Determination of biomass of European pine mistletoe (*Viscum album* ssp. *austriacum* (Wiesb.) Vollman) on infected Scots pine (*Pinus sylvestris* L.) branches

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Abstract

European pine mistletoe, *Viscum album* ssp. *austriacum* (Wiesb.) Vollman, is a semi-parasitic plant growing on many tree species. Mistletoe produces its own food using water and mineral nutrients from host tree by phytosysnthesis. This biotic pest is commonly found in pure Scots pine forests, *Pinus sylvestris* L., of Eastern Black Sea Region, resulting in substantial diameter increament and growth loss, and even the death of host tree. All these call for more information about the effect of mistletoe on trees. The objective of this study is to determine the biomass of mistletoe and pine needles on infected branches of scots pine and conduct a comparative analysis with the biomass of uninfected branches. In this regard 98 mistletoe infected and 47 uninfected branches were cut off from different parts of tree crowns of scots pine trees growing on the same site within the boundaries of Şiran State Forest Enterprise. Allometric measurements were carried out in the field, and oven dry weight of each sample were determined in the laboratory. Correlation and regression analyses were conducted to examine relationship between several variables and to develop regression models. The results of this study can be an invaluable contribution to modelling the effects of this pests on host tree and also controlling mistletoe damage.

Key words: European pine mistletoe, *Viscum album* ssp. *austriacum*, Scots pine, Biomass

Introduction

European pine mistletoe, *Viscum album* ssp. *austriacum* (Wiesb.), is a semi-parasitic evergreen plant growing on many plants including Scots pine (Preston 1977, Norton et al. 2002, Mathiasen et al. 2008, Dobbertin & Rigling 2006, Rigling et al. 2010, Galiano et al. 2011, Zweifel et al. 2012, Sanguesa-Barreda et al. 2013). Extracting water and mineral nutrients from host tree and producing its own food through photosynthesis (Zuber, 2008), mistletoe causes a decrease in height and diameter growth of host tree. This mistletoe is commonly found in pure Scots pine forests, *Pinus sylvestris* L., of Eastern Black Sea Region resulting in diameter and growth loss (Eroğlu ve et al., 1993, Bilgili et al. 2013b, Kanat et al. 2010, Catal & Carus 2011). Furthermore, depending on the number and proportion of mistletoe on trees, even the death of host tree can also be seen (Kenaley et al. 2008, Sanguesa-Barreda et al. 2013). Thus, adverse effects caused by mistletoe on forests give birth to a need to have more information about this biotic pest. The objective of this study is to determine and compare the biomass of both mistletoe and pine needles on infected branches of scots pine and the biomass of pine needles on uninfected branches.

Material and Methods

The study area was carried out on forests of scots pine within the boundaries of Şiran State Forest Enterprise. A total of 98 Infected and 47 uninfected branches from forests of scots pine from the same habitats were cut from different sections of the host trees (Figure 1).

Stem diameter at the base (mm), crown length (cm), height (cm) and morphological age (year) (Bilgili et al. 2013a) of mistletoe is determined (Figure 2,3a). In addition, diameter of tree branches (mm) before and after mistletoe was measured (Figure 2, 3).

