

# EFFECT OF *SPIRULINA* SPP. EXTRACTS ON TOMATO AND ONION SEED GERMINATION

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**Abstract.** The aim of this study was to evaluate the effect of *Spirulina* spp. extracts on tomato and onion seeds germination. The tomato and onion seeds were soaked in different *Spirulina* spp. extracts for 5 days. The relative seeds germination (RSG), relative root growth (RRG), germination index (GI), germination rate (GR) and germination potential (GP) were calculated. GR reached 86.7 % for the tomato seeds treated with 0.2 g/100 mL, followed by 80.0 % for the tomato seeds treated with 0.4 g/100 mL and 66.7 % for the tomato seeds treated with 0.6 g/100 mL and 0.8 g/100 mL extract. For onion seeds, the highest GR value (40.0 %) was obtained for the seeds treated with 0.4 g/100 mL extract, while the lowest (20.0 %) was obtained for the seeds treated with 0.6 g/100 mL and 0.8 g/100 mL extract. The highest GI for tomato seeds, after 5 days, was 50.0 % (0.2 g/100 mL extract), followed by 40.4 % (0.4 g/100 mL extract), 24.0 % (0.6 g/100 mL extract), while the lowest value was 14.4 % (0.8 g/100 mL extract). The GI for onion seeds, after 5 days, was 33.3 % for 0.2 g/100 mL extract, 40.0 % for 0.4 g/100 mL extract, 20.0 % for 0.6 g/100 mL extract and 13.3 % for 0.8 g/100 mL extract.

**Keywords:** seed germination, *Spirulina* spp., germination indices

## INTRODUCTION

Owing to the harmful effect of synthetic fertilizers to the environment, the need to replace them with natural fertilizer increased in recent years (Akgül, 2019; Supraja et al., 2020). The microalgal extracts have been shown to have beneficial effects on seeds germination due to their plant growth-promoting substances, such as polysaccharides, auxins, cytokinins, betaines, amino acids, vitamins, polyamines (Arokiarajan et al., 2020; Supraja et al., 2020, González-Pérez et al., 2022). Several methods, such as mechanical or physical (e.g., autoclaving, sonication, microwaving and others), chemical (e.g., osmotic shock, use of specific acids, sodium hydroxide) and enzymatic (e.g., cellulase, protease) can be used to obtain the microalgal extracts (González-Pérez et al., 2022).

Dziergowska et al., examined the effects of the macroalgal extract of *Cladophora glomerata* and static magnetic field on the germination of soybean seeds and recommended the simultaneous use of a 20 % macroalgal extract and 3 min of 250 mT magnetic induction (Dziergowska et al., 2021). Puglisi et al., studied the effect of different concentrations of microalgal extracts from *Chlorella vulgaris* and *Scenedesmus quadricauda* on *Beta vulgaris* seeds germination. The results revealed that *Chlorella vulgaris* extract at the concentrations of 1 mg C<sub>org</sub>/L and 2 mg C<sub>org</sub>/L exhibited a positive effect both on the germination process and morphological traits of sugar beet seedlings (Puglisi et al., 2020). Akgül, 2019 investigated the effect of different concentrations of *Spirulina platensis* on wheat and barley seed germination and found that the application of 100 % cell extract showed an inhibitory effect on wheat and barley seed germination. The application of 25 % and 75 % extract had a positive effect on wheat germination and seedling growth, while in barley only the

application of 25 % cell extract activated germination and seedling growth (Akgül, 2019). Supraja et al., investigated the efficacy of microalgal extracts from a mixed consortium consisting mainly of *Chlorella* sp., *Scenedesmus* sp., *Spirulina* sp., and *Synechocystis* sp. as biostimulants for the growth of tomato plant. In this regard, it was found that the seed treatment with microalgal extracts was more effective compared to foliar spray (Supraja et al., 2020). Also, *Scenedesmus obliquus* extracts stimulated the germination of watercress, mung bean and cucumber seeds (Navarro-López et al., 2020), while *Chlorella sorokiniana* extract accelerated the seed germination of tomato and rice plants (Puglisi et al., 2020). Despite all the beneficial effects of microalgal extracts on seeds germination and growth, the following challenges should be considered: to reduce the cost of microalgal-based biostimulants production and to determine the molecular response of biostimulants in crops (González-Pérez et al., 2022). The objective of this study was to investigate the effect of *Spirulina* spp. extracts (0.2 g/100 mL, 0.4 g/100 mL, 0.6 g/100 mL and 0.8 g/100 mL) on tomato and onion seeds germination for 5 days. The *Spirulina* spp. was chosen due to its high protein content and nutritive properties, its natural distribution in an alkaline environment, which prevents its easy contamination and is a promising green alternative to chemical fertilizers (Akgül, 2019).

