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RESEARCH ARTICLE

Nano-fertilizer prevents environmental pollution and improves physiological traits of wheat grown under drought stress conditions

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Abstract

Nano fertilizers offer benefits in nutrition management through their strong potential to increase nutrient use efficiency. Traditional fertilizers are not only costly for the producer but may be harmful to humans and the environment. Furthermore, nano fertilizers may also be used for enhancing abiotic stress tolerance. This study was performed on the evaluation of nano chelated nitrogen and urea fertilizers on the physiological characteristics of wheat under drought stress conditions. Experiments were carried out in two locations in Fars province, Iran. The experimental design was performed as a split-split plot in RCBD design. The first factor included irrigation treatments (normal and withholding irrigation at the flowering stage), sub factor was nitrogen treatment (0, 37, 74 and 110 k g.ha^{-1}) in the form of Urea fertilizer, and sub-sub factor was nitrogen (0, 14, 27 and 41 kg.ha^{-1}) in the form of nano chelated nitrogen fertilizer. Studied traits were RWC, Ion Leakage, Protein, Phosphorus and Potassium content, Remobilization and photosynthesis rate. According to the analysis of variances, stress, nitrogen (urea) and nano chelated nitrogen had significant effects on all studied traits. Mean comparisons showed that drought stress led to 13% reduction in RWC, 21% Ion Leakage, 26% Protein, 13% Phosphorus and 26% Potassium content, 22% Remobilization and 69% photosynthesis rate compared to normal irrigation. In conclusion Application of 41 kg.ha^{-1} nano chelated nitrogen fertilizer in comparison with urea led to increase 4% in Rwc, 3% Ion leakage, 52% protein, 26% phosphor, 6% potassium, 6% Remobilization and 21% photosynthesis rate compared to control, respectively.

Keywords: nano fertilizers; nano-nitrogen; environmental pollution; drought stress; wheat; physiological traits; conventional fertilizer.

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1. Introduction

Nano fertilizer, the most important field of agriculture has been to the attention of the soil scientists as well as the environmentalists due to its capability to increase yield, improve soil fertility, reduce pollution and make a favorable environment for microorganisms.

Among mineral nutrients, nitrogen is the first and foremost nutrient required for crop plants as it is a vital structural constituent of many proteins and enzymes chlorophyll, Rubisco, nucleic acids, some hormones and thus N fertilization is an essential agronomic management practice to enhance the crop productivity and plays a significant role during the vegetative growth of crops (Ata-Ul-Karim et al., 2016); but unfortunately, nitrogen is lost through the processes of nitrate leaching, de-nitrification and ammonia volatilization and runoff to surface and ground water and so induces economic losses and environmental pollution.

Nano fertilizers in boosting nutrients uptake and nutrients use efficiency, reducing losses through leaching and gaseous emissions along with reducing the risk of nutrient toxicity for ensuring food security achieved through higher productivity and economic turnouts by practicing the sustainable farming practices (Iqbal, 2020).

Abid et al. (2016) reported that nitrogen nutrition improves the potential of wheat to alleviate the effects of drought stress during vegetative growth periods. The leaves are a sink for N during the vegetative stage and, afterwards, this N is remobilized for use in the developing seeds. Much of this remobilization occurs during senescence where N is transported mainly via amino acids. Up to 80% of grain N contents are derived from leaves in wheat (Kichey et al., 2007).

Water limitations accompanied by low N is the main constraint to wheat yield and has widely been reported to affect the leaf water relations, Chl fluorescence and photosynthetic processes leading to the restricted plant growth rate, early senescence, reduced grain filling duration (GFD) with limited grain weight and poor crop productivity (Madani et al., 2010; Mobasser et al., 2014).

An adequate assessment of the impacts of drought stress under different N levels on the physiological activities and yield attributes can provide the valuable insights for wheat cultivation under drought stress (Teixeira et al., 2014).

Efficient nitrogen nutrition has the potential to alleviate drought stress in crops by maintaining metabolic activities even at low tissue water potential. Wang et al. (2018) reported that nitrogen fertilization improved water-use efficiency of winter wheat through increasing water use during vegetative rather than grain filling. Wu suggested that nutrient application has the potential to mitigate the drastic effects of water stress on Moso bamboo by improving photosynthetic rate, water-use efficiency, and increasing membrane integrity.

