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Original article

The effect of Trichoderma fungus and chitosan on resistance of basil (*Ocimum basilicum*) to salt stress

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Extended abstract

Introduction

The basil (*Ocimum basilicum*), is a medicinal plant of the Lamiaceae family. Since these plants are quite rich in essential oils, they are commonly produced for economic purposes. Also these plants contain phenylpropanoid compounds. Basils are commonly used in gastronomy and oral health care. Unfortunately, the production of theses crops is reduced under different stress. Salinity is the greatest concern in plant production and may result in serious losses in yields. There are 24 million ha of saline soil in Iran, which is equal to 15% of Iran's agricultural lands. Therefore, the use of elicitors can be very effective in improving the plant's resistance potential. Chitosan and Trichoderma fungus with elicitor's action induce defense mechanisms of plants.

Materials and methods

In the present study in order to evaluated the effect of Trichoderma fungus and chitosan on tolerance to salinity stress of basil, two separate experiments were carried out in a greenhouse of a Gonbad-Kavous university in a factorial arrangement based on randomized compelete design with 3 repeats at 2016. At first experiment, at first seeds of basil inoculated with Trichoderma fungus, then these seeds were planted in pots. One month plants were treated salinity stress in 4 levels (0, 75,150 and 200 mM) of NaCl for 2 weeks. At second experiment, at first, one month plants' leaves spray with chitosan. Then after 24 hours theses plants were exposed salinity stress like first experiments. Control treat without chitosan spray and inoculation with the fungus were conducted.

Results

The results of analysis of variance showed indicated that effect of chitosan, salinity and fungus on stem length, root length, root volume, fresh weight of stem, fresh weight of root, fresh weight of leaves, dry weight of stem, dry weight of root and harvest index were significant. While, the effect of chitosan × salt and fungus × salt was not significant for any of the studied treats. The findings showed a decrease of all of studied triats with increasing salinity levels, while chitosan and fungus pretreatment improved the effect of salinity stress. So that, the treated plant showed the significant increasing in all of the treats

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compared to control plants. Also the results showed chitosan and Trichoderma fungus pretreatment caused resistance to salinity stress up to 150 mM in basil. But increasing salinity stress up to 200 mM caused decrease tolerance in basil to salinity stress and yield loss in all studied treats.

Conclusion

The results of this study confirmed that chitosan and Trichoderma can act as biological elicitors. It seems that these elicitors by increasing the uptake of water and nutrients and better transfer of these substances in plant organs and ultimately lead to improvement of stem length and root length and increasing dry weight and fresh weight of stem and root on treated basil caused the negative effect of salinity stress in these plants were significantly reduced compared to control plants. Thus, it is suggested comprehensive molecular and enzymes studied is needed to better understand how chitosan and trichoderma fungi function in reducing stress effects.

***Keywords*:** Inducer, Morphological triats, Resistance, Stress

Table1. Some of physical and chemical properties of soil

Sand	Silt	Clay	K	P	N	Organic carbon	Neutralizing materials	pH	EC
----------%----------			------ ppm -----		----------%----------				ds/m
50	34	16	340	13	0.08	0.78	10.8	7.6	0.96

Table 2. Analysis of variance of studied traits of basil treated with chitosan under salt stress

S.O.V.	df	Harvest index	Leaf dry weight	Root dry weight	Leaf dry weight	Leaf wet weight
Chitosan	1	4.8**	0.023 *	0.001*	0.025**	2.25*
Salt	3	10.3**	0.157 **	0.002 **	0.046 **	4.1**
Chitosan*Salt	3	0.14	0.0007	0.000016	0.0003	0.06
Error	16	0.403	0.004	0.00016	0.002	0.3
C.V%		*7.3*	*9.6*	*13.8*	*8.54*	*9.09*

Table 2. Continued

S.O.V.	df	Root wet weight	Shoot wet weight	Root Volume	Root lenght	Shoot length
Chitosan	1	0.068**	0.48**	0.017 *	12.98**	21**
Salt	3	0.073**	1.4**	0.07**	9.6**	39.1**
Chitosan*Salt	3	0.0005	0.018	0.003	0.156	0.43
Error	16	0.005	0.052	0.0048	0.4	0.5
C.V%		*14.3*	*8.64*	*8.01*	*6.4*	*2.5*

ns, * and **: non-significant and significant at the 5 and 1% probability level, respectively

Table 3. Analysis of variance of studied traits of basil treated with Trichoderma fungus under salt stress

S.O.V.	df	Harvest index	Leaf dry weight	Root dry weight	Leaf dry weight	Leaf wet weight
Fungus	1	10.14 **	0.08 **	0.001 **	0.085 **	3.9 *
Salt	3	7.76 **	0.136 **	0.001 **	0.053 **	3.17 **
Fungus*Salt	3	0.552 ns	0.0018 ns	0.00005 ns	0.0003 ns	0.2 ns
Error	16	0.55	0.004	0.0001	0.0019	0.53
C.V%		*8.3*	*0.2*	*10.7*	*8.8*	*11.9*

Table 3. Continued

S.O.V.	df	Root wet weight	Shoot wet weight	Root Volume	Root lenght	Shoot length
Fungus	1	0.19 **	1.48 **	0.248 **	7.04 **	56.1 **
Salt	3	0.09 **	1.01 **	0.23 **	7.89 **	33.1 **
Fungus*Salt	3	0.0002 ns	0.09 ns	0.051 ns	0.007 ns	0.53 ns
Error	16	0.0076	0.078	0.027	0.47	1.03
C.V%		*15.8*	*10.14*	*17.5*	*7.15*	*3.54*

ns, * and **: non-significant and significant at the 5 and 1% probability level, respectively.

