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Original article

Effect of nanosilicil potassium on growth and yield of maize (*Zea mays* L.) under drought stress

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Extended abstract

Introduction

Water-deficit stress is known as drought stress, which reduces agricultural production mainly by disrupting the osmotic equilibrium and membrane structure of the cell. Drought stresses, either flooding or drought, affect multiple aspects of plant physiology and metabolism. Flooding results in reduced oxygen supply to roots, leading to the malfunctioning of critical root functions, including limited nutrient uptake and respiration. Nanotechnology research has opened up a new opportunity in crop improvement. Silica is one of the most common elements in the earth's crust and in the plants' ash. Although Si is not always considered a necessary element for plants, it is assumed to be necessary for some plants. During the last decade, an array of exploratory experiments has been conducted to gauge the potential impact of nanotechnology on crop improvement. Nanotechnology is one of the most significant techniques in the protection of agricultural products and food, and much research attribute to its utilization a number of environmental benefits. Application of nanotechnology in agriculture and related industries can increase production, improve quality and protect the environment and global resources. Nano fertilizers can increase the efficiency nutrient use by controlling the release of the nutrients from the fertilizer.

Materials and methods

In order to study the influence of potassium nano-silica (PNS) on maize under different levels of drought stress, a factorial experiment was conducted based on a completely randomized block design with three replications at the Center of Agricultural Research and Education and the Natural Resources of Qazvin, during the 2017-2018 growing season. The first factor was drought stress and the second factor nano-silica/potassium fertilizer was included (control) 1 and 2 per thousand. There were 5 rows of 5 m with a row distance of 75 cm. Plant distance within a row was 20 cm. Seeds were disinfected with Vitawax fungicide before they were planted. Seeds were planted in groups of 3 at 3-5 cm depth to guarantee that a healthy plant was established at each plant site. Superfluous plants were removed when plants had 4-6 leaves. The solution of PNS was sprayed at 0, 100 and 200 ppm concentrations when plants had 6-8 leaves. The control group was treated with distilled water. Weeds were removed manually during the experiment. The harvest was performed manually when seeds were physiologically ripe.

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Results and discussion

The results showed that by increasing drought stress, plant height, plant fresh weight, plant dry weight, leaf number per plant, number of ear per plant, ear length, ear diameter, row number per ear, number of seeds per ear, ear cob weight, ear weight and seed thousand weight decreased. It was observed that the by using nano-silica/potassium the morphological characteristics of corn and the absorption of nutrients were improved, fresh weight, dry weight, number of ear per plant, ear length, number of rows per ear, ear weight and ear weight, were obtained in 2 in 1000 nano-silica/ potassium. Number of leaves per plant, ear diameter, number of seeds per row and seed thousand weight of levels 1 and 2 in 1000 nano-silica/potassium were in a statistical group.

Conclusions

The results of this study indicated that the using of nano-silica/potassium fertilizer under favorable irrigation conditions and drought stress by providing nutrients could improve morphological indices and absorption of nutrients. Nano-silica/potassium fertilizer was decreased the effects of drought stress and was increased plant tolerance to drought stress conditions.

Acknowledgements

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***Keywords*:** Drought, Maize, Nano-silica/potassium, Yield components

Table 1. Physicochemical characteristics of the soil

Soil text	K	P	N	O.C	pH	EC×10^3	S.P
	----------ppm----------		%	%		dS.m^{-1}	%
Lom Clay	305	9	0.08	0.8	7.5	0.7	45

Table 2. The results of variance analysis on the study of the influence of potassium Nano silica fertilizer on corn in drought stress

S.O.V	df	Height of plant	Wet weight of plant	Dry weight of plant	Number of leaves in plant	Number of ears in plant	Length of ear
Block	2	124.5^{ns}	12366.3**	5050.5**	3.83*	0.002^{ns}	5.45^{ns}
Drought stress (a)	2	3586.3**	119519.5**	20530.9**	25.35**	0.48**	84.53**
Potassium Nano silica (b)	2	1859.3**	40878.6**	10050.8**	3.34*	0.2**	30.23**
a*b	4	494.7*	5692.8*	1035.5*	0.66^{ns}	0.09**	7.43*
Error		136.15	1871.41	274.2	0.67	0.01	2.41
CV%		*6.53*	*6.2*	*7.1*	*7.02*	*8.79*	*9.07*

