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Investigation of Feeding Activities for Red Pine and Yellow Pine Species Grown in Turkish Forest Nurseries

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Abstract

In agricultural activities carried out in our country, one of the main items that increase the cost of production is fertilizer and fertilization activities. In the researches and studies conducted, it is known that the majority of the productions in private and public areas are based on traditional understanding and far from scientific methods and methods. This is a factor that both increases the cost during the production period and causes the lack of quality and desired amount of production. The aim of this study is to understand the level of plant nutrition activities and fertilizer use during the production phase for coniferous seedlings produced in Turkish Forest Nursery production facilities. Fertilizer is a commodity that we are completely dependent on foreign countries for raw materials. Every year, millions of dollars in our budget go abroad for fertilizer supply. It should be our national duty and main goal to carry out feeding activities by bringing our own resources to the forefront and to ensure that the amount of fertilizer used is used as much as needed. The aim of the study is to prevent excessive fertilizer consumption and to ensure that these activities are carried out with scientific methods and to make suggestions to the interlocutors regarding the results.

Keywords: *Sapling morphology and physiology, plant nutrition, plant nutrients, fertilization, coniferous tree species.*

Türkiye Orman Fidanlıklarında Yetiştirilen Kızılçam ve Sarıçam Türlerine Yönelik Gerçekleştirilen Besleme Faaliyetlerinin İncelenmesi

Öz

Ülkemizde gerçekleştirilen tarımsal faaliyetlerde, üretim maliyetini arttıran ana kalemlerden biride gübre ve gübreleme faaliyetleridir. Yapılan araştırma ve çalışmalarda özel ve kamu alanlarındaki üretimlerin büyük çoğunluğunun gelenekçi anlayışa bağlı, bilimsel yöntem ve metotlardan uzak olarak uygulandığı bilinmektedir. Bu da üretim periyodu boyunca hem maliyeti arttıran bir unsur olarak karşımıza çıkmakta hem de kaliteli ve istenilen miktarda üretim yapılamamasına neden olmaktadır. Bu çalışmada ki amaç, Türkiye Orman Fidanlık üretim tesislerinde üretilen iğne yapraklı fidanlara yönelik, üretim aşamasında gerçekleştirilen bitki besleme faaliyetleri ve gübre kullanımının hangi seviyede olduğunu anlamaya yöneliktir. Gübre hammadde anlamında tamamen dışa bağlı olduğumuz bir emtiadır. Her yıl bütçemizde milyonlarca dolar gübre tedariği için yurtdışına gitmektedir. Kendi öz kaynaklarımızın ön plana çıkarılarak besleme faaliyetlerinin gerçekleştirilmesi ve kullanılan gübre miktarlarının ihtiyaç olduğu kadar kullanılmasını sağlamak milli görevimiz ve temel hedefimiz olmalıdır. Çalışmanın amacı, aşırı gübre tüketiminin önüne geçmek ve bilimsel metotlarla bu faaliyetlerin yapılmasını sağlamak ve sonuçlarına ilişkin muhataplarına önerilerde bulunmaktır.

Anahtar kelimeler: *Fidan morfolojisi ve fizyolojisi, bitki besleme, bitki besin maddeleri, gübreleme, iğne yapraklı ağaç türleri.*

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1. Introduction

Since our country has 7 different geographical regions, it has made it necessary to act according to the microclimate structure and ecological conditions of these different regions during the plant production phase. This diversity in both soil and climate conditions of our geographical regions has caused the methods and methods in plant production to be applied in a unique way. The nutrient needs of different species in growing conditions and the amount of nutrients removed from the soil differ at the same rate, so these amounts are not known exactly. The lack of knowledge and experience in plant nutrients and plant nutrition can have a serious impact on the production, quality and results of the seedlings on which the study is based, and unconscious efforts can cause unnecessary labor and costs. Within the scope of cultivation, all inputs available in all kinds of activities, both commercial and non-commercial, are a whole and should be evaluated within the same framework. Whether it is the production of saplings for a stand to be established in an industrial sense, or in all kinds of activities carried out in a closed greenhouse environment to meet the need for vegetables, it is useful to evaluate the basic inputs as a whole. Because our main material is firstly the soil (growing medium) and secondly the requirements of the grown plant material. The stages and processes to be passed through in the process from the seed stage to the sapling are the same. The only difference here is that the variety you are dealing with has different ecological requirements according to its morphological structure.

