IJANS International Journal of Agricultural and Natural Sciences
Uluslararası Tarım ve Doğa Bilimleri Dergisi
E-ISSN: 2651-3617 1(1): 06-09, 2018

Effects of Different Organic Extracts on Seed Germination of Some Carrot (*Daucus carota* L.) Cultivars

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Abstract
Climate change and use of intensive chemical input, which are the most important problems of nowadays, cause many biotic and abiotic stresses in plants. For this reason, efforts to develop sustainable approaches, aims to reduce the stress factors to the least, improve productivity and quality, have become notable. Unlike chemical fertilizers, organic preparations such as seaweed extract and microbial fertilizers that dissolve in soil without harming the environment play an important role in increasing the yield and quality of plants. In this context in order to increase the emergence rates and to provide a homogenous and healthy germination, 2 different carrot (*Daucus carota* L.) cultivars' seeds were treated for 12 hours by using 3 different doses of seaweed extract and microbial fertilizers. In the study, germination percentages of seeds, cotyledon occurrences, leaf emergences, root lengths and numbers were evaluated and recorded. In terms of seed germination the use of 1,0 ml/l microbial fertilizers accelerated germination. It was also found that treatment with 0,25 g/l seaweed extract had a vigorous seedling development.

Keywords: Carrot, *Daucus carota* L., seaweed, microbial fertilizers, germination, seedling development

INTRODUCTION

At the present day, the environmental pollution has been increasing and it is a very worrisome case affecting agricultural ecosystem negatively. Although many years ago agricultural lands were non-polluted and high-yielding, nowadays they are polluted and low-yielding. In addition, the agricultural areas are inefficient and have low productivity [1]. These situations emphasize the importance of alternatives that are beneficial to human health and for being environmentally friendly. Thus, the organic inputs have been in use in order to increase the yield and quality in crop production. In this context, seaweed and microbial fertilizers are amongst to important alternatives.

Seaweed extracts are important macro algae and their usage in agriculture goes back to many years ago [2], [3], [4]. In recent times, they have gained popularity due to their potential to be used in organic and sustainable agriculture [3]. In particular, they contain many nutrients, amino acids, vitamins and plant growth hormones that encourage plant growth [3], [5], [6], [7], [8]. In many crops (wheat, tomato, soybean, maize), many previous researchers [3], [5], [9], [10], [11], [12], [13] reported the benefits of seaweed extracts in terms of their contribution to growth and yield.

Microbial fertilizers are emerging as a highly interesting alternative to chemical fertilizers, which have negative affects on environment [14]. On the other hand microbial fertilizers are environmental friendly and encourage plant growth and increase crop yield. It ensures all these in an ecologically sustainable way [15]. The basic mechanism of these microbial fertilizers is based on increasing the uptake of nutrients such as iron and zinc [14], [16]. Proper inoculation must be established to benefit from microbial fertilizers [14].

One of the most important stages of plant life cycle is seed germination. Accelerating the seed germination is one of the important mechanisms on increasing the survival rate of plants. In addition, increasing seed germination rate subsequently increases the yield.

The various pre-germination applications can be made to accelerate seed germination. Pre-germination is defined as a physiological method to allow seeds to receive water in a controlled manner that improves plant growth in the event of stress [1], [17]. Exactly at this point, tolerance of seaweed extracts against environmental stresses is remarkable [3], [12], [18]. In addition, these soluble, non-toxic and non-polluting extracts contribute to the uptake of more nutrients from the soil [3], [12]. Successful application of pre-germination techniques in vegetable crops are remarkable since they increase seed germination, are easy to apply and non-risky as well as being environmental friendly [3], [6].

In present study seeds of two different carrot cultivars were treated with three different doses of seaweed extract and microbial fertilizer in order to investigate the effects of these organic inputs in carrot seed germination and growing.

MATERIALS AND METHODS

Experiments were conducted at the field of Department of Horticulture, Faculty of Agriculture, Akdeniz University.

Seeds of Soprano and Bolero carrot cultivars were used and subjected to different treatments by using seaweed extract and microbial fertilizer. Seaweed extract and microbial fertilizer solutions were prepared in three different concentrations, 1,0 ml/l, 2,0 ml/l, 3,0 ml/l and 0,25 g/l, 0,30 g/l and 0,50 g/l for microbial fertilizer and seaweed extract, respectively. The seeds were kept in these solutions for 12 hours. Seeds of control group were kept in pure water during this period. The number of seeds used for each application was 10 and the study was carried out in three replications. The applied seeds were planted in a mixture of peat : perlite (3: 1). Afterwards observations and recording were conducted in terms of seed germination rates, cotyledon emergences, first leaf formations, and root length and number.

Descriptive statistics were presented with mean and standard deviation values. The normality assumption was checked with the Shapiro Wilk Test. Two way anova was applied to see the effects of application and germination and rooting. Duncan test was used in binary comparisons as a result of the significant difference. Mixed ANOVA was used to investigate the effects of cultivars and treatments on time. In meaningful cases, binary comparisons were made using the Bonferroni-Dunn Procedure. Analyzes were performed with SPSS 23.0 program and $p < 0.05$ was considered as statistically significant.

