Effect of Organic Fertilization and Deficit Irrigation Management on Processing Tomato

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Introduction

- Organic fertilizers increase soil organic matter content, improve soil properties, and reduce the negative impact of chemical fertilizer on the soil and the environment.
- With the persistent drought situation due to a changing climate, critically timed deficit irrigation could be a sustainable water resource management strategy to deliberately reduce the use of irrigation water.
- Improved soil conditions due to the use of organic fertilizers could maintain the yield and quality of high-water-demanding processing tomato crop even in the water-deficit irrigation conditions.

Objectives

- To study the impact of the different fertilization types and irrigation levels and their interactions on the processing tomato crop for:
  - vegetative and physiological parameters
  - yield and fruit quality parameters
- To determine if a combination of organic fertilizer and deficit irrigation (75% ETc) combination could replace the traditional management of processing tomato crop (chemical fertilizer and irrigation of 100% ETc)

Materials and Methods

The experiment was conducted at "L. Toniolo" Experimental Farm of the University of Padova, Legnaro (45˚21'05" N, 11˚57'02" E) (PD) in a plastic tunnel greenhouse with a covered roof to avoid rainfall influence and open sides to permit air circulation from June 2022 to September 2022 using a split-plot experimental design.

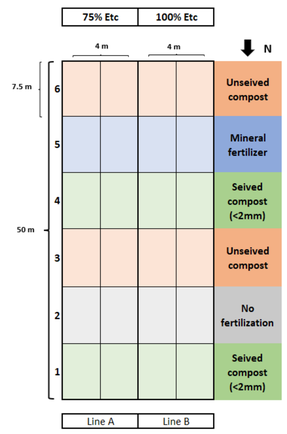


Figure 1: Experimental layout of the greenhouse

Figure 2: a) Drip installation in the greenhouse, b) Establishment of the tomato plants in two lines (Line A: 75% ETc and Line B: 100% ETc), c) Data collection for vegetative parameters, d) Data collection for physiological parameters by using LI-CORE, e) Harvesting of the tomato fruits to determine yield parameters, f) Destructive sampling of the fruits and biomass to determine quality parameters in laboratory analysis, g) Samples ready for qualitative analysis, h) Portable refractometer to measure total soluble solids content, i) Portable pH meter

150 N: 100 P_2O_5: 200 K_2O kg ha^{-1}
17045 kg compost ha^{-1} (29.96 kg P_2O_5, 45.5 kg K_2O)
16 m^3 and 12 m^3 water for 100% ETc and 75% ETc respectively per the irrigation schedule

Treatments

Four fertilizer treatments

i. Control (no fertilization)
ii. Mineral fertilizer
iii. Compost (unseived)
iv. Compost < 2mm (sieved)

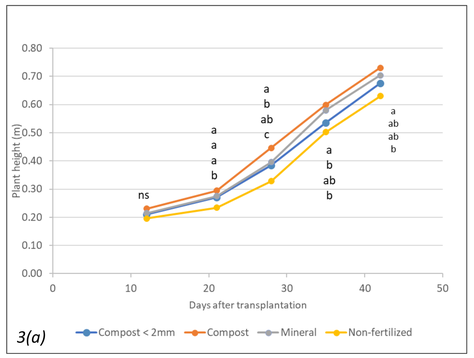
All the fertilization treatments were applied in factorial combination with two irrigation treatments, 100% ETc and 75% ETc by installing drip irrigation system on the soil surface.

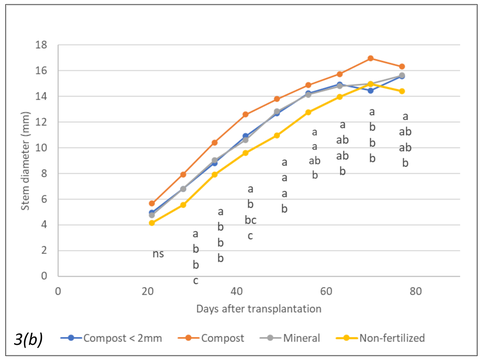
Data Collection

➢ Six representative plants from of each plot were selected for recording data once every week
- vegetative parameters: height of the plant, stem diameter
- physiological parameters: stomatal conductance (mol m^{-2} s^{-1}), transpiration (mol m^{-2} s^{-1}), and fluorescence (PhiPS2) (6 am, 12 pm, 6 pm, and 12 am)
- yield parameters: weight and number of ripe/unripe fruits per plant, yield per plant
- quality parameters: soluble solids content, pH