The forest structure of our country and the diversity of species produced in nurseries have made it necessary to carry out studies on this subject with more accurate methods and methods. Therefore, the aim of this study is to determine the plant nutrition methods applied in forest nurseries, especially in the sapling production phase, to compare these activities with technical, economic, and scientific methods, and to prevent uniform nutrition methods in nurseries located in different geographical regions and to determine and recommend new nutrition methods (Leventoğlu, 2024).

Nurseries have continuously increased their numerical capacity since their establishment. Today, there are 84 Nursery Management Directorates and 102 Forest Nursery Chiefs under 28 Regional Directorates of Forestry under the General Directorate of Forestry (OGM, 2021). Forest nurseries continue to meet and produce seedlings and seeds demanded by the Ministry of Forestry and society. Sapling production programs are determined by the units to which they are affiliated, except for the nurseries.

The first establishment date of the State Forest Nursery Enterprises coincides with the first years of the Republican Period (Tolunay & Çavuşoğlu, 2015). With the Nursery Law No. 682 dated 14.02.1925, the first state forest nursery enterprise in accordance with scientific and technical principles was established in Ankara in 1925 by the order of Atatürk. In our country, the duty of forest tree seed production and sapling cultivation was assigned to the state forest nursery enterprises in accordance with the relevant legislation (Gül & Gül, 2023). Forest nurseries can be defined as "an open and/or closed piece of land used to grow the seedlings needed for a specific purpose, to be transferred and planted in other places later" (Yahyaoğlu, 1993; Anonim, 1996). There are two different types of state forest nurseries under the General Directorate of Forestry: permanent forest nurseries and temporary forest nurseries (Ürgenç, 1991).

State forest nurseries have an important place in the production of forest tree seedlings, so it is very important to determine the plant nutrition practices carried out in forest nurseries and to understand their compatibility with current practices. In addition to bare-root sapling production for afforestation, production was carried out with the classical covered sapling production technique in polyethylene tubes and bags in open field conditions until the 1990s. Grown in various types of containers through and its container to the afforestation or planting site brought and planted with soil (Ayan, 2007). State Forest Nurseries, on the one hand, produce the sapling material required for afforestation, and on the other hand, they enable the production of new information on species, origins, growing environment, etc. through various researches (Gültekin, 2005).The fact that the forest structure of our country and the diversity of species produced in nurseries are very high has made it necessary to carry out studies on this subject with more accurate methods and methods. Changing economic conditions, increasing demand for forest products and afforestation, the fact that afforestation is generally carried out on soils poor in plant nutrients and on rugged terrain due to the preference of fertile soils in cultivated agriculture have made modern nursery and tree growing obligatory (Brohi et al., 2012).

The production of quality, healthy, and cost-effective saplings is of great importance in the sapling production phase. It is not enough to produce saplings only in quantity but it should be the main objective to produce saplings in accordance with the standards in order to be successful both in afforestation works and in park gardens and landscaping (Kalıpsız, 1970). Tolay (1983), The success of saplings in afforestation studies is measured by sapling quality. This situation emerges as a result of the interaction of environmental conditions. Şimşek (1987). Quality sapling means a sapling that shows high retention success in afforestation studies, which shows very good development by maintaining its life actively during the period when growth is very fast and at the same time is in economic balance.

In the measurements carried out for the determination of morphological characteristics, sapling height, root collar diameter, stem/root fresh and dry weight ratio, sapling height/root collar diameter ratio, root percentage measurements were determined and data belonging to the analyzed sapling species were obtained.

Root development potential, plant water potential and plant water tension, mineral nutrient content, resistance to stress factors (uprooting, transportation, transplanting, cold, frost and drought etc.), bud dormancy (Ürgenç, 1986; Tolay, 1986; Ürgenç et al., 1991; Yahyaoğlu & Genç, 2007; Deligöz, 2007). The main element that forms the basis of plant nutrition is the delivery of plant nutrients to the plants by various means during the periods when the plants need them. If there is not enough nutrients in the soil to meet the needs of the plants grown in the soil, plant nutrients must be given to the soil through fertilization. If the soil is not fed, after a while the yield decreases due to the lack of nutrients. For this reason, the soil must be nourished in order to grow sufficient and high quality seedlings (Karaöz, 1992; Gezer & Gül, 2009).