Tablr 2. Continued

S.O.V	df	Diameter of ear	Number of rows in ear	Number of seeds in each row	Weight of the ear's wood	Weight of ear	Thousand Kernel Weight
Block	2	0.39^{*}	0.56^{ns}	7.4^{ns}	1.86^{ns}	412.3^{ns}	392.44^{ns}
Drought stress (a)	2	4.35^{**}	21.03^{**}	212.33^{**}	24.32^{**}	15560^{**}	6543.83^{**}
Potassium Nano silica (b)	2	1.23^{**}	4.81^{*}	37.79^{**}	19.16^{**}	2649^{**}	1230.9^{**}
a*b	4	0.08^{ns}	0.16^{ns}	10.6^{*}	2.94^{*}	421.3^{*}	88.37^{ns}
Error		0.08	0.85	3.53	0.98	134.1	185.57
CV%		*6.53*	*7.42*	*6.1*	*6.05*	*6.25*	*6.39*

* and **mean significant in the possibility levels of 5% and 1%, respectively, ns: insignificant effect

Table 3. Comparison of the effects of drought stress levels on number of leaves, ear diameter, and number of rows per ear and 1000-seed weight in maize.

Irrigation regimes (mm evaporation from Pan)	Number of leaves in plant	Diameter of ear (cm)	Number of rows in ear	Thousand Kernel Weight (g)
30	13.25^{a}	4.92^{a}	14.11^{a}	241.6^{a}
60	11.8^{b}	4.13^{b}	12.14^{b}	210^{b}
90	9.9^{c}	3.54^{c}	11.1^{c}	188^{c}

The means with same letters do not have a significant difference on 5% level based on Donkan Test.

Table 4. Comparison of the effects of potassium nanosilicate fertilizers on leaf number, ear diameter, number of rows per ear and 1000-seed weight in maize.

Potassium Nano silica (‰)	Number of leaves in plant	Diameter of ear (cm)	Number of rows in ear	Thousand kernel weight (g)
0	10.95^{b}	3.78^{b}	11.48^{b}	199.78^{b}
1	11.97^{a}	4.31^{a}	12.53^{ab}	218.79^{a}
2	12.03^{a}	4.49^{a}	13.11^{a}	221.08^{a}

The means with same letters do not have a significant difference on 5% level based on Donkan Test.

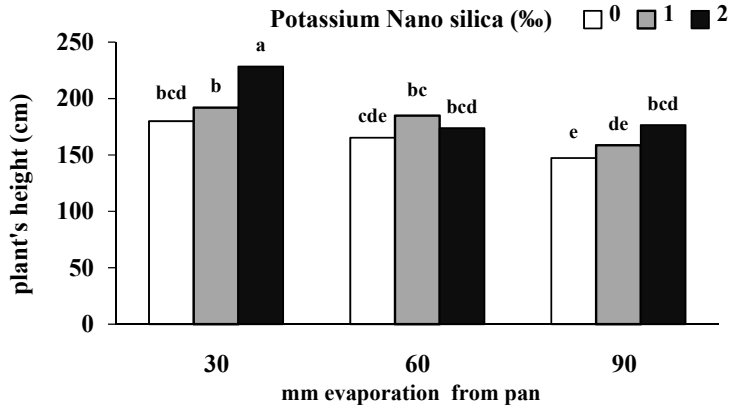

Fig. 1. The mean comparison of effect of potassium Nano silica fertilizer under drought stress on maize plant's height. Treatments with at least one similar letter do not have a significant statistical difference on the possibility level of 0.5%

