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# Title: Growth promotion and productivity of tomato using two plant biostimulants: Arbuscular mycorrhizal fungi and seaweed extract

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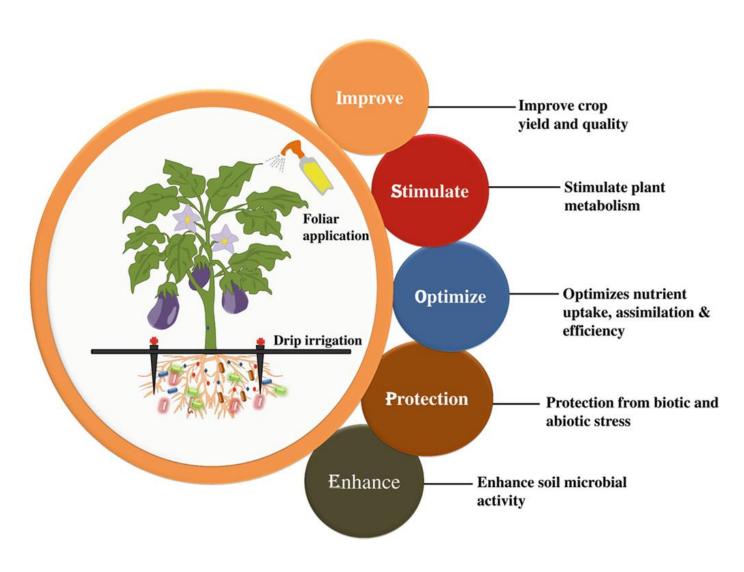
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# Introduction

## Plant biostimulants

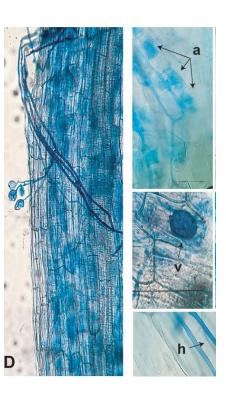
Any substance or microorganism that improves nutritional efficiency, tolerance or quality of particular traits.

- humic and fulvic acids
- protein hydrolysates
- botanical and seaweed extracts inorganic compounds
- beneficial fungi and bacteria



# Arbuscular Mycorrhizal Fungi (AMF)

Rhizophagus intraradices



# Seaweed Extract (SWE) Ulva lactuca



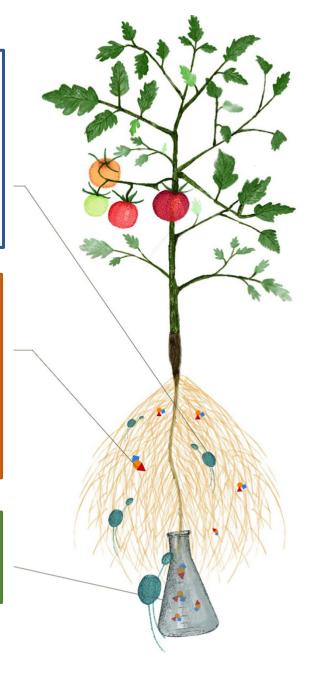
#### **AMF**

stimulate plant growth
promote abiotic stress
tolerance, improve resistance
to both pests and diseases
improve the nutritional status
increased yields and
fertilization efficiency

#### **SWE**

promote seed establishment
and germination
increase growth, yields,
flower and fruit production
resistance to biotic and
abiotic stress
postharvest shelf life

