

Effect of nano NPK application and proline spraying on vegetative growth characteristics of WONDERFUL pomegranate seedlings under salt stress.

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Abstract. The experiment was conducted in lathouse of the Department of Plant Production, Al-Musayyib Technical College for the period from 1/9/2021-1/5/2022. To know the effect of nano NPK at three concentrations (150, 75.0 mg L⁻¹) and spraying of the amino acid proline at a concentration (300.0 mg L⁻¹) on WONDERFUL pomegranate seedlings irrigated with four levels of saline irrigation water (9, 6, 3, 1.3 dSm⁻¹) The vegetative measurements (plant height, stem diameter, number of branches, length of branches, chlorophyll) were conducted. The research was conducted according to the CRD design with three replications, three seedlings for the experimental unit and three factors (4 * 3 * 2), the number of transactions was 24 for each replicate, the results were analyzed using the GENSTAT program according to the least significant difference test L.S.D under the probability level (0.05). The results showed that the salinity level 1.3 dSm m⁻¹ excelled in all the studied traits, as it gave a significant increase of (86.92 cm, 7.111 mm, 11.55 seedling branches⁻¹, 19.14 cm, 30.58 SPAD), respectively. Also, the concentration of 150 mg L⁻¹ of nano-NPK excelled in all vegetative traits, where it gave an increase of (77.79 cm, 6.779 mm, 9.85 seedling branches⁻¹, 16.78 cm, 29.75 SPAD), and proline concentration 300 mg L⁻¹ excelled in chlorophyll content and the number of branches

Keywords: nano-NPK fertilizer; salinity stress; proline foliar application; pomegranate (*Punica granatum L.*); vegetative growth parameters.

1. INTRODUCTION

Pomegranate belongs to Punicaceae family and its scientific name is *Punica granatum L.*, the pomegranate is located in deciduous fruit trees and is widespread in temperate regions. It is believed to be native to Iran, southwest Asia and Iraq [1]. There are many local cultivars in Iraq, but the American

cultivar has recently spread and gained the attention of researchers due to its strong vegetative growth, abundant production and its suitability to the conditions of Iraq[2]. Salinity, whether soil salinity or irrigation water salinity, is one of the most important challenges facing the agricultural sector, especially in arid and semi-arid areas[3] and negatively affects the growth and productivity of plants, as its accumulation leads to inhibition of enzyme activity as well as affects all metabolic and physiological processes. Iraq comes With the introduction of the Arab countries affected by salinity[4] (Batany, 1996) Because of the damage caused by salinity, it is necessary to use anti-saline agents to reduce its damage to the plant, including proline. It is a natural amino acid in the plant that accumulates and accumulates in the plant when exposed to salt stress. It stimulates plant growth and increases its response to fertilizers and salinity tolerance. This acid plays a role in controlling the osmotic effort and stability of cell membranes. It is considered a storehouse of nitrogen and carbon needed for growth. Proline is one of the important means that reduce the harmful effects of salinity [5] . Fertilizer is the technology of mixing soluble fertilizers with irrigation systems, whether it is drip, sprinkler or tank irrigation[6]. In view of the lack of studies on the management of nano-nutrients and the spraying of proline on seedlings of lavender pomegranate under salt stress, this study was conducted with the aim of:

- 1) Knowing the tolerance of the lavender pomegranate seedlings to the salinity levels of the irrigation water
- 2) Possibility of improving the tolerance of pomegranate seedlings Wonderful to salinity by using the technique of applying and spraying Proline separately
- 3) Knowing the combined effects of NPK nano-proline fertilizer on the tolerance of Wonderful pomegranate seedlings to a salinity of irrigation water