Table 4. Means comparison effect of chitosan in basil under salt stress

Treatment	Harvest index	Leaf dry weight	Root dry weight	Leaf dry weight	Leaf wet weight
		---------- g ----------			
Control	8.2 b	0.64 b	0.085 b	0.43 b	5.7 b
Chitosan	9.2 a	0.7 a	1 a	0.5 a	6.3 a

Table 4. Continued

Treatment	Root wet weight	Shoot wet weight	Root volume	Root lenght	Shoot length
	----------g----------		mm	----------cm----------	
Control	0.46 b	2.3 b	0.84 b	9.04 b	27.1 b
Chitosan	0.56 a	2.8 a	0.89 a	10.5 a	29 a

Means in each column followed by similar letter are not significantly different at 5% probability level, using LSD Test

Table 5. Means comparison effect of Trichoderma fungus in basil under salt stress

Treatment	Harvest index	Leaf dry weight	Root dry weight	Leaf dry weight	Leaf wet weight
		---------- g ----------			
Control	8.2 b	0.64 b	0.085 b	0.43 b	5.7 b
Fungus	9.5 a	0.75 a	1 a	0.55 a	6.5 a

Table 5. Continued

Treatment	Root wet weight	Shoot wet weight	Root volume	Root lenght	Shoot length
	---------- g ----------		mm	---------- cm ----------	
Control	0.46 b	2.3 b	0.84 b	9.04 b	27.1 b
Fungus	0.64 a	3 a	1.04 a	10.12 a	30.18 a

Means in each column followed by similar letter are not significantly different at 5% probability level, using LSD Test

Table 6. Means comparison effect of salt in basil after treatment with chitosan

Salt level	Harvest index	Leaf dry weight	Root dry weight	Leaf dry weight	Leaf wet weight
mM	%	---------- g ----------			
0	10.1 ^{a}	0.85 ^{a}	0.1 ^{ab}	0.55 ^{a}	6.9 ^{a}
75	9.2 ^{b}	0.72 ^{b}	0.11 ^{a}	0.52 ^{a}	6.3 ^{ab}
150	8.18 ^{c}	0.63 ^{c}	0.086 ^{bc}	0.44 ^{b}	5.7 ^{b}
200	7.09 ^{d}	0.47 ^{d}	0.07 ^{c}	0.35 ^{c}	5.03 ^{c}

Table 6. Continued

Salt level	Root wet weight	Shoot wet weight	Root volume	Root lenght	Shoot length
mM	---------- g ----------		mm	---------- cm ----------	
0	0.56 ^{ab}	3.15 ^{a}	0.85 ^{b}	10.4 ^{ab}	31.09 ^{a}
75	0.64 ^{a}	2.9 ^{a}	1.02 ^{a}	10.86 ^{a}	29 ^{b}
150	0.47 ^{bc}	2.4 ^{b}	0.83 ^{b}	9.7 ^{b}	27 ^{c}
200	0.38 ^{c}	2.05 ^{c}	0.76 ^{c}	8 ^{c}	25 ^{d}

Means in each column followed by similar letter are not significantly different at 5% probability level, using LSD Test

Table 7. Means comparison effect of salt in basil after treatment with Trichoderma fungus

Salt level	Harvest index	Leaf dry weight	Root dry weight	Leaf dry weight	Leaf wet weight
mM	%	---------- g ----------			
0	10.17 ^{a}	0.85 ^{a}	0.096 ^{b}	0.57 ^{a}	6.96 ^{a}
75	9.3 ^{ab}	0.74 ^{b}	0.11 ^{a}	0.55 ^{a}	6.3 ^{ab}
150	8.4 ^{b}	0.68 ^{b}	0.088 ^{b}	0.49 ^{b}	5.8 ^{bc}
200	7.5 ^{c}	0.49 ^{c}	0.075 ^{c}	0.37 ^{c}	5.2 ^{c}

Table 7. Continued

Salt level	Root wet weight	Shoot wet weight	Root volume	Root lenght	Shoot length
mM	---------- g ----------		mm	---------- cm ----------	
0	0.6 ^{a}	3.2 ^{a}	0.92 ^{b}	10.1 ^{ab}	31.5 ^{a}
75	0.69 ^{a}	2.9 ^{a}	1.22 ^{a}	10.6 ^{a}	29.4 ^{b}
150	0.49 ^{b}	2.5 ^{b}	0.84 ^{b}	9.5 ^{b}	27.5 ^{c}
200	0.41 ^{b}	2.2 ^{b}	0.77 ^{b}	8 ^{c}	26.1 ^{c}

Means in each column followed by similar letter are not significantly different at 5% probability level, using LSD Test