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Evaluation Seed Yield, Its Components and Morphological Traits of Corn in Response of Consume Super Absorbent Polymers and Nitroxin

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ABSTRACT

BACKGROUND: Super absorbent polymers (SAP) by increasing the capacity of water storage and nutrition materials, reduction of wasting water and evaporation from the surface of soil improve crop production under water stress condition. Bio-fertilizers have the significant advantages to chemical fertilizers; for instance, they do not produce toxic and bacterial substances in the food chain, are able to reproduce spontaneously, can improve the physical and chemical properties of the soil, are affordable economically and are acceptable environmentally.

OBJECTIVES: This research is aimed to examine the changes of seed yield, its components and morphological traits of corn affected different level of SAP and Nitroxin bio-fertilizer.

METHODS: Current study was carried out via factorial experiment based on randomized complete blocks design with three replications during 2015-2016. The first factor included different level of SAP (S_1= nonuse of SAP or control, S_2= 100 kg.ha^{-1} and S_3= 150 kg.ha^{-1} SAP) and second factor consisted three level of Nitroxin (N_1= nonuse of Nitroxin or control, N_2= 1 L.ha^{-1} and N_3= 3 L.ha^{-1} Nitroxin, used in stem elongation).

RESULT: Result analysis of variance revealed effect of SAP on all measured traits (instead ear diameter, number of row per ear) was significant, also effect of Nitroxin on all measured traits (instead plant height, stem diameter, ear length, harvest index) was significant. Interaction effect of treatments on all measured traits (instead plant height) was not significant. According result of mean comparison of different level of super absorbent that maximum plant height (179 cm) stem diameter (2.5 cm), ear length (19 cm), seed yield (8455 kg.ha^{-1}), biologic yield (13266 kg.ha^{-1}), harvest index (60%), Number of seed per row (27), 100-seed weight (23 gr) was noted for use 150 kg.ha^{-1} super absorbent and minimum amount of mentioned traits was belonged to control treatment. Also between different level of Nitroxin the highest amount of measured traits observed for 1 L.ha^{-1} treatment.

CONCLUSION: Generally results of current study indicated consume 150 kg.ha^{-1} SAP and 1 L.ha^{-1} Nitroxin led to improve seed yield, its components, harvest index and morphological traits from aspect economically and it can be advised to producers.