Noaema et al. (2020) indicated that spraying by Boron and Potassium nanoparticles with highest concentration of 8 m. L^{-1}, showed a significant increase in many features of growth and yield of Wheat.

The results of spraying the liquid nano NPK fertilizers on wheat compared with the control treatment showed increases in grains yield (48.99%), protein percentage (27.24%), gluten ratio in flour (58.45%) and flag leaf area (38.69%), nitrogen (19.37%), phosphorus (44.11%) and potassium (12.03%) (Burhan & Al-hassan, 2019).

Although, the application of micronutrient fertilizers nanoparticles that mostly were sprayed with water has been indicated to improve the growth conditions, and has increased the crop yield in the previous studies (Abdel-Motagally & El-Zohri, 2018; Rastogi et al., 2019; Ali et al., 2019; Ahmadian et al., 2021) but according to the review of the literature there are limited studies about the application of macronutrient nano-fertilizers like nano chelated nitrogen with irrigation water in the wheat farms under deficit-water stress condition. Thus, In the present study we compared the effects of different N levels of nano chelated nitrogen, which is synthetized based on novel Nano chelating technology, with urea and the aim of this study was to investigate whether nutrition nitrogen supply in the form of a nanostructure can improve the drought tolerance of wheat and also the Assessment impact of nitrogen nanostructure in the absorption of protein phosphorus potassium by wheat plant and the extent of assimilating remobilization and current photosynthesis rate under dry conditions.

2. Materials and methods

Experiments were carried out in two locations including Khodayan (52 ˚ 20' E, 29˚ 8 ' N) and Nasrabad (52˚ 64' E and 29˚ 58' N), Fars province, Iran. Table 1 shows some physicochemical properties of the soil at 0 to 30 cm.

Experimental design was performed as a split-split plot in RCBD design. The first factor included irrigation treatments (normal and withholding irrigation at flowering stage), sub factor was nitrogen treatment (0, 37, 74 and 110 $kg.ha^{-1}$) in the form of urea, and sub-sub factor was nitrogen (0, 14, 27 and 41 $kg.ha^{-1}$) in the form of nano chelated nitrogen. The doses of urea and nano chelated nitrogen fertilizer were 80, 160 and 240 kg/ha which above mentioned doses are the doses of nitrogen element in the fertilizers that are calculated based on this data: Urea has 46% nitrogen and nano nitrogen chelated fertilizer contains 17% nitrogen.

Table 1

Some physicochemical properties of the soil at 0 to 30 cm

	Khodayan	Nasrabad
Ec (dS/m)	1.2	1.3
pH	7.6	7.4
OM%	2.4	2.2
C	1.65	1.63
P (ppm)	13	15
K (ppm)	370	380
Mn (ppm)	4	3.7
Fe (ppm)	7.5	7.7
Clay %	34.86	36.75
Silt %	47.23	47.55
Sand%	17.9	15.7
N (kg/ha)	18.6	21.21

The field was as fallow in the last year. Field operation was done according to usual regional methods (plow, disc, land leveling and furrow). Fertilizer levels were determined after soil analysis (Table 1). Each plot contained 6 rows with 4 meters length and 0.2 m distance, with a constant density of 450 plants per square meter. In the stem extension stage of wheat, weeds chemical control were carried out using Granstar herbicide (for the control of grassy weeds) and Puma super (for broadleaf weeds).

some properties measured such as leaf area, RWC, K, N and P content, remobilization and photosynthesis rate.

Relative water content was determined according to Schonfeld et al. (1998) by soaking leaf sample (0.5 g) in 100 ml of distilled water at 4 °C in the dark for 24 h. The turgid leaves were quickly blotted dry prior to the turgid weight measurement. Dry weight of leaves was determined after oven-drying at 70 °C for 48 h. RWC was calculated according to Smart & Bingham (1974), using the following equation: RWC = [fresh weight- dry weight/ turgid weight – dry weight] × 100

Leaf membrane damage was determined by recording of electrolyte leakage (EL) as described by Valentovic et al. (2006) with a few modifications. Plant material (0.5 g) washed with deionized water was placed in tubes with 20 ml of deionized water and incubated for 24 h at 25 °C. Subsequently, the electrical conductivity of the solution (L1) was measured. Samples were then autoclaved at 120 °C for 20 min and the final conductivity (L2) was measured after equilibration at 25 °C. The EL was defined as follows: EL (%) = (L1/L2) × 100

Phosphorus measured by colorimetric method, since phosphorus forms a yellow complex with the introduction of molybdate vanadate, we can read up to 450 nm at wavelength. Grain subsamples from each treatment were collected for determining grain P concentration. The subsamples were dried in a forced air oven at 66 °C, ground to pass a 140 mesh sieve (100 mm), and analyzed for total P using inductively coupled plasma mass spectrometry (PerkinElmer, Waltham, MA) after a wet acid digestion (Chapman & Pratt, 1961).