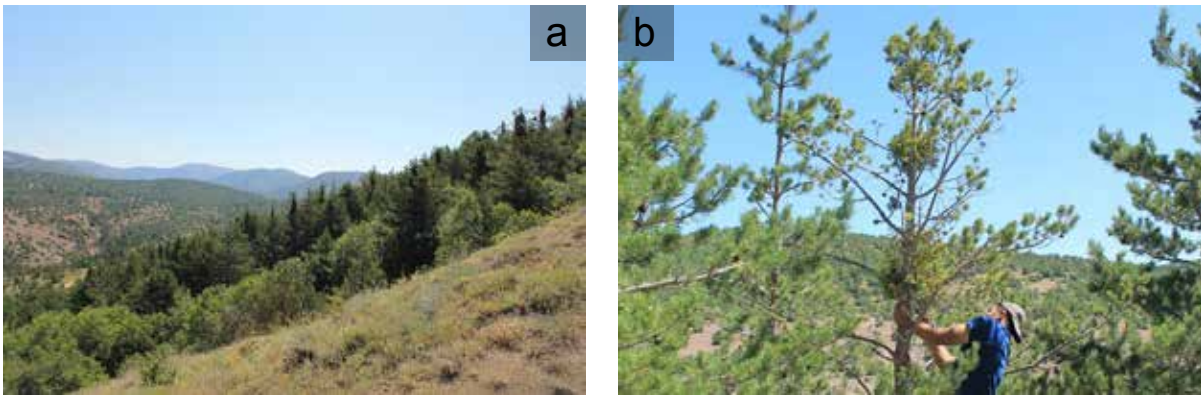

Figure 1. Supply of infected branches of mistletoe to be used in the studies of mistletoe and pine needle biomass (b) and general view from forests of scots pine collected (a)

Figure 2. Measuring height (c) and stem diameter (d) of mistletoe.

Figure 3. Measurements of crown length of mistletoe (a) and the diameter of tree branch after mistletoe (b)

To determine the total biomass, samples were separated into groups of pine needle – branch and mistletoe leaf – branch and numbered and put inside sample dishes in the laboratory. All of the samples were dried in oven and weights as oven-dried were determined (Figure 4).

Figure 4. Separation of infected and uninfected branches into different sections (a) and numbering them (b)

All the samples were oven-dried at 105 ºC and kept inside oven for 24 hours or until no changes seen in their weights and weighed with 0.01 gr precision to determine biomass (Figure 5). Obtained data were recorded on the carnets of inventory and database was prepared.

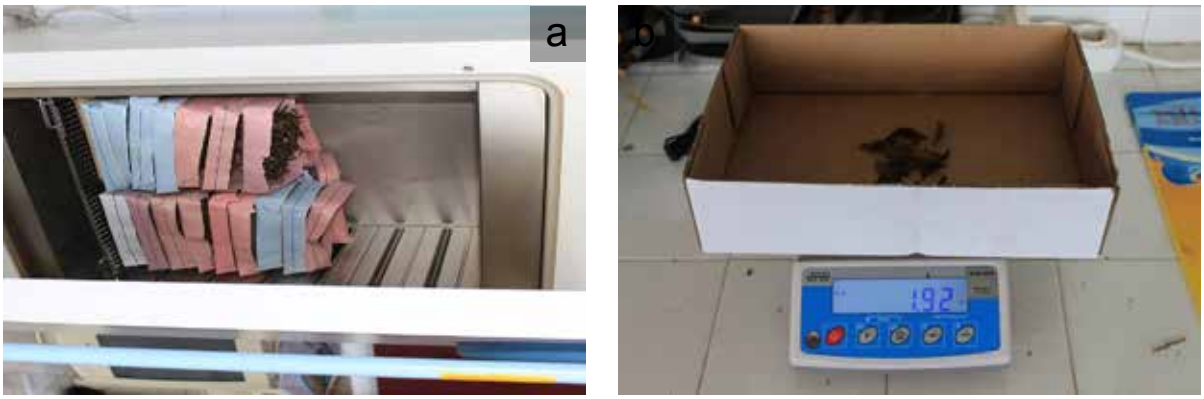

Figure 5. Determination of oven-dry weights of each samples (a, b).

Resource

Correlation and regression analyses were conducted over data. As a result of correlation analyses, significant correlation between mistletoe biomass and mistletoe stem diameter (r=89,5; p<0,01), crown diameter (r=78,8; p<0,01) and height (r=64,9; p<0,01) was identified. In addition, high correlation was found between mistletoe stem diameter and crown diameter (r=81,6; p<0,01), height and crown diameter (r=92,2; p<0,01). The results of correlation analysis for uninfected branches show that there was high correlation between total pine needle amount and branch diameter (r=87,6; p<0,01).

