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COMPARATIVE STUDIES OF SEAWEEDS EXTRACT ON SEEDS GERMINATION OF TOMATO

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Abstract
Effects of SuperFifty seaweeds extract on tomato seed germination parameters, on roots and shoots length was investigated at the Plant Physiology Laboratory from University of Pitesti. The seeds of tomato were soaked in the solutions of seaweed extract in seven experimental variants. Experimental variants include seeds germinated on filter paper wetted with 1:1000 and 5:1000 dilutions of seaweeds extract (V2 and V3). Also, the variants include tomatoes seeds soaked for 24 hours in diluted seaweeds extract (V4 and V5), and tomatoes seeds soaked for 1 minute in diluted seaweeds extract (V6 and V7). Control variant represent tomatoes seeds germinated on filter paper wetted with distilled water (V1). Tomato seeds soaked for 1 minute in 1:1000 dilution of seaweeds extract SuperFifty showed the germinative energy higher than control (64,44%, $p<0.05$). Soaking the tomato seeds for 24 hours in diluted 5:1000 seaweeds extract SuperFifty produced a stimulation of the growth of roots and shoots of tomato seedlings. For the same variant, germinative energy and germination rate were not significantly affected.

Keywords: Ascophyllum nodosum, root growth, seed germination, shoot growth, tomato.

1. INTRODUCTION

The literature published results with extracts of seaweed produced in the laboratory or purchased from the marketplace (with different names of commercial products). Researchers have obtained extracts from different species of seaweeds: *Cladophora dalmatica, Enteromorpha intestinalis, Ulva lactuca, Corallina mediterranea, Jania rubens, Pterocladia pinnate* (el-Sheekh and el-Saied, 2000), *Codium tomentosum, Gracilaria gracilis, Cystoseira barbata* (Demir et al., 2006), *Ascophyllum nodosum, Ecklonia maxima* (Tuhy et al., 2013) etc. Experiments with seeds from different species have shown that extracts of seaweed can have a stimulating effect more or less pronounced. Seaweed extracts act as plant growth stimulants and beneficial effects are more noticeable under stress (www.chaseseorganics.co.uk).

In several publications it demonstrated that seaweeds extracts have a stimulating effect on root growth. If treatments with seaweeds extracts are apllied in the early stages of growth, the stimulating effect is more pronounced (Rayorath et al., 2008).

The objective of this study was to evaluate the effects of SuperFifty seaweeds extract on tomato seed germination parameters, on roots and shoots length.

2. MATERIALS AND METHODS

Tomato seeds (*Lycopersicon esculentum* Mill.), without having any visible signs of infection, with uniform size, shape and color, were selected for this study. The seeds were placed in plastic Petri

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dishes, on Whatman filter in seven experimental variants (three replicates on Petri dishes, 30 seeds each) (Table 1). The product with seaweed extract used is SuperFifty (http://www.bioatlantis.com/). This is a concentrated extract of seaweed with strong antioxidant activity, which improves the productivity and development of root system.
For all experimental variants were made determination of germinative energy, rate of germination, root and shoots length of tomato seedlings.
Germination rate is the maximum number of seeds that can germinate, expressed as a percentage. The germinative energy is defined as the percentage germination of seeds in a given sample which germinate in a certain period (defined as the period of energy). The germinative energy is a measure of a speed of germination.
Germination temperature was 20-22^{o}C through the experiment.

Table 1. Experimental variants

Variants	Germination conditions
V1 (control)	Filter paper wetted with 10 ml distilled water
V2	Filter paper wetted with 10 ml of 1:1000 dilution of seaweed extract (SuperFifty)
V3	Filter paper wetted with 10 ml of 5:1000 dilution of seaweeds extract (SuperFifty)
V4	Seeds were soaked for 24 hours in diluted seaweeds extract (SuperFifty) 1:1000. After 24 hours, the seeds were placed in plastic Petri dishes, and filter paper wetted with 10 ml distilled water.
V5	Seeds were soaked for 24 hours in diluted seaweeds extract (SuperFifty) 5:1000. After 24 hours, the seeds were placed in plastic Petri dishes, with filter paper wetted with 10 ml distilled water.
V6	Seeds were soaked for 1 minute in diluted seaweeds extract (SuperFifty) 1:1000. After 1 minute, the seeds were placed in plastic Petri dishes with filter paper wetted with 10 ml distilled water.
V7	Seeds were soaked for 1 minute in diluted seaweeds extract (SuperFifty) 5:1000. After 1 minute, the seeds were placed in plastic Petri dishes with filter paper wetted with 10 ml distilled water.

Graphical representation and statistical analysis of the results was performed using SPSS 16.0 software (IBM Corporation, Armonk, New York, USA). Means were compared using LSD test at 5% level.

