The effect of nitrogen and moisture superabsorbent changes the yield, biological traits, and nitrogen percentage in fields pumpkin seeds

Abstract

This study performed to investigate the effect of nitrogen and moisture superabsorbent on yield, yield components, seed nitrogen and some biological traits in field pumpkin during two crop years in Kermanshah, Iran. The experiment was carried out as a split-plot based on randomized complete block design with three replications. The main plot factor were the application of moisture superabsorbent in various levels at 0 (control), 40, 80, 160 kg ha^{-1} ,respectively; and nitrogen fertilization at the levels of 0, 50, 100 and 150 kg ha^{-1}was considered as sub-factor. Results illustrated that treatments significantly affected all traits except for fruit number. In most traits, there was an increasing trend when nitrogen levels increased, although N2 levels of 100 and 150 kg ha-1 were not significantly different.. In addition, increasing the moisture superabsorbent enhanced the mentioned traits.

Key words: nitrogen , moisture superabsorbent , pumpkin

Introduction

For centuries, people have utilized medicinal plants to alleviate their pain and heal wounds as a natural gift. As the adverse effects of chemical drugs were identified gradually, the medicinal plants attracted more attention, that increased use of these herbs (Omidbeigi, 2000) (Omidbeigi, 2000). Field pumpkin (Cucurbita pepo L.) is a valuable medicinal plant in most developed countries that there are many uses for the its seed oil both in traditional and modern medicine (Unis and Al Shahri, 2000; Parisin et al., 2008). The use of superabsorbent in the soil is an effective method that helps save water (Kabiri and Zohorianmehr, 2006). Researchers confirm that superabsorbents can preserve moisture and nutrients in soil when mixed with it. Under these conditions, the plant will face water and nutrient deficiencies with less probability (Efooglu et al, 2009) and perform better in arid and semi-arid areas (Islam et al, 2011). Nitrogen is one of the most effective elements for improving both the quantitative and qualitative yield of medicinal plants (Rahmati et al. 2009). the highest fresh weight of pumpkin fruit was achieved by an average of 2.61 Kg, 1000-grains weight (160.36 gr), and the maximum yield of fruit and seeds by 127.00 and 1.51 t ha^{-1}, respectively using 200 kg nitrogen (Gholipouri and Hamaran 2006. Aroyi (2001) investigated on the effect of different levels of nitrogen on field pumpkin, and reported that the application of 75 kg N2 (in Ammonium Nitrate form) in the soil caused the highest fruit yield, while increased level of nitrogen reduced fruit yield to 150 kg so that plants treated with 225 and 300 kg ha^{-1} of nitrogen did not produce much fruit in two years. Many researchers (Aroy, 2001; Sevider et al., 1994) have explained that a decrease in fruit yield can be attributed to an abundance of foliage due to increased N2 fertilization, which causes young foliage to act as a strong sink and absorb nutrients produced in photosynthesis, resulting in the disturbance of vegetative buds differentiation into a reproductive stage; and ultimately, not fruiting. Conversely, Aghaei and Ehsanzadeh, (2011) stated that increasing nitrogen levels reduced fruit number, fruit and grain yield in plants .Similarly, Majidian et al. (2008) observed that nitrogen consumption increased yield and water use efficiency of maize plants. Hamzai and Babaei (2013) stated that increasing nitrogen application up to 180 kg ha^{-1} enhanced grain yield in field pumpkin. Usually, the highest level of fertilizer efficiency is obtained by absorbing the first nitrogen unit, and nitrogen efficiency decreases with increasing levels of nitrogen (Rabiei and Tousi Kohl, 2011). Superabsorbent increases soil moisture and nutrient reserves leading to increased growth and yield of plants under water stress (Dragicevic et al.,2011). The combination of superabsorbent polymers and balanced consumption of chemical fertilizers (fertilization according to soil test results) and bio-fertilizers led to the highest yield compared to other treatments. Superabsorbent polymers can absorb water from irrigation, prevent deep subsidence and increase water use efficiency. Researches have shown that these compounds improve yield and yield components in corn via retaining water under drought stress and increase the qualitative and growth indices in chrysanthemum (Fazeli Rostampour et al., 2010). Considering the shortage of water resources and the nitrogen fertilizer effect on the medicinal plant's yield, this study aimed to investigate the effects of moisture superabsorbent and nitrogen fertilizer on yield and yield components of field pumpkin across two crop years.

