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Original article

Effects of uniconazole and biofertilizers application on yield and some biochemical charactewristics of wheat under soil salinity stress

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Extended abstract

Introduction

Soil salinity is one of the most serious limiting factors for crop growth and production in the arid and semi-arid regions due to increasing use of poor quality of irrigation water. Several strategies have been developed in order to decrease the toxic effects caused by high salinity on plant growth. Among them, use of bio-fertilizers such as plant growth promoting rhizobacteria (PGPR) and mycorhyza and also plant growth regulator such as uniconazole play a very important role in yield improvement. Inoculation of plants with native suitable microorganisms may decrease the deleterious effects of environmental stresses and increase stress tolerance of plants by a variety of mechanisms, including synthesis of phytohormones such as auxins, cytokinin and gibberellins, solubilization of minerals like phosphorus, production of siderophores and increase in nutrient uptake, N2 fixation. Arbuscular mycorrhizal fungi symbiosis is considered a valuable component in most agricultural systems due to their role in plant nutrition and soil health. So, application of bio fertilizers and uniconazole can improve crop yield under soil salinity stress. Therefore, the aim of this study was evaluation of yield and some biochemical traits of wheat under soil salinity stress in response to uniconazole and bio fertilizers application.

Material and methods

In order to evaluation of yield and some biochemical traits of wheat under soil salinity stress in response to uniconazole and bio fertilizers application, a factorial experiment was conducted based on randomized complete block design with three replications in a research greenhouse of the Faculty of Agriculture and Natural Resources of Mohaghegh Ardebili University in 2018. Treatments were included soil salinity in four levels (no application of salinity as control and application of 40, 80 and 120 mM soil salinity), by NaCl and application of uniconazole and bio fertilizers (control or no application of bio fertilizers and uniconazole, application of uniconazole, mycorrhiza fungi, pseudomonas putida, mycorrhiza with pseudomonas, mycorrhiza with uniconazole, both application of mycorrhiza with uniconazole and pseudomonas). Mycorrhiza fungi (mosseae) was purchased from the Zist Fanavar Turan Corporation and soils were treated based on method of Gianinazzi et al. (2001). *Psedomunas putida* strain 186 was

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isolated from the rhizospheres of wheat by Research Institute of Soil and Water, Tehran, Iran. The soil was with pH about 7.8 and EC about 2.68 dsm^{-1}. The wheat cultivar "zagros" was used in the experiment with plant density of 360 seeds m^{-2}. For inoculation, seeds were coated with gum Arabic as an adhesive and rolled into the suspension of bacteria until uniformly coated. The strains and cell densities of microorganisms used as PGPR in this experiment were 1×107 colony forming units (CFU).

Relative water content: Weight of fresh leaf was measured just after detached from the plants then taken turgid weight after leaf was incubated in distilled water for 24 h to obtain a full turgidity. Dry weight of leaf was measured after it was dried at 60°C for 24 h in an oven. Relative water content was measured according to the following formula (Chelah et al. 2011).

$$RWC\ (\%) = [(FW-DW) / (TW-DW)] \times 100$$

Where, RWC, FW, DW and TW are relative water content, fresh weight, dry weight and turgid weight respectively.

Chlorophyll content: A portable chlorophyll meter (SPAD-502; Konica Minolta Sensing, Inc., Japan) was used to measure the leaf greenness of the wheat plants.

Quantum yield: The quantum yield was measured by the uppermost fool expanded leaf using a fluorometer (chlorophyll fluorometer; Optic Science-OS-30 USA).

Electrical conductivity: Electrical conductivity was calculated by following the standard method of Jodeh et al. (2015). Electrical conductivity (EC) values were measured at room temperature of 23±1 °C using an electrical-conductivity meter. At plant maturity, grain yield in each pot were harvested five plants per pot.

Statistical analysis: Analysis of variance and mean comparisons were performed using SAS ver 9.1 computer software packages. The main effects and interactions were tested using the least significant difference (LSD) test at the 0.05 probability level.

