Journal of Cleaner Production 81 (2014) 146–149

Contents lists available at ScienceDirect

Journal of Cleaner Production

journal homepage: www.elsevier.com/locate/jclepro

The effects of marble wastes on soil properties and hazelnut yield

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ARTICLE INFO

Article history:
Received 2 April 2014
Received in revised form
29 May 2014
Accepted 3 June 2014
Available online 11 June 2014

Keywords:
Marble waste
Soil amendment
Soil acidity
Hazelnut yield

ABSTRACT

Wastes generated in the dimension stone industry have become an environmental concern in Turkey which is one of the leading dimension stone (mostly marble and travertine) producers in the world. Use of such wastes rich in $CaCO_3$ for the remediation of acidic and calcium deficient soils might be an environmentally sound way to reduce the amount of wastes to be disposed. The objective of this study was to determine the effects of marble quarry and cutting wastes on the soil properties and Tombul hazelnut cultivar under the field conditions. Field tests were conducted for one year in Giresun, Turkey. The results showed that marble wastes had a significant effect on the neutralization of the soil as well as on the hazelnut yield. The soil pH was increased from 4.71 to 5.88 upon marble waste application at rates equal to agricultural lime requirement. Hazelnut yield increased from 1120.3 kg ha^{-1} on the field with no marble waste treatment to 1605.5 kg ha^{-1} with marble wastes. This study indicates that marble quarry and cutting wastes could be used in the hazelnut fields for the neutralization of acidic soil to increase the yield.

1. Introduction

Turkey has large deposits of high quality marble and is one of the leading producers (Celik and Sabah, 2008). Large quantities of wastes are produced in different stages of marble quarrying and processing operations. It is estimated that only 10–20% of the marbles excavated are made into the final products. The rest is discarded as waste in the form of substandard blocks, chips, cutting sludge, etc. In whatever form the wastes may be, they pose serious environmental problems. Many researchers have recently been involved in finding a solution to this problem. Most have explored the possibility of the use of marble wastes in various areas such as building materials, bricks, ceramics and cement additives (Bilgin et al., 2012; Gazi et al., 2012; Aliabdo et al., 2014). It has been determined that fine marble wastes can also be used as an amendment for acidic soil (Tozsin et al., 2014). It is a well known practice to treat acidic soils with lime to increase the pH of the soil as well as to introduce free Ca^{++} ions for cation exchange needed for the amelioration of the soil (Mylona et al., 2000; Aarab et al., 2006; Potgieter-Vermaak et al., 2006; Kumpiene et al., 2008; Ciancio et al., 2014). Zornoza et al. (2012) studied the soil biochemical properties in a mine tailing pond five years after application of marble wastes and it was concluded that values for most biochemical properties were higher in treated soils than in control (untreated soils). The economic benefits of marble waste utilization attributes to the reduction of the amount of agricultural lime. Environmentally, when marble wastes are recycled, less material is dumped as landfill and more natural resources are saved (Kelestemur et al., 2014).

On the other hand, Turkey is the leading hazelnut producer of the world, supplying approximately 70% to the total global production, followed by Italy (12%), the United States (6%) and Spain (2%) (Oliveira et al., 2008; Ozdemir and Akinci, 2004). Therefore, hazelnut grown in the Black Sea Region of Turkey is very important in terms of country's economy (Koksal et al., 2006; Ackurt et al., 1999; Demirbas et al., 2008). The Black Sea Region has a wet climate with 1000–2500 mm annual precipitation. This climate together with the geological formation of the area has resulted in

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http://dx.doi.org/10.1016/j.jclepro.2014.06.009
0959-6526/