Materials and methods

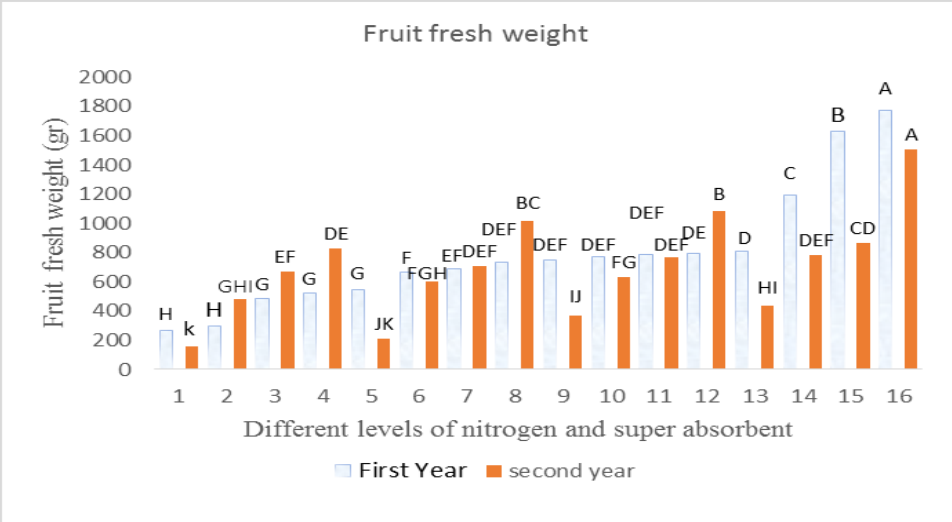
This study was performed to investigate the effect of different levels of nitrogen fertilizer and moisture superabsorbent on yield and yield components in field pumpkin seedlings, during two crop years in a research field in Kermanshah, Iran. Its geographical coordinates are between 36 and 33 degrees and 15 and 35 degrees north and 24 and 45 degrees to 30 and 48 degrees east longitude. The experiment was carried out as a split-plot in randomized complete block design with three replications. Experimental treatments were consisted of four moisture super absorbent levels (0 (control), 40, 80, 160 kg ha^{-1}, respectively) as the main factor and four N2 levels in the form of Urea (0, 50, 100, 150 kg ha^{-1}, respectively) as a sub-factor. In early June, after field preparation operations, such as plowing, disking, and applying super absorbent, manual sowing of seeds was conducted in bulks. The length of planting lines, seed spacing on, and the distance between rows were 5m, 40cm, and 4 m, respectively. Also, there was a one-meter distance between the plot and block as corridor. The plants were thinned manually to achieve their appropriate density, at the 4-leaf stage. Weeds also were controlled manually. The measured traits were fruit fresh and dry weight, leaf dry weight, stem dry weight, fruits number, grain weight, grain number, number of grains per fruit, and seed nitrogen.

Results and discussion

Fruit fresh weight

Results demonstrated that superabsorbent, nitrogen and their interaction affected the fresh weight of fruits significantly over a period of two years (Table 1). The co-application of 120 kg ha-1 superabsorbent and 150 kg ha-1 N2 resulted in the highest average fresh weight while. the lowest one was related to control treatment , So that this treatment indicated an approximately 57% increase compared to the control. According to results, at different levels of superabsorbent, this trait increased with enhancing consumed nitrogen. The primary reason for this rise could be the availability of moisture provided by increasing the consumption of superabsorbent and improving the amount of available N2 to the plant, leading to increased vegetative growth; and ultimately, higher fresh fruit weight. Additionally, there was no significant effect between the interaction impact of 40 and 80 kg ha-1 superabsorbent and 100 and 150 kg ha-1 of N2 treatments in terms of this trait. Higher fresh weight and greater consumption of both N2 and moisture superabsorbent may indicate the availability of moisture and nitrogen since N2 is the main nutrient necessary for vegetative growth, which results in higher fresh weight (Fig 1). Similarly, Gholipouri et al. (2006) and Arvai (2001) stated that by increasing the consumed N2 in field pumpkin, the fruit fresh weight increased.