Measurement of potassium was determined by the flame photometer (UK, 410 model, Sherwood) method (Munns et al., 2010) And protein by the standard macro-Kjeldahl procedure. This method (Kjeldahl, 1883) is used worldwide as the standard for analyzing nitrogen and protein content in food. Typical analyses are protein in corn, barley wheat, and seeds.

Sample preparation and analysis

During a period of anthesis and maturity, plants were sampled. Dry matter changes of these parts-expressed as the sample means-before and after anthesis were then calculated. Positive differences between dry matter at two successive stages were attributed to the storage of assimilates and negative values to remobilization to the grains (Cox et al., 1986; Papakosta & Gagianas, 1991; Arduini et al., 2006):

Dry matter remobilization (mg per shoot) = (dry matter at anthesis stage in the organ) - (dry matter at maturity stage in the same organ).

Current photosynthesis rate = Contribution of reserves of assimilate to grain (%)/GY (mg/plant)

Contribution of reserves of assimilate to grain (%) = (Dry matter remobilized/ grain dry matter accumulation between day 24 and maturity) x 100.

Data analysis

Data were analyzed using the general linear model (GLM) procedure of the statistical analysis system, SAS software. When analysis of variance showed significant treatment effects, Duncan's multiple range tests were applied to compare the means at $p < 0.05$.

3. Results and discussion

RWC and Ion leakage

According to analysis of variances it was founded that interaction effects between Location* Drought Stress* Urea* Nano showed significant effect at 5% statistically level on RWC and Ion leakage (Table 1).

Stress treatment caused a significant decrease in the leaf RWC and increase in electrolyte leakage compared with control and recovered conditions According to mean comparisons, drought stress led to 13 reduction in RWC and 21% increase in ion leakage compared to normal irrigation, respectively.

Application of 37, 74 and 110 kg.ha^{-1} urea led to 3, 7 and 16% increase in RWC and 14, 21 and 24% decrease in ion leakage compared to control, respectively. Mostly In the drought stressed plots, nitrogen supply increased RWC and decrease ion leakage. Application of 14, 27 and 41 kg.ha^{-1} nano fertilizer led to 15, 21 and 37% increase in RWC and 15, 22 and 29% the reduction of ion leakage compared to control, respectively. In relation to interaction between stress, urea and nano fertilizer on RWC, it was found that at normal and stress condition the highest mean of RWC (78 and 69%, respectively) were obtained by 110 kg.ha^{-1} urea and 41 kg.ha^{-1} nano fertilizer and interaction between stress, urea and nano fertilizer in ion leakage showed that at normal condition and stress condition the lowest mean of ion leakage (28% and 32%) were obtained by 110 kg.ha^{-1} urea and 41 kg.ha^{-1} nano fertilizer.

The ability of the plant to survive in severe water deficits depends on its ability (ion leakage) to restrict water loss through the leaf epidermis after the stomata have attained minimum aperture (El Jaafari, 2000). Shangguan et al. (2000) showed nitrogen nutrition and water stress had effects on leaf photosynthetic gas exchange and water use efficiency in winter wheat. According to results of Wu et al. (2008), appropriate or low N supply, therefore, would be recommended to stimulate growth, enhance WUE, alleviate drought stress, and consequently contribute to *S. davidii* seedling establishment under dry condition, but excess N supply should be avoided. Loss of membrane integrity was reported with the increase of electrolyte leakage under drought stress (Fan et al., 1994).

In drought stress, cell growth is adversely affected by the water loss, and this causes the cells to remain small (Zlatev, & Lidon, 2012). Moreover, reduction in cell growth leads to a decrease in cell wall synthesis and many plants accumulate some solutes in the cell in response to drought stress (Mahajan & Tuteja, 2005; Assaha et al., 2016; Saravia et al., 2016). The increase in the number of intracellular solutes is very important in keeping cell water. Sugars, amino acids and many ions especially K+ are considered as solutes effective in osmotic adjustment (Kacar et al., 2006; Ozen & Onay, 2007).