Results and discussion

The results showed that application of biofertilizers and uniconazole under no salinity condition decreased hydrogen peroxide content, malondialdehyde and electrobc conductivity of flag leaf (77.6, 115.52 and 241.48% respectively) in comparison with no application of bio fertilizers under 120 mM salinity. But, increased chlorophyll index, relative water content, quantum yield, grain 100 weight and spike length (60.21, 43.27, 30.47,46.66 and 51.34% respectively) in comparison with no application of bio fertilizers under 120 mM salinity condition. Also, application bio fertilizers and uniconazole increased grain yield per plant about 108.84% in comparison with no application of bio fertilizers at the highest soil salinity level. Based on the results of this study, it seems that bio fertilizers and uniconazole application can be suggested to improve of grain yield of wheat under soil salinity condition.

***Keyewords*:** Hydrogen peroxide, Malondialdehyde, Mycorrhiza, Quantum yield

Tabel 1. Analysis of variance (Mean squared) of biological fertilizers and uniconazole on yield, yield components and biochemical traits of wheat under soil salinity conditions

Source of variations	df	MDA	H_2O_2	Anthocyanin	EC	Fv/Fm	RWC
Replication	2	0.0002^{**}	0.099^{**}	0.00005^{**}	89.14^{**}	0.00007^{ns}	7.34^{**}
Salinity (S)	3	0.013^{**}	1.888^{**}	0.00012^{**}	34459.10^{**}	0.062^{**}	1370.62^{**}
Biofertilizers,Uniconazole (B)	6	0.0006^{**}	0.071^{**}	0.000005^{**}	2243.74^{**}	0.005^{**}	126.43^{**}
S×B	18	0.00003^{*}	0.012^{**}	0.0000003^{**}	50.79^{**}	0.0001^{**}	3.10^{**}
Error	54	0.000017	0.005	0.0000001	3.44	0.00005	0.98
C.V (%)	-	*3.88*	*4.96*	*2.32*	*1.68*	*0.87*	*5.11*

Table 1. Continued

Source of variations	df	SPAD	Spike length	100-grain weight	number of grain per spike	Grain Yield (per Plant)
Replication	2	3.1^{ns}	0.13^{**}	0.54^{**}	42.65^{**}	0.07^{**}
Salinity (S)	3	1785^{**}	6.29^{**}	4.09^{**}	38.61^{**}	2.12^{**}
Biofertilizers,Uniconazole (B)	6	139.6^{**}	0.55^{**}	0.35^{**}	4.96^{**}	0.008^{**}
S×B	18	2.9^{*}	0.02^{**}	0.04^{*}	0.72^{*}	0.0004^{**}
Error	54	1.7	0.01	0.02	0.38	0.0002
C.V (%)	-	*2.09*	*2.28*	*3.24*	*3.93*	*1.30*

ns, * and ** are non-significant, significant at P≤0.05 and P≤0.01, respectively

Tabel 2. Means Comparison of the effect of biological fertilizers and uniconazole on the content of malondialdehyde, hydrogen peroxide content, anthocyanin content, electrical conductivity and quantum yield of wheat flag leaf under salinity conditions of soil