Fig 1. Fruit fresh weight



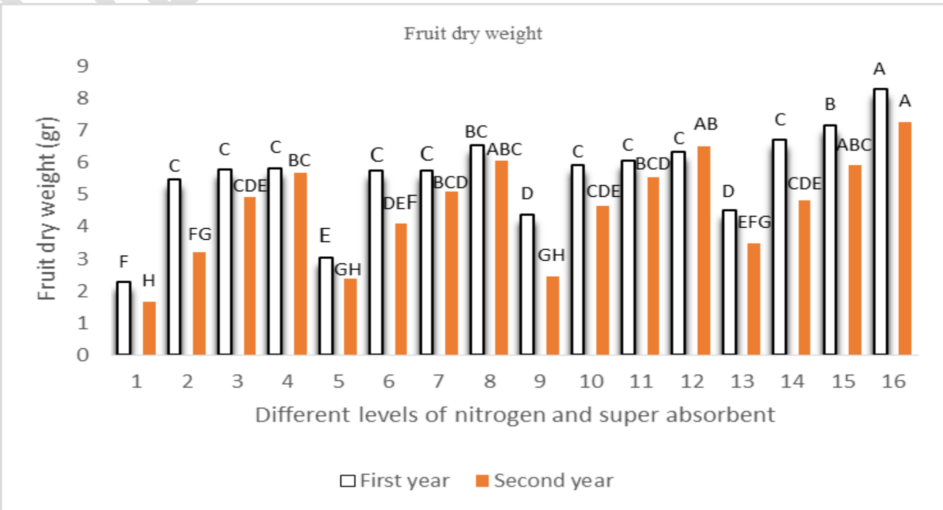
(Means followed by the same letters in each column are not significantly different (Duncan multiple range test 5%

1: Nitrogen 0 + Super Adsorbent 0
2: Nitrogen 0 + Super Adsorbent 50
3: Nitrogen 0 + Super Adsorbent 100
4: Nitrogen 0 + Super Adsorbent 150
5: Nitrogen 40 + Super Adsorbent 0
6: Nitrogen 40 + Super Adsorbent 50
7: Nitrogen 40 + Super Adsorbent 100
8: Nitrogen 40 + Super Adsorbent 150
9: Nitrogen 80 + Super Adsorbent 0
10: Nitrogen 80 + Super Adsorbent 50
11: Nitrogen 80 + Super Adsorbent 100
12: Nitrogen 80 + Super Adsorbent 150
13: Nitrogen 120 + Super Adsorbent 0
14: Nitrogen 120 + Super Adsorbent 50
15: Nitrogen 120 + Super Adsorbent 100
16: Nitrogen 120 + Super Adsorbent 150

Fruit dry weight

According to results, superabsorbent, nitrogen and their interaction significantly affected fruit dry weight (Table 1). There was a maximum average of this trait in the interaction effect of 120 kg ha-1 superabsorbent and 150 kg ha-1 nitrogen treatment , whereas the lowest one was achieved in the control treatment, so that this treatment increased about 73% compared to the control. Results revealed that with different levels of superabsorbent along with increased nitrogen, the dry weight of the fruit was enhanced. Moreover, there was no significant difference between the interaction effect of control, 40, and 80 kg ha^{-1} of superabsorbent and 50, 100, and 150 kg ha^{-1} of nitrogen treatments (Fig 2). In the same vein, Similarly, Qolipouri et al. (2006) and Aroy (2001) found that increasing nitrogen consumption in field pumpkin led to increased fresh weight and biomass in the fruits.

Fig 2. Fruit dry weight



(Means followed by the same letters in each column are not significantly different (Duncan multiple range test 5%