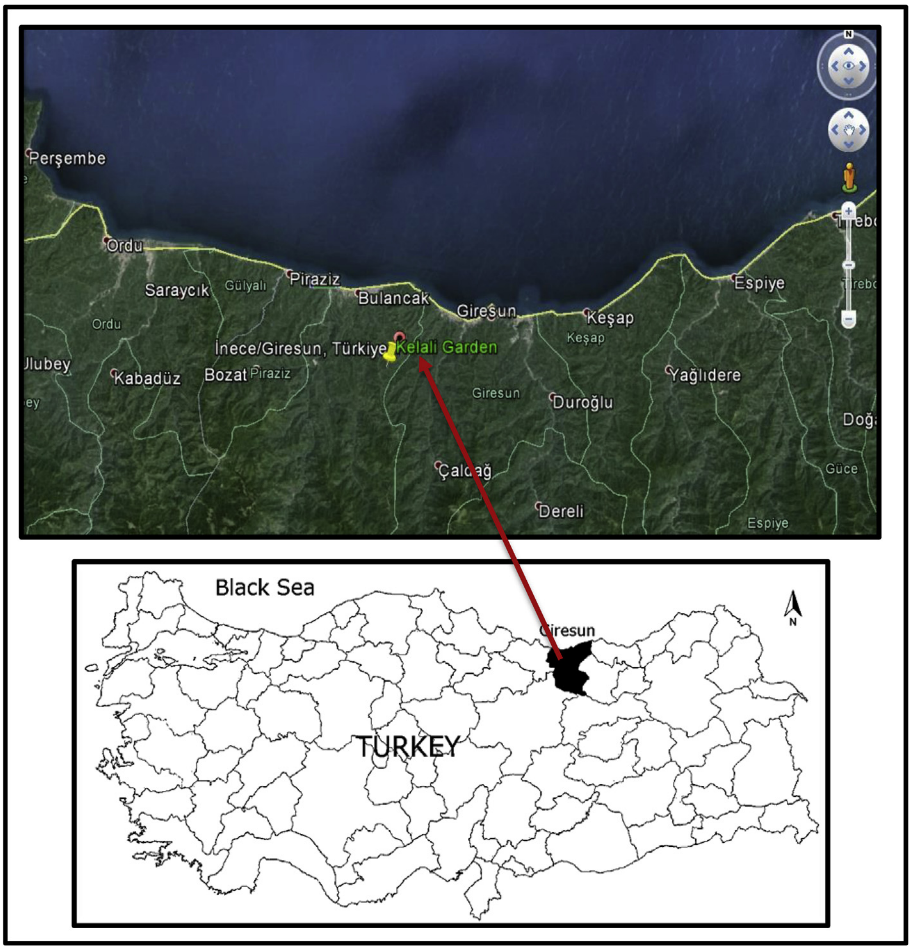

Fig. 1. The location of the study area.

Table 1
Some physical and chemical properties of the studied soil.

Texture				Available P (kgP_2O_5 ha^{-1})	Available K (kg K_2O ha^{-1})	Exchangeable cations ($cmol_c$ kg^{-1})				Cation exchange capacity ($cmol_c$ kg^{-1})	pH 1:2.5 (v/v)	H Saturation (%)
Clay (%)	Silt (%)	Sand (%)	Textural class			Ca	Mg	Na	K			
21.0	34.8	44.2	Loam	56.5	250	6.95	1.79	0.70	0.70	23.1	4.71	56.0

the formation of the acidic soil. Therefore, whenever needed, agricultural lime is used to improve the fertility.

In this study, the aim is to determine if the agricultural lime can be replaced by marble quarry wastes (MQW) and/or marble cutting wastes (MCW) in hazelnut fields. Field tests in a selected orchard were conducted to determine the effect of MQW and MCW on the soil pH and hazelnut yield.

2. Materials and methods

The study was conducted in the Kelali garden, Inece village, Bulancak town, Giresun, which is located at the Eastern Black Sea Region of Turkey (Fig. 1).

Physical and chemical properties of the studied soil are given in Table 1. The soil is loamy-textured with a pH of 4.71. The pH and $CaCO_3$ contents of the liming materials used as soil amendment materials, i.e. agricultural lime (AL), marble quarry waste (MQW) and marble cutting waste (MCW), were 13.03, 8.44 and 8.08; and 100%, 99.24% and 94.12%, respectively. The chemical composition of the AL, MQW and MCW are given in Table 2.

The amount of agricultural lime needed to bring the soil pH from 4.71 to 6.50 was calculated as described by Saruhan and Genc (1972). Considering the purity of MQW (99.24% $CaCO_3$) and MCW (94.12% $CaCO_3$), the amount of lime required was adjusted with

Table 2
Chemical composition of the AL, MQW and MCW materials. LoI: Loss on ignition (CO_2).

Oxide compound (%)	AL	MQW	MCW
CaO	55.86	55.04	50.80
Na_2O	0.04	1.87	0.68
MgO	0.58	2.01	9.84
Al_2O_3	0.70	0.63	0.76
Fe_2O_3	0.29	0.22	0.48
K_2O	0.08	0.05	0.04
LoI	42.60	35.20	37.20