## MATERIALS AND METHODS

### 1. Extract preparation and experimental conditions

*Spirulina* spp. extracts were prepared by mixing different *Spirulina* spp. amounts (0.2 - 0.8 g) with distilled water (100 mL) for 15 min. The extracts were denoted as follows: T1 - 0.2 g/100 mL, T2 - 0.4 g/100 mL, T3 - 0.6 g/100 mL and T4 - 0.8 g/100 mL. The obtained extracts were centrifuged at 4000 rpm and filtered using filter paper. The tomato (*Solanum lycopersicum* L.) and onion (*Allium cepa* L.) seeds were sterilized with 10 mL of 5 % solution of sodium hypochlorite for 10 min and washed several times with distilled water. 15 seeds of tomato and onion were placed in 90 mm Petri dishes on a layer of filter paper (15 seeds per replication) and 5 mL of each *Spirulina* spp. extract was added. Petri dishes with distilled water were used as control. The Petri dishes were placed in a growth chamber in the dark at room temperature ( $25 \pm 2$  °C). The germinated seeds were monitored daily for 5 days. Three replicates per treatment were performed.

### 2. Germination indices

$$\text{RSG (\%)} = (n_e/n_c) \times 100 \quad (1)$$

$$\text{RRG (\%)} = (m_e/m_c) \times 100 \quad (2)$$

$$\text{GI (\%)} = (\text{RSG} \times \text{RRG})/100 \quad (3)$$

$$\text{GR (\%)} = (t_e/t) \times 100 \quad (4)$$

$$\text{GP (\%)} = (t_s/t) \times 100 \quad (5)$$

where,  $n_e$  is the number of seeds germinated in the *Spirulina* spp. extract,  $n_c$  is the number of seeds germinated in the control,  $m_e$  is the mean root length in the *Spirulina* spp. extract,  $m_c$  is the mean root length in the control (Pampuro et al., 2017),  $t_e$  is the

total number of germinated seeds on day 5,  $t$  is the total number of seeds,  $t_s$  is the total number of germinated seeds on day 2 (Chen et al., 2021).

The relative seeds germination (RSG) (equation 1), relative root growth (RRG) (equation 2), germination index (GI) (equation 3), germination rate (GR) (equation 4) and germination potential (GP) (equation 5) were calculated as follows: (Pampuro et al., 2017), (Santos et al., 2020), Fuentes et al., 2004), (Chen et al., 2021).

## RESULTS AND DISCUSSION

### 1. Tomato germination response

The percentages of RSG, RRG and GI of tomato seeds in different water extracts of *Spirulina* spp. are reported in Figure 1. It was seen that the T1 extract reached 50.0 % RSG on day 2, 90.9 % on day 3 and 100.0 % RSG on day 4 and 5, respectively. The T2 extract exhibited almost similar values as 0.2 g/100 mL extract for RSG on day 2 (50.0 %), day 3 (90.9 %), day 4 (100.0 %) and day 5 (92.3 %) respectively. The T3 and T4 extracts showed smaller RSG values than T1 and T2 extracts. The T3 extract reached 50.0 % RSG on day 2, 72.7 % on day 3, 83.3 % on day 4 and 76.9 % on day 5, respectively, while the T4 extract reached 50.0 % RSG on day 2, 81.8 % on day 3, 83.3 % on day 4 and 76.9 % on day 5, respectively.

After 5 days, the percentage value of RRG was 50.0 % for the seeds treated with T1, 43.8 % for the seeds treated with T2, 31.3 % for the seeds treated with T3 and 18.8 % for the seeds treated with T4.