Results

Vegetative parameters



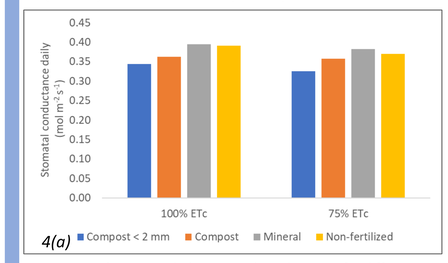


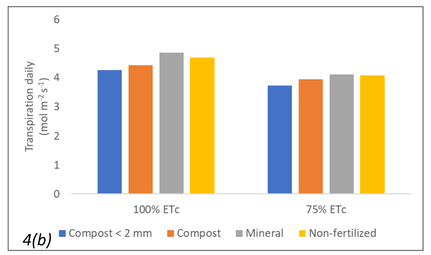
Maximum plant height (0.75 m) and stem diameter (17.0 mm) recorded for plants fertilized with unseived compost; however, both parameters did not show significant differences in response to the irrigation level.

Figure 3: a) Trend of increase in height of tomato with respect to the days after transplantation, b) Trend of stem diameter of tomato with respect to the days after transplantation for different fertilization treatments, different letters indicate significant differences between treatments (p-value<0.05)

Physiological parameters

Deficit irrigation reduced both stomatal conductance (0.37 mol m^{-2} s^{-1} at 100% ETc and 0.35 mol m^{-2} s^{-1} at 75% ETc) and transpiration (4.49 mol m^{-2} s^{-1} at 100% ETc and 3.93 mol m^{-2} s^{-1} at 75% ETc). For daily fluorescence, the highest (0.77) and lowest (0.73) values were recorded for 75% ETc and 100% ETc respectively and mineral fertilization.





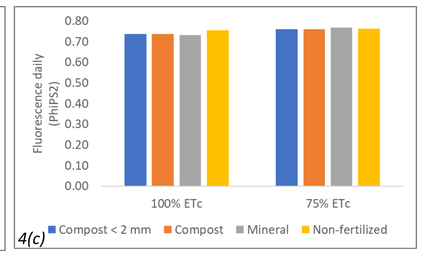
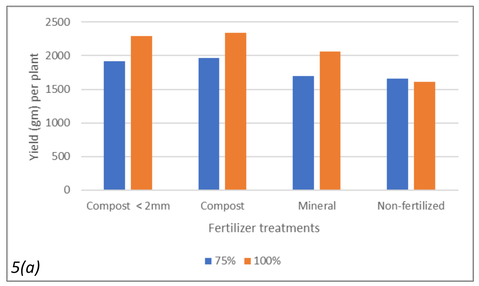


Figure 4: a) Average daily stomatal conductance for different irrigation and fertilization treatments, b) Average daily transpiration for different irrigation and fertilization treatments, c) Average daily fluorescence values for different irrigation and fertilization treatments

Yield and quality parameters

Average yield (2 kg plant^{-1}) was not significantly different among the treatments but the number of fruits per plant was significantly different for fertilization types and the highest value (60 fruits plant^{-1}) was recorded for unseived compost. Significantly higher soluble solid content (+5.8%) and pH (+1.4%) at 100% ETc than 75% ETc was recorded.



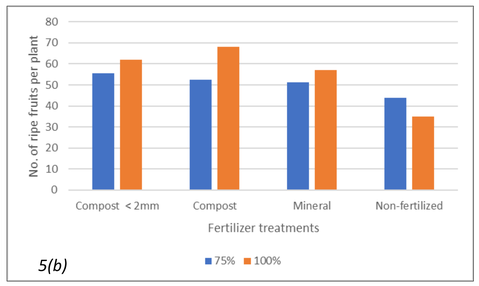


Figure 5: a) Average yield per plant of processing tomato, x-axis: fertilization treatments, y-axis: average yield per plant (gm), b) Average no. of fruits per plant of processing tomato, x-axis: fertilization treatments, y-axis: average no. of fruits per plant, bars represents error, different letters indicate significant differences between treatments (p-value<0.05)

Table 1: Mean TSS value, letters indicate significant differences between the treatments (p-value<0.05)

Total Soluble Solids (TSS) (°Brix)		
Fertilization	Irrigation (Etc)	
	75%	100%
Compost <2mm	4.18	4.33
Compost	4.15	4.25
Mineral	4.03	4.20
Non-fertilized	4.10	4.63
Average	4.12	4.35
Significance	b	a

Table 2: Mean pH value, letters indicate significant differences between the treatments (p-value<0.05)

pH		
Fertilization	Irrigation (Etc)	
	75%	100%
Compost <2mm	4.20	4.23
Compost	4.17	4.27
Mineral	4.27	4.30
Non-fertilized	4.17	4.23
Average	4.20	4.26
Significance	b	a

Conclusion

- Compost application, whether sieved or not, can improve the vegetative and physiological parameters of the processing tomato fertilization without reducing the yield.
- Deficit irrigation can be a valuable solution to reduce agricultural water use with only a few effects on quality parameters.

Acknowledgments

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