KEYWORDS: *Fertilizer, Maize, Nutrient, Plant height, Stem diameter.*

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1. BACKGROUND

Water availability in soil is key for fertilizer use efficiency and increased crop yields. Therefore, improving the effectiveness of water application and optimum use of water and nutrient sources have been considered as the main targets for stable agriculture in dry and semidry regions. According to this approach, one of the ways to increase fertilizer use efficiency with limited water supply in soil is application of a superabsorbent polymer that provides water and necessary nutrients to crop roots during the growth period of the plant (Gunes *et al*., 2016). Correct management and applying improved techniques for saving and conserving the humidity of soil and increasing the soil water holding capacity is among the activities for increasing the productivity and consequently exploiting limited water resources. New method in science of soil and water is using super absorbent materials as reservoirs and prevention from water wastage and increase of irrigation efficiency. Applying SAP in agriculture has significant role in increase of soil capacity of holding and absorbing water to resist drought conditions and reduction of bad effects of drought (Rafiei *et al*., 2010). SAP or hydrogels are loosely cross-linked, three-dimensional networks of flexible polymer, and because of few numbers of widthwise connections (Kiatkamjornwong, 2007) are able to absorb and store water hundreds times of their dry weight (Abedi-Koupai and Asadkazemi, 2006). Super absorbents, depending on their source and structure, are divided in two main groups of the natural and synthesis. Synthesis SAP depending on the type of used monomer in their synthesis usually is divided into three groups: 1- crosslinked polyacrylates and lyacrylamides. 2- Hydrolyzed cellulose polyacrylonitrile (PAN) or starch PAN graft copolymers. 3- cross linked copolymers of maleic anhydride. The SAPs used in the agriculture are polyelectrolyte gels often composed of acrylamide (AM), acrylic acid (AA), and potassium acrylate (Zohuriaan Mehr and Kabiri, 2008). Super absorbent polymers by increasing the capacity of water storage in soil and nutrition materials, reduction of wasting water of soil, reduction of water evaporation from the surface of soil and increasing the aeration of soil causes the better growth and enlargement of plants and as a result, increase the yield under normal irrigation and water stress condition. These materials decrease the number of irrigation times by increasing the gaps of irrigation, therefore water cost and energy will be saved (Moslemi *et al*., 2011). Abedi Koupai and Sohrab (2006) estimated that 2–8 g of hydrogel per 1 kg of soil increased the moisture content by roughly 100%–260%, respectively, in comparison with the control. Poormeidany and Khakdaman (2006) reported that the use of a polymer during planting reduced the irrigation rate and intervals with acceptable seedling survival rate. The addition of a polymer to peat decreased the water stress of the plant and increased the time to wilt (Karimi *et al*., 2009). Islam *et al*. (2011a) evaluate the effectiveness of different rates of SAP (low, 10; medium, 20; high, 30 and very high, 40 kg.ha^{-1}) for winter wheat production under drought-affected field and reported the optimum application rate of SAP would be 30 kg.ha^{-1} as it increases both wheat yield and soil fertility. Lower rates (10 and 20 kg.ha^{-1}) are not sufficient and higher rate (40 kg.ha^{-1}) is not economic. They suggested that the application of SAP at 30 kg.ha^{-1} could be an efficient soil management practice for winter wheat production in the drought-affected regions. Bio-fertilizers have the significant advantages to chemical fertilizers; for instance, they do not produce toxic and bacterial substances in the food chain, are able to reproduce spontaneously, can improve the physical and chemical properties of the soil, are affordable economically and are acceptable environmentally (Shaukat *et al*., 2006). Nitroxin contains nitrogen fixation bacteria (Azotobacter) not only fixes the air nitrogen and balance the uptake of macro and micronutrients but also enhances plant growth and increase the quality and quantity of products through the synthesis and secretion of growth promoting substances (Ansari and Rousta, 2008). Vadivel *et al*. (1999) concluded that the application of Nitroxin biological fertilizer had a significant effect on all measured parameters except 1000-grian weight and grain-straw ratio. Grain yield, straw yield, plant height, spike length, number of grains per spike and number of spikes per square meter increased in Nitroxin treatment in comparison to the control treatment. Nitroxin biofertilizers include a series of nitrogen-fixing bacteria of the genus Azotobacter, and Azospirillum that causes the growth of roots and aerial parts of the plant (Gilik *et al*., 2001). In study of *Azotobacter* and *Azospirillum* bacteria on corn was found that inoculation with these bacteria increases corn yield (Biari *et al*., 2011). Application of Nitroxin biological fertilizer in the sesame plant increases number of seeds per capsule, seed weight, biological function, and seed yield (Boraste, 2009). According to (Boraste, 2009) plant height and plant diameter in corn increase much more in the effect of inoculation with *Azotobacter* and *Azospirillum* bacteria than non-inoculated. Besides, inoculation of wheat seeds with bacteria such as *Azotobacter* and *Azospirillum* can lead to stem dry weight, and dry weight of plant (Defreitas, 2000). Rahi (2013) reported that increase in Nitroxin also increased fresh and dry weights of leaf, stem, chlorophylls a, b, total carotenoids, and anthocyanin content of the plants linearly. Tarang *et al*. (2013) reported applications of Nitroxin bio-fertilizer and chemical fertilizer (400 kg.ha^{-1} urea with 300 kg.ha^{-1} ammonium phosphate) had a significant effect on traits of root dry weight, number of seed per row (36.5), number of seeds per ear (458.56), 1000-grain weight, seed (13.23 t.ha^{-1}) and biological yield (26.4 t.ha^{-1}), and also harvest index (53.88%). Fallahi *et al.* (2008) founded that Nitroxin bio-fertilizer had significant effects on main yield components, seed yield; essential oil .They concluded that this biofertilizer can be considered as a replacement for chemical fertilizers the absorbed nitrogen during this time leads to the increase of the number of spikelet.

In different experiments it was observed that the yield and its components increased in the crop inoculated with Azospirillum.

2. OBJECTIVES

This research is aimed to examine the changes of seed yield, its components and morphological traits of corn affected different level of SAP and Nitroxin bio-fertilizer.

3. MATERIALS AND METHODS

3.1. Field and Treatments Information

Current study was carried out to assess effect of SAP and bio-fertilizer (Nitroxin) on morphological characteristics and mays production according factorial experiment based on randomized complete blocks design with three replications during 2015-2016. The first factor included different level of SAP (S_1= nonuse of SAP or control, S_2= 100 kg.ha^{-1} and S_3= 150 kg.ha^{-1} SAP) and second factor included three level of Nitroxin (N_1= nonuse of Nitroxin or control, N_2= 1 L.ha^{-1} and N_3= 3 L.ha^{-1} Nitroxin, used in stem elongation). Place of research was located in Izeh region at longitude 50 22′ E and latitude 31"13' N in Khuzestan province (South west of Iran). The average annual rainfall, temperature, and evaporation in the region are 694 mm, 21 °C and 2000 mm, respectively. The mean metrological information of experiment location was mentioned in table 1. Before planting compound samples of the soil were taken from a depth of 0-30 cm. The dried samples of soil were passed through 2 mm sieve and some of the physical and the chemical properties (soil texture, pH, salinity, organic matter, some of macro elements concentration) were measured (Table 2).

