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The effects of different salt, biostimulant and temperature levels on seed germination of some vegetable species

ERTAN YILDIRIM, ATILLA DURSUN*, ÍSMAIL GÜVENÇ, A. METIN KUMLAY

*Corresponding author (atilladursun@hotmail.com)
Department of Horticulture at Agriculture Faculty, Atatürk University, 25240 – Erzurum, Turkey

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Summary

This research was conducted to determine the effects of two biostimulants (humic acid and biozyme) or three different salt (NaCl) concentrations at the temperature 10, 15, 20 and 25° C on parsley, leek, celery, tomato, onion, lettuce, basil, radish and garden cress seed germination. Two applications of both biostimulants increased seed germination of parsley, celery and leek at all temperature treatments. Germination rate decreased depending on high salt concentrations. At different salt and temperature levels garden cress was characterised by the highest germination percentage compared to other vegetable species.Interactions between NaCl concentrations and temperatures, as well as biostimulants and temperatures were significant at $p = 0.001$ in for all vegetable species except onion in NaCl concentrations and temperatures compared to that of the control.

Key words: Vegetable seed germination, salt, biostimulant, temperature.

INTRODUCTION

Salinity has been recognized as a major agricultural problem in arid and semi-arid regions. Differences in salt tolerance among plant species have also been long recognized; however, the role that salt tolerance plays in causing differences in nutrient uptake and metabolism between various plants, among plant species, at different stages of growth is still a major concern among investigators, and has not been fully understood (Pessarakli, 1991; Kawasaki et al., 1983).

The effect of salinity on a plant may depend on ontogeny, humidity, temperature, light, irrigation management, cultural practices, soil fertility, air pollution and the particular growth or yield parameter measured. Techniques for selecting plants for salt tolerance are well established. These usually involve screening at a particular growth stage, e.g., germination, seedling development or maturation. Some particularly salt-tolerant plants, such as barley, may be screened from seed to seed. Screening mature plants not only takes more time, energy, and space than screening at earlier growth stages, but also requires more sophisticated control or measurement of salinity (Shannon, 1979).

A crop improvement program must be based on adequate variability for the desired trait, and indeed considerable variability for tolerance of salinity has been observed among and between species (Norlyn and Epstein, 1984). Since salt tolerance at germination is a first indicator of plant salt tolerance, an evaluation of salt tolerance at germination may be useful for rapid screening of genotypes (Goertz and Coons, 1989).

Despite the many studies conducted to test the influence of salinity on vegetable crops, only few of them provided clear indications about the effects of brackish water used at the different growth stages. Also, as far as salt resistance limits of seeds during germination are concerned, the data reported in literature are quite indefinite and even unavailable for some crops (Cucci et al., 1994). High temperature interacting with high salt levels decreased germination percentages and rates more than either alone in several field crop species (Stone et al., 1979).

Rapid and uniform germination and emergence are desirable for stand establishment in some vegetables. High rates of fertilizer application, particularly nitrogen (N) fertilizers, can delay and reduce seedling emergence of many vegetable crops (Smith and Hadley, 1989). There has been a notable increase of research over the past decade on the use of naturally derived or organic materials in agriculture. Some of these are biostimulants, i.e., nonnutrional products that may reduce fertilizer use and increase yield and resistance to water and temperature stresses. Among the materials that stimulate plant growth in relatively small amounts are humic acids, marine algae, polymers of lactic acid, B vitamins, and ascorbic acid. Under certain conditions, biostimulants work well and suggest possible uses in horticulture (Russo and Berlyn, 1992).

Akeson et al., (1981) determined that kinetin also stimulated sugar beet emergence under the combined stresses of low moisture, low temperature, and high soil impedance. Sivritepe (2000) established that seaweed extract could be used in osmotic conditioning treatments of pepper seeds.

The objectives of this study were to: 1) compare the NaCl tolerance during germination 2) determine the effect of two biostimulants on germination of some vegetables at different temperature levels.