3. RESULTS AND DISCUSSIONS

Tomato seeds germinated in distilled water registered a value of 48.88% for germinative energy (V1). For experimental variants V2, V3, V4, V5 and V7 results were slightly higher or slightly lower than V1 (figure 1). Only for V6 (seeds soaked for 1 minute in diluted seaweeds extract 1:1000; after 1 minute, the seeds were placed in plastic Petri dishes with filter paper wetted with 10 ml distilled water) seeds have an average value of germinative energy significantly higher (64.44%) compared to the control variant ant the other variants influenced with seaweed extracts.
In figure 2 are shown the results of determining the rate of germination. Comparing all seven variants tested did not show significant differences ($p>0.05$), all amounts being between 82.22% and 85.55%.

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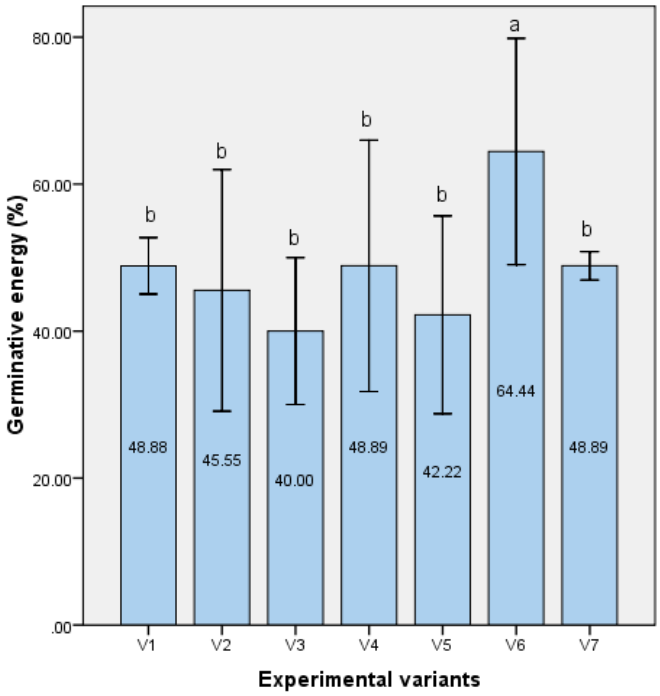

Figure 1. Effects of SuperFifty on tomato seed germination energy

Demir et al. (2006) test suspensions obtained from seaweed *Codium tomentosa, Gracilaria gracilis* and *Cystoseira barbata* on germination of tomato. At 25°C and 15°C, all suspensions had no effect on tomato seeds. The results obtained in pepper and eggplants are higher in the presence of brown and green algae extract. Stimulating effect of pepper and eggplants seeds germination is significantly higher under the influence of extracts of green algae. The *Ascophyllum nodosum* extract provides rapid emergence of high numbers of 'Alvorada' bean seedlings (Carvalho et al., 2013).

In figure 3 are shown the results of determining the root length of tomato seedlings. The highest average (5.92 cm) was registered for seedlings from variant V5 (seeds were soaked for 24 hours in diluted seaweeds extract SuperFifty 5:1000; after 24 hours, the seeds were placed in plastic Petri dishes, with filter paper wetted with 10 ml distilled water). Plantlets roots of variants V2, V3, V4, V6 and V7 are slightly higher compared to the control, but the mean differences are not significant ($p>0.05$).

In figure 4 are shown the results of determining the shoots length of tomato seedlings. For control mean value was 3.75 cm, while for V5 and V6 variants values were significantly higher (4.18, 4.19 respectively) ($p<0.05$). Tomato seedlings shoot dimensions of the variants V3, V4 and V7 were between 3.95 cm and 4.03 cm, without significant differences from the control and V5 and V6 ($p>0.05$).

Research carried out at *Brasica* shows that plant germinated from seeds soaked in seaweeds extract have higher shoot mass. Also, seaweed extracts stimulated seeds germination (Tuhy et al., 2013). Stimulatory effect of seaweeds extract is due to the presence of plant hormones: auxins, cytokinins, gibberellins.

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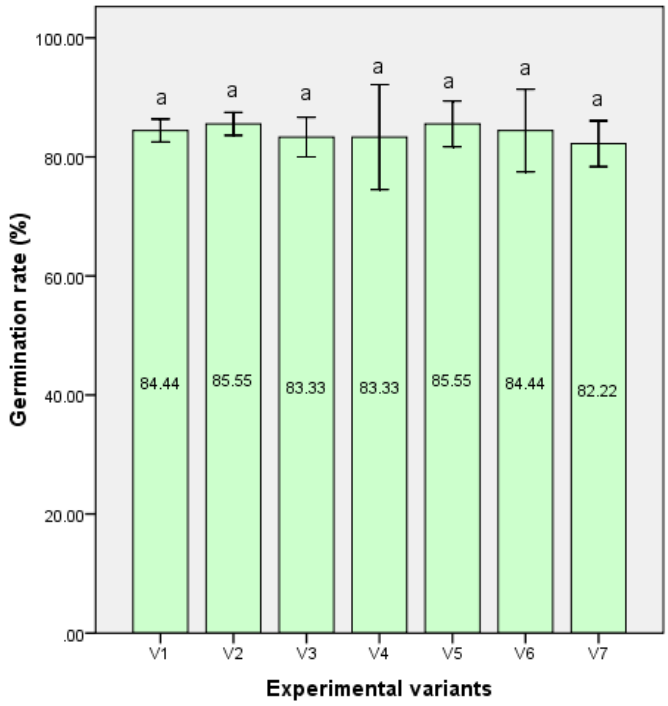