Discussion and Results

Linear regression analyses yielded the following model (1) that explained %91 of the variability in the total biomass of mistletoe when the mistletoe stem diameter was used as independent variable (Figure 3).

ln(total mistletoe biomass)= -2,475+2,169×ln(mistletoe stem diameter) (r2=0.91) (1)

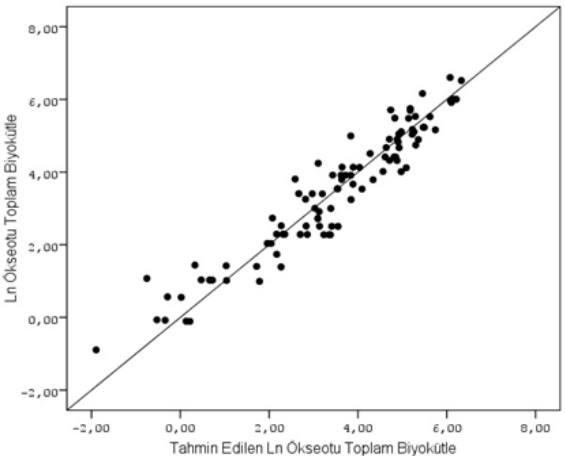

Figure 3. The relationship between measured and predicted total biomass of mistletoe. Cross straight line represents full compliance.

To predict the total pine needle amount on mistletoe infected branches, the model (2) obtained through using the diameter of branch after mistletoe as an independent variable explained %71 of the variability in total pine needle biomass (Figure 4).

Ln (total pine needle biomass)=-2,486+2,252×ln(branch diameter after mistletoe) (r2=0.71) (2)

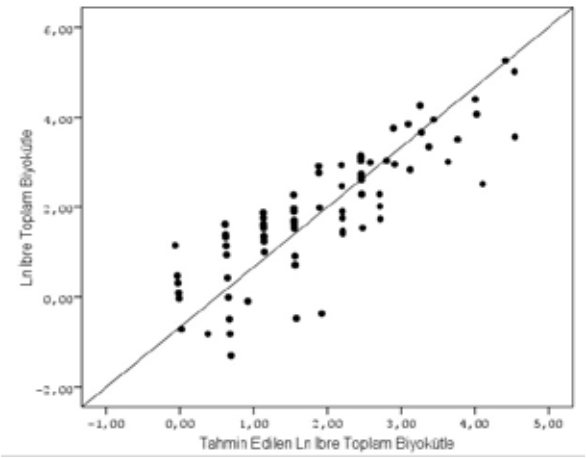

Figure 4. The relationship between measured and predicted biomass of total leaf of infected branch. Cross straight line represents full compliance.

Being obtained as a result of regression analysis on uninfected branches, the model (3) explained %89 of the variability in total pine needle biomass depending on the diameter of branch (Figure 5).

ln (total leaf biomass)=-0,564+1,666×ln(branch diameter) (r2=0.89) (3)

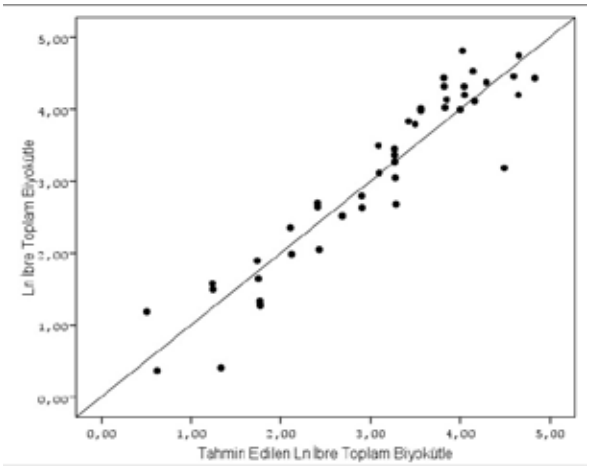

Figure 5. The relationship between measured and predicted total pine needle biomass of uninfected branch. Cross straight line represents full compliance.