**SWE + AMF**benefits
additive or synergistic



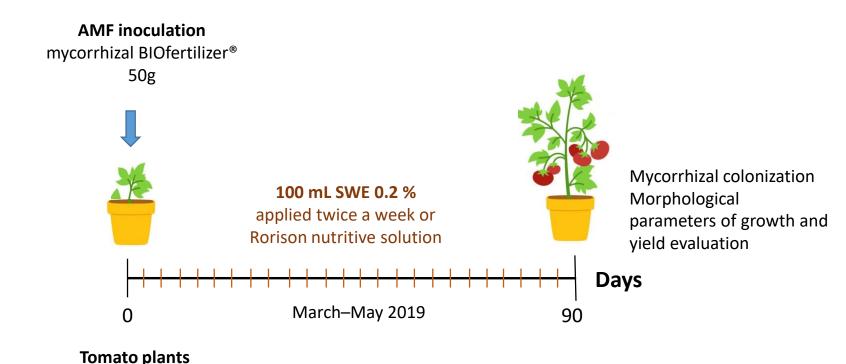
# Methodology

### Greenhouse plant growth conditions and experimental design

A random block experiment with 4 treatments with 14 repetitions each (n = 56 plants).

#### **Treatments**

- 1) Control plants watered with Rorison nutritive solution
- 2) RI plants inoculated with AMF
- 3) SWE plants treated with the seaweed extract
- 4) RI + SWE plants inoculated with AMF and treated with SWE



(S. lycopersicum) Kristen Seed®

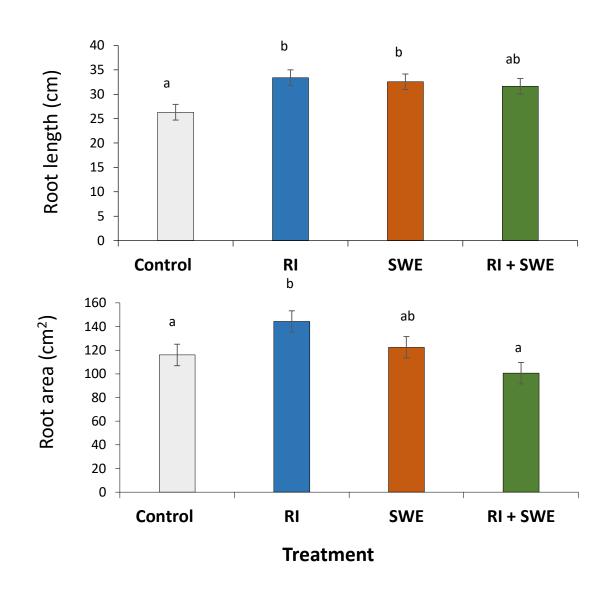
Seedlings were potted in sterile substrate mixture (sand:vermiculite 1:1)

# Results

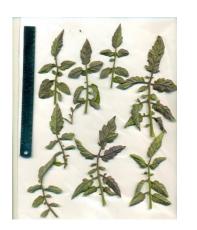
### **Growth promotion in tomato plants**

SWE and AMF inoculation significantly increased root length.

No significant differences were present among plants that were treated with both biostimulants (RI + SWE).







None of the treatments resulted in positive growth promotion in aerial tissues.

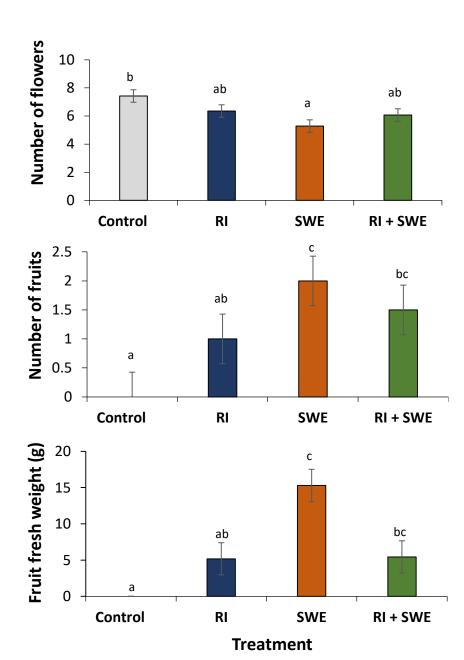
	Foliar area (cm²)	Number of leaves	Stem lenght (cm)	Sprout fresh weight (g)
Control	$185.3\pm11.6^{a}$	70.9±8.7ª	54.6±7.9 <sup>a</sup>	$16.2{\pm}1.6^{a}$
RI	$179.8\pm10.5^{a}$	73.3±5.4 <sup>a</sup>	56.7±7.7 <sup>a</sup>	15.5±1.6a
SWE	$170.5\pm12.3^{a}$	62.3±10.3 <sup>a</sup>	47.2±5.0 <sup>a</sup>	15.4±1.5 <sup>a</sup>
RI + SWE	161±15.6°	63.7±13.8 <sup>a</sup>	48.3±5.4a	14.4±2.1a