Treatment Combination	MDA	H_2O_2	Anthocyanin	EC	Fv/Fm	Relative water content
	----------(µmol/gFW)----------			(μsm^{-2})		%
s1×a1	0.091^{op}	0.274^{jklmn}	0.0133^{r}	82.68^{p}	0.858^{fg}	91.10^{f}
s1×a2	0.087^{pq}	0.272^{jklmn}	0.0139^{qr}	67.99^{s}	0.866^{ef}	93.52^{e}
s1×a3	0.085^{pq}	0.269^{klmn}	0.0145^{pq}	$65.73r^{s}$	0.877^{de}	95.58^{d}
s1×a4	0.083^{q}	0.265^{lmn}	0.0144^{q}	63.44^{s}	0.885^{cd}	95.93^{cd}
s1×a5	0.071^{r}	0.258^{lmn}	0.0153^{o}	58.76^{t}	0.895^{bc}	97.28^{bc}
s1×a6	0.070^{r}	0.256^{mn}	0.0151^{op}	56.71^{t}	0.901^{b}	98.21^{b}
s1×a7	0.070^{r}	0.250^{n}	0.0156^{no}	52.87^{u}	0.929^{a}	100.08^{a}
s2×a1	0.107^{ijkl}	0.304^{ghi}	0.016^{mn}	124.48^{j}	0.819^{kl}	84.44^{jk}
s2×a2	0.105^{jkl}	0.298^{hij}	0.0163^{lm}	113.06^{l}	0.829^{jk}	86.74^{hi}
s2×a3	0.104^{klm}	0.292^{hijk}	0.0164^{lm}	105.26^{m}	0.835^{ij}	87.69^{gh}
s2×a4	0.102^{lmn}	0.283^{ijkl}	0.0166^{klm}	96.57^{n}	0.843^{hi}	88.99^{g}
s2×a5	0.098^{mno}	0.280^{ijklm}	0.0167^{jk}	82.64^{o}	0.850^{gh}	91.24^{f}
s2×a6	0.096^{no}	0.278^{ijklm}	0.0171^{jk}	80.29^{p}	0.855^{fg}	91.04^{f}
s2×a7	0.094^{o}	0.276^{jklmn}	0.0173^{jk}	73.21^{q}	0.870^{e}	93.13^{e}
s3×a1	0.124^{f}	0.347^{de}	0.0177^{ij}	136.07^{h}	0.774^{p}	80.86^{mno}
s3×a2	0.118^{fg}	0.339^{ef}	0.0181^{ghi}	129.37^{i}	0.785^{op}	81.70^{lmn}
s3×a3	0.114^{gh}	0.334^{ef}	0.0181^{hi}	125.38^{j}	0.795^{no}	82.40^{lm}
s3×a4	0.113^{ghi}	0.329^{efg}	0.0183^{ghi}	117.64^{k}	0.801^{mn}	83.19^{kl}
s3×a5	0.111^{hij}	0.326^{efg}	0.0188^{efg}	111.488^{m}	0.809^{lm}	85.61^{ij}
s3×a6	0.111^{hij}	0.318^{fg}	0.0186^{fgh}	104.82^{m}	0.817^{l}	85.36^{ij}
s3×a7	0.107^{hijk}	$0.316f^{gh}$	0.0192^{def}	98.23^{n}	0.831^{ij}	88.10^{gh}
s4×a1	0.151^{a}	0.444^{a}	0.0193^{de}	180.54^{a}	0.712^{s}	69.85^{r}
s4×a2	0.146^{ab}	0.438^{ab}	0.0198^{cd}	173.16^{b}	0.743^{r}	72.63^{q}
s4×a3	0.144^{ab}	0.435^{ab}	0.02^{c}	166.35^{c}	0.754^{qr}	76.19^{p}
s4×a4	0.143^{bc}	0.414^{bc}	0.0204^{bc}	160.01^{d}	0.761^{p}	76.30^{p}
s4×a5	0.136^{cd}	0.406^{c}	0.0203^{bc}	153.47^{e}	0.775^{p}	79.44^{o}
s4×a6	0.130^{de}	0.370^{d}	0.0207^{b}	148.60^{f}	0.784^{op}	80.77^{no}
s4×a7	0.123^{f}	0.350^{de}	0.0225^{a}	143.75^{g}	0.794^{no}	82.77^{l}
LSD	0.006	0.02	0.0007	3.03	0.01	1.62

Means with similar letters in each column are not significantly different according by LSD test 0.05 level

S_1, S_2, S_3 and S_4 no salinity, 40, 80 and 120 mM in soil salinity. a_1, a_2, a_3, a_4, a_5, a_6, and a_7 are no application of bio fertilizers, application of uniconazole, pseudomon, application of mycorrhiza, application of uniconazole and mycorrhiza, application of mycorrhiza and pseudomonas, application of mycorrhiza and pseudomonas and uniconazole.