Protein, phosphorus and potassium

According to analysis of variances it was founded that interaction effects between Location* Drought Stress* Urea* Nano, on Phosphorus and Location*nano, drought stress* nano treatments on Protein and urea*nano Location*nano drought stress* nano treatments on Protein and on Potassium had significant effects at 5% statistically level. And location*nano had significant effects on potassium at 1% statistically level (Table 1).

According to mean comparisons, drought stress led to 26% increase in Protein content compared to normal irrigation. Application of 37, 74 and 110 kg.ha^{-1} urea led to 4, 10 and 17% increase in Protein content and application of 14, 27 and 41 kg.ha^{-1} nano fertilizer led to 33, 54 and 69% increase compared to control. In relation to interaction between stress, urea and nano fertilizer, it was found that at normal and stress condition the highest mean of Protein content were obtained by 41 kg.ha^{-1} nano fertilizer in drought condition it seemed that Drought stress and nano-nitrogen fertilizer increased the amount of protein in wheat.

Table 2

Comparison of the performance of conventional urea and nano nitrogen fertilizers in the studied physiological traits

Application of nitrogen (kg.ha^{-1}) from both references of fertilizers	RWC%		Ion leakage%	
	Conventional fertilizer (urea)	Nano nitrogen fertilizer	Conventional fertilizer (urea)	Nano nitrogen fertilizer
80	3	15	14	15
160	7	21	21	22
240	16	37	24	29

Table 3
Comparison of the performance of conventional urea and nano nitrogen fertilizers in the studied physiological traits

Application of nitrogen (kg.ha^{-1}) from both references of fertilizers	% Protein		Phosphorus (mg)		Potassium (mg)	
	Conventional fertilizer (urea)	Nano nitrogen fertilizer	Conventional fertilizer (urea)	Nano nitrogen fertilizer	Conventional fertilizer (urea)	Nano nitrogen fertilizer
80	4	33	17	26	11	11
160	10	54	35	58	18	25
240	17	69	54	80	27	38

Table 4
Comparison of the performance of conventional urea and nano nitrogen fertilizers in the studied physiological traits

Application of nitrogen (kg.ha^{-1}) from both references of fertilizers	Remobilization (mg/plant)		Photosynthesis rate (mg/plant)	
	Conventional fertilizer (urea)	Nano nitrogen fertilizer	Conventional fertilizer (urea)	Nano nitrogen fertilizer
80	23	21	5	16
160	51	50	1	30
240	63	73	3	55

Proteins are compounds of fundamental importance for all functions in the cell (Sara et al., 2012). In this regard, the declared impaired protein synthesis accompanied with a reduction in the plant growth and the crop yield under water stress condition which is due to the reduced number of polysomal complexes in tissues with lower water content (kabiri et al., 2014). In addition, the generation of ROS caused the oxidation of amino acids and could burst the protein structure under drought stress. However, a significant relationship was observed among total proteins and grain yield of wheat under rain-fed conditions (Farshadfar et al., 2008). On the other hand, an increase in shoot proteins of the wheat plants cultivated under water stress condition was observed (Noman et al., 2018). The drought stress-induced proteins allow plants to make biochemical and structural adjustments that enable plants to cope with the stress (Al-jebory et al., 2012).

The presence of proline is one of the common traits in most of the cereals under drought (Gurumurty et al., 2019). Wheat plants accumulate proline than the other osmoregulators, especially in leaves because of the increasing collapse of proteins with an immediate decline in its synthesis during the grain filling stage under water deficit (Nazarali et al., 2011). It is osmotically active, controls storage of useful N, and plays a major part in membrane stability. It also helps by scavenging free radicals and buffering cellular redox potential which helps wheat plants to combat abiotic stresses. As a signaling controller molecule, it initiates many mechanisms that help in adaptation to drought (Marci et al., 2013).

According to mean comparisons, drought stress led to 13 reduction in Phosphorus content compared to normal irrigation. Application of 37, 74 and 110 kg.ha^{-1} urea led to 17%, 35% and 54% increase in phosphorus content and application of 14, 27 and 41 kg.ha^{-1} nano fertilizer led to 26%, 58% and 80% increase compared to control. In relation to interaction between stress, urea and nano fertilizer, it was found that at normal and stress condition the highest mean of Protein content were obtained by (110,74) kg.ha^{-1} urea and 41 kg.ha^{-1} nano fertilizer.

