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Kilci M.

in

Mutke S. (ed.), Piqué M. (ed.), Calama R. (ed.).
Mediterranean stone pine for agroforestry

Zaragoza : CIHEAM / FAO / INIA / IRTA / CESEFOR / CTFC
Options Méditerranéennes : Série A. Séminaires Méditerranéens; n. 105

2013
pages 21-28

Effects of nutrients on cone losses of stone pine (*Pinus pinea* L.) in Kozak Basin

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Abstract. Kozak Basin is located in Bergama District in Izmir Province. The basin is a bowl-shaped stone pine forest area, with a size of 16,000 hectares, which occupies one-third of the total stone pine area in Turkey. Almost all the forest area in the Basin is private. In recent years, cone losses of stone pine have increased. For this reason, in this study 8 different areas were examined to determine the relations between cone losses and nutrients over the 2005-2008 period. Almost all of cone losses occurred in the new conelets according to the results of cone counting in the sampling area. Therefore, evaluations were conducted based on this period. Significant differences in cone losses were found between years and localities. To determine the relationship between cone losses and nutrients, one-, two- and three-year old needles were taken from the sample trees and their size and weight were measured, then the samples were analysed in terms of micro- and macro nutrients. Soil samples were taken beneath the same sample trees and analysed. By examining the relationship between cone losses and nutrients in the needles, a negative correlation between cone losses and nitrogen (N), phosphorus (P), calcium (Ca) and manganese (Mn) could be determined. In other words, when these nutrients diminished, cone losses increased. It is considered that among these elements, especially P and Ca combined with drought could be a factor in cone losses.

Keywords. Stone pine – Cone loss – Cone yield – Nutrient.

Effet des nutriments sur les pertes en cônes chez le pin pignon (**Pinus pinea** ***L.) dans le bassin de Kozak***

Résumé. *Le bassin de Kozak se trouve situé dans la zone de Bergama, province d'Izmir. Ce bassin est une zone forestière de pins pignons en forme de cuvette, d'une superficie de 16000 hectares, qui représente un tiers de la surface totale de pin pignon de la Turquie. Presque toute la surface forestière de ce bassin est de propriété privée. Dernièrement, la perte de cônes chez les pins pignons s'est accrue. C'est pour cette raison que dans le cadre de cette étude, 8 zones différentes ont été examinées afin de déterminer le rapport entre les pertes de cônes et les nutriments disponibles sur 2005-2008. Pratiquement toutes les pertes de cônes avaient lieu sur les jeunes cônes selon les résultats du dénombrement dans la surface d'échantillonnage. Donc, des évaluations ont été menées basées sur cette période. Des différences significatives de perte de cônes furent trouvées entre années et localités. Afin de déterminer le rapport entre perte de cônes et nutriments, des aiguilles de pin d'une, deux et trois années d'âge furent prélevées sur les arbres échantillonnés pour mesurer leur taille et leur poids, et pour les analyser ensuite concernant les micro et macronutriments. Des échantillons de sol furent prélevés sous ces mêmes arbres échantillonnés, et analysés. D'après l'examen du rapport entre pertes de cônes et nutriments dans les aiguilles de pin, une corrélation négative a été déterminée entre pertes de cônes et azote (N), phosphore (P), calcium (Ca) et manganèse (Mn). Autrement dit, lorsque ces nutriments diminuaient, les pertes de cônes augmentaient. On considère que parmi ces éléments, ce sont spécialement le P et le Ca qui, combinés à la sécheresse, pourraient être un facteur intervenant dans la perte de cônes.*

Mots-clés. *Pin pignon – Perte de cônes – Production de cônes – Nutriment.*

I – Introduction

Kozak Basin is located in Bergama District in Izmir Province. The basin is a bowl-shaped stone pine forest area, with a size of 16,000 hectares, which occupies one-third of the total stone pine area in Turkey. Almost all the forest area in the Basin is private, some belongs to the Government. There seems to be a decrease in cone productivity in various parts of the Basin since 2005. Therefore, this study aims to identify the effects of nutrients on conelet losses of stone pine in Kozak Basin in Izmir Province. For this purpose, relationships were investigated between nutrition status of trees in the same watershed from different localities and conelet losses. Thus, soil properties and nutrient contents of sampling areas and nutrient contents of needles were analysed and determined statistically.