2. MATERIALS AND METHODS

The seedlings were obtained from the Najaf specialist nursery / Department of Horticulture of the Ministry of Agriculture in September 2021, as homogeneous as possible, at the age of one year, and they were prepared for the experiment, where they were planted with polyethylene bags. 3: Service operations were conducted for all seedlings, from watering and removing the weeds, The floor of the lahhouse was furnished with nylon to prevent the growth of the weed and to avoid the descent of salty irrigation water to the floor of the lahhouse and to cover the surface of the canopy with saran to protect the seedlings from the heat and harmful sunlight. Factors (4 * 3 * 2) and three replicates with 24 experimental units (3 seedlings for the experimental unit). The factors were as follows: The first factor: - NPK nano fertilizer was used (12:12:36) and according to the recommendation, three concentrations (150,75,0) mg L⁻¹ were added to the ground using the Fertigation technique after dissolving these levels with saline concentrations and watering the seedlings according to the required concentrations

The second factor: - Irrigation with four levels of saline water (9,6,3,1.3) mg.L⁻¹, and the saline irrigation water was prepared by dissolving Nacl salt in tanks of 150 liters for each salt level according to the concentrations shown above. The concentrations were measured with an Ec meter. The third factor: - spraying the shoots with the amino acid Proline at two levels (300.0) mg L⁻¹ using a 2-liter sprayer. These

concentrations are within the recommended limits. The seedlings were sprayed with eight sprays, 4 sprays in the first season and 4 sprays in the second season. The experiment was completed a month after the last spray was scheduled. The samples were taken for analysis and the results are taken for analysis using the GENSTST program and the differences between the means were compared according to the least significant difference test (LSD) at the level of 0.05).

Studied traits:

Seedling height (cm): The height of seedlings for each replicate was measured at the end of the experiment using the metric tape.

Main stem diameter (mm): The main stem diameter of each seedling was measured using VERNIER and averaged for each experimental unit.

Number of side branches (seedling branch⁻¹): Calculating the number of branches for each seedling and extracting the average number of branches for the experimental unit

Side branch lengths (cm): The lengths of the branches were calculated for each seedling and the average lengths were extracted for each experimental unit.

Chlorophyll content of leaves (SPAD. Unit): Chlorophyll was measured in pomegranate leaves for each seedling at the end of the experiment with a SPAD device. Unit and calculate the rate for each trial unit

3. RESULTS AND DISCUSSION

Effect of NPK nano-coating and proline spraying on vegetative growth traits of Wonderful cultivar pomegranate seedlings under salt stress. The results in tables (5-1) indicate a significant decrease in all vegetative growth traits represented (seedling height, stem diameter, number of branches, length of branches, chlorophyll content of leaves) at levels of saline irrigation water 9 dm⁻¹ While at the salinity level of 1.3 dSm⁻¹, the highest average of the above-mentioned vegetative traits were recorded, and they were significantly excelled on the rest of the treatments. The reason for this decrease may be due to the increase in salinity in the soil solution and the effects that inhibit the growth and productivity of the plant, and the disruption of the nutritional balance due to the unavailability of nutrients at high salinity levels [7]. Also, the reason for the decrease is due to an indirect effect as a result of the change in the osmotic potential, where the increase in the osmotic potential of the soil solution when salt stress causes the plant's inability to absorb the water necessary for growth [8] mentioned that the inhibition of plant growth under salt stress is the result of the plant's inability to absorb the water necessary for growth, and perhaps the reason is that the high concentrations of sodium and chlorine ions caused the plant's toxicity with these ions. The results of tables (5-1) indicate the nano-NPK at a concentration of 150 mg L⁻¹ excelled in all vegetative growth indicators (seedling height, stem diameter, number of branches, branch lengths, chlorophyll content of leaves). The reason for the increase may be due to the fact that the nano-fertilizers have a high surface area, which makes them efficient in absorption by the plant, which is reflected in the speed of growth and the efficiency of the photosynthesis process. [9] Nano-fertilizers have the ability to stimulate cells to expand and elongate, by directly affecting the leaf formation areas, as well as affecting the growth hormones cytokinins, thus increasing the number of leaves [10].