According to mean comparisons, drought stress led to 26 reduction in Potassium content compared to normal irrigation. Application of 37, 74 and 110 kg.ha^{-1} urea led to 11%, 18% and 27% increase in Potassium content and application of 14, 27 and 41 kg.ha^{-1} nano fertilizer led to 11%, 25% and 38% increase compared to control. In relation to interaction between stress, urea and nano fertilizer, it was found that at normal and stress condition the highest mean of Protein content were obtained by 110 kg.ha^{-1} urea and 14,27,41 kg.ha^{-1} nano fertilizer by 74 kg.ha^{-1} urea and 27,41 kg.ha^{-1} nano fertilizer.

Nanoparticles record significantly higher uptake owing to free passage from nano sized pores and by molecular transporters as well as root exudates. Nanoparticles also utilize various ion channels which lead to higher nutrient uptake by crop plants. Within the plant, nanoparticles may pass through plasmodesmata that results in effective delivery on nutrients to sink sites (Iqbal, 2020).

Remobilization and current photosynthesis rate

According to analysis of variances it was founded that Interaction between Location* Drought Stress*Urea*Nano had significant effect on remobilization and photosynthesis rate at 5% statistically level (Table 1).

According to mean comparisons, drought stress led to 22% increase in remobilization and 69% reduction in photosynthesis rate compared to normal irrigation. Application of 74 and 110 kg.ha^{-1} urea led to 6% increase in remobilization and 22% and 34% photosynthesis rate compared to control.

Application of 37, 74 and 110 kg.ha^{-1} urea led to 23%, 51% and 63% increase in Remobilization and application of 14, 27 and 41 kg.ha^{-1} nano fertilizer led to 21%, 50% and 73% increase compared to control. Application of 37, 74 and 110 kg.ha^{-1} urea led to 5%, 1% and 3% increase in photosynthesis rate and application of 14, 27 and 41 kg.ha^{-1} nano fertilizer led to 16%, 30% and 55% increase compared to control.

In relation to interaction between stress, urea and nano fertilizer, it was found that at drought condition the highest mean of remobilization (178.50 g/m^2) were obtained by 110 kg.ha^{-1} urea and 41 kg.ha^{-1} nano fertilizer and 74 kg.ha^{-1} urea and 41 kg.ha^{-1} nano fertilizer (166.50 g/m^2) and in normal condition (155.33 g/g.m^2). At stress condition the highest mean of photosynthesis rate (382.50, 419.33, 421.50 g/m^2) was obtained by (37,74,110) kg.ha^{-1} urea and 41 kg.ha^{-1} nano fertilizer. The highest mean of photosynthesis rate in stress conditions (141.83 g/g.m^2) was obtained by 110 kg.ha^{-1} urea and 41 kg.ha^{-1} nano fertilizer.

Table 5
Mean analysis of physiological trait of wheat under drought stress conditions