Up to now, the Basin has been subjected to several studies focusing on different aspects. Çukur (1994) examined natural potential of growth conditions of stone pine communities in Aegean region and their contribution to the economy of the region and the country. Bilgin and Ay (1997) investigated pine nut industry in Bergama -Kozak and Aydın- Koçarlı regions in Aegean region and its contribution to the economy. Kılcı *et al.* (2000) studied the factors affecting stone pine growth in the west of Anatolia –which also includes Kozak region– and revealed the ecological characteristics of the natural and planted stone pine areas, compared them and gave suggestions for new plantation areas. Another study, which is currently continued by Kılcı and his colleagues, will give the effect of fertilization on cone productivity in a stone pine plantation area bearing low yield in Kozak region at the end of 2012. Calama *et al.* (2007) analysed the effect of mineral fertilization on cone production and size, which are closely related to nut yield and quality in south west Spain and compared the effect of different doses of lime superphosphate, dolomite and potassium.

II – Materials and methods

The material of this study was composed of one-, two- and three-year old cones and needles and soil samples in stone pine stands in Kozak Basin.

In this study, the relationships between nutrients and conelet losses in eight different sampling areas in Kozak province were determined in 2005-2008. Plots placed in Kozak region on granite bedrock were determined from two altitudes (500 m and above, 500 m and below), two wind conditions (open to sea wind and not) and number of cones on tree (few and abundant). In total, eight sampling areas were chosen with these factors (Table 1). Five trees and two branches on each tree –preferably middle parts of the trees– a total of 80 branches were chosen and marked. All branches were determined twice a month during the vegetation period, once a month out of the vegetation period, and then one-year old cones (conelets), two- and three-year old cones were counted. In the top 1/3 part of the crown, and from the branches in the sunny side, one-, two- and three-year old needles from each tree were collected for the analysis. In each sample site soil samples representing the area were taken for the determination of the physical and chemical properties and macro-micro elements of soil regarding soil horizons.

Table 1. Locations and some properties of sampling areas

Field No.	Altitude (m)	Sea wind	Cone existence	Average rainfall (mm)†
1	718	-	+	939
2	577	-	-	743
3	688	+	+	939
4	380	+	-	743
5	225	+	-	743
6	245	-	-	743
7	523	+	+	743
8	450	-	+	939

†Source DSİ (1963-1998).

III – Results

1. Soil properties

Bedrock material of all the sampling areas is granite. Soil properties are given in Table 2 as averages of horizons. This bedrock creates coarse textured soils when it is fragmented. Soils of all sampling areas have coarse texture. As is seen in Table 2 soils are sand, loamy sand and sandy loam. Soil reaction (pH) of all areas is between 6.07 and 6.67. Therefore, they are slightly acidic and neutral. Additionally, soils of all areas are salt- and lime- free. Organic material amounts of top soils in the sampling areas are between 1.7 and 8.1%. All areas have high and very high organic matter content. There are differences between sampling areas in terms of the nutrients.

2. Needle properties

Figure 1 shows the needle lengths determined in the study area. The lengths of the needles collected from the sampling areas were between 9.56 and 14.95 cm. Our observations showed that there was a lack of water in the sampling areas 2, 4, 5, and 6 (there is no evidence of water in those plots such as a stream or spring) in the summer months (though there is no meteorological station around the study area except for the DSI rainfall station). Therefore, the needle lengths in those sampling areas were shorter and they were sparse. Almost all of the three-year old needles fell on the ground. In the sampling areas 1, 3, 7 and 8 there was no lack of water (there are some springs pouring even in summertime) and the needle lengths were longer in those areas.