### Number of fruits per plant was higher in all biostimulant treatments.

SWE with highest number and weight of fruits, followed by RI + SWE

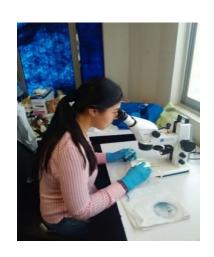




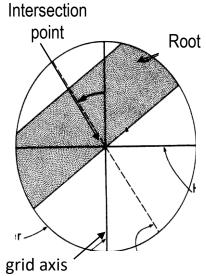


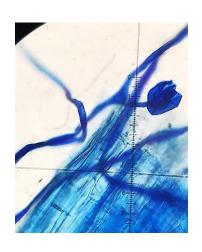
## AMF Rhizophagus intraradices colonization

# The magnified intersection method (McGonigle *et al.*,1990)



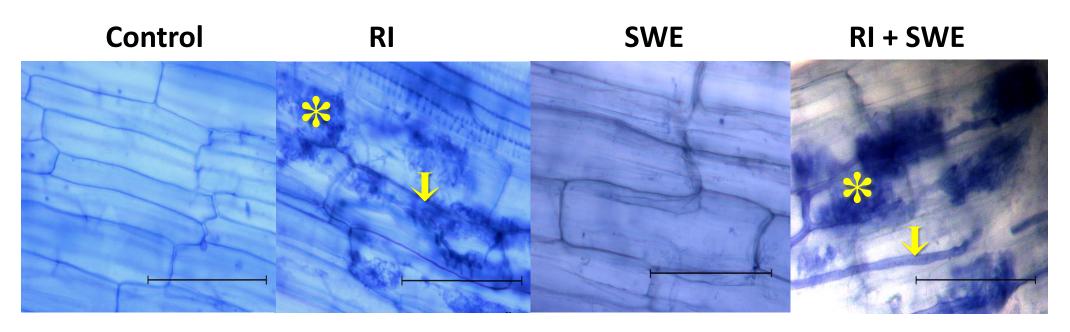






 $\% LCR = 100 \times \frac{Number\ of\ intersections\ with\ HMA\ structures}{Total\ number\ of\ counted\ intersections}$ 

# Rhizophagus intraradices fungal structures in tomato plant roots



SYMBOLS: \*, arbuscles;  $\Psi$ , intraradical hypha; scale bars represent 100mm 40X

## U. lactuca extract promotes mycorrhizal symbiosis

	Hypha	Arbuscles	%CRL
RI	49.5 <sup>a</sup>	8.8 <sup>a</sup>	49.2 <sup>a</sup>
RI + SWE	<b>52.3</b> <sup>a</sup>	65.5 <sup>b</sup>	82.6 <sup>b</sup>

RI + SWE treatment showed 8-fold the number of arbuscles than those of the RI treatment.

# Conclusions

- AMF and SWE each was found to positively stimulate plant growth and performance in different but complementary ways.
- AMF promoted growth and root development, whereas SWE promoted flowering and tomato fruit formation.
- *U. lactuca* extract stimulated the development of fungal structures and *R. intraradices* colonization (%) in tomato plant roots.
- No advantageous effects were observed from the joint application of the two biostimulants.



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