

# Effects of compost tea treatments on productivity of lettuce and kohlrabi systems under organic cropping management

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## Abstract

The use of compost tea (CT) is becoming interesting for applications in organic agriculture. CTs are oxygenated extracts of compost that give positive effects on the crops because contain bioactive molecules and microorganisms that improve plant growth and health. This study was carried out to evaluate the effects of CTs applied as foliar spray and drenching, respectively, on kohlrabi and lettuce cultivation. The CT tested here was originated by an aerated water-extraction of two artichoke and fennel composts. CT treatments considerably improved crop yields. CT, in fact, increased lettuce and kohlrabi commercial yields higher 24% and 32%, respectively. Due to CT, the physiological and nutritional status of the plants increased, as noticed by foliar chlorophyll content assessment measured during crop cycles. The results provided encouraging indications about the practical application of CT in horticultural organic farming system.

## Introduction

Vegetable crops are grown and consumed worldwide as source of fibres and nutraceutical compounds in human diets. Consumers tend to prefer organic foods compared to others, because they are perceived more nutritious and tasty. Moreover, food security reasons and environmental concerns are orienting the market and the growers toward sustainable agricultural systems, based on natural-deriving methods with the reduction of synthetic inputs. Compost is popular in organic agriculture because it replaces fertilizers and improves soil global fertility (Pane *et al.*, 2013b). Relatively new compost-derived products, such as compost teas (CTs), although they are less common, show remarkable perspectives for diffusion and development among organic growers (Shaheen *et al.*, 2013). They are gaining great interest in many country of North America (Hargreaves *et al.*, 2009), Asia (Siddiqui *et al.*, 2008) and, recently, scientific attention for these products started also to expand in Europe (Litterick *et al.*, 2004). CTs are obtained by aerobic liquid extraction of quality composts from few hours to some days that essentially results in dissolved organic and inorganic molecules and useful microorganisms (Ingham, 1999). CTs can be counted among the most innovative organic source products developing in the field of crop management (Praveena Deepthi and Narayan Reddy, 2013). These compost-based formulates has been reported to produce beneficial effects when applied directly to the plants. Hargreaves *et al.* (2009) found that, for strawberry production, the foliar spray of CT was effective as soil application of compost. In addition, CTs were largely studied for their suppressive properties against disease development, due to antagonistic action of resident microbial community and/or improved plant defences (Pane *et al.*, 2012). Nevertheless, only few workers assessed CTs foliar applications, while it is largely reported as a nutritional liquid solution for crop fertigation. CTs used in nitrogen-phosphorous-potassium fertilizers integration increased vegetative biomass and bioactive components production in the medicinal herb *Centella asiatica* (Siddiqui *et al.*, 2011). Hormone-like molecules secreted by microbes, humic substances and nutritional elements contained in teas, are believed that may play a crucial role in the bio-stimulation of plants by upgrading their physiological status (Zaccardelli *et al.*, 2012). Therefore, CTs may contribute at reducing the unsustainable use of chemical-based pesticides and fertilizers in the ecosystems. By taking into account that CTs are promising in sustainable horticultural crop management, further insights regarding their spray application in organic active systems, are still necessary. The present work was conducted to investigate the effects of a blend of two CTs from agricultural residue composts on agronomic performances of two vegetable productions, lettuce and kohlrabi, cultivated under greenhouse in a biological farm located in Southern Italy.

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## Materials and methods

### On-farm compost-tea production

Two composting piles were formed by mixing different materials according to the following composition: C1=composted 78.0% artichoke, 20% woodchips and 2% mature compost starter; C2=composted 43.5% artichoke, 23.5% fennel, 11.0% escarole residues, 20% woodchips and 2% mature compost starter (each value is expressed as dry weigh percentage). Raw piles were designed with an initial carbon/nitrogen ratio of about 30, in order to favour the composting switch on. The on-farm composting process was carried out in two parallel static piles of about 6 m<sup>3</sup> in volume, under forced aeration for the first 45 days that included a thermophilic and a mesophilic phase, followed by a final curing period of about two months. The on-farm composting system was assembled by using tools currently available in a farm. In fact, mechanical aeration was provided by air injection through a net of tubes connected to a blower (0.75 KW) that was periodically activated (5 min every 3 h) with an electronic timer, and pile wetting was achieved through a PVC irrigation system, manually activated on demand (when relative humidity <50%). Composting temperatures were measured by thermo-sensors placed in the core of the pile at 15 cm from the pile bottom. Compost chemical analyses were performed as indicated in Pane *et al.* (2013a).