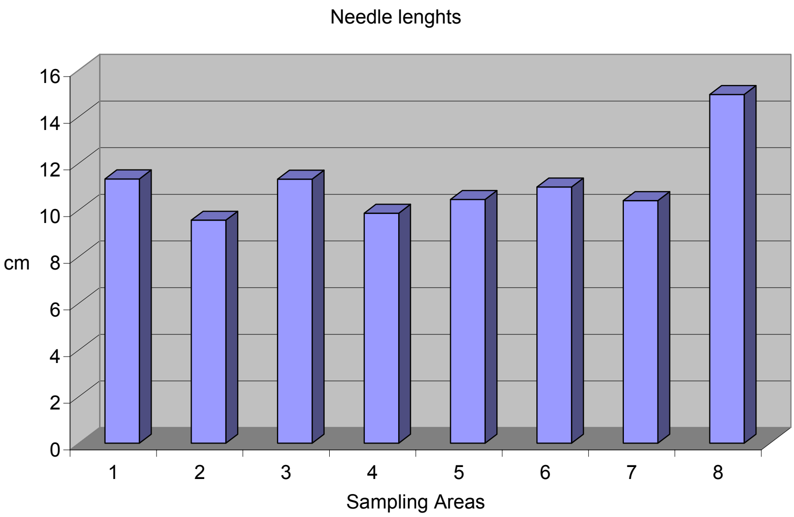

Fig. 1. Mean needle lengths (cm) determined in the sampling areas.

Fresh weights of the needles were 10.27-17.87 g (g/100 needles), and dry weights of them were 4.53-7.79 g (g/100 needles) (Fig. 2).

Table 2. Physical and chemical properties of soils in the study area

Plot No.	Sand (%)	Clay (%)	Silt (%)	Texture (USDA)	pH (1:2.5 water)	N (%)	P (ppm)	K (ppm)	Ca (ppm)	Mg (ppm)	Na (ppm)	Fe (ppm)	Cu (ppm)	Zn (ppm)	Mn (ppm)
1	73.97	6.77	19.25	SL	612	0.08	8.8	75	2166	448	9	35	0.5	0.7	26.7
2	71.92	8.13	19.95	SL	6.11	0.12	42.6	182	982	491	10	27	0.8	1.9	25.3
3	75.25	7.13	17.61	LS	6.07	0.11	29.5	110	876	250	9	19	0.7	3.5	20.2
4	80.92	4.80	16.28	LS	6.43	0.15	15.9	110	1490	355	6	10	0.5	4.8	29.5
5	82.25	4.80	12.95	LS	6.54	0.08	8.9	92	1153	295	6	6	0.8	3.5	47.9
6	77.59	7.80	14.61	LS	6.69	0.06	7.8	90	1123	378	9	6	0.8	1.6	25.4
7	78.59	5.80	14.95	LS	6.41	0.06	5.3	55	1166	348	20	15	0.3	1.0	17.6
8	88.59	2.47	8.95	S	6.19	0.13	9.0	46	703	166	9	40	0.7	2.3	12.9

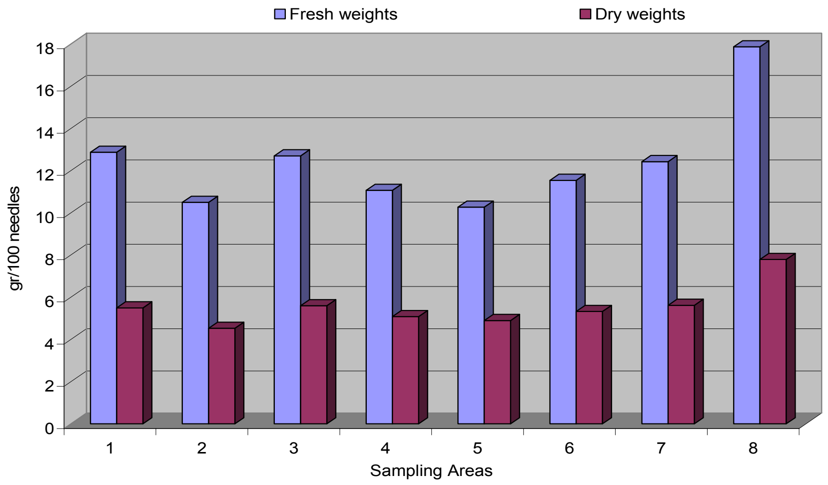

Fig. 2. Mean needle fresh and dry weights determined in the sampling areas (g/100 needles).