1: Nitrogen 0 + Super Adsorbent 0

2: Nitrogen 0 + Super Adsorbent 50

3: Nitrogen 0 + Super Adsorbent 100

4: Nitrogen 0 + Super Adsorbent 150

5: Nitrogen 40 + Super Adsorbent 0

6: Nitrogen 40 + Super Adsorbent 50

7: Nitrogen 40 + Super Adsorbent 100

8: Nitrogen 40 + Super Adsorbent 150

9: Nitrogen 80 + Super Adsorbent 0

10: Nitrogen 80 + Super Adsorbent 50

11: Nitrogen 80 + Super Adsorbent 100

12: Nitrogen 80 + Super Adsorbent 150

13: Nitrogen 120 + Super Adsorbent 0

14: Nitrogen 120 + Super Adsorbent 50

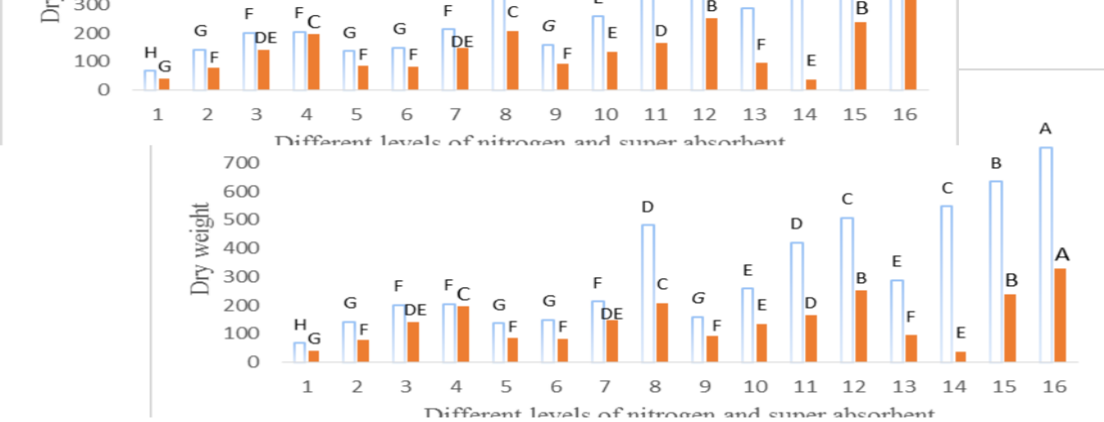
15: Nitrogen 120 + Super Adsorbent 100

16: Nitrogen 120 + Super Adsorbent 150

Leaf dry weight

Results revealed that superabsorbent, nitrogen and their interaction had a significant effect on leaf dry weight (Table 1). Co-application of 120 kg ha^{-1} superabsorbent and 150 kg ha^{-1} N2 recorded the highest leaf dry weight by so that this trait increased nearly 91% compared to the control. With increasing superabsorbent and nitrogen consumption, leaf dry weight has increased. It might be explained by an increase in the biomass of a plant due to the consumption of N2 and the availability of moisture (Fig3). Aghaie and Ehsanzadeh (2011) also found similar results.