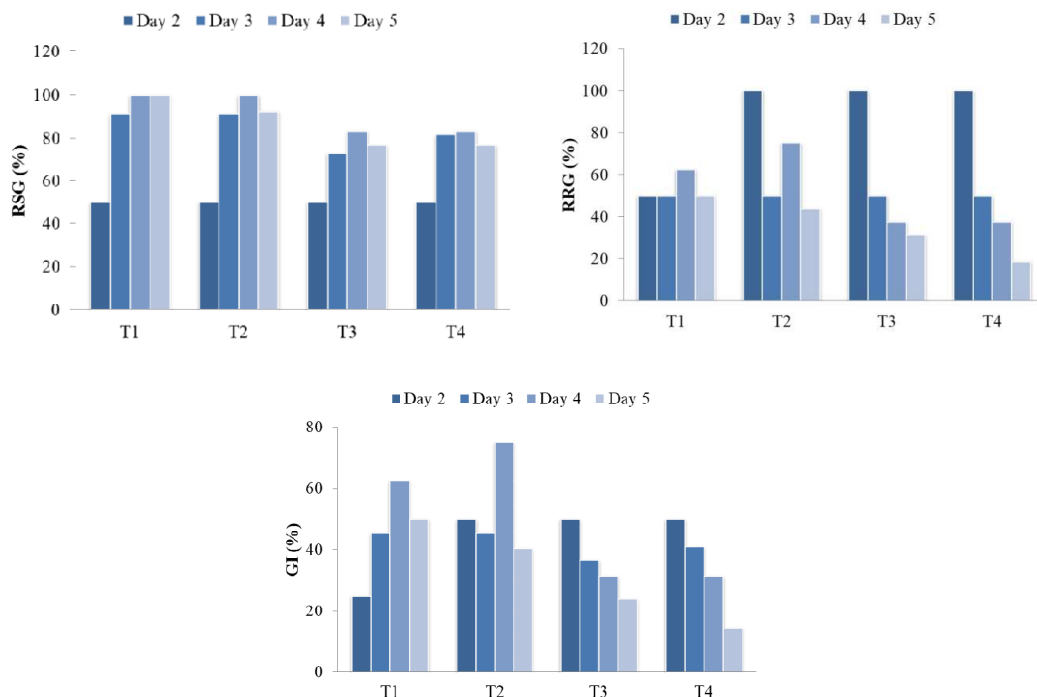


Figure 1. RSG, RRG and GI of tomato seeds in different water extracts of *Spirulina* spp.

The results showed that after 5 days of germination, the GI value calculated for the seeds treated with T1 extract was 50.0 %. Also, the percentage value of GI for the seeds treated with T2 extract was 40.4 %, the GI value for the seeds treated with T3 extract was 24.0 %, while the GI value for the seeds treated with T4 extract decreased to 14.4 %.

The percentages of GR and GP of tomato seeds in different water extracts of *Spirulina* spp. are reported in Figure 2. The results showed that the GR value calculated for the seeds treated with T1 extract was similar to that obtained for control (untreated seeds) (86.7 %). The percentage value of GR for the seeds treated with T2, T3 and T4 extract slowly decreased to 80.0 % and 66.7 %, respectively compared to the value obtained for control. All the *Spirulina* spp. extracts presented smaller GP values after 2 days compared to the control. As shown in Figure 2, the extracts presented a GP value of 6.7 %, while the control presented a GP value of 13.1 %.

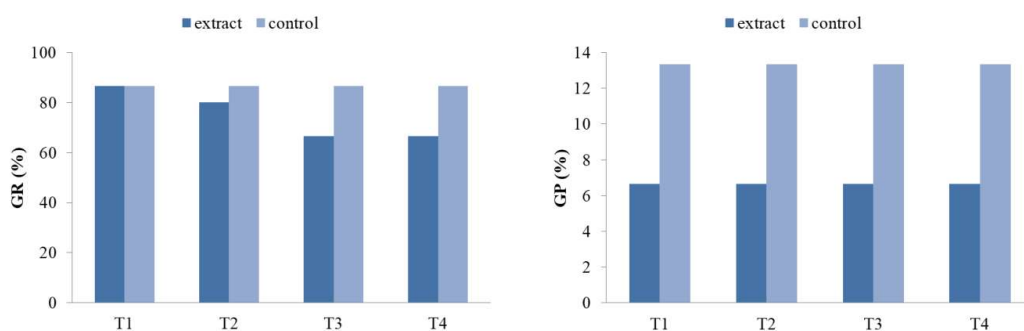


Figure 2. GR and GP of tomato seeds in different water extracts of *Spirulina* spp.

## 2. Onion germination response

The percentages of RSG, RRG and GI of onion seeds in different water extracts of *Spirulina* spp. are reported in Figure 3.

It was seen that after 5 days of treatment, smaller RSG values for onion seeds compared to tomato seeds were obtained. Thus, the T1 extract reached 55.6 % RSG, the T2 extract exhibited a slightly higher value of 66.7 %, and the T3 and T4 extracts presented a similar RSG value of 33.3 %. After 5 days, the percentage value of RRG was 60.0 % for the seeds treated with T1, T2 and T3, while for the seeds treated with T4 the RRG value was only 40.0 %. The GI value calculated, after 5 days, was 33.3 % for T1 extract, 40.0 % for T2 extract, 20.0 % for T3 extract and 13.3 % for T4 extract.

The percentages of GR and GP of onion seeds in different water extracts of *Spirulina* spp. are reported in Figure 4. All the *Spirulina* spp. extracts presented smaller GR and GP values compared to the control. The highest GR value (40.0 %) was obtained for the seeds treated with T2 extract, while the lowest GR values were obtained for the seeds treated with T3 and T4 extracts (20.0 %). All the extracts, except the T4 extract, presented a GP value of 6.7 % after 2 days of treatment, while the control presented a GP value of 13.1 %.