RESULT AND DISCUSSION

Seaweed (0,25 g/l, 0,30 g/l and 0,50 g/l) and microbial fertilizer (1,0 ml/l, 2,0 ml/l and 3,0 ml/l) were applied to seeds of Soprano and Bolero carrot cultivars. During the period from seed sowing to seedling development, the reactions of the cultivars to the treatments were weekly observed and recorded.

Differences in seed germination were observed primarily following the planting of the pre-treated seeds. There were statistically significant differences in terms of seed germination between the cultivars (Table 1). Although there was no statistical difference between treatments, it was expected that cultivars with different genetic and molecular structures would be different regarding the germination. Rapid seed germination and good seedlings development are important for the seedling to be in sufficient condition [19]. After seed sowing, the first germination was recorded in Bolero cultivar, which received 1,0 ml/l microbial fertilizer on the fifth day. Immediately afterwards, germination was observed in the seeds of the Bolero cultivar which were subjected to other doses of microbial fertilizer. Germination with a seaweed extract at the dose of 0,50 g/l applied to Bolero seeds occurred on the 6th day after sowing (Fig. 1).

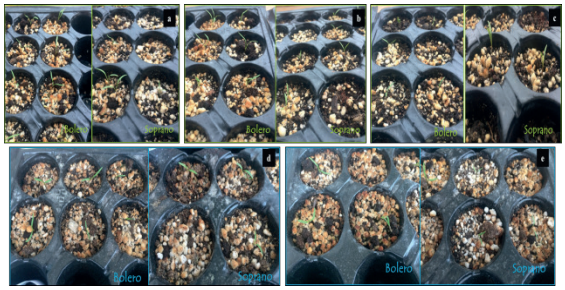

Fig. 1. Day 7; Microbial fertilizers – a. 1,0 ml/l; b. 2,0 ml/l; c. 3,0 ml/l; Seaweed extractions; d. 0,30 g/l; e. 0,50 g/l.

Fig. 2. Day 14; Microbial fertilizers – a. 1,0 ml/l; b. 2,0 ml/l; c. 3,0 ml/l; Seaweed extractions; d. 0,25 g/l; e. 0,30 g/l; f. 0,50 g/l.

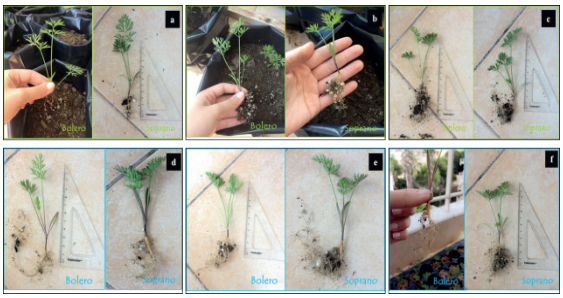

Fig. 3. Day 28; Microbial fertilizers – a. 1,0 ml/l; b. 2,0 ml/l; c. 3,0 ml/l; Seaweed extractions; d. 0,25 g/l; e. 0,30 g/l; f. 0,50 g/l.

Table 1. Germination rates (%) of Soprano and Bolero carrot seeds

Cultivars	Treatments*							
	I	II	III	IV	V	VI	VII	Average of Cultivars
Soprano	60,00	71,33	52,67	52,67	62,00	65,33	43,33	58,19^{B}
Bolero	90,67	82,00	63,33	74,00	76,00	75,33	58,00	74,19^{A}
Average of Treatments	75,33	76,66	58,00	63,33	69,00	70,33	50,66	

Different letters in the same column and rows indicate a statistically significant difference $P_{cultivars}$: 0,0041; $P_{treatments}$: 0,1091; $P_{cultivarsxtreatments}$: 0,9262 *Treatments I: Microbial fertilizers 1,0 ml/l; II: Microbial fertilizers 2,0 ml/l; III: Microbial fertilizers 3,0 ml/l; IV: Seaweed 0,25 g/l; V: Seaweed 0,30 g/l; VI: Seaweed 0,50 g/l; VII: Control

Following the germination, seedlings of the cultivars had been observed weekly. According to the findings, there were statistical differences between cultivars and treatments in terms of weekly development (Table 2). When we examined the seedling growth of the Bolero cultivar weekly, it was found that there was a difference between the application of 1,0 ml/l and 2,0 ml/l bacterial fertilization. Also, it was found that differences between all three doses of seaweed extract applications and control group. When the microbial fertilizer was applied as 3,0 ml/l, there was a statistically significant difference in the first 2 weeks of seedling development. When we examined the Soprano cultivar, differences in the first 2 weeks of seedling development were observed in bacterial fertilization treatments of all 3 doses (Fig. 2).

When both control group and seaweed treatments were examined, statistical differences were observed in all 4-week seedling developments.

