

Compost addition and pre-planting soil moisture conditions
alter soil nutrients, plant growth and nutrition, and the
formation of mycorrhizas

By

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Declaration

I declare that this thesis is a record of original work and contains no material, which has been accepted for the award of any other degree or diploma in any university. To the best of my knowledge and belief, this thesis contains no material previously published or written by another person, except where due reference is made in the text.

Thi Thanh Hue Ngo

14 December 2016

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Preface

This research was performed over 10 months as part of a Master of Biotechnology (Plant Biotechnology). In accordance with the requirements of the program, the research is presented in the format of a manuscript for submission to a peer-reviewed scientific journal. I have chosen to follow the format of the highest ranked journal in the field of soil science, *Soil Biology and Biochemistry*. My co-author for the manuscript is A/Prof Timothy Cavagnaro. A/Prof Timothy Cavagnaro suggested the project, helped guide me in developing the experimental design that I used in the glasshouse experiment, assisted me in the interpretation of the results, and provided written feedback on earlier drafts of the manuscript.

The manuscript in this thesis is intended as the first draft of a manuscript for future publication. The word count for the manuscript (excluding references) is 7019 words.

I have followed these instructions except that I have typed double-spaced, made custom margins with a 1.5 cm at the top, bottom and on right-hand side of the page and a 3.5 cm on the left-hand side of the page. In addition, I have inserted tables and figures at appropriate places in the text, and I have not displayed line numbers in order to satisfy the thesis guidelines for the Master of Biotechnology (Plant Biotechnology) program.

I also note that there is some disagreement in the literature over the use of the term mycorrhizal colonisation versus mycorrhizal infection of roots. On the advice of my supervisor, I have used mycorrhizal colonisation in this thesis, in order to be consistent with earlier publications on this topic arising from his group.

Abstract

Composts are important materials to improve soil fertility. The release of nutrients from composts is affected by soil moisture. Recent work has shown that soil moisture conditions prior to planting can have a profound impact on soil nutrients, plant growth and nutrition, which is defined as the carry-over effect of soil moisture. However, the carry-over effect of soil moisture, especially in compost-amended soils has not been fully investigated. The present research aimed to investigate how soil moisture conditions prior to planting can alter available nutrients in the soil with and without compost addition. Arbuscular mycorrhizal fungi (AMF), which are abundant in the rhizosphere of most terrestrial plants, play an important role in nutrient uptake of plants. Thus, this study also investigated whether the pre-planting moisture conditions and compost addition affect the formation of mycorrhizas. A pot experiment was set up in a glasshouse-controlled condition over 88 days of the experiment. Soil moisture conditions were manipulated as wet (75% of field capacity (FC)), dry (25% FC) and cycle (one wet-dry cycle between 75% and 25% FC) treatments during pre-planting period. Soil moisture then was maintained constantly at 75% FC for all pots during planting period. Tomato and wheat were used as model plants to test potential carry-over effects of compost addition and pre-planting moisture conditions on plants. Overall, the results indicate a clear effect of soil moisture conditions prior to planting on plant growth and nutrition and mycorrhizal colonisation. The N content of plants was clearly associated with N availability in the soil. However, the P content of plants was not correlated with plant-available P in the soil. Tomato and wheat expressed superior growth in the pre-planting dry conditions where mycorrhizal colonisation of roots was also greatest, despite low available N nutrient in the soil at the time of planting. The study suggests that there is a possible synergistic effect of compost and mycorrhizal application in plant growth that needs to be further investigated.

Highlights

- The impacts of compost addition and pre-planting soil moisture on plants was investigated.
- Plant available N and P were higher in compost-amended soil than un-amended soil.
- Available N was affected by soil moisture conditions, but available P was not.
- Compost addition and pre-planting soil moisture had carry-over effect on plant growth and nutrition.
- Compost addition and pre-planting soil moisture affected mycorrhizal colonisation.

Key words

Compost, soil moisture, climate change, mycorrhiza, tomato, wheat

1. Introduction

Global plant production is strongly impacted by soil degradation. Plant productivity cannot be maintained when soils are degraded, in part due to the low capacity of degraded soils to provide nutrients to plants (Gretton and Salma, 1997; Tilman et al., 2001; Wiebe, 2004; Foley et al., 2005). One method to improve soil nutrient availability is the application of inorganic fertilizers. Inorganic fertilizers applied to soils provide nutrients to plants immediately. However, intensive use of chemical fertilizers can lead to continuous environmental degradation; for example, nutrients not taken up by plants can contaminate waterways due to lost in run-off and/or leaching below the root zone (Puckett et al., 1999; Foley et al., 2011; Essaid et al., 2016). Inorganic fertilizers (especially phosphorus) are also becoming increasingly expensive due to high global demand and depletion of natural rock phosphate (Cordell et al., 2009; Ashley et al., 2011). Therefore, alternative methods to improve soil