Fig 3. Leaf dry weight



1: Nitrogen 0 + Super Adsorbent 0

2: Nitrogen 0 + Super Adsorbent 50

3: Nitrogen 0 + Super Adsorbent 100

4: Nitrogen 0 + Super Adsorbent 150

5: Nitrogen 40 + Super Adsorbent 0

6: Nitrogen 40 + Super Adsorbent 50

7: Nitrogen 40 + Super Adsorbent 100

8: Nitrogen 40 + Super Adsorbent 150

9: Nitrogen 80 + Super Adsorbent 0

10: Nitrogen 80 + Super Adsorbent 50

11: Nitrogen 80 + Super Adsorbent 100

12: Nitrogen 80 + Super Adsorbent 150

13: Nitrogen 120 + Super Adsorbent 0

14: Nitrogen 120 + Super Adsorbent 50

15: Nitrogen 120 + Super Adsorbent 100

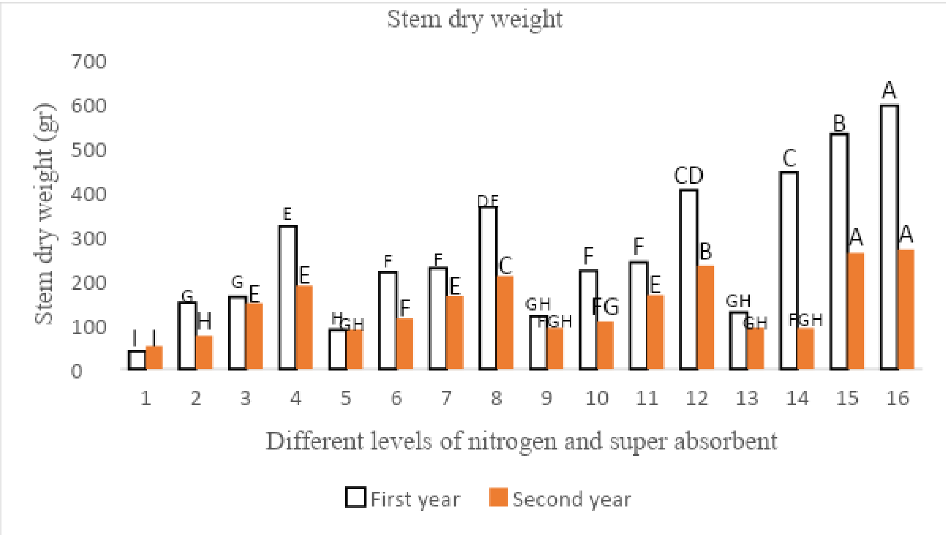
16: Nitrogen 120 + Super Adsorbent 150

(Means followed by the same letters in each column are not significantly different (Duncan multiple range test 5%

Stem dry weight

Superabsorbent, N2 treatment and their interaction significantly affected stem dry weight during two years of experiments (Table 1). The highest and lowest values of this trait were associated with the application of 120 kg ha^{-1} superabsorbent and 150 kg ha^{-1} pure N2, Our findings confirm that vegetative growth was directly associated with the use of N2 and superabsorbent. Additionally, this plant's extensive vegetative growth was stimulated and enhanced by favorable environmental conditions resulted in the maximum dry stem biomass when high N2 consumption and superabsorbent were used (Fig 5). Rabiei and Tousi-e-Cohl (2011) reported similar results.

Fig 4. Stem dry weight



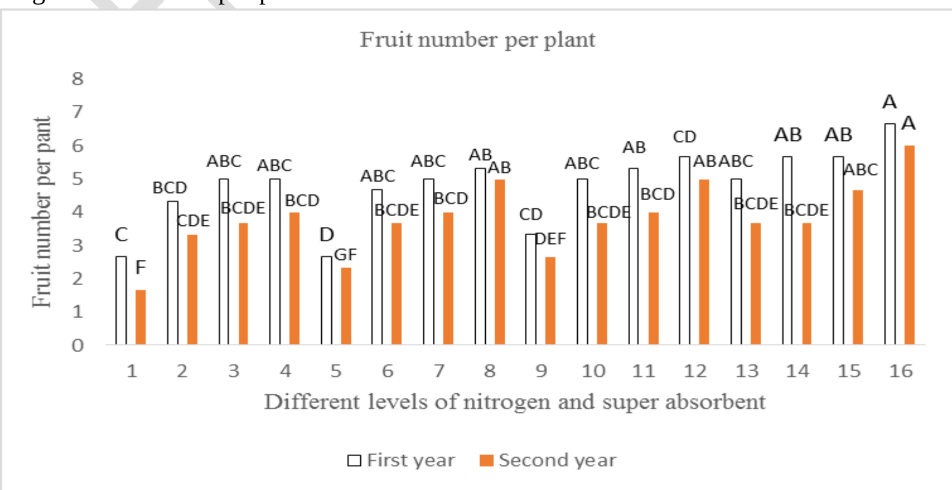
1: Nitrogen 0 + Super Adsorbent 0	9: Nitrogen 80 + Super Adsorbent 0
2: Nitrogen 0 + Super Adsorbent 50	10: Nitrogen 80 + Super Adsorbent 50
3: Nitrogen 0 + Super Adsorbent 100	11: Nitrogen 80 + Super Adsorbent 100
4: Nitrogen 0 + Super Adsorbent 150	12: Nitrogen 80 + Super Adsorbent 150
5: Nitrogen 40 + Super Adsorbent 0	13: Nitrogen 120 + Super Adsorbent 0
6: Nitrogen 40 + Super Adsorbent 50	14: Nitrogen 120 + Super Adsorbent 50
7: Nitrogen 40 + Super Adsorbent 100	15: Nitrogen 120 + Super Adsorbent 100
8: Nitrogen 40 + Super Adsorbent 150	16: Nitrogen 120 + Super Adsorbent 150

Means followed by the same letters in each column are not significantly different (Duncan multiple range test 5%)

Fruit number per plant

The main effects of superabsorbent and nitrogen on fruit number per plant were not significant in the first year of the experiment, while their main and interaction effects were significant in the second year. The highest average of this trait across two-year experiment was recorded for the treatment of 150 kg ha^{-1} N2 and 120 kg ha^{-1} superabsorbent, while 50, 100 and 150 kg ha^{-1} nitrogen treatments were not significantly different. The lowest fruit number was recorded in control treatment. In addition, it is notable that the difference between 100 and 150 kg ha^{-1} of N2 application at various levels of superabsorbent was not significant during two years of experiment. Considering that the number of fruits per plant was not impacted by nitrogen consumption and superabsorbent, it can be claimed that this trait is largely influenced by its specific genetic pattern and does not respond greatly to environmental conditions (Fig 6). Fazeli Rostampour et al. (2010) also reported similar results in their studies.