Especially in seaweed treatment at 0,25 g/l affected the development of seedlings positively. Seaweed extracts also contribute to the growth and development of plants as well as increasing the yield. It has been reported that seaweed extracts improve seedling development performance, because they contain many important amino acids and plant growth regulators [3], [20], [21]. In addition, it has been reported that seaweed extract treated plants are more tolerant to environmental stresses [8]. In this study, it was also observed that the plants treated with seaweed extract had a vigorous growth.

Table 2. 4-Week seedling growths of Soprano and Bolero carrot cultivars

Week 1								
Cultivars	**Treatments***							
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**Average of Cultivars**
Soprano	2,87	2,91	3,29	2,72	2,84	3,65	2,47	2,96
Bolero	3,90	3,25	2,29	3,73	2,93	3,68	2,79	3,22
Average of Treatments	3,39	3,08	2,79	3,22	2,88	3,67	2,63	3,09

Week 2								
Cultivars	**Treatments***							
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**Average of Cultivars**
Soprano	3,85	3,73	4,20	4,06	4,29	4,03	3,50	3,95
Bolero	5,92	5,60	3,74	5,15	4,87	5,38	3,60	4,89
Average of Treatments	4,88	4,66	3,97	4,60	4,58	4,70	3,55	4,42

Week 3								
Cultivars	**Treatments***							
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**Average of Cultivars**
Soprano	7,08	6,66	6,70	6,05	7,24	6,60	5,98	6,61
Bolero	9,25	8,43	6,87	8,23	7,55	7,65	6,73	7,81
Average of Treatments	8,16	7,54	6,78	7,14	7,39	7,12	6,35	7,21

Week 4								
Cultivars	**Treatments***							
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**Average of Cultivars**
Soprano	7,83	7,49	7,50	7,70	8,20	7,97	7,53	7,74
Bolero	10,82	10,23	7,69	9,38	8,77	8,94	8,39	9,17
Average of Treatments	9,32	8,86	7,59	8,54	8,48	8,45	7,96	8,46

Different letters in the same column and rows indicate a statistically significant difference *Treatments I: Microbial fertilizers 1,0 ml/l; II: Microbial fertilizers 2,0 ml/l; III: Microbial fertilizers 3,0 ml/l; IV: Seaweed 0,25 g/l; V: Seaweed 0,30 g/l; VI: Seaweed 0,50 g/l; VII: Control

At the end of the 4th week following the seedling development, root length measurements of the plants were conducted. There were no statistically significant differences between the cultivars in terms of root development. However, statistically significant differences were found between both the treatments and the cultivars x treatment interactions (Table 3). In terms of root development, 2,0 ml/l bacterial fertilization was the most successful treatment. It was followed by 0,25 g/l and 0,30 g/l seaweed treatments and 1,0 ml/l microbial fertilizer (Fig. 3). It has been reported that the interaction between microorganisms and root facilitates and increases the intake of plant nutrients by the soil [14], [18]. Finding of present study is in agreement with studies that the root lengths of our plants obtained from bacterial fertilization are better.

Table 3. Root length measurements of plants

Cultivars	**Treatments***							
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**Average of Cultivars**
Soprano	$5,25^{ABC}$	$6,37^{A}$	$3,37^{F}$	$4,67^{B-F}$	$5,63^{AB}$	$5,20^{A-D}$	$3,66^{EF}$	4,88
Bolero	$5,54^{AB}$	$4,92^{A-E}$	$5,06^{A-E}$	$5,46^{AB}$	$3,97^{C-F}$	$3,76^{DEF}$	$3,95^{C-F}$	4,66
Average of Treatments	$5,39^{AB}$	$5,64^{A}$	$4,21^{CD}$	$5,06^{ABC}$	$4,80^{ABC}$	$4,48^{BCD}$	$3,81^{D}$	

Different letters in the same column and rows indicate a statistically significant difference *Treatments I: Microbial fertilizers 1,0 ml/l; II: Microbial fertilizers 2,0 ml/l; III: Microbial fertilizers 3,0 ml/l; IV: Seaweed 0,25 g/l; V: Seaweed 0,30 g/l; VI: Seaweed 0,50 g/l; VII: Control

CONCLUSION

Increasing food demand due to world population increase is confronted as one of today's major problems. As a result of the use of chemical inputs and misapplications, our agricultural areas are at risk. In recent times, environmentally friendly alternative solutions with high sustainability have come to the forefront in order to avoid such problems. In this context, the use of seaweed extracts and microbial fertilizers both in terms of soil, plant and human health are remarkable.

In this study, effects of different doses of seaweed and microbial fertilizers were evaluated in terms of seed germination, seedling growth and rooting. According to the results obtained, microbial fertilizers practices are prominent in terms of germination whereas seaweed application is more effective in seedling development. In particular, the use of 1,0 ml/l microbial fertilizers accelerated seed germination. Strong seedling growth was observed in 0,25 g/l seaweed application. We believe that trying different concentrations of seaweed extract and the microbial fertilizers will shed more light on revealing further benefits of organic inputs.

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