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Effects of Silicon Nanocolloid Pre-Treatment on Seed Germination Characteristics of Wheat (*Triticum aestivum*) Under Drought Stress

[1]Karim Barzegar Ghajari, [2]Abbas Maleki, [3]Rahmatollah Pirdashti

[1]MA Agriculture, Islamic Azad University, Ilam Branch, Department of Agriculture, Ilam, Iran.
[2]Islamic Azad University, Ilam Branch, Department of Agriculture, Ilam, Iran.
[3]Sari Agricultural Sciences And Natural Resources, Department of Agronomy and Plant Breeding, Sari, Iran.

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ABSTRACT

Wheat (*Triticum Aestivum*) is appropriated 17 percent of arable land under cultivation in the world. Drought stress is the most important problem that decreasesyield of crops. One of way to increase the component of seed germination and emergence is use of pre-treatment techniques. Use of nanotechnology is expanding in all fields including agriculture. In this study effect ofsilicon Nano-colloid pre-treatment was investigatedonseed germination propertiesof wheatunder drought stress. Experiment was done as factorial completely randomized design with four replications. Treatments consisted of six levels of drought stress (0, -3, -6, -9, -12, -15 bar) and five levels of silicon Nano-colloid (0, 15, 30, 45, 60 milligrams per liter). In this experiment, Morvarid cultivar was used. Results showed that with increasing drought stress from -3 to -6 bar, germination percentage, mean daily germination rate, germination speed, and germination speed index was decreased significantly and the most speed germination was observed under -3 bar drought stress in 30 mg/l Nano silicon. With increasing drought stress from -3 to -6 bar, allometric coefficient was increased significantly but different amount of silicon nano was no significant effect on allometric coefficient.

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INTRODUCTION

Wheat is form cereal and the most important crop plants that is allocated 17 percent of arable land under cultivation in the world. Almost 32 percent of wheat grown in developing countries was experienced various types of stress during the growing season [8]. Among abiotic stress, drought is the most important problem that decreases the yield of crops [3]. Resorts indicate that pre-treatment increases the germination percentage, germination speed and uniformity of germination and seedling emergence [2,4]. Use of nanotechnology is expanding in all fields including agriculture. Nano products is include a mixture of particles with a size between 1 and 100 nm, which can change their physical and chemical properties of raw materials Monica and Kermonini, [6]. Silicon reduces the effects of such stresses as salinity, drought, nutrient imbalanced, high temperatures and freezing. In addition, silicon helps plants prevail to biotic and abiotic stress [5]. In this study effect of silicon Nano-colloid pre-treatment was investigated on seed germination characteristics under drought stress that seems it is necessary to overcome the stress and negative effects of it.

MATERIALS AND METHODS

Experiment was done in laboratory of Sari agricultural sciences and natural resources university in 1392. Experiment was done as factorial randomized design with 4 replications.Treatments consisted of six levels of drought stress (0, -3, -6, -9, -12, -15 bar) and five levels of silicon Nano-colloid (0, 15, 30, 45, 60 milligrams per liter). In this experiment, Morvarid cultivar was used. In order to synthesize silicon Nano initially 100 mg of Nano powder was added to 1000 cc of distilled water (100 mg/l) and placed for 20 min in ultrasonic bath (S 60 H). Surfactant soluble at a 0.5 per thousand concentration was added to avoid precipitation of silicon Nano soluble powder. To create different levels of drought stress was prepared with different concentration of

Corresponding Author: Karim Barzegar Ghajari, MA Agriculture, Islamic Azad University, Ilam Branch, Department of Agriculture, Ilam, Iran.
E-mail: iaumaleki@yahoo.com

polyethylene glycol 6000 (PEG6000) by the methods of Michel and Kaufmann. Drought levels was include 0, -3, -6, -9, -12, -15 bar that to create them in order of 0, 143.18, 213.64, 267.98, 313.88, 354.36 gr polyethylene glycol 6000 in a liter of distilled water was used. Seeds were disinfected with one percent sodium hypochlorite solution then seeds were disinfected were treated at specified levels of silicon Nano for 12 hours. 25 treated seeds were placed in each petri dish after sterilization the petri dishes and put the 90 mm filter paper on it. And 5 ml of polyethylene glycol in different concentration was added to petri dishes. Then petri dishes were placed in germinator with 20 ° C and 96% humidity for 8 days. Germination counts were performed on a daily basis and at the same time. seed is taken as germinated that had 2 mm or more root length. T the end, allometric coefficient and germination components include length of seedling vigor, germination speed, germination rate, germination index and germination medium was determined daily using Germin software [1]. Data analyses by using SPSS 18 and MSTATC and comparison with Duncan test (α=0.01).