The main purpose of this study is to understand the level of plant nutrition activities and fertilizer use during the production phase for coniferous seedlings produced in Turkish Forest Nursery production facilities

2. Material and Method

In order to determine the development and nutritional status of Red pine and Yellow pine seedlings produced in nurseries, evaluations were made on seedling samples. In the selection of the nurseries included in the study, attention was paid to the fact that the nurseries were located in the regions where Red pine and Yellow pine sapling cultivation is intensive and that the production capacity of these species produced in these nurseries was high in terms of production amounts.

2.1. Sampled Nurseries

Saplings were sampled from 12 forest nurseries geographically selected among the forest nurseries in our country, as shown in.

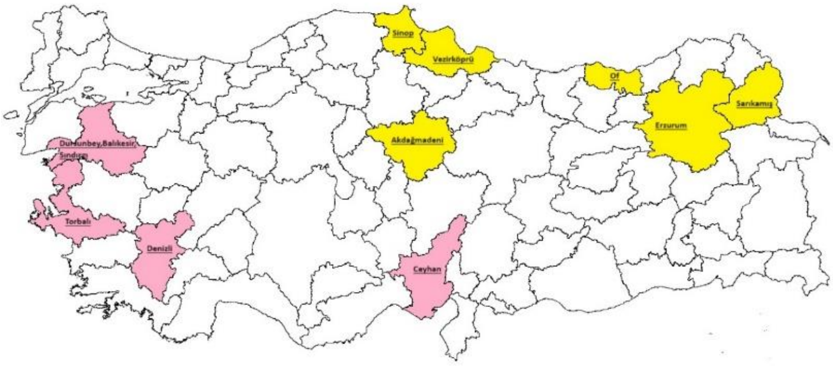

Figure 1. Distribution of the nurseries where seedlings were sampled in the geographical regions of Türkiye

2.2. Method

In order to make the saplings comparable in the study, 1+0 aged Red Pine and Yellow Pine saplings, which are the most produced species in our country, were preferred. Saplings were sampled as bare-rooted, tubed and enso-coated saplings. While determining these species and the nurseries where the samples were to be taken, it was paid attention to the species that are widely and abundantly produced throughout the country or in its region. For this, OGM Sapling Stocks database records for 2019 were used. Each species was sampled from 6 different nurseries.

2.2.1. Sapling sampling

Sapling samples of these 2 species, which are the most widely produced in forest nurseries, were taken and measurements and evaluations were made regarding their morphological and physiological characteristics.

a. Sapling morphological measurements: Some morphological measurements of the 1+0 year old coniferous saplings, which are the subject of the research, were started in 2019. Sampling was carried out in August-September when the needles reached full maturity at the end of summer. For each sapling type, 20 plant samples were taken from 3 different nurseries. Sampling of bare-root saplings was carried out by uprooting the saplings at a depth of at least 25 cm with the help of a worker using a waist shovel without damaging the roots. The uprooted saplings were wrapped in this to prevent moisture loss and transported to the laboratories for measurements. In the case of polyethylene tubes and enso-coated samples, 20 samples of each species were taken from the production pad and transported to the laboratory. In total, morphological measurements were carried out on 360 sapling samples of 2 species. The roots of the plant samples collected in the laboratories of Gübre Fabrikaları A.Ş. Samsun Regional Plant were first cleaned from soil and mortar materials in medium-pressure water. Root collar diameter measurements were taken with a digital caliper with a precision of 0.1 mm while the sapling samples were still fresh (Figure 2). The stem length of the plant was measured and noted. Leaves were then manually removed from the stem. After the morphological measurements, the seedling samples, which were divided into three parts as root, stem and leaf, were labeled and subjected to drying to determine their dry weights. They were dried in a drying cabinet at 65°C for about 48 hours until they reached constant weight (Yahyaoğlu & Genç, 2007).