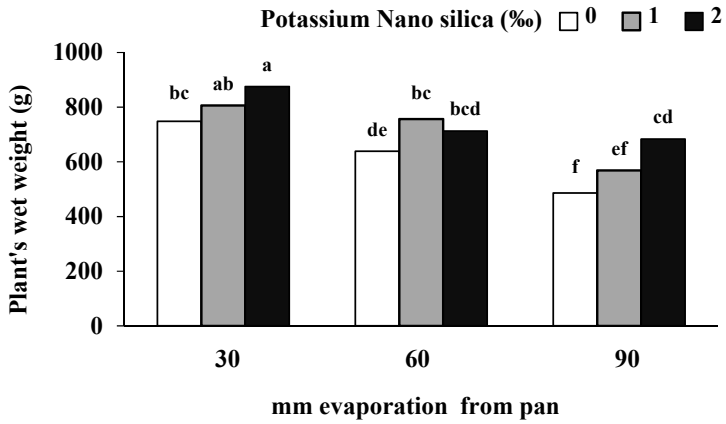

Fig. 2. The mean comparison of potassium Nano silica fertilize level under drought stress on the plant's wet weight. The treatments with at least one similar letter do not have a significant statistical difference on the possibility level of 5%.

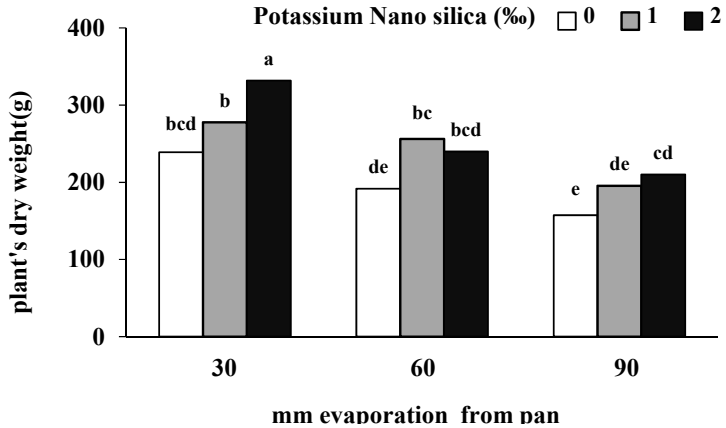

Fig. 3. The comparison of the mean effect of potassium Nano silica fertilizer under drought stress on the maize's dry weight. The treatments with at least one similar letter do not have a significant statistical difference on the possibility level of 5%

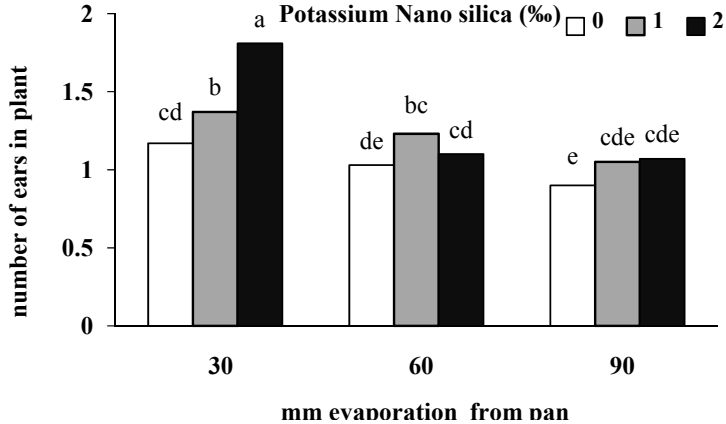

Fig. 4. The comparison of the mean effect of potassium Nano silica fertilizer under drought stress on the noumber of ears in maize plant. The treatments with at least one similar letter do not have a significant statistical difference on the possibility level of 5%.

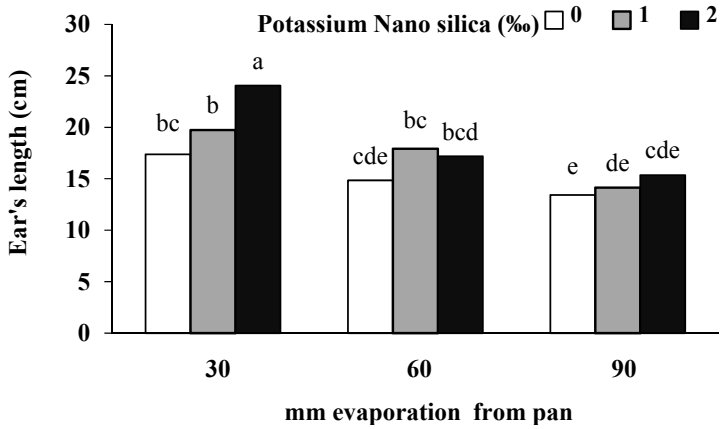

Fig. 5. The comparison of the mean effect of potassium Nano silica under drought stress on ear's length of maize plant. The treatments with at least one similar letter do not have a significant statistical difference on the possibility level of 5%

