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Assessment of trace elements concentration of soils in vineyard plantation under intensive system

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Abstract
A survey was conducted to investigate the levels of metals *viz.*, Fe, Mn, Zn, Cu, Cd, Pb, Ni and As in soils in areas under vineyard comparing the agricultural crop lands. Five locations (vineyard - 4 and agricultural crop land - 1) were selected in each village for collecting soil sample (surface and sub-surface) with the coverage of five villages. All the vineyard soil samples recorded higher concentration of DTPA extractable Cd, Cu, Fe and Pb. The Cd concentration was found to be below critical limits in agricultural crop lands. Overall DTPA extractable Cd, Cu and Pb concentration followed the order of Kamayagoundanpalli > Surilipatti > Rayappanpatti > Anamalayanpatti > Narayanathevanpatti. The DTPA extractable Zn followed the sequence of Kamayagoundanpalli > Anamalayanpatti > Surilipatti > Rayappanpatti > Narayanathevanpatti whereas the DTPA extractable Cr, Mn and Ni concentration followed the order of Surilipatti > Kamayagoundanpalli > Rayappanpatti > Anamalayanpatti > Narayanathevanpatti.

Keywords: DTPA extractable metals, soils, vineyard, villages

Introduction
Soil is a dynamic living system (Patil and Saler, 2013) [12]. The future existence of living beings relies on the soil, which is a complex mixture of mineral matter (45%), water (25%), air (25%) and organic matter (5%). Since, it serves as a media for the growth of plants, the food production for the burgeoning population depends on the sustainability of soil. The rapid advancements in the field of science and technology to meet out the growing demands increased the reliability on agrochemicals in several decades. The agricultural practices like monoculture, intensive tillage, usage of fertilizers, pesticides focuses on maximization of production & profit and not on quality of soil which led to degradation of soils (Gliessman, 1998) [4]. Agrochemicals are the chemical products which include fertilizers, insecticide, herbicides and fungicide and hormones utilized in agriculture with the aim of improving the crop production. Application of metal containing fertilizers and pesticides contributes to the metal contamination in soil (Turgut (2003) [17]; Robinson *et al.* (2001)) [14]. The heavy metals are considered as soil contaminants due to their widespread occurrence, acute and chronic toxicity. The heavy metals are the chemical elements with the density greater than 4.5 g cm^{-3}, which are not degraded & stable in nature and accumulate in the soils (Alkorta *et al.*, 2004) [2]. Since they are non- biodegradable in nature, there might be chances of affecting the biosphere for a long time (Karishma and Prasad, 2014) [7].

One among the remunerative farming enterprise in India is considered to be the grape cultivation. In India, grapes were grown under three agroclimatic zones viz., top tropical, mild tropical and sub-tropical climatic regions. Considering the grape cultivation in Tamil Nadu, Coimbatore, Madurai and Theni districts are well known which comes under mild tropical region. The consumption of pesticides in vineyards is on higher side. The pesticides may reach the soil through direct application to soil surface or during application to crops. About half of the sprayed quantity retains on the plant as the leaf creates a non-wetting interface for the pesticide whereas the remaining quantity is subjected to runoff and contaminates the soil and water thereby affecting the terrestrial and aquatic life (Wadhwani and Lall, 1972) [19]. For management of anthracnose and downy mildew in grapes, a spray of bordeaux mixture (or) any other copper fungicide is recommended (Jung *et al.*, 2013) [6]. Utilization of these fungicides over a long term basis lead to the accumulation of copper (Cu) in soils of vineyard (Bernard *et al.* (2001) [3]; Rusan *et al.* (2007)). Adding this Mirlean *et al.* (2005) [10] reported that copper sulphate utilized in the preparation of Bordeaux mixture contains metals other than copper which significantly contributed to the metal concentration in the grape products of Brazil. Several authors (Merry *et al.* (1983) [9]; Narimanidze and Bruckner (1999)) [11] reported

the need to study the effect of copper based fungicide on metal contamination of soil. Romanazzi *et al.* (2016) [15] opinioned that Cu applied through foliar sprays reaches the soil which can't be metabolized by soil microbes. Reduction in growth of grapes, lowered soil pH, reduction in microbial and earthworm populations were reported on excessive accumulation of Cu in surface soil (Pontiroli *et al.*, 2001) [13]. The profitability in the field of viticulture has improved the grapes cultivation, which in turn drastically increased the environmental pollution.