Fig 5.Fruit number per plant



1: Nitrogen 0 + Super Adsorbent 0	9: Nitrogen 80 + Super Adsorbent 0
2: Nitrogen 0 + Super Adsorbent 50	10: Nitrogen 80 + Super Adsorbent 50
3: Nitrogen 0 + Super Adsorbent 100	11: Nitrogen 80 + Super Adsorbent 100

4: Nitrogen 0 + Super Adsorbent 150

5: Nitrogen 40 + Super Adsorbent 0

6: Nitrogen 40 + Super Adsorbent 50

7: Nitrogen 40 + Super Adsorbent 100

8: Nitrogen 40 + Super Adsorbent 150

12: Nitrogen 80 + Super Adsorbent 150

13: Nitrogen 120 + Super Adsorbent 0

14: Nitrogen 120 + Super Adsorbent 50

15: Nitrogen 120 + Super Adsorbent 100

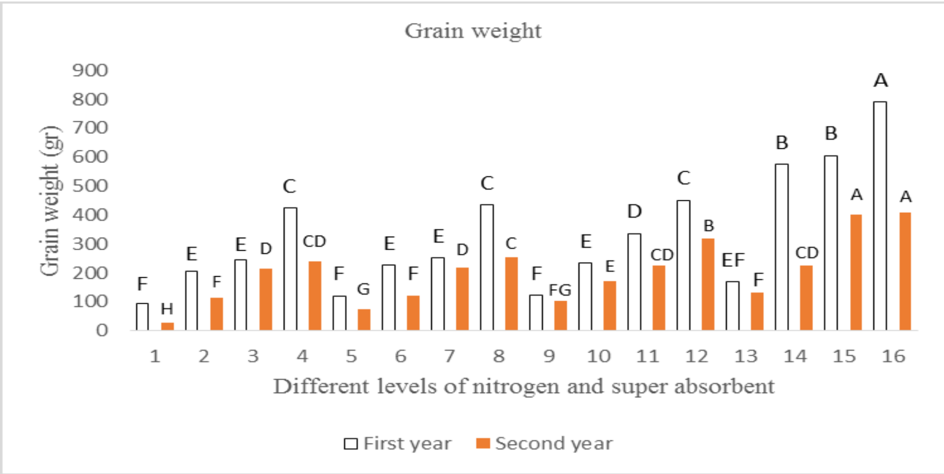
16: Nitrogen 120 + Super Adsorbent 150

(Means followed by the same letters in each column are not significantly different (Duncan multiple range test 5%

Grain weight

Results illustrated there was a significant effect of superabsorbent, N2, and interaction of these two factors on grain weight during two years of experiment (Table 1). Mean comparison results illustrated that the highest grain weight was related to N2 application of 150 kg ha^{-1}, and 120 kg ha^{-1} of superabsorbent, while the lowest one, was achieved in the control treatment. This phenomenon could be explained by increasing seed storage simultaneously with higher consumption of nitrogen and superabsorbent (Fig 6). Hamzai and Babaei (2013) also stated similar results on pumpkin parchment.

Fig 6. Grain weight



Grain weight
Grain weight (gr)
900
800
700
600
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Different levels of nitrogen and super absorbent
First year
Second year