3. Cone losses

Figure 3 shows one-year old cone losses in the sampling areas in 2005-2008. In all sampling areas, most of the cone losses were observed in one-year old cones. Therefore, these conelet losses were taken into account in the evaluations. In the sampling areas 2, 4, 5 and 6 most of the cone losses happened in one-year olds. In some areas the trees had normal amount of conelets at the beginning of the season, but especially in July and August they lost almost all of their conelets. For example, in the 1st sampling area, 65 conelets were counted at the beginning of the season in 2005. At the end of the season, 62 of them were alive. But in the 4th sampling area, 111 conelet were counted at the beginning of the season. By the end of July, only half of this amount was alive. Only one conelet stayed alive at the end of the summer season. The sampling areas 1, 3, 7 and 8 had higher living percentage of conelets than the other sampling areas.

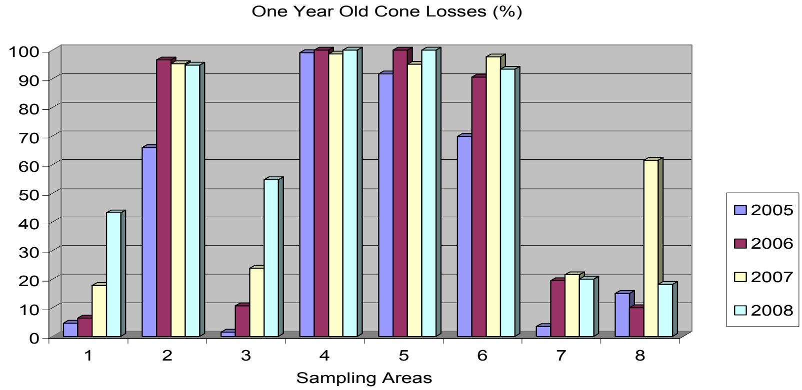

Fig. 3. One-year old cone losses in the sampling areas according to the year.

According to the statistical assessments there was a negative correlation between cone losses and altitude, needle lengths, needle fresh/dry weights (Table 3) and some nutrients in the needles (Table 4). However there no correlation was found between conelet formation or needle size and altitude.

Table 3. Correlation of cone losses and needle lengths, needle fresh/dry weights and altitude

	Length of needle	Needle fresh weight	Needle dry weight	No. of conelet	Conelet loss	Percentage of loss	Altitude
Length of needle		0.885**	0.863**	-0.126ns	-0.273ns	-0.361*	0.044ns
Needle fresh weight	0.885**		0.917**	-0.133ns	-0.429**	-0.506**	0.241ns
Needle dry weight	0.863**	0.917**		-0.104ns	-0.295ns	-0.364*	0.051ns
No. of conelet	-0.126ns	-0.133ns	-0.104ns		0.588**	0.090ns	0.000ns
Loss of conelet	-0.273ns	-0.429**	-0.295ns	0.588**		0.691**	-0.550**
Percentage of loss	-0.361*	-0.506**	-0.364*	0.090ns	0.691**		-0.776**
Altitude	0.044ns	0.241ns	0.051ns	0.000ns	-0.550**	-0.776**	