MATERIALS AND METHODS

The vegetable species tested in salinity trials were garden cress (*Lepidium sativum* L.), lettuce (*Lactuca sativa* L.) cv. Yedikule, onion (*Allium cepa* L.) cv.

Çorum sogani, basil (*Ocimum basilicum*) cv. Dal, leek (*Allium ampeloprasum* L.) cv. Kalem, tomato (*Lycopersicon esculentum* L.) cv. S.C.2121, celery (*Apium graveolens* L.) cv. Çanakkale, parsley (*Petroselinum crispum* Mill.) and radish (*Raphanus sativus* L.) cv. Kara turp. Celery, parsley and leek were used as materials for biostimulant trials.

Aqueous solutions of NaCl were prepared with osmotic potentials of 0.0, – 0,9 and – 1.5 Mpa (0.0, 10.6 and 17.7 g.liter^{-1}, respectively) (Goertz, 1991).

For biostimulant trials, seeds of each species seeds were soaked for 12 hour in either a 1 % (v/v) solution of humic acid, biozyme or distilled water (Wilczek and Timothy, 1982).

Each combination of 3 replicates of 100 was then placed on 3 pieces of Whatman number 1 filter paper moistened with distilled water in a 9 cm glass petri dish. Petri dishes were placed in incubators at 10°, 15°, 20° and 25°. The experiment was arranged according to randomized complete-block design with 3 replicates (Duzgunes et al., 1987). The counting of germinated seeds was done according to the rules of ISTA (1996). Humic acids include carboxyls, phenolic hydroxyls, ketones, and quinones. Biozyme contains biologically derived plant growth promoters such as cytokinins, auxin precursors, enzymes and amino acids specially blended to promote emergence and development of seedling and enhance root growth. Arcsin transformation of percentage germination values was used to stabilize variance. Percentage germination was analyzed using analysis of variance followed by an LSD mean separation test.

RESULTS AND DISCUSSION

The seed germinability changed depending on species and was affected by the salinity of applied water. The germination percentage decreased linearly as salinity increased (Table 1). Garden cress had the highest germination percentage compared to the other vegetable species at different salt and temperature levels. Celery and parsley did not germinate at any salt and temperature levels. Therefore, celery and parsley were found to be the most sensitive, whereas cress, onion, basil and radish were the most resistant. Generally, the higher the temperature and salt level the greater the reduction of the germination percentages (Table 1). Interaction among NaCl (salt concentrations) and temperatures were significant at $p = 0.001$ in all of the vegetable species except onion (Table 1). These findings agree with Stone et al. (1979), but they are not similar to results of Goertz and Coons (1989) and Esechie (1994) according to which high temperatures decreased the negative effects of salinity stress.

Table 1.

Influence of water salinity on seed germinability of some vegetable crops (%).

Species	Salt Concentration	Temperatures					
		10 °C	15 °C	20 °C	25 °C	Mean	$LSD_{0.05}$
Cress	0.0(Control)	100	100	100	97	99	1.59
	10.6	100	100	100	94	99	
	17.7	100	100	86	83	92	
	Mean	100	100	95	91		
	$LDS_{0.05}$	1.83					
Lettuce	0.0	96	98	86	85	91	1.54
	10.6	83	64	40	38	56	
	17.7	0	0	0	0	0	
	Mean	60	54	42	41		
	$LDS_{0.05}$	1.33					
Onion	0.0	97	97	89	86	92	2.98
	10.6	94	85	83	82	86	
	17.7	63	44	40	41	47	
	Mean	85	75	71	70		
	$LDS_{0.05}$	2.58					
Basil	0.0	88	87	88	86	87	1.70
	10.6	72	70	72	82	74	
	17.7	12	15	22	41	23	
	Mean	57	57	61	70		
	$LDS_{0.05}$	1.47					
Leek	0.0	55	83	58	56	63	0.86
	10.6	38	53	27	25	36	
	17.7	7	5	0	0	3	
	Mean	33	47	28	27		
	$LDS_{0.05}$	0.74					
Tomato	0.0	89	96	97	85	92	1.57
	10.6	23	13	14	5	14	
	17.7	0	0	0	0	0	
	Mean	37	36	37	30		
	$LDS_{0.05}$	1.36					
Celery	0.0	56	68	50	51	56	0.78
	10.6	0	0	0	0	0	
	17.7	0	0	0	0	0	
	Mean	19	23	17	17		
	$LDS_{0.05}$	0.67					
Parsley	0.0	75	76	73	73	74	1.12
	10.6	0	0	0	0	0	
	17.7	0	0	0	0	0	
	Mean	25	25	24	24		
	$LDS_{0.05}$	0.97					
Radish	0.0	94	96	97	96	96	1.60
	10.6	85	87	65	66	76	
	17.7	55	51	46	47	50	
	Mean	78	78	69	70		
	$LDS_{0.05}$	1.38					