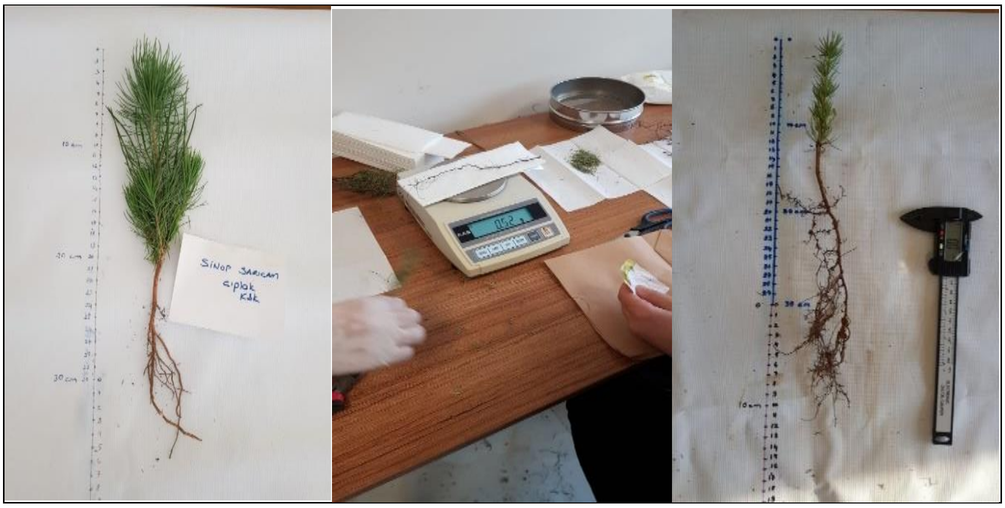

Figure 2. Morphology measurement procedures of seedlings to be analyzed before drying

Seedling height (SH), root collar diameter (CRD), stem dry weight (SDW), root dry weight (RDW), leaf dry weight (DWW) and whole seedling dry weight (FDW) were measured. Based on these measurements, the SDW/RDW ratio and LDW/SDW values were measured or calculated for each seedling separately and recorded. Abbreviated definitions of sapling morphological characteristics are as follows: (Dirik, 1994; Ürgenç et al., 1991; Semerci, 2002; Deligöz, 2007; Yahyaoğlu & Genç, 2007; Tüfekçi, 2007). Sapling Height (SL): Length between root collar and top bud (cm), Root Collar Diameter (CRD): Diameter measured at the point just above the root closest to the stem (mm),

Stem Dry Weight (SDW): Oven-dry (48 h at 65°C) weight (g) of the above-ground organs of the seedling,

Root Dry Weight (RWW): Oven-dried (48 h at 65°C) weight (g) of the root parts cut at the root collar diameter and separated from the stem,

Leaf Dry Weight (LDW): Oven dry (48 hours at 65°C) weight of the leaf (g).

Sapling Dry Weight (DWW): SDW + RDW + LDW , Stem/Root Ratio: SDW / RDW, Leaf Ratio LDW / SDW

b. Sapling nutrient analysis: After all morphological measurements were performed, root, stem and leaf samples were ground in a grinder, placed in plastic ziplock bags, labeled and sent to the laboratories of Eskişehir Forest Soil and Ecology Research Institute Directorate for chemical analysis. Plant nutrient analyses of root, stem and leaf organs of 20 seedlings of each species were performed. The proportional results obtained from the nutrient analyses were multiplied by the mass value of the relevant sapling organ and the nutrient content taken by the root, stem and leaf parts of each sapling was calculated. The nutrient content of these 3 organs was summed and the amount of nutrients taken from the soil by the whole sapling was calculated on an element basis. The plant analysis methods in Table 1 are as follows.

Table 1. Plant analysis methods

Abbreviation	Analysis Name	Analysis Method
N	Nitrogen	Kjeldahl Method
P	Phosphorus	Ammonium Meta Vanadate Yellow Color Method in P Spectrophotometer
K	Potassium	Flame Photometric Method
Ca	Calcium	AAS Method
Mg	Magnesium	AAS Method
S	Sulfur	Turbidimetric barium sulfate method

N determination: Kjeldahl Method (Kacar, 1972). The method is based on the principle that nitrogen in the form of organic compounds in the sample is converted into ammonium nitrogen by reduction by wet combustion with concentrated H2SO4 in the presence of a catalyst. After the nitrogen is converted into ammonium nitrogen, the ammonia released by distillation in a strong alkaline medium is kept in an acid and the amount is determined by titration.

P determination: Spectrometric vanadate molybdate phosphoric acid yellow color method (Kacar & Inal, 2008). The method is based on the principle of determination of the yellow color formed by the replacement of the oxygens of vanadate and molybdate with PO_4 by spectrophotometer at 430 nm.

K determination: Fleym photometer method (Kacar & Inal, 2008). Fleym Photometer is a mineral analysis method based on the measurement of the intensity of rays of a certain wavelength emitted from the flame of an element.