V – Discussion

The sampling areas were located on granite bedrock and lime-free soil. Almost all of the cone losses occurred in one year-old cones with respect to the cone counts in the sampling areas. Therefore, this period was taken into account for the evaluations. There were significant differences determined in cone losses between years and regions (Fig. 3). Except for the sampling area 1, the rest of the areas have low Ca content in the soil (Table 2). It was determined that cone losses increased while N, P, Ca and Mn amounts of the needles decreased (Table 4). Among these elements, especially P and Ca displayed more significant results during the correlation analysis. It is known that these elements have positive effects on fruit and seed formation (Kaçar, 1977; Özbek *et al.*, 1984). Calama *et al.* (2007) showed that best cone crops are attained with treatments adding larger amounts of phosphorous, potassium chloride and dolomite, leading to average crops per stone pine tree over 3 times larger than control in the sandy areas having low nutrients and lime content in Spain. The differences among Ca amounts in the sampling areas might be resulted from the location of the sampling fields and the existence of water leakage.

Correlation analysis was applied to question the relationship between needle lengths, needle fresh/dry weights and cone losses, and a negative correlation was detected in between them (Table 3). Cone losses increased while needle length and needle fresh/dry weight decreased. The reason of this situation might be water deficiency. Thus, in plot 8 there is no water deficiency because of topographical conditions (it is placed in flat area in lower altitude); although there is lower soil nutrient content in this area than in other plots, water sufficiency reduces cone losses.

There were also field comparisons conducted in relation to the cone losses (Fig. 3). In some fields, as field no 2 and 4, cone losses were abundant although there were much more nutrients in the soil. However it was determined that the trees did not take the nutrients sufficiently according to the data such as needle lengths, needle weights and needle nutrient content. Water deficiency in the soil might be the reason for this situation. Since it was found that there are soluble nutrients like K, Ca, Mg, Na, PO_4 and NO_3 in gravitation water in the other parts of Kozak region (Kılcı *et al.*, 2000).

Table 4. Correlation of cone losses and (macro and micro) nutrient contents in needles

	N	P	K	Ca	Mg	Na	Fe	Cu	Zn	Mn	Conelet counted	Conelet loss	Conelet loss (%)
N		0.68 **	0.56 *	0.40 **	0.45 **	0.73 **	0.80 **	0.07 ns	0.06 ns	-0.02 ns	-0.08 ns	-0.26 ns	-0.37 *
P	0.68 **		0.56 **	0.39 *	0.24 ns	0.31 ns	0.61 **	0.09 ns	0.01 ns	0.28 ns	-0.19 ns	-0.34 *	-0.34 *
K	0.56 **	0.56 **		0.38 *	0.09 ns	0.35 *	0.53 **	0.20 ns	0.06 ns	0.24 ns	0.09 ns	-0.21 ns	-0.31 ns
Ca	0.40 **	0.39 *	0.38 *		0.39 *	0.15 ns	0.19 ns	0.19 ns	0.40 *	0.55 **	0.08 ns	-0.18 ns	-0.47 **
Mg	0.50 **	0.23 ns	0.09 ns	0.39 *		0.35 *	0.32 *	-0.20 ns	0.21 ns	0.04 ns	0.23 ns	0.23 ns	0.05 ns
Na	0.73 **	0.31 ns	0.35 *	0.15 ns	0.35 *		0.61 **	-0.01 ns	0.10 ns	-0.29 ns	-0.05 ns	-0.03 ns	-0.18 ns
Fe	0.80 **	0.61 **	0.53 **	0.19 ns	0.32 *	0.61 **		0.06 ns	-0.20 ns	-0.15 ns	-0.06 ns	-0.23 ns	-0.27 ns
Cu	0.07 ns	0.09 ns	0.20 ns	0.19 ns	-0.20 ns	-0.01 ns	0.06 ns		0.35 *	0.18 ns	-0.19 ns	-0.16 ns	-0.04 ns
Zn	0.06 ns	0.01 ns	0.06 ns	0.405 *	0.21 ns	0.10 ns	-0.20 ns	0.35 *		0.42 **	0.08 ns	0.02 ns	-0.13 ns
Mn	-0.02 ns	0.28 ns	0.24 ns	0.55 **	0.04 ns	-0.29 ns	-0.15 ns	0.18 ns	0.42**		-0.14 ns	-0.41 **	-0.48 **
Conelet counted	-0.08 ns	-0.19 ns	0.09 ns	0.08 ns	0.23 ns	-0.05 ns	-0.06 ns	-0.19 ns	0.08 ns	-0.14 ns		0.56 **	0.09 ns
Conelet loss	-0.26 ns	-0.34 *	-0.21 ns	-0.18 ns	0.23 ns	-0.037 ns	-0.23 ns	-0.16 ns	0.02 ns	-0.41 **	0.60 **		0.71 **
Conelet loss (%)	-0.37 *	-0.335 *	-0.310 ns	-0.471 **	0.052 ns	-0.176 ns	-0.269 ns	-0.041 ns	-0.128 ns	-0.477 **	0.088 ns	0.706 **	