Figure 2. Effects of SuperFifty on tomato seed germination rate

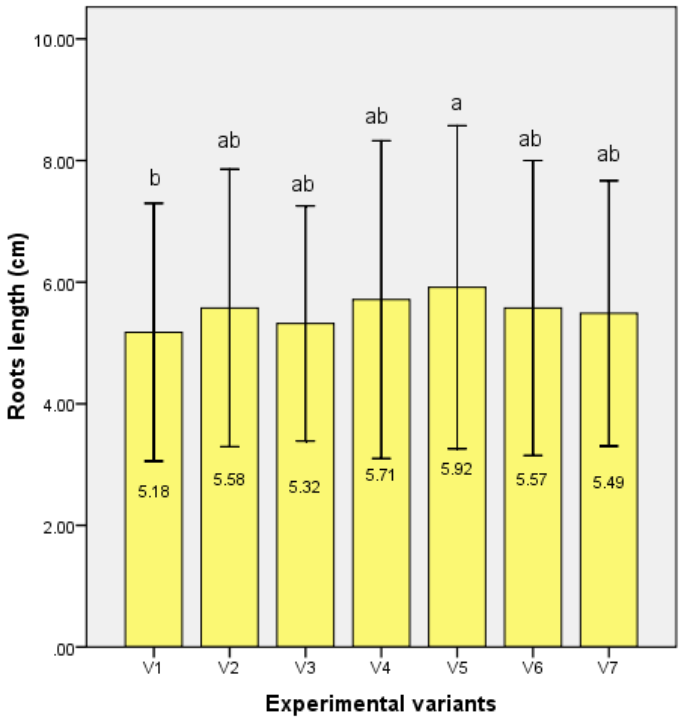

Figure 3. Effects of SuperFifty on roots length of tomato seedlings

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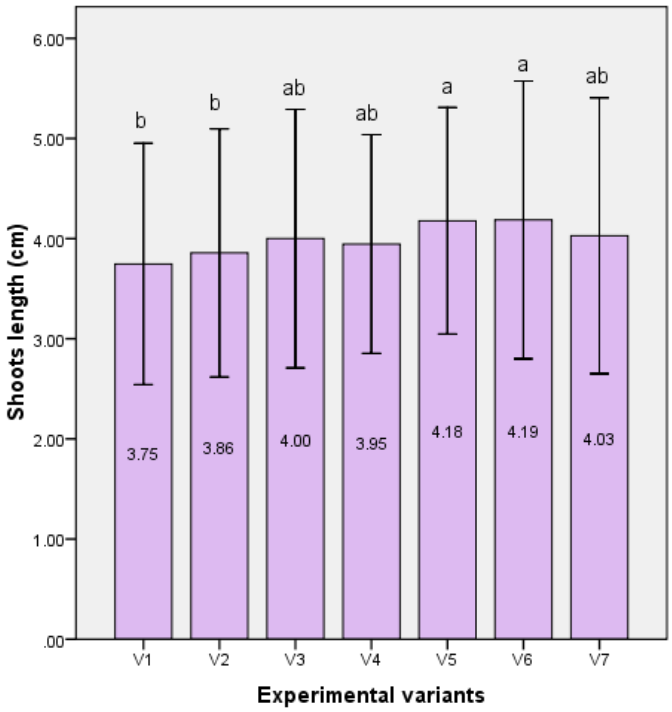

Figure 4. Effects of SuperFifty on shoots length of tomato seedlings

Craigie (2011) reviewed that seaweeds extracts stimulates germination, root growth, plant vigor and pathogen resistance.
But a clear inhibition of the germination rate was observed by Sivritepe and Sivritepe (2008) at 1:250 dilution of 10% Maxicrop solution, compared with seeds soaked in water.
Numerous studies have revealed that seaweeds components: nutrients, vitamins, cytokinins, auxins, gibberellins and abscisic acid-like growth substances influence cellular metabolism, leading to higher growth (Stirk et al., 2003; Khan et al., 2009).
Several researches showed that seaweeds extracts at low concentration (diluted 1:1000 or more) have stimulative effects on physiological processes in plants (Crouch and van Staden, 1993).

4. CONCLUSIONS

Soaking the tomato seeds for 24 hours in diluted 5:1000 seaweeds extract SuperFifty produced a stimulation of the growth of roots and shoots of tomato seedlings. For the same variant, germinative energy and germination rate were not significantly affected.
Tomato seeds soaked for 1 minute in 1:1000 dilution of seaweeds extract SuperFifty (V6) showed the germinative energy higher than control. For this experimental variant, stimulating effects were observed regarding to shoots length.

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