Determination of Ca and Mg: AAS method (Kacar & Inal, 2008). Atomic absorption spectroscopy is a technique used to determine the concentration of a metal element in a liquid solution. This technique is based on the principle of measuring the amount absorbed as a result of the transition from the ground state to the excited state by the absorption of light in the UV and visible region by free atoms.

S determination Turbidimetric barium sulfate method (Kacar, 1972). It is determined in Spectronic 20D colorimeter device. This is a method of determining the degree of turbidity of a solution by measuring the amount of light passing through the solution (the part of the light that does not undergo absorption and the part of the diffraction light) with a photometer and the concentration of the substance that forms the turbidity.

2.2.2. Data analysis and evaluation

Considering the data obtained from the measurement of the morphological characteristics of the seedlings, the analysis of variance technique was used to determine the differences between the seedlings with different packaging types using the SPSS package program. After the analysis of variance, Tukey test, one of the multiple comparison methods, was used to determine which species with different packaging types were different from each other at $p<0.05$ level of significance. Differences were indicated with Latin letters on averages (Kalıpsız, 1981; Özdamar, 2002, 2004).

3. Findings and Discussion

3.1. Coniferous Sapling Species Analysis Findings

3.1.1. Morphology results

In Table 2, which includes the average morphological data of red pine seedlings, the highest values in terms of diameter and height were 2.36 mm and 37.40 cm in enso-pot and bare root seedlings from Balıkesir and Dursunbey nurseries. In terms of root weight, the highest value was found in enso-covered seedlings with 2.09 g. When analyzed in terms of stem weight, it is seen that the red pine sapling obtained from Torbalı nursery and the enso-pot packaging type red pine sapling obtained from the same nursery have more weight than the other saplings with 1.69 g. In terms of leaf weight, the highest value was found in the red pine sapling obtained from Sındırgı nursery with 2.38 g.

Table 2. Average morphological data of red pine sapling species

Packaging	Nursery	Quantity	Diameter (mm)	Height (cm)	Root (g)	Stem (g)	Leaf (g)	Whole Plant	Stem/ Root	Leaf Ratio
Bare root	Dursunbey	20	2,04	37,40	1,76	1,50	1,81	5,07	0,85	0,36
Bare root	ceyhan	20	1,95	36,14	1,50	1,54	1,58	4,63	1,03	0,34
Bare root	Torbalı	20	1,94	35,21	1,46	1,37	1,42	4,25	0,94	0,33
Tube	Torbalı	20	1,82	30,21	1,73	1,69	1,47	4,88	0,98	0,30
Tube	Sındırgı	20	2,17	36,28	1,79	1,51	2,38	5,68	0,84	0,42
Tube	ceyhan	20	1,96	33,46	1,95	1,67	1,44	5,07	0,85	0,28
Enso-pot	Balıkesir	20	2,36	34,09	2,09	1,56	2,11	5,75	0,75	0,37
Enso-pot	Denizli	20	1,79	31,66	1,80	1,65	1,28	4,73	0,92	0,27
Enso-pot	Torbalı	20	1,82	33,23	1,73	1,69	1,47	4,88	0,98	0,30

In Table 3 shows the average morphological data of yellow pine seedlings, and the highest values in terms of diameter and height were 2.66 mm and 33.95 cm for enso-pot seedlings from Erzurum and Of nurseries. In terms of root weight, the weight of enso-pot seedlings was higher than bare root and tubular seedlings (1.57 g.-1.63 g.). In terms of stem weight, enso-pot type yellow pine sapling obtained from Of nursery and bare root packaging type yellow pine sapling obtained from Sarıkamış nursery were observed. The highest leaf weight value (2.32 g) was obtained from the enso-pot type yellow pine sapling obtained from Erzurum nursery.