The objectives of this investigation are: 1) to obtain data on the buildup of metals in different locations in mild tropical vineyards, and 2) to compare their buildup data with data from agricultural crop lands.

Materials and Methods

Study area

Five vine growing (20 years old vineyards) villages of Theni district of Tamil Nadu *viz.*, Anamalayanpatti, Kamayagoundanpatti, Narayanathevanpatti, Rayappanpatti and Surilipatti were studied. The studied vineyards were selected based on their higher contribution of area and grapes yield. The location of the study area is shown in Fig.1.

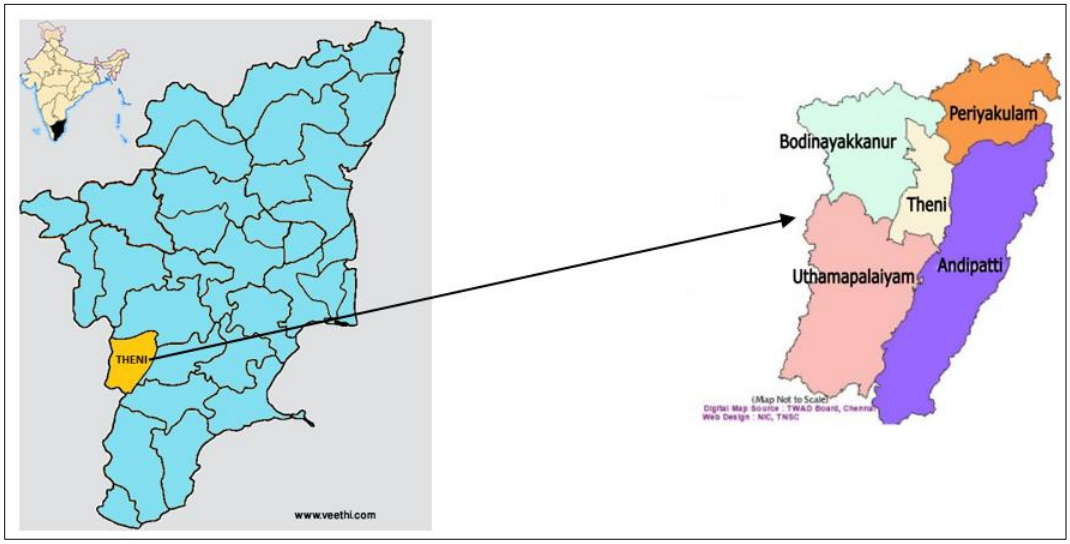

Fig 1: Location map of study area

Soil sample preparation & analysis of heavy metals

In each of the selected vine growing villages, a total of 10 soil samples of which 5 nos. from surface (topsoil) and another 5 nos. from sub-surface were collected in sterilized polythene bags. The collected samples were labeled. Prior to analysis, the soil samples were air dried, grounded and sieved through a sieve of 2.0 mm. To assess the bio available heavy metals, 10.0 g of soil sample was mixed with DTPA (Diethylene Triamine Penta Acetic acid) extractant and equilibrated in horizontal shaker for 2.0 hrs, then filtered and analyzed for metal contamination (Cu, Fe, Mn, Zn, Cr, Ni, Pb & Cd) using Varian Spectra AA 200 FAAS (Lindsay and Norwell (1978) [8]; USEPA (1979)) [18].