Table (1) Effect of nano NPK and proline spraying on plant height under salt stress

N×S	Proline mg L ⁻¹		NPK nano mg.L ⁻¹	salinity levels (ds.m ⁻¹)
	P2(300)	P1 (0)		
87.82	89.13	86.50	N1 (0)	S1 1.3 (dS.m ⁻¹)
85.73	83.53	87.93	N2 (75)	
87.22	85.17	89.27	N3 (150)	
80.97	82.00	79.93	N1 (0)	S2 3 (dS.m ⁻¹)
80.92	80.53	81.30	N2 (75)	
79.65	80.93	78.37	N3 (150)	
70.42	69.13	71.70	N1 (0)	S3 6 (dS.m ⁻¹)
72.67	73.00	72.33	N2 (75)	
75.90	75.17	76.63	N3 (150)	
70.35	71.17	69.53	N1 (0)	S4 9 (dS.m ⁻¹)
71.13	72.70	72.70	N2 (75)	
68.38	68.30	68.47	N3 (150)	
77.60	77.30	77.89	average P	
S×N	P	S×N×P	L.S.D _(0.05)	
5.880	2.401	8.316		
average S	Salinity and Proline levels interaction			
86.92	85.94	87.90	S1	S × P
80.51	79.87	79.87	S2	
72.99	72.43	73.56	S3	
69.96	69.68	70.23	S4	
3.395	4.801			L.S.D _(0.05)
average N	interaction of nano NPK and proline			
77.39	77.86	76.92	N1	N×P
77.61	76.66	78.57	N2	
77.79	77.39	78.18	N3	
2.940	4.158			L.S.D _(0.05)

Table (2) Effect of nano NPK and proline spraying on stem diameter under saline stress

N×S	Proline mg L ⁻¹		NPK nano mg.L ⁻¹	salinity levels (ds.m ⁻¹)
	P2(300)	P1 (0)		
7.183	6.867	7.500	N1 (0)	S1 1.3 (dS.m ⁻¹)
7.003	7.333	6.733	N2 (75)	
7.117	7.167	7.067	N3 (150)	
6.883	6.800	6.967	N1 (0)	S2 3 (dS.m ⁻¹)
7.100	7.100	7.100	N2 (75)	
6.750	6.800	6.700	N3 (150)	
6.383	6.233	6.533	N1 (0)	S3 6 (dS.m ⁻¹)
6.583	6.267	6.900	N2 (75)	
6.400	6.400	6.400	N3 (150)	
6.067	6.067	6.067	N1 (0)	S4 9 (dS.m ⁻¹)
6.400	6.433	6.367	N2 (75)	
6.133	6.000	6.267	N3 (150)	

6.669	6.622	6.717	average P	
S×N	P	S×N×P	L.S.D(0.05)	
0.4177	0.1705	0.5906		
average S	Salinity and Proline levels interaction			
7.111	7.122	7.100	S1	S × P
6.911	6.900	6.922	S2	
6.456	6.300	6.611	S3	
6.200	6.167	6.233	S4	
0.2411	0.3410			L.S.D(0.05)
average N	interaction of nano NPK and proline			
6.629	6.492	6.767	N1	N×P
6.600	6.592	6.608	N2	
6.779	6.783	6.775	N3	
0.2088	0.2953			L.S.D(0.05)

Table (3) Effect of nano NPK and proline spraying on number of branches under saline stress

N×S	Proline mg L⁻¹		NPK nano mg.L⁻¹	salinity levels (ds.m⁻¹)
	P2(300)	P1 (0)		
11.15	12.00	10.30	N1 (0)	S1 1.3 (dS.m⁻¹)
11.42	12.63	10.20	N2 (75)	
12.08	12.30	11.87	N3 (150)	
10.47	9.53	11.40	N1 (0)	S2 3 (dS.m⁻¹)
10.80	11.20	10.40	N2 (75)	
10.53	9.97	11.10	N3 (150)	
8.57	8.83	8.30	N1 (0)	S3 6 (dS.m⁻¹)
9.25	8.97	9.53	N2 (75)	
9.08	9.63	8.53	N3 (150)	
8.53	7.33	9.73	N1 (0)	S4 9 (dS.m⁻¹)
7.95	8.60	7.30	N2 (75)	
7.70	7.53	7.87	N3 (150)	
9.79	9.88	9.71	average P	
S×N	P	S×N×P	L.S.D(0.05)	
1.546	0.631	2.187		
average S	Salinity and Proline levels interaction			
11.55	12.31	10.79	S1	S × P
10.60	10.23	10.97	S2	
8.97	9.14	8.79	S3	
8.06	7.83	8.30	S4	
0.893	1.263			L.S.D(0.05)
average N	interaction of nano NPK and proline			
9.68	9.43	9.93	N1	N×P
8.85	10.35	9.36	N2	