Table 3. Average morphological data of yellow pine saplings

Packaging	Nursery	Quantity	Diameter (mm)	Height (cm)	Root (g)	Stem (g)	Leaf (g)	Whole Plant	Stem/ Root	Leaf Ratio
Bare root	A.madeni	20	1,07	17,40	1,50	1,09	1,50	4,09	0,73	0,37
Bare root	Erzurum	20	1,25	28,25	1,14	1,05	1,20	3,39	0,92	0,35
Bare root	Sinop	20	1,42	22,85	1,33	1,43	2,26	5,02	1,07	0,45
Bare root	Sarıkamış	20	1,20	18,55	1,31	1,49	1,38	4,17	1,14	0,33
Tube	A.madeni	20	1,01	22,45	1,13	1,02	1,07	3,22	0,90	0,33
Tube	Vezirköprü	20	1,88	32,85	1,12	1,14	2,08	4,34	1,02	0,48
Enso-pot	Of	20	2,45	33,95	1,57	1,57	1,73	4,88	1,00	0,35
Enso-pot	A.madeni	20	1,89	25,30	1,48	1,19	1,64	4,31	0,81	0,38
Enso-pot	Erzurum	20	2,66	31,65	1,63	1,44	2,32	5,39	0,88	0,43

In Table 4, where the Tukey test results of the species with different packaging types included in the study are presented, while the differences between the species without similar letters are different from each other, the differences between the species with similar letters are not statistically significant. When analyzed in terms of diameter, height, root and whole seedling, the differences between bare root, enso-pot and tubular packaging types were found to be statistically significant ($p<0.05$).

When examined in terms of stem, the differences between the bare root and tubular packaging types were not statistically significant ($p>0.05$), while the differences between the seedlings with these packaging types and the enso-coated seedlings were statistically significant ($p<0.05$).

When analyzed in terms of leaf organs, the differences between the seedlings with enso-pot and tube packaging types were not statistically significant ($p>0.05$), while the differences between the seedlings with these packaging types and bare-rooted seedlings were statistically significant ($p<0.05$).

Table 4. Tukey test results of seedling averages in different packaging types

Diameter					**Stem**				
Tukey HSD[a,b,c]					**Tukey HSD[a,b,c]**				
Packaging	Quantity	Subset			Packaging	Quantity	Subset		
		1	2	3			1	2	3
Bare root	140	1,55c			Bare root	140	1,35b		
Tube	100		1,78b		Tube	100	1,36b		
Enso-pot	120			2,16a	Enso-pot	120		1,51a	
Height					**Leaf**				
Tukey HSD[a,b,c]					**Tukey HSD[a,b,c]**				
Packaging	Quantity	Subset			Packaging	Quantity	Subset		
		1	2	3			1	2	3
Bare root	140	27,96c			Bare root	140	1,59b		
Tube	120		31,14b		Tube	100		1,70a	
Enso-pot	100			33,18a	Enso-pot	120		1,75a	
Root					**Whole plant**				
Tukey HSD[a,b,c]					**Tukey HSD[a,b,c]**				
Packaging	Quantity	Subset			Packaging	Quantity	Subset		
		1	2	3			1	2	3
Bare root	140	1,42c			Bare root	140	4,37c		
Tube	100		1,55b		Tube	100		4,62b	
Enso-pot	120			1,71a	Enso-pot	120			4,98a

3.1.2. Analysis findings

The amounts of plant nutrients in the leaves of the species in the study are given in Table 5. Yellow pine has the highest amount of N in its leaves. When analyzed in terms of P, it is seen that the Red pine species with Enso-coated packaging type has the highest amount taken by the leaves. In terms of K, the species with the highest amount of K is enso-coated Yellow pine with 16.18 g/1000 saplings. In terms of Mg element, the highest amount was taken by the leaves of bare-rooted Red pine with 4.59 g/1000 saplings. In terms of Ca, although Ca element was taken by the leaves of both species in the study at similar levels, especially bare-rooted Red pine was differentiated with 18,29 g/1000 saplings compared to other packaging types and species. The highest uptake of sulfur by the leaves of the species was observed in Red pine with tubular packaging type (2.52 g/1000 seedlings)

Table 5. Average amounts of plant nutrients in the leaves of different species (g/1000 saplings)

Packaging	**Sapling**	**Organ**	**N**	**P**	**K**	**Mg**	**Ca**	**Sulphur**
Bare root	Red pine	Leaf	20,99	2,72	9,31	4,59	18,29	2,25
Tube	Red pine	Leaf	23,59	3,71	10,20	3,70	9,82	2,52
Enso-pot	Red pine	Leaf	25,71	4,26	10,44	3,99	19,20	1,77
Bare root	Yellow pine	Leaf	27,58	2,85	8,70	2,59	15,06	1,90
Tube	Yellow pine	Leaf	27,45	2,84	9,55	2,41	10,48	1,45
Enso-pot	Yellow pine	Leaf	27,69	3,78	16,18	2,06	12,72	2,21

