academic Press, Orlando, 1984.
[3] J. Kolek and V. Kozinka. Physiology of the Plant Root System, Kluwer Academic Press, Norwell, MA, 1992.
[4] F.S. Baker. Principles of Silviculture, University of California, McGraw-Hill Book Company Inc., New York, 1950.
[5] M.J. Kelty., B.C. Larson, C.D. Oliver, The Ecology and Silviculture of Mixed-Species Forests, Kluwer Academic Publishers, London, 1992.
[6] B. Kacar, A.V. Katkat, Ş. Öztürk. Plant Physiology, Nobel Publisher, Ankara, 2010.
[7] G.W. Watson, A.M. Hewitt, M.Custic and M. Lo. "The Management of Tree Root Systems in Urban and Suburban Settings: A Review of Soil Influence on Root Growth" Arboriculture and Urban Forestry Vol. 40(4), pp.193-217, 2014.
[8] F.H. Schweingruber. Wood Structure and Environment, Springer Verlag, Berlin, 2007.
[9] Anonim. The Mnagement Plan of Yenice Kızılkaya Forest Range District (201-2029), GFD Publisher, Ankara, 2010.
[10] H.B. Özel and M. Ertekin. "Ecological Conditions in the Natural Group Regeneration Areas of Oriental Beech (Fagus orientalis Lipsky.) in Bartın and Devrek District" Journal of Bartın Forestry Faculty", Vol.12 (17), pp.47-64, Bartın, 2010.
[11] J.Grabosky, N. Bassuk, L. Irwin and H.V. Es. "Shoot and Root Growth of Three Tree Species in Sidewalks", Journal of Environmental Horticulture, Vol 19(4), pp.206-211, 2001.
[12] E.F. Solly, I. Schöning, S. Boch, E. Kandeler, S. Marhan, B. Michalzik, J. Müller, J. Zscheischler, S.E. Trumbore and M. Schrumpf "Factor Controlling Decomposition Rates of Fine Root Litter in Temperate Forests and Grasslands", Plant Soil, DOI: 10.1007/s11104-014-2151-4, May 2014.