Results:

Analysis of variance showed that the treatment effect of drought on seed germination was significant in (α=0.01) for germination component (table 1). While simple effect of silicon nano treatment and interaction of different level of silicon nano and drought stress was only significant on germination speed (table 1). Germination percentage, mean germination daily, germination speed was decreased with increasing stress from -3 to -6 bar (table2). Most germination speed was observed on -3 bar and 30 mg silicon nano per liter (figure1). Although silicon nano values were not significant on germination percentage but germination percentage was the lowest with uses 60 mg/l of silicon nano (table2). Results showed that germination rate daily is statistically affected by the amount of drought stress significant in one percent level (table1). So that with increasing drought stress from -3 to -6 bar germination speed was increased significantly. Although silicon nano values were not significant effect on germination speed, but germination speed was increased significantly by using 60 mg/l silicon nano (table2). Germination index were significant statistically at one percent level only on drought stress levels (table1). So that germination index was significantly increased with increasing stress from -3 to -6 bar. Although silicon nano was not significant for germination index but taking silicon nano increases germination index (table2).

Mean square values of the components of germination is affected by drought and silicon nano.

			Mean square				
Allometric coeficient	Germination index	Germination speed ratio	Germination speed daily	Mean germination daily	Germination speed	Germination percent	Sources of change
2.13**	1.25**	178.13**	23.91**	31.26**	262.4**	201.06**	Drought
0.005	0.09	45.96	1.34	1.21	9.07**	77.73	NanoSilicon
0.003	0.1	40.51	0.81	0.54	3.88*	34.73	A×B
0.006	0.1	19.59	0.56	0.54	1.58	34.57	error
18	15.59	9.55	8.53	6.36	9.82	6.36	CV
*And **significant in 5 and 1 percent							

Germinated wheat seeds under drought stress and silicon nano.

From the results we can say allometric coefficient is statistically significant just under the drought stress at one percent (table1). Allometric coefficient was significant by increasing drought stress from -3 to -6 bar (table2). Also silicon nano values were not significant for allometric coefficient (table1).

Comparison of germination components under drought stress and silicon nano.

Allometric coefficient	Germination index	Germination rate coefficient daily	Daily rate of germination	Mean daily germination	Germination rate	Germination percentages	Treatment
							Drought(bar)
0.74 a	1.97 b	50.53 a	0.08 b	12.42 a	14.6 a	99.40 a	0
0.43 b	1.85 b	52.88 a	0.08 b	12.12 a	15.21 a	97 a	-3
0.09 c	2.33 a	35.59 b	0.1 a	10.12 b	8.65b	81 b	-6
							Nano Silicon(mgl^{-1})
0.41 a	1.95 a	48.31 a	0.08 b	11.7 a	13.42 a	93.66 a	0
0.45 a	2.10 a	45.16 ab	0.08 b	11.62 a	12.33 bc	93 a	15
0.43 a	1.99 a	48.45 a	0.08 b	11.79 a	13.84 a	94.33 a	30
0.40 a	2.17 a	45.68 ab	0.08 b	11.66 a	12.87 ab	93.33 a	45
0.41 a	2.04 a	414.07 b	0.09 a	11 b	11.64 c	88 b	60

Means with similar letters in each column no significant difference at the 5% level according to Duncan's multiple range test

Discussion:

Based on the results, we can say that the drought stress has the different effects on wheat germination components. So that germination percent, germination speed, mean daily germination was decreased by increasing drought stress. Characteristic such as germination time, daily rate of germination, germination index and allometric coefficient was increased by increasing drought stress. We can conclude that drought stress, causes accelerated during germination time, germination daily rate and allometric coefficient. Also different levels of silicon nano have different effect on germination components in wheat. So that traits such as germination percent and germination speed were decreased by increasing the concentration of silicon nano but no effect on mean daily germination. Also the increase of silicon nano did not effect on morphological traits of wheat such as germination time, germination rate daily, germination index and allometric coefficient. It can be said that silicon nano causes increase traits such as germination time, germination rate and allometric coefficient. Use both silicon nano and drought stress causes accelerated germination time and germination index.

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