Based on the average values of the species, the amounts of plant nutrients in their stems are given in Table 6. The species with the highest amount of N in their stems are enso-covered Yellow pine and Red pine with the same packaging type, respectively. In terms of P, the highest amounts were taken up by the leaves of enso-coated Scots pine and Red pine species. In terms of K, the highest K uptake was 9.16 g/1000 seedlings of scuba Red pine and 9.08 g/1000 seedlings of Yellow pine with enso-pot packaging type. The species with the highest amount of magnesium in the stem organ was bare-rooted Red pine with 3.06 g/1000 saplings, while the species with the highest amount of Ca and S in the stem organ was Red pine with bare root packaging type.

Table 6. Average amounts of plant nutrients in the stems of different species (g/1000 seedlings)

Packaging	Sapling	Organ	N	P	K	Mg	Ca	Sulphur
Bare root	Red pine	stem	10,45	1,76	7,60	3,06	27,47	3,14
Tube	Red pine	stem	12,69	2,54	9,16	2,54	12,49	1,14
Enso-pot	Red pine	stem	13,97	2,68	8,87	2,52	19,74	1,25
Bare root	Yellow pine	stem	11,47	1,69	5,05	2,55	12,32	1,60
Tube	Yellow pine	stem	13,54	1,65	5,91	1,87	5,77	0,84
Enso-pot	Yellow pine	stem	15,56	3,22	9,08	1,59	4,54	2,33

Based on the average values of the species, the amounts of plant nutrients in the roots are given in Table 7. The species with the highest amount of N in the root organ are Yellow pine and Red pine with enso-pot packaging type, respectively. In terms of P, the highest amount of P was taken up by the roots of the species with the same packaging type. In terms of K, the species with the highest K uptake were Red pine with scuba packaging type with 10.26 g/1000 seedlings and the same species with enso-coated packaging type with 9.64 g/1000 seedlings. The species with the highest amount of magnesium element in the root organ (5.20 g/1000 saplings) was bare-rooted Red pine, while the species with the highest amount of Ca element in the root organ was bare-rooted Red pine. When the similar situation was examined in terms of S element, it was determined that the species with the highest amount of S element in the roots was bare-rooted Red pine with 7.52 g/1000 saplings.

Table 7. Average amounts of plant nutrients in the roots of different species (g/1000 saplings)

Packaging	Sapling	Organ	N	P	K	Mg	Ca	Sulphur
Bare root	Red pine	root	9,02	1,79	6,87	5,20	31,77	7,52
Tube	Red pine	root	12,70	3,11	10,26	4,87	16,18	1,20
Enso-pot	Red pine	root	14,78	3,26	9,64	4,78	27,36	1,69
Bare root	Yellow pine	root	12,09	1,87	5,18	2,63	12,34	2,00
Tube	Yellow pine	root	14,48	1,59	5,63	1,74	6,15	1,06
Enso-pot	Yellow pine	root	18,26	3,93	8,26	1,68	5,57	2,28

3.1.3. Nutrient element ratios in leaves

The nutrient concentration ratios in the leaves of coniferous species are given in Table 8.

Table 8. Nutrient concentration ratios in the leaves of coniferous species average

Nursery	Packaging	Species	Organ	N(%)	P(%)	K(%)	Mg(%)	Ca(%)	Sulphur(%)
Dursunbey	Bare root	Red pine	leaf	100	16	51	12	41	11
Ceyhan	Bare root	Red pine	leaf	100	10	42	31	147	6
Torbalı	Bare root	Red pine	leaf	100	12	39	25	91	14
Torbalı	Tube	Red pine	leaf	100	17	61	16	54	12
Sındırgı	Tube	Red pine	leaf	100	14	36	7	27	7
Ceyhan	Tube	Red pine	leaf	100	16	30	30	49	15
Balıkesir	Enso-pot	Red pine	leaf	100	14	41	11	37	9
Denizli	Enso-pot	Red pine	leaf	100	17	41	14	78	6
Torbalı	Enso-pot	Red pine	leaf	100	20	41	24	118	6
Akdağmadeni	Bare root	Yellow pine	leaf	100	9	27	5	64	10
Erzurum	Bare root	Yellow pine	leaf	100	10	33	15	40	7
Sinop	Bare root	Yellow pine	leaf	100	11	36	14	55	5
Sarıkamış	Bare root	Yellow pine	leaf	100	11	32	7	52	6
Akdağmadeni	Tube	Yellow pine	leaf	100	13	47	10	50	6
Vezirköprü	Tube	Yellow pine	leaf	100	8	23	8	27	5
of	Enso-pot	Yellow pine	leaf	100	13	46	6	45	6
Akdağmadeni	Enso-pot	Yellow pine	leaf	100	17	100	7	52	7
Erzurum	Enso-pot	Yellow pine	leaf	100	12	41	9	43	10