		Photosynthesis rate	Remobili-zation	Rwc%	Ion leakage	Protein	Phosphorus	Potassium
Location	1	376479.188*	26110.0052*	1346.3597*	72.7053*	0.2938*	0.00470*	40.8022*
error	4	4973.948	157.1042	2.3399	12.7533	0.0488	0.0261	0.0183
Drought Stress	1	2574743.521*	21653.7552*	6185.6367*	2101.9165*	0.26034*	0.3375*	0.00079*
Location* Drought stress	1	26980.083*	163.1719*	20.9682*	2.8009*	0.03713*	0.00012*	0.3409ns
error	4	3016.990	15.3542	3.7096	0.6065	0.0159	0.0035	0.0092
Urea	3	2585.597*	26532.3385*	305.9155*	1071.9645*	9.6649*	2.1247*	1.0723**
Location*Urea	3	15437.562*	209.6441*	9.1995**	0.1511*	0.0473**	0.00095**	0.2310ns
Drought Stress*Urea	3	11274.063*	401.2830*	8.4085*	428.8480*	0.3731*	0.0149*	0.0161*
Location*Stress*Urea	3	21400.931*	364.3385*	9.9050*	0.0918**	0.0174*	0.00387*	0.0198ns
Error	24	452.767	4.7708	4.4526	0.2982	0.0106	0.00366	0.0038*
Nano	3	80060.806*	30024.1302*	358.6398*	159.6003*	50.3620*	0.50453*	1.0061*
Location*Nano	3	21861.576*	252.6858*	6.4588*	0.4238*	0.0041*	0.01796*	0.0206**
Drought Stress*Nano	3	12503.465*	76.2135*	38.6992ns	7.7204*	0.0553*	0.04411*	0.0013ns
Location* Drought Stress*Nano	3	7410.972*	75.2413*	6.5717*	0.5821**	0.0123ns	0.0192ns	0.00686ns
Urea*Nano	9	2528.097*	309.8154*	8.5489*	17.7025*	0.0651ns	0.02096ns	0.0264*
Location*Urea*Nano	9	2155.433*	167.2876*	9.8344*	0.1226*	0.00861ns	0.0069ns	0.0117ns
Drought Stress*Urea*nano	9	1060.229*	39.1487*	18.0554*	7.6695*	0.0260ns	0.01305ns	0.0061ns
Location* Drought Stress*Urea*Nano	9	2369.671*	45.2228*	11.3220*	0.2147*	0.0038ns	0.00287**	0.0045ns
Error	96	371.116	1.8924	2.3200	0.1982	0.0094	0.01089	0.0042
CV		8.77	1.29	2.41	1.02	2.97	17.26	6.07

ns, **,*: no significant and significant at p≤ 0.01, p ≤ 0.05 respectively.

Table 6
Means comparison of physiological trait of wheat under drought stress conditions