Interaction among NaCl (salt concentrations) and temperatures were significant at $p = 0.001$ in all of the vegetable species except onion compared to control.

Table 2.
Germination percentages of leek, celery and parsley after treatment with humic acid, biozyme and distilled water at 4 germination temperatures

Species	Biostimulants	Temperatures					
		10 °C	15 °C	20 °C	25 °C	Mean	$LSD_{0.05}$
Celery	Control	56	68	50	51	56	1.42
	Humicacid	87	85	85	75	83	
	Biozyme	62	75	67	67	68	
	Mean	68	76	67	64		
	$LDS_{0.05}$	1.23					
Parsley	Control	75	76	73	73	74	1.94
	Humicacid	89	94	87	80	88	
	Biozyme	91	94	95	85	91	
	Mean	85	88	85	79		
	$LDS_{0.05}$	1.68					
Leek	Control	55	83	58	56	63	1.59
	Humicacid	78	91	90	85	86	
	Biozyme	68	94	79	69	78	
	Mean	67	89	76	70		
	$LDS_{0.05}$	1.83					

Interaction among biostimulators and temperatures were significant at p=0.001 in all of the vegetable species compared to control.

It was determined that garden cress, onion, basil and radish were resistant to salinity during germination. Therefore, they can be grown in saline soils. Celery, parsley and leek seeds treated with biostimulants responded similarly (Table 2). The highest germination percentages were observed at 15° C for all treatments. Interaction among biostimulators and temperatures were significant at $p = 0.001$ in all of the vegetable species (Table 2). These results are similar to those of Wilczek and Timothy (1982). In both leek and celery, humic acid was more effective than biozyme, whereas biozyme was more effective in parsley. Cytokinins had been reported to promote seed germination in many plant species (Wilczek and Timothy, 1982). Consequently these two biostimulant can be used to promote germination for leek, celery and parsley.

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Streszczenie

Wpływ zróżnicowanej koncentracji chlorku sodu, biostymulatorów oraz temperatury na kiełkowanie nasion niektórych gatunków warzyw

Badano wpływ trzech koncentracji NaCl, dwóch biostymulatorów (kwas huminowy i biozyme) oraz zróżnicowanej temperatury (10, 15, 20 i 25° C) na kiełkowanie nasion pietruszki (*Petroselinum crispum* Mill.), pora (*Allium ampeloprasum* L.), selera (*Apium graveolens* L.) pomidora (*Lycopersicon esculentum* L.), cebuli (*Allium cepa* L.), sałaty (*Lactuca sativa* L.), bazylii (*Ocimum basilicum* L.), rzodkiewki (*Raphanus sativus* L.) oraz pieprzycy siewnej (*Lepidium sativum* L.). Kiełkowanie nasion zmniejszało się w zależności od koncentracji NaCl. Dwukrotne zastosowanie obu biostymulatorów zwiększało kiełkowanie nasion pietruszki, selera i pora, niezależnie od temperatury. Nasiona pieprzycy kiełkowały lepiej od innych warzyw w różnych stężeniach soli i w różnych temperaturach. Współdziałania między koncentracją NaCl i temperaturą oraz między biostymulatorami i temperaturą były istotne przy $p = 0.01$ dla wszystkich gatunków warzyw z wyjątkiem cebuli.