Models show that there is difference in the total pine needle amount for the same diameter of the infected and uninfected branches, which can be considered effect of mistletoe on trees. Conducting accurate measurements on infected and uninfected trees may produce significant results for revealing this situation. Results of this study can be used for studies of modeling the effect of mistletoe on host tree and may make significant contributions to pest control.

Acknowledgement

This study was supported by TUBITAK "The Scientific and Technological Research Council of Turkey, Project No: TOVAG-112O258".

References

Bilgili, E., Serdar B., Eroğlu, M., Coşkuner K.A. and Baysal, İ. 2013a. Determination of age of Mistletoe (*Viscum album* ssp. *austriacum* (Wiesb.) Vollman) on Scots pine (*Pinus sylvestris* L.). International Caucasian Forestry Symposium. Page 27, 24-26 October 2013. Artvin

Bilgili, E., Eroğlu, M., Baysal, İ. and Coşkuner K.A. 2013b. Distribution of Mistletoe (*Viscum album* L.) and Damage Level in Scots Pine (*Pinus sylvestris* L.) Forests: A Case Study in Zigana State Forest Enterprise. International Caucasian Forestry Symposium. Page 34, 24-26 October 2013. Artvin

Catal, Y. and S. Carus. 2011. Effect of pine mistletoe on radial growth of crimean pine (*Pinus nigra*) in Turkey. Journal of Environmental Biology 32:263-270.

Dobbertin, M. and A. Rigling. 2006. Pine mistletoe (*Viscum album* ssp *austriacum*) contributes to Scots pine (*Pinus sylvestris*) mortality in the Rhone valley of Switzerland. Forest Pathology 36:309-322.

Eroğlu, M., Bilgili E., Başkaya, Ş. 1995. Research on Spread, Density and Effect of *Viscum album* L. on the Development of Trees in Scots Pine Forests. 1st National Forestry Congress 160-168 23-25 October. Trabzon

Galiano, L., J. Martinez-Vilalta, and F. Lloret. 2011. Carbon reserves and canopy defoliation determine the recovery of Scots pine 4 year after a drought episode. New Phytologist 190:750-759.

Kanat, M., M. H. Alma, and F. Sivrikaya. 2010. The effect of *Viscum album* L. on annual diameter increment of *Pinus nigra* Arn. African Journal of Agricultural Research 5:166-171.

Kenaley, S., R. Mathiasen, and E. J. Harner. 2008. Mortality associated with a bark beetle outbreak in dwarf mistletoe-infested ponde*Rosa* pine stands in Arizona. Western Journal of Applied Forestry 23:113-

120.Mathiasen, R. L., D. L. Nickrent, D. C. Shaw, and D. M. Watson. 2008. Mistletoes: Pathology, systematics, ecology, and management. Plant Disease 92:988-1006.
Norton, D. A., J. J. Ladley, and A. D. Sparrow. 2002. Host provenance effects on germination and establishment of two New Zealand mistletoes (Loranthaceae). Functional Ecology 16:657-663.

Preston, A. P. 1977. Effects of Mistletoe (*Viscum album* L.) on Young Apple-Trees. Horticultural Research 17:33-&.

Rigling, A., B. Eilmann, R. Koechli, and M. Dobbertin. 2010. Mistletoe-induced crown degradation in Scots pine in a xeric environment. Tree Physiology 30:845-852.

Sanguesa-Barreda, G., J. C. Linares, and J. J. Camarero. 2013. Drought and mistletoe reduce growth and water-use efficiency of Scots pine. Forest Ecology and Management 296:64-73.

Zuber, D., K. 2008. Biology and Evoluation of Eurpean Mistletoe (*Viscum album*). Phd Theis. Diss. ETH No. 18080

Zweifel, R., S. Bangerter, A. Rigling, and F. J. Sterck. 2012. Pine and mistletoes: how to live with a leak in the water flow and storage system? Journal of Experimental Botany 63:2565-2578