Results and Discussion

In Surilipatti village, Cu, Zn, Fe, Mn, Cd, Cr, Pb & Ni concentration ranged from 6.81 to 23.34, 4.69 to 13.74, 6.36 to 31.68, 3.15 to 11.80, 0.41 to 0.92, 0.11 to 0.54, 0.06 to 0.87 and 0.03 to 1.00 mg kg^{-1} soil respectively whereas it was found to be 5.75 to 14.33, 3.73 to 9.98, 4.26 to 12.11, 3.20 to 8.60, 0.13 to 0.47, 0.00 to 0.21, 0.00 to 0.29 and 0.00 to 0.73 mg kg^{-1} soil respectively in Narayanathevanpatti village. Similarly in Kamayagoundanpatti village, Cu, Zn, Fe, Mn, Cd, Cr, Pb and Ni concentration varied between 7.18 to 27.43, 7.67 to 15.01, 6.67 to 51.04, 5.23 to 12.90, 0.11 to 1.93, 0.03 to 0.78, 0.04 to 1.11 and 0.02 to 1.26 mg kg^{-1} soil respectively. For the village Anamalaiyanpatti, the concentration of Cu, Zn, Fe, Mn, Cd, Cr, Pb & Ni concentration ranged from 6.19 to 14.23, 1.72 to 10.80, 4.73 to 16.88, 1.50 to 9.0, 0.04 to 0.58, 0.06 to 0.75, 0.03 to 0.59 and 0.01 to 0.67 mg kg^{-1} soil respectively whereas it was found to be 7.76 to 17.18, 3.83 to 8.13, 7.42 to 16.97, 3.30 to 7.00, 0.11 to 0.92, 0.01 to 0.40, 0.01 to 0.60 and 0.00 to 0.57 mg kg^{-1} soil respectively in Rayappanpatti village. The DTPA extractable metal concentration in soil samples were compared with critical levels (Cd- 0.31mg kg^{-1}, Pb-0.13 mg kg^{-1}, Fe- 13.0 mg kg^{-1}, Ni- 8.1 mg kg^{-1}, Zn- 1.5 mg kg^{-1}, Cu- 2.0 mg kg^{-1}, Cr- 8.0 mg kg^{-1} and Mn- 2.00 mg kg^{-1}) outlined by Maclean *et al*. (1987) and Rowell (1994) (Fig. 2 & 3).

All the vineyard soil samples recorded higher concentration of Cd, Cu, Fe & Pb. The Cd concentration was found to be below critical limits in agricultural crop lands. The accumulation of metals like Cu, Zn, Fe, Mn, Cd, Cr, Pb and Ni get increased by cultivation of grapes. This confirmed the findings of Mirlean *et al*. (2005) [10] who reported the presence of metals other than copper in copper sulphate of Bordeaux mixture. Supporting the results of present investigation, Grant and Sheppard (2008) [5] reported that P fertilizers contain metals like Cd as a contaminant with levels varying from traces to 300 mg kg^{-1} of product. Adding this, Alkhader and Abu Rayyan (2014) [1] observed the presence of heavy metals like Cd, Pb and As contaminants in fertilizers like Di Ammonium Phosphate, Mono Ammonium Phosphate and Single Super Phosphate.

Overall the vineyard soil samples recorded higher concentration of Cd, Cu & Pb concentration followed the order of Kamayagoundanpalli > Surilipatti > Rayappanpatti > Anamalayanpatti > Narayanathevanpatti. The DTPA extractable Zn followed the sequence of Kamagoundanpatti > Anamalayanpatti > Surilipatti > Rayappanpatti > Narayanathevanpatti whereas the DTPA extractable Cr, Mn & Ni concentration followed the order of Surilipatti > Kamayagoundanpatti > Rayappanpatti > Anamalayanpatti > Narayanathevanpatti.