Acknowledgements

I would like to thank Dr. Devrim Semizer-Cuming for the help with the translation.

References

Anonymous, 2011. DSI Rainfall Data, 1963-1998. DSI. (in Turkish).

Anonymus, 2006. Stone Pine Action Plan. Republic of Turkey Ministry of Environment and Forestry, General Directorate of Forestry 24 p. (in Turkish).

Bilgin F. and Ay Z., 1997. Socio-Economic Studies on Stone Pine (*Pinus pinea* L.) Farming Systems in Aegean Region, Ege Forestry Research Institute, No: 8, Izmir, Turkey (in Turkish).

Bremner J.M., 1965. Total Nitrogen In: *Methods of Soil Analysis.* Part 2. C.A. Black (ed.), Amer. Soc. of Agr. Inc., Madison, Wisconsin.

Calama R., Madrigal G., Candela J.A. and Montero G., 2007. Effect of fertilization on the production of an edible forest fruit: Stone pine (*Pinus pinea* L..) nuts in south-west Andalusia. In: *Investigación Agraria: Sistemas y Recursos Forestales*, 16(3), p. 241-252.

Çukur H., 1994. Natural Potential of Growth Area of Stone Pine (*Pinus pinea* L.) in Aegean Region and their Economical Contributions to the Country. Dokuz Eylül University, Social Science Institute, Geography, USA, PhD, Thesis, 27 p. (in Turkish).

Gülçür F., 1974. Physical and Chemical Analysis Methods of Soil, İ.Ü. Faculty of Forestry, Publication No: 201 (in Turkish).

Hart J., 1997. Analytical Laboratories Serving Oregon [online], FG 74, Oregon State University, Corvallis, http://193.255.91.11/journal/1302-0056/2002-03-04/2004/Volume 6/ Number 6/142-152.pdf [Consulted in September 2011].

Jackson M.L., 1958. *Soil Chemical Analysis*. Prentice-Hall Inc. Englewood Cliffs, New Jersey, USA.

Kacar B., 1972. *Chemical Analysis of Soil and Plants II, Plant Analysis.* Ankara University Faculty of Agriculture Pub. No: 453 (in Turkish).

Kacar B., 1977. *Plant Nutrition*. Ankara University, Faculty of Agriculture, Publication No: 637, Ankara (in Turkish).

Kacar B., 1993. *Chemical Analysis of Soil and Plants*. Ankara University Faculty of Agriculture, Education, Research and Development Association, Publication No: 3, Bizim Büro Publishing, Ankara (in Turkish).

Kılcı M., Sayman M. and Akbin G., 2000. The Factors Which Affect the Growth of Stone Pine (*Pinus pinea* L.) in West Anatolia Region. Ministry of Forestry, Pub, No: 115, İzmir Forestry Soil Lab., Publication No: 9, İzmir, 130 p (in Turkish).

Kılcı M., Sayman M. and Akbin G., 2003. F*orest Ecosystems and Soil Survey.* İzmir Forest Soil Laboratory, Publication No: 16, Izmir, Turkey (in Turkish).

Özbek H., Kaya Z. and M. Tamcı 1984. *Plant nutrition and metabolism* (Translated from K. Mengel). Çukurova University Faculty of Agriculture, Publication No: 162, 590 p. (in Turkish).