Tabel 3. Means Comparison of the effect of biol fertilizers and uniconazole on relative water content, chlorophyll index, spike length, 100-grain weight and grain yield per plant of wheat under soil salinity conditions

Treatment Combination	SPAD	Grains per spike	Spike length	100-grain weight	Yield per Plant
			(cm)	----------(g)----------	
s1×a1	68.46^{e}	16.33^{cdef}	5.27^{efg}	5.16^{cdef}	1.485^{d}
s1×a2	70.44^{de}	16.66^{cde}	5.36^{def}	5.19^{bcdef}	1.492^{d}
s1×a3	71.75^{bcd}	17.33^{bc}	5.42^{cde}	5.23^{bcde}	1.507^{cd}
s1×a4	71.63^{cd}	17^{bcd}	5.48^{cd}	5.24^{bcd}	1.518^{bc}
s1×a5	73.85^{ab}	17.33^{bc}	5.59^{bc}	5.34^{bc}	1.533^{b}
s1×a6	73.14^{abc}	18^{b}	5.75^{b}	5.42^{b}	1.533^{b}
s1×a7	75.03^{a}	19.66^{a}	6.29^{a}	6.09^{a}	1.606^{a}
s2×a1	60.71^{h}	15.33^{fghi}	4.86^{ikl}	4.94^{fghij}	1.134^{i}
s2×a2	62.82^{gh}	15.66^{efgh}	4.99^{ijk}	4.97^{efghij}	1.141^{hi}
s2×a3	66.10^{f}	16.33^{cdef}	5.04^{hij}	5.00^{defghi}	1.150^{hi}
s2×a4	66.03^{f}	15.66^{efgh}	5.12^{ghi}	5.02^{defghi}	1.161^{gh}
s2×a5	68.53^{e}	16^{defg}	5.21^{fgh}	5.08^{defgh}	1.176^{fg}
s2×a6	69.43^{e}	17b^{cd}	5.26^{efg}	5.11^{cdefg}	1.202^{ef}
s2×a7	71.62^{cd}	16.66^{cde}	5.36^{def}	5.17^{bcdef}	1.220^{e}
s3×a1	51.70^{l}	14.66^{hij}	4.44^{pqr}	4.52^{lm}	0.925^{m}
s3×a2	54.36^{jk}	14.66^{hij}	4.51^{opq}	4.60^{klm}	0.933^{lm}
s3×a3	56.43^{ij}	14.66^{hij}	4.56^{op}	4.73^{jkl}	0.945^{klm}
s3×a4	57.27^{i}	14.66^{hij}	4.63^{mno}	4.79^{ijk}	0.951^{kl}
s3×a5	60.99^{h}	14.66^{hij}	4.75^{lmn}	4.85^{ghijk}	0.958^{jk}
s3×a6	61.24^{h}	15^{ghij}	4.81^{klm}	4.83^{hijk}	0.965^{jk}
s3×a7	63.60^{g}	15.66^{efgh}	5.07^{hi}	4.97^{efghij}	0.976^{j}
s4×a1	46.83^{o}	13.33^{k}	4.15^{u}	4.15^{o}	0.769^{p}
s4×a2	47.74^{no}	14.66^{hij}	4.22^{tu}	4.17^{o}	0.771^{p}
s4×a3	49.39^{mn}	14^{jk}	4.25^{stu}	4.24^{no}	0.775^{p}
s4×a4	49.98^{lm}	14^{jk}	4.31^{rstu}	4.36^{mno}	0.783^{op}
s4×a5	53.93^{k}	15.33^{fghi}	4.36^{qrst}	4.39^{mno}	0.801^{no}
s4×a6	54.22^{k}	14.33^{ijk}	4.43^{pqrs}	4.45^{mn}	0.807^{n}
s4×a7	55.92^{ijk}	15.66^{efgh}	4.59^{nop}	4.60^{klm}	0.820^{n}
LSD	2.12	1.01	0.184	0.25	0.02

S_1, S_2, S_3 and S_4 no salinity, 40, 80 and 120 mM soil salinity soil.

a_1, a_2, a_3, a_4, a_5, a_6, and a_7 are no application of bio fertilizers, application of uniconazole, pseudomon, application of mycorrhiza, application of uniconazole and mycorrhiza, application of mycorrhiza and pseudomonas, application of mycorrhiza and pseudomonas and uniconazole.

Means with similar letters in each column are not significantly different according by LSD test at 0.01(*) and 0.05 (**) probability level.