9.85	9.86	9.84	N3	
0.773	1.093			L.S.D _(0.05)

Table (4): Effect of nano NPK and proline spraying on branch lengths under saline stress.

N×S	Proline mg L ⁻¹		NPK nano mg.L ⁻¹	salinity levels (ds.m ⁻¹)
	P2(300)	P1 (0)		
18.55	19.87	17.23	N1 (0)	S1 1.3 (dS.m ⁻¹)
19.22	20.13	18.30	N2 (75)	
18.73	18.80	18.66	N3 (150)	
19.97	20.73	19.20	N1 (0)	S2 3 (dS.m ⁻¹)
17.86	17.37	18.36	N2 (75)	
19.58	17.80	21.37	N3 (150)	
15.17	15.80	14.53	N1 (0)	S3 6 (dS.m ⁻¹)
15.11	15.21	15.02	N2 (75)	
16.34	16.31	16.37	N3 (150)	
13.38	12.30	14.47	N1 (0)	S4 9 (dS.m ⁻¹)
13.94	13.44	14.43	N2 (75)	
12.45	12.50	12.40	N3 (150)	
16.69	16.69	16.69	average P	
S×N	P	S×N×P	L.S.D _(0.05)	
2.002	0.817	2.831		
average S	Salinity and Proline levels interaction			
19.14	18.63	19.64	S1	S × P
18.83	19.60	18.08	S2	
15.54	15.77	15.31	S3	
13.26	12.75	13.77	S4	
1.156	1.634		L.S.D _(0.05)	
average N	interaction of nano NPK and proline			
16.77	17.18	16.36	N1	N×P
16.53	16.54	16.53	N2	
16.78	16.35	17.20	N3	
1.001	1.415		L.S.D _(0.05)	

Table (5): Effect of nanoNPK and proline spraying on chlorophyll content of leaves under salt stress.

N×S	Proline mg L ⁻¹		NPK nano mg.L ⁻¹	salinity levels (ds.m ⁻¹)
	P2(300)	P1 (0)		
32.52	33.60	31.43	N1 (0)	S1 1.3 (dS.m ⁻¹)
28.45	26.83	30.07	N2 (75)	
27.47	26.37	28.57	N3 (150)	
27.57	31.17	23.97	N1 (0)	S2 3 (dS.m ⁻¹)
33.08	38.03	28.13	N2 (75)	

31.08	28.13	34.03	N3 (150)	S3 6 (dS.m ⁻¹)
29.42	26.73	32.10	N1 (0)	
24.15	24.63	23.67	N2 (75)	
26.48	29.07	23.90	N3 (150)	
29.50	32.53	26.47	N1 (0)	S4 9 (dS.m ⁻¹)
26.17	28.67	23.67	N2 (75)	
23.85	22.37	25.33	N3 (150)	
28.31	29.01	27.61	average P	
S×N	P	S×N×P	L.S.D_(0.05)	
8.304	3.390	11.744		
average S	Salinity and Proline levels interaction			
30.58	32.44	28.71	S1	S × P
29.48	28.93	30.02	S2	
26.68	26.81	26.56	S3	
26.51	27.86	25.16	S4	
4.794	6.780			L.S.D_(0.05)
average N	interaction of nano NPK and proline			
27.22	26.48	27.49	N1	N×P
27.96	29.54	26.38	N2	
29.75	31.01	28.49	N3	
4.152	5.872			

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