The values in the table are elemental ratios calculated based on 100 units of N. Across all nurseries and species, leaves contain 8-20 units of P, 23-100 units of K, 5-31 units of Mg, 27-147 units of Ca and 5-15 units of S for 100 units of N. When species averages are taken, it is seen that there are 10-17 units P, 32-58 units K, 7-22 units Mg, 38-87 units Ca and 5-11 units S for 100 units N (Table 9).

Table 9. Proportional distribution of nutrient concentrations in leaves of coniferous species (for 100 units of nitrogen)

Species	Packaging	Organ	Nursery	N(%)	P(%)	K(%)	Mg(%)	Ca(%)	Sulphur(%)
Red pine	Bare root	leaf	average	100	13	44	22	87	11
Red pine	Tube	leaf	average	100	16	43	16	42	11
Red pine	Enso-pot	leaf	average	100	17	41	16	75	7
Yellow pine	Bare root	leaf	average	100	10	32	9	55	7
Yellow pine	Tube	leaf	average	100	10	35	9	38	5
Yellow pine	Enso-pot	leaf	average	100	14	58	7	46	8

3.1.4. Discussion

Although it is stated that the results of soil analysis are effective on fertilization programs, it has been observed that fertilization is made with the traditional understanding that has been going on for years rather than the results of the analysis. Reich et al. (1997) proved that "the amount of available nitrogen (N) in the soil is a very important limiting factor in the growth of forest trees". Sayman et al. (2002) determined that 28.93 g nitrogen (N); 44.18 g phosphorus (P2O5); 51.18 g potassium (K2O) per unit area (315 seedlings/m2) would be sufficient for fertilization in the cultivation of scuba red pine seedlings under the same conditions, considering economic factors. Ayan (1998), in a study carried out in Yellow Pine (*Pinus silvestris L.*), it was concluded that the seedlings produced in systems with slow-acting fertilizer additives showed sufficient growth only in terms of height in terms of compliance with TSE standards, but not in terms of crotch diameter. Fertilization needs will also vary according to the type of seedlings produced (broadleaf or coniferous) and the type (bare-root or tubed/closed). Leaf analysis as well as soil analysis is necessary to determine these needs (Landis et al., 2005).

4. Conclusion and Suggestions

Afforestation activities are significant investments for the development of our forests. Our nurseries, which provide the most critical input of these investments, must be developed and made functional at scientific and technical levels. Considering the amount of fertilizer used by the nurseries in the nursery production phase, it is seen that especially nitrogen fertilizers are used in excessive amounts. It is understood that the soil analysis results of the related nurseries and the fertilizer types and dosages used do not scientifically coincide with each other. Fertilizers that accumulate in the soil due to excessive use create residues in the environment and increase costs.

In particular, more organic-based fertilizers should be preferred than inorganic fertilizers. The adverse effects of chemical fertilizers containing excessive salt on both physical and chemical structure are seen from the nursery analysis results. The types of fertilizers preferred by nurseries generally consist of generic products. Using new generation fertilizers, slow-release, organomineral, multi-component water-soluble composites should be encouraged and product trial areas should be established in pilot regions.

Variables such as different seedling densities, irrigation, fertilization types, and dosages applied by nurseries directly affect the quality of the seedlings produced. Large saplings eventually take much more nutrients from the soil, while small saplings take much less. Therefore, instead of standard fertilization, it would be appropriate for each nursery to apply different feeding programs depending on the species produced and the quality characteristics targeted in each species.

The values in the study will at least partially inform the implementing producers about how much fertilizer should be applied in the cultivation of Red pine and Yellow pine sapling species. By relating the nutrient values removed from the soil by a certain number of saplings in the study to the number of saplings per unit area, it can be estimated how much nutrients the saplings receive on an area basis and how much nutrients should be replaced after uprooting.

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Author Contribution and Conflict of Interest Declaration Information

The author declares that there is no conflict of interest in the article.

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