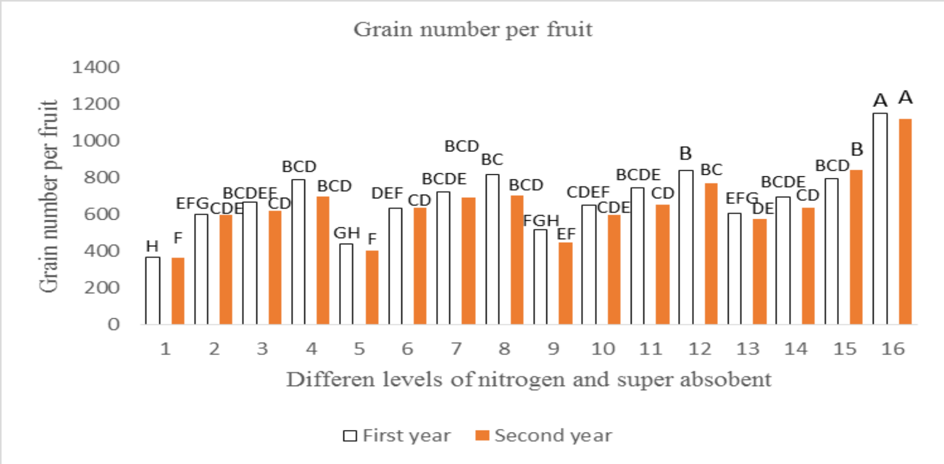
1: Nitrogen 0 + Super Adsorbent 0	9: Nitrogen 80 + Super Adsorbent 0
2: Nitrogen 0 + Super Adsorbent 50	10: Nitrogen 80 + Super Adsorbent 50
3: Nitrogen 0 + Super Adsorbent 100	11: Nitrogen 80 + Super Adsorbent 100
4: Nitrogen 0 + Super Adsorbent 150	12: Nitrogen 80 + Super Adsorbent 150
5: Nitrogen 40 + Super Adsorbent 0	13: Nitrogen 120 + Super Adsorbent 0
6: Nitrogen 40 + Super Adsorbent 50	14: Nitrogen 120 + Super Adsorbent 50
7: Nitrogen 40 + Super Adsorbent 100	15: Nitrogen 120 + Super Adsorbent 100
8: Nitrogen 40 + Super Adsorbent 150	16: Nitrogen 120 + Super Adsorbent 150

(Means followed by the same letters in each column are not significantly different (Duncan multiple range test 5%

Grain number per fruit

Superabsorbent, N2 treatment and their interaction significantly affected grain number per fruit across both years of experiments (Table 1). Mean comparison results of this trait showed that during both years the highest number of grains per fruit was associated with N2 application at 150 kg ha^{-1}, and 120 kg ha^{-1} of superabsorbent (Fig7).

Fig 7. Grain number per fruit



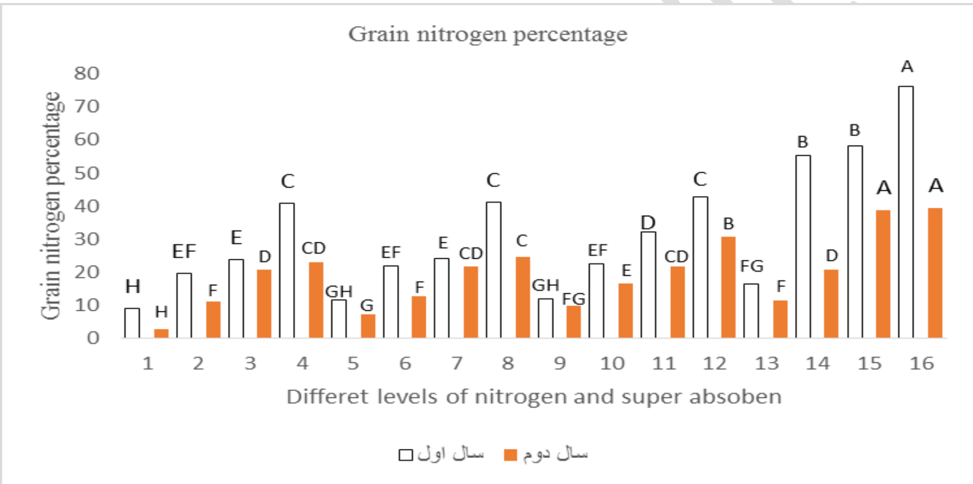
1: Nitrogen 0 + Super Adsorbent 0	9: Nitrogen 80 + Super Adsorbent 0
2: Nitrogen 0 + Super Adsorbent 50	10: Nitrogen 80 + Super Adsorbent 50
3: Nitrogen 0 + Super Adsorbent 100	11: Nitrogen 80 + Super Adsorbent 100
4: Nitrogen 0 + Super Adsorbent 150	12: Nitrogen 80 + Super Adsorbent 150
5: Nitrogen 40 + Super Adsorbent 0	13: Nitrogen 120 + Super Adsorbent 0
6: Nitrogen 40 + Super Adsorbent 50	14: Nitrogen 120 + Super Adsorbent 50
7: Nitrogen 40 + Super Adsorbent 100	15: Nitrogen 120 + Super Adsorbent 100
8: Nitrogen 40 + Super Adsorbent 150	16: Nitrogen 120 + Super Adsorbent 150