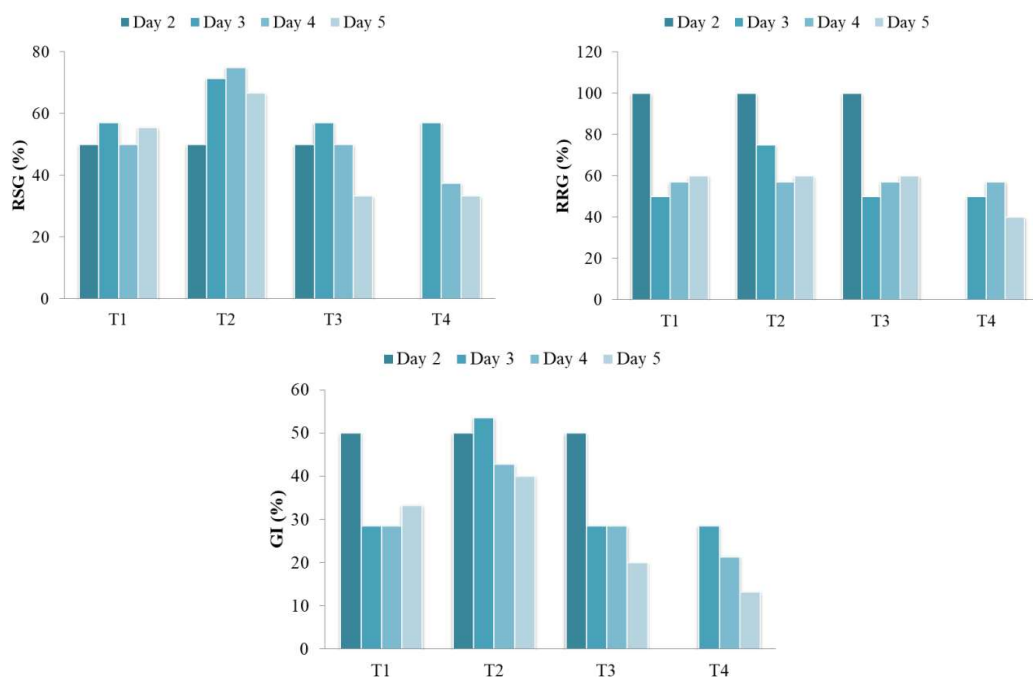


Figure 3. RSG, RRG and GI of onion seeds in different water extracts of *Spirulina* spp.

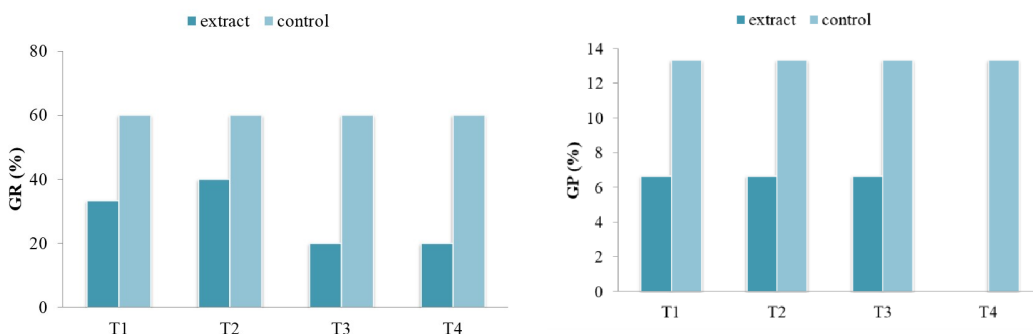


Figure 4. GR and GP of onion seeds in different water extracts of *Spirulina* spp.

### CONCLUSIONS

A relative seeds germination percentage of 76.9 to 100.0 % was observed for tomato seeds compared to 33.3 to 66.7 % for onion seeds after 5 days. The relative root growth percentage for tomato seeds decreased from 50.0 % (0.2 g/100 mL) to 18.8 % (0.8 g/100 mL) compared to 60.0 % (0.2 g/100 mL, 0.4 g/100 mL, 0.6 g/100 mL) to 40.0 % (0.8 g/100 mL) for onion seeds. After 5 days, GI percentages of 14.4 to 50.0 % were obtained for the tomato seeds treated with the microalgal extract compared to 13.3 to 40.0 % for the onion seeds. Further investigations should be performed to identify the best concentration of *Spirulina* spp. extract that presents a positive effect on both germination and growth of seeds.

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