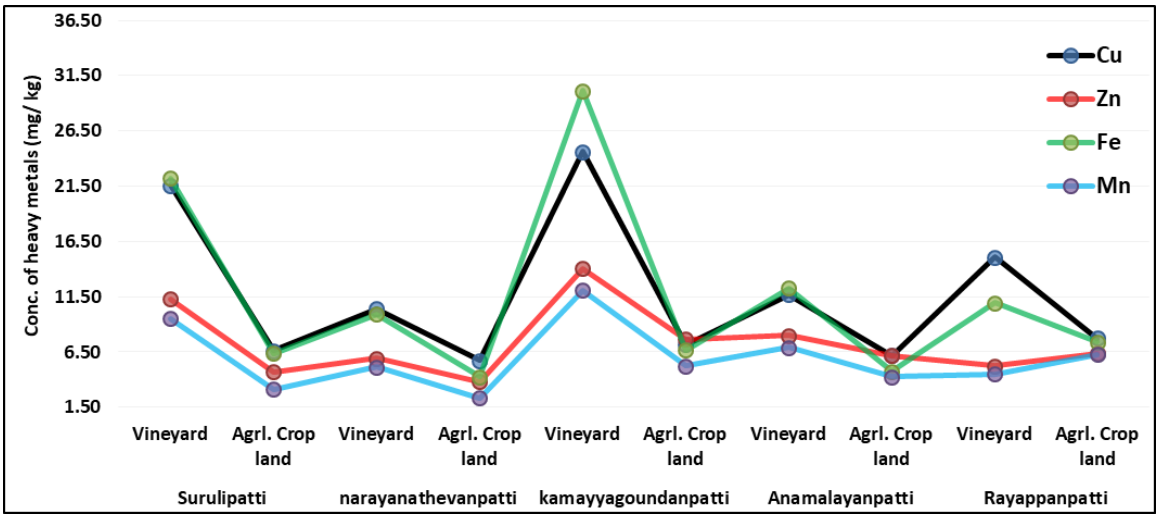

Fig 2: Influence of intensive cultivation of grapes on soil DTPA extractable Cu, Zn, Fe and Mn

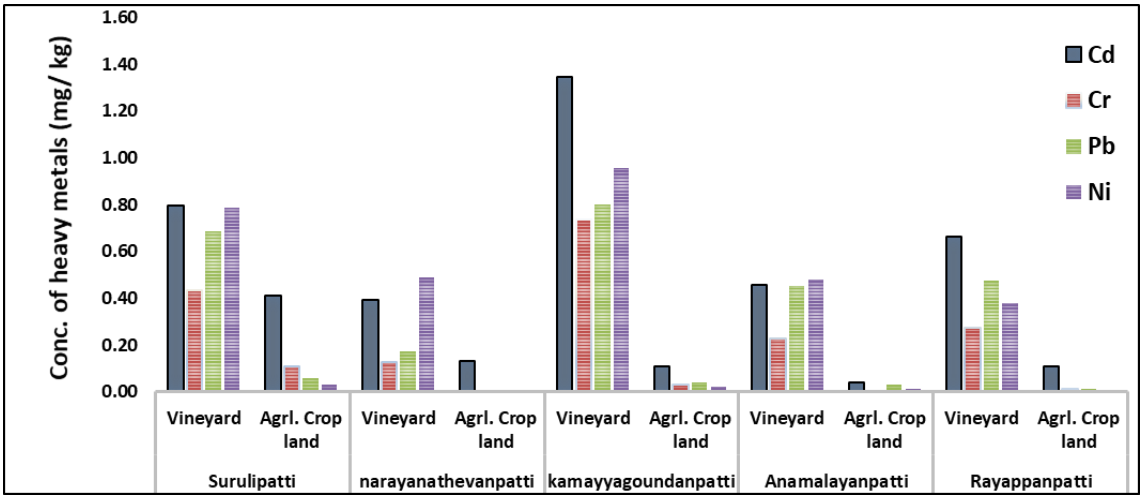

Fig 3: Influence of intensive cultivation of grapes on soil DTPA extractable Cd, Cr, Pb and Ni

Conclusion

Long term application of P fertilizers and pesticides are likely sources of heavy metals in agricultural soils. Development and adoption of plan/ policy is needed to check and reduce the metal concentration, their contamination in vineyard soils and transfer to crop plants which could defend our environment from pollution and thus peril to health of human can be minimized.

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