			RWC %	Ion leakage %	% Protein	Phosphorus (mg)	Potassium (mg)	Remobilization (mg/plant)	Photosynthesis rate (mg/plant)
Normal	0	0	51.3 $^{\text{I}}$	49.03 $^{\text{ABC}}$	5.5 $^{\text{N}}$	0.19 $^{\text{IJ}}$	0.73 $^{\text{KLM}}$	49.5 $^{\text{P}}$	242.67 $^{\text{G}}$
		14	59.4 $^{\text{HIJ}}$	46.08 $^{\text{CD}}$	7.6 $^{\text{LMN}}$	0.21 $^{\text{HIJ}}$	0.9 $^{\text{E-J}}$	62.5 $^{\text{NOP}}$	341.83 $^{\text{A-F}}$
		27	62.4 $^{\text{FGH}}$	40.01 $^{\text{FG}}$	8.7 $^{\text{JKL}}$	0.29 $^{\text{EF}}$	0.96 $^{\text{E-H}}$	79.83 $^{\text{MNO}}$	377.83 $^{\text{A-E}}$
		41	70.9 $^{\text{BCD}}$	36.2 $^{\text{IJK}}$	9.9 $^{\text{F-K}}$	0.34 $^{\text{CDE}}$	1.05 $^{\text{CDE}}$	88.83 $^{\text{K-N}}$	408.5 $^{\text{AB}}$
	37	0	53.6 $^{\text{KL}}$	47.32 $^{\text{BCD}}$	6 $^{\text{MN}}$	0.21 $^{\text{HIJ}}$	0.8 $^{\text{G-M}}$	60.83 $^{\text{OP}}$	297 $^{\text{C-G}}$
		14	61.25 $^{\text{GHI}}$	38.9 $^{\text{FGH}}$	8.2 $^{\text{KLM}}$	0.25 $^{\text{F-J}}$	0.97 $^{\text{E-H}}$	80.17 $^{\text{MNO}}$	329.17 $^{\text{B-G}}$
		27	63.28 $^{\text{FGH}}$	37.29 $^{\text{GHI}}$	9.3 $^{\text{I-L}}$	0.31 $^{\text{DEF}}$	1.21 $^{\text{ABC}}$	100.67 $^{\text{H-L}}$	385.33 $^{\text{ABC}}$
		41	73.9 $^{\text{AB}}$	34.5 $^{\text{LMN}}$	10.6 $^{\text{D-J}}$	0.38 $^{\text{BC}}$	1.32 $^{\text{AB}}$	109.67 $^{\text{G-J}}$	421.5 $^{\text{A}}$
	74	0	55.4 $^{\text{JKL}}$	45.02 $^{\text{CDE}}$	6.5 $^{\text{LMN}}$	0.23 $^{\text{G-J}}$	1 $^{\text{CDE}}$	74.33 $^{\text{NOP}}$	257.5 $^{\text{FG}}$
		14	64.3 $^{\text{EFGH}}$	36.07 $^{\text{IJK}}$	9 $^{\text{I-L}}$	0.34 $^{\text{CDE}}$	1.01 $^{\text{CDE}}$	93 $^{\text{J-N}}$	288.17 $^{\text{EFG}}$
		27	66.4 $^{\text{DEF}}$	32.66 $^{\text{MNO}}$	9.7 $^{\text{G-K}}$	0.39 $^{\text{BC}}$	1.32 $^{\text{AB}}$	115.5 $^{\text{E-I}}$	310.33 $^{\text{C-G}}$
		41	75.5 $^{\text{AB}}$	30.1 $^{\text{OP}}$	11 $^{\text{D-H}}$	0.42 $^{\text{AB}}$	1.37 $^{\text{AB}}$	136.17 $^{\text{D}}$	382.5 $^{\text{A-D}}$
	110	0	61.7 $^{\text{FGHI}}$	43.25 $^{\text{EF}}$	6.5 $^{\text{LMN}}$	0.27 $^{\text{FG}}$	1.17 $^{\text{BCD}}$	84.67 $^{\text{LMN}}$	293.67 $^{\text{D-G}}$
		14	68.9 $^{\text{CDE}}$	34.74 $^{\text{LMN}}$	9.8 $^{\text{F-K}}$	0.35 $^{\text{CD}}$	1.25 $^{\text{AB}}$	105.5 $^{\text{H-K}}$	300 $^{\text{C-G}}$
		27	73.4 $^{\text{ABC}}$	30.62 $^{\text{OP}}$	10.8 $^{\text{D-I}}$	0.45 $^{\text{A}}$	1.35 $^{\text{AB}}$	128.33 $^{\text{DEF}}$	311.83 $^{\text{C-G}}$
		41	78.06 $^{\text{AB}}$	28.01 $^{\text{P}}$	12 $^{\text{B-E}}$	0.47 $^{\text{A}}$	1.39 $^{\text{AB}}$	155.33 $^{\text{BC}}$	419.33 $^{\text{A}}$
Stress	0	0	42.3 $^{\text{N}}$	53.65 $^{\text{A}}$	7.5 $^{\text{LMN}}$	0.12 $^{\text{K}}$	0.65 $^{\text{M}}$	59.83 $^{\text{OP}}$	53 $^{\text{I}}$
		14	50.4 $^{\text{LM}}$	49.93 $^{\text{ABC}}$	9.8 $^{\text{F-K}}$	0.19 $^{\text{IJ}}$	0.73 $^{\text{J-M}}$	78 $^{\text{NOP}}$	84.33 $^{\text{HI}}$
		27	53.4 $^{\text{KL}}$	43.88 $^{\text{EF}}$	11.6 $^{\text{C-F}}$	0.23 $^{\text{G-J}}$	0.8 $^{\text{G-M}}$	98 $^{\text{I-M}}$	99.67 $^{\text{HI}}$
		41	61.9 $^{\text{FGHI}}$	38.2 $^{\text{FGH}}$	12.9 $^{\text{ABC}}$	0.30 $^{\text{DEF}}$	0.91 $^{\text{E-I}}$	108.33 $^{\text{G-J}}$	117.33 $^{\text{HI}}$
	37	0	44.6 $^{\text{N}}$	51.98 $^{\text{AB}}$	7.9 $^{\text{KLM}}$	0.19 $^{\text{IJ}}$	0.68 $^{\text{LK}}$	76.67 $^{\text{NOP}}$	68 $^{\text{HI}}$
		14	52.25 $^{\text{L}}$	43.01 $^{\text{EF}}$	10.2 $^{\text{E-J}}$	0.22 $^{\text{G-J}}$	0.77 $^{\text{H-M}}$	91.17 $^{\text{J-N}}$	86.67 $^{\text{HI}}$
		27	54.28 $^{\text{KL}}$	40.83 $^{\text{FG}}$	12.3 $^{\text{A-D}}$	0.29 $^{\text{EF}}$	0.83 $^{\text{F-K}}$	117.67 $^{\text{E-H}}$	109.67 $^{\text{HI}}$
		41	64.9 $^{\text{EFG}}$	36.5 $^{\text{IJK}}$	13 $^{\text{ABC}}$	0.34 $^{\text{CDE}}$	0.94 $^{\text{E-I}}$	132.5 $^{\text{DE}}$	129.5 $^{\text{HI}}$
	74	0	46.4 $^{\text{MN}}$	46.99 $^{\text{CD}}$	8.1 $^{\text{KLM}}$	0.21 $^{\text{HIJ}}$	0.73 $^{\text{J-M}}$	103.33 $^{\text{H-K}}$	91.33 $^{\text{HI}}$
		14	55.3 $^{\text{JKL}}$	40.01 $^{\text{FG}}$	10.6 $^{\text{D-J}}$	0.25 $^{\text{F-J}}$	0.79 $^{\text{G-M}}$	117.33 $^{\text{E-H}}$	100.67 $^{\text{HI}}$
		27	57.4 $^{\text{IJK}}$	37.89 $^{\text{GHI}}$	12.9 $^{\text{ABC}}$	0.31 $^{\text{DEF}}$	0.86 $^{\text{F-K}}$	139.83 $^{\text{CD}}$	112.33 $^{\text{HI}}$
		41	66.5 $^{\text{DEF}}$	34.1 $^{\text{LMN}}$	13.5 $^{\text{AB}}$	0.39 $^{\text{BC}}$	0.89 $^{\text{E-J}}$	166.5 $^{\text{AB}}$	152.17 $^{\text{H}}$
	110	0	52.7 $^{\text{KL}}$	47.92 $^{\text{CDE}}$	9.3 $^{\text{H-L}}$	0.26 $^{\text{FGH}}$	0.79 $^{\text{G-M}}$	112.17 $^{\text{F-I}}$	95.17 $^{\text{HI}}$
		14	59.9 $^{\text{GHIJ}}$	37.94 $^{\text{GHI}}$	11.2 $^{\text{C-G}}$	0.31 $^{\text{DEF}}$	0.86 $^{\text{F-K}}$	126.83 $^{\text{D-G}}$	105.17 $^{\text{HI}}$
		27	64.4 $^{\text{EFGH}}$	35.84 $^{\text{KLM}}$	13 $^{\text{ABC}}$	0.39 $^{\text{BC}}$	0.89 $^{\text{E-J}}$	158 $^{\text{B}}$	114.67 $^{\text{HI}}$
		41	69.06 $^{\text{CDE}}$	32.01 $^{\text{MNO}}$	14 $^{\text{A}}$	0.39 $^{\text{BC}}$	0.9 $^{\text{E-J}}$	178.5 $^{\text{A}}$	141.83 $^{\text{HI}}$