(Means followed by the same letters in each column are not significantly different (Duncan multiple range test 5%

Grain nitrogen percentage

Results illustrated that superabsorbent and nitrogen had a significant effect on grain nitrogen percentage (Table 1.). Mean comparison results of this trait illustrated that the maximum grain nitrogen percentage was recorded in 150 kg ha-1 of nitrogen and 120 kg ha^{-1} of superabsorbent treatment, whereas the control treatment illustrated the lowest one. In addition to increasing nitrogen consumption, some of it may be absorbed and stored in the seeds, thus increasing the percentage of nitrogen in the seeds (Fig 8). Similar results were observed by Dragasevic et al. (2011).

Fig 8. Grain nitrogen percentage



1: Nitrogen 0 + Super Adsorbent 0

2: Nitrogen 0 + Super Adsorbent 50

3: Nitrogen 0 + Super Adsorbent 100

4: Nitrogen 0 + Super Adsorbent 150

5: Nitrogen 40 + Super Adsorbent 0

6: Nitrogen 40 + Super Adsorbent 50

7: Nitrogen 40 + Super Adsorbent 100

8: Nitrogen 40 + Super Adsorbent 150

9: Nitrogen 80 + Super Adsorbent 0

10: Nitrogen 80 + Super Adsorbent 50

11: Nitrogen 80 + Super Adsorbent 100

12: Nitrogen 80 + Super Adsorbent 150

13: Nitrogen 120 + Super Adsorbent 0

14: Nitrogen 120 + Super Adsorbent 50

15: Nitrogen 120 + Super Adsorbent 100

16: Nitrogen 120 + Super Adsorbent 150

(Means followed by the same letters in each column are not significantly different (Duncan multiple range test 5%

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SOV.	Fruit fresh weight	Fruit dry weight	Leaf dry weight	Stem dry weight	Fruit number per plant	Grain weight	Grain number per fruit	Grain nitrogen percentage
Repetition	1.44	43719.56	20379.34	5876.15	0/06	599.91	1907.65	0.015
Superabsorbent	3.119*	197776.2**	560859.438**	351883.319**	2.243^{ns}	516592.477**	43906.743**	0.227^{ns}
Error1	0.56	44015	8215.46	4513.91	0.7	551.91	8072.87	0.0001
Nitrogen	5.288*	323448.746**	2696.619**	38015.64**	1.632^{ns}	48246.026**	86032.576**	1.1**
N*S	8.249*	106970.921**	7752.652**	2064.321**	4.706^{ns}	12355.43**	122577.428**	0.1**
Error2	1.40	3868.96	1810.12	771.67	1.04	2110.92	8262.84	0.01
CV.	21.11	7.84	13.19	10.43	21.21	13.91	13.18	13.91

Table of Analysis of variance (1 Year)

* and ** mean significant at 5% and 1% probability, respectively. ns means non-significant.

Table of Analysis of variance (2 Year)

SOV.	Fruit fresh weight	Fruit dry weight	Leaf dry weight	Stem dry weight	Fruit number per plant	Grain weight	Grain number per fruit	Grain nitrogen percentage
Repetition	1.44	43719.56	20379.34	5876.15	0/06	599.91	6953.521	0.015
Superabsorbent	3.119*	197776.2**	560859.438**	351883.319**	2.243ns	516592.477**	43906.743**	0.427**
Error1	0.56	44015	8215.46	4513.91	0.7	551.91	8072.87	0.001
Nitrogen	5.288*	323448.746**	2696.619**	38015.64**	1.632ns	48246.026**	86032.576**	1.955**
N*S	8.249*	106970.921**	7752.652**	2064.321**	4.706ns	12355.43**	122577.428**	0.001ns
Error2	1.40	3868.96	1810.12	771.67	1.04	2110.92	8262.84	0.01
CV.	21.11	7.84	13.19	10.43	21.21	13.91	13.18	5.91

* and ** mean significant at 5% and 1% probability, respectively. ns means non-significant.