A compost extractor in liquid phase with a forced air blowing system, assembled using farmer facilities, was used to produce *on farm* aerated CTs in a 7-day fermentation cycle. Mechanical aeration was done by air injection through a submersed branched tube connected to a compressor. Automatic ventilation (3 min every 3 h) was activated by an electromagnetic valve that received an impulse from an electronic timer. Compost, contained in a plastic bag with holes of 3 mm of diameter, was placed in a 50-L polyethylene container with a quantity of liquid (20 L of water) so to have a 1:5 v/v ratio. At the end of the process, after one week, CTs were filtered and mixed (50% vol.) to prepare compost tea blend that then was stored at 4°C until used.

### Greenhouse trial

Agronomic trials were carried out in 2012, under a greenhouse system in a loamy soil, at organic farm *IdeaNatura* located in Eboli (Salerno District, Campania Region, Italy). The experimental design was a randomized complete block with plot areas of about 5.40 m<sup>2</sup> each, replicated three times. Two separate experiments were carried out in order to evaluate CT treatments, as aerial spray on kohlrabi cultivation and, as soil drenching, on lettuce. Lettuce cv. Palomis (*Lactuca sativa* var. *gentilina*) and kohlrabi cv. Volturno (*Brassica oleracea* var. *gongyloides*) plantlets were transplanted on November 16<sup>th</sup> and 26<sup>th</sup> 2012, respectively, both on single rows, at distances of 0.30×0.30 m, so to have a density of about 11 plants m<sup>-2</sup>. Blended CT, water diluted 10% vol., was weekly applied by spraying aerial parts on kohlrabi and, as

drenching (0.5 L m<sup>-2</sup>), at the base of lettuce plants. Plants vegetative and phytosanitary status were monitored during the whole cycle by direct clinical observations. The physiologic-nutritional status of the plants, instead, was followed measuring the chlorophyll concentration in the last leaf completely developed, using SPAD-meter (Konica Minolta, Inc., Tokyo, Japan) on ten different plants. At harvesting, occurred on March 22<sup>nd</sup> 2013 for kohlrabi (20 plants on 1.80 m<sup>2</sup> assay area) and



Figure 1. Liquid-based blowing system for the on-farm production of aerated compost tea.

Table 1. Main chemical quality characteristics of the composts used to produce compost tea.

| Composts       | pH   | EC<br>(mS cm <sup>-1</sup> ) | N<br>(%) | P<br>(%) | K<br>(%) | Chemical features |           |           |             |             |             |             |             |             |
|----------------|------|------------------------------|----------|----------|----------|-------------------|-----------|-----------|-------------|-------------|-------------|-------------|-------------|-------------|
|                |      |                              |          |          |          | Ca<br>(%)         | Mg<br>(%) | Na<br>(%) | Mn<br>(ppm) | Cd<br>(ppm) | Cr<br>(ppm) | Cu<br>(ppm) | Pb<br>(ppm) | Zn<br>(ppm) |
| C <sub>1</sub> | 9.01 | 6.99                         | 1.73     | 0.023    | 4.28     | 8.30              | 1.78      | 0.38      | 307.66      | 0.38        | 20.69       | 21.01       | 13.45       | 70.50       |
| C <sub>2</sub> | 9.48 | 6.60                         | 1.58     | 0.020    | 5.10     | 6.71              | 0.93      | 0.50      | 322.86      | 0.43        | 16.70       | 32.67       | 15.51       | 68.15       |
| Legal limits   |      |                              |          |          |          |                   |           |           |             | <1.5        | <100        | <150        | <140        | <500        |

EC, electrical conductivity; N, nitrogen; P, phosphorus; K, potassium; Ca, calcium; Mg, magnesium; Na, sodium; Mn, manganese; Cd, cadmium; Cr, chromium; Cu, copper; Pb, lead; Zn, zinc.



## Conclusions

A number of reports have shown that CTs are able to protect plants against biotic stresses caused by pathogenic factors. Conversely, stimulatory effects of CTs on plant growth and productivity have been previously less investigated although, lately, they are receiving great attention. Here, field trials indicated the potential of this organic formulate to induce bio-stimulation effects by enhancing productivity of the plants. These functions played by CTs, in fact, potentially can have a great impact on sustainable agricultural systems. They may determine a more efficient growth of the plants, reducing dependence from external inputs, such as pesticides and fertilizers. Therefore, advances on this topic could increase the potential for diffusion and practical applications of these organic formulates. However, since underlying mechanisms of action are still largely unknown, further studies are still necessary.

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