Different letters indicating significant difference at $p < 0.05$.

In cereals the growth of seeds is supported by the transportation of assimilates to some extent That these stock materials are mostly reserves in the stem before flowering stage and It is called Remobilization. Under drought stress current photosynthesis decreased and the role of remobilization increased during the grain filling in some genotypes for example in that research mobilized dry matter content and remobilization percentage from shoot to grain under water deficit were (11.2%) greater than those under well watering condition (Ehdaie et al., 2008).

Seed filling rate in plants is mainly dependent on two carbon resources (1) currently synthesized assimilates from photosynthesis, and (2) carbohydrate (assimilates) reserves translocated to the seed from vegetative tissue in leaves and stem. Usually, drought and heat stress during seed filling causes early senescence and reduces seed-filling duration and enhances assimilate remobilization from the source to sink. These results agree with the results of (Plaut et al., 2004; Yang & Zhang, 2006)

Overall, these results showed that all traits were affected by drought stress and application of nitrogen to some extent can reduce negative effects of stress on yield traits and using of nano-nitrogen fertilizer in lower levels not only prevents environmental and groundwater pollution but also plays an important role in enhancing the performance of various physiological traits.

4. Conclusions

According to the problem of environmental pollution and hunger dilemma of the growing population of the world, it seems that the use of nano-fertilizers can not only reduce environmental pollution, eutrophication, pollution of groundwater and diseases caused by overusing of conventional fertilizers, but also due to smaller particle diameters, with more penetration into the roots and leaves of plants can improve the physiological traits and yield of crops. Therefore, it is recommended to replace nano-fertilizers with conventional fertilizers, especially in sandy soils due to the possibility of more leaching of conventional urea fertilizer and groundwater pollution.

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