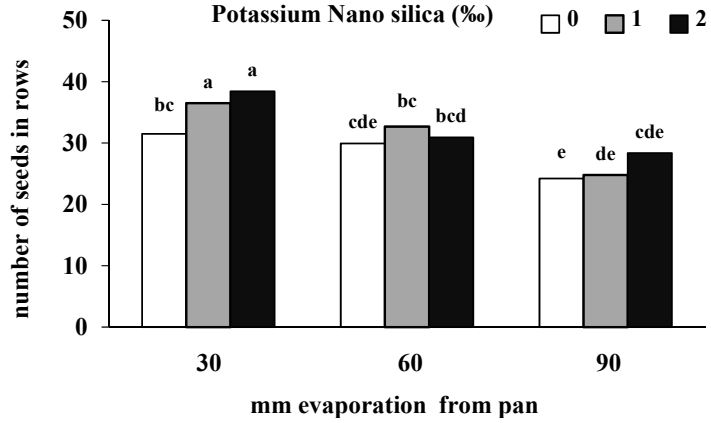

Fig. 6. The comparison of the mean influence of potassium Nano silica under drought stress on the number of seeds in rows in maize plant. The treatments with at least one similar letter do not have a significant statistical difference on the possibility level of 5%

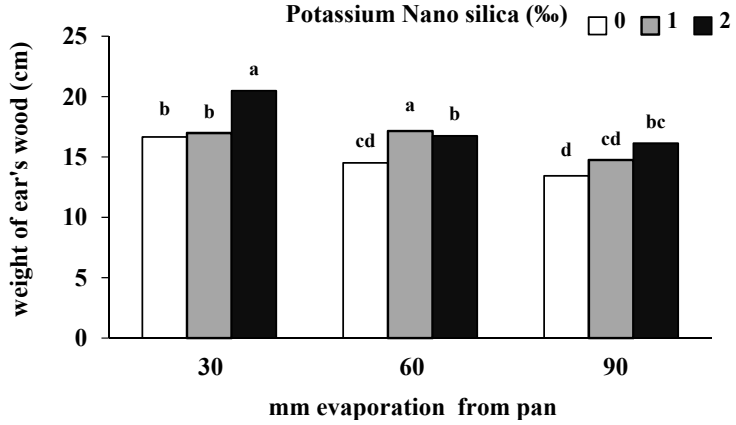

Fig. 7. The comparison of the mean influence of potassium Nano silica fertilizer under drought stress on the weight of ear's wood. The treatments with at least one similar letter do not have a significant statistical difference on the possibility level of 5%.

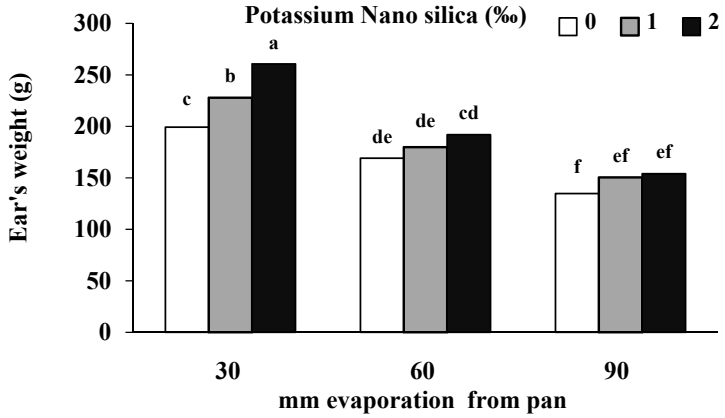

Fig. 8. The comparison of the mean influence of potassium Nano silica under drought stress on the weight of ear. The treatments with at least one similar letter do not have a significant statistical difference on the possibility level of 5%.