Table 1. Mean of metrological information of experiment location at 2015-2016

Month	**Temperature ^{0}C**		**Precipitation (mm)**
	Max	Min	
May.	38	1.2	11.8
Jun.	42	8.8	0.6
Jul.	45.5	13	0
Aug.	46	18.8	0
Sep.	46.5	16.5	0
Oct.	38.8	14	1.1
Nov.	30	10	20

Table 2. Physical and chemical properties of studied field

K (ppm)	**P (ppm)**	**Mg^{2+} (Meq.l^{-1})**	**pH**
33.7	13.6	1.9	7.5
O.C (%)	**E_c (ds.m^{-1})**	**Na^+ (Meq.l^{-1})**	**Ca^{2+} (Meq.l^{-1})**
1.3	1.59	3.75	4.4
Clay (%)	**Sand (%)**	**Silt (%)**	**Soil texture**
29	33	38	Clay loam

3.2. Farm Management

For mix seeds with bio-fertilizer of Nitroxin (Prepared by Asian love Biotechnology Company), seed was first spread on a clean plastic. Then, the appropriate amount of inoculum (1 liter per 60 kg of seed) was gradually sprayed on the seeds and by seeding the seeds inoculum was done. Then the inoculated seeds were shaded and immediately after drying, seeds planted (Akabarynia, 2004). During the planting, separate disposable gloves for each treatment were used to prevent mixing of the effects of treatments. The land preparation operations were carried out in early June 2012, in order to stimulate seed germination of the weeds, to better control them and provide adequate moisture for plowing operations, the experimental plots were irrigated before land preparation. After reaching the moisture content of the soil to the optimal level, a plow operation was carried out with Chislow's plow, and then the disc and leveler applied. Each plot with dimensions of 4.5 × 6 m and including 6 rows of planting at a distance of 75 cm and block spacing of 3 meters were considered. For application of super adsorbent treatments, it was used directly at depth of 15 cm after the preparation of the plots. The spacing of the seeds on each row was 20 and the distance on the rows was 75 cm. Maize seeds were inoculated immediately before planting with Nitroxin bacteria according recommended method. The first irrigation was carried out to optimize the bacterial placement and improve seedling emergence immediately after cultivation. Four days later, the second irrigation took place to better germination. Subsequent irrigation was performed as needed by leakage every six days. Controlling weeds was done mechanically and manually. During the test period, no disease and pests were seen. Nitroxin was applied with the second irrigation. The harvest of corn was done at the end of September in the physiological ripening stage.

3.3. Measured Traits

The final harvest area of each plot was 1.5 m^2. Seed yield, its components and qualitative traits were estimated after the physiological maturity. After separating seed from selected plants and weighing them, seed yield was calculated based on 14% moisture. In order to estimate 100 seed weigh, 10 samples of seed containing 10 seed were separated and the means was calculated. The number of seed per unit area was obtained from number of plants per unit area (m^2) and number of seed per ear. To calculate the number of rows per ear, from each plot, ten rows were randomly selected and its number was counted and the mean was considered as this attribute. Harvest index (HI) was calculated according to formula of Gardner *et al*. (1985) as follows: **Equ.1.** HI= (Seed yield/Biologic yield) ×100.

For measure morphological traits such as plant height, ear length, stem diameter and ear diameter, 10 samples of plant selected and mentioned traits was measured.

3.4. Statistical Analysis

Analysis of variance and mean comparisons were done by SAS software (Ver.9.1) and Duncan test at 5% probability level. Curved was drawn with Excel software (Ver.2010).

4. RESULT AND DISCUSSION

4.1. Plant height

Result of analysis of variance revealed effect of different level of SAP on plant height was significant at 1% probability level but effect of Nitroxin was not significant, also interaction effect of treatments was significant at 5% probability level (Table 3). Mean comparison result of different level of SAP indicated maximum plant height (178 cm) was noted for 150 $kg.ha^{-1}$ SAP and minimum of that (156 cm) belonged to control treatment (Fig. 1). SAP provide better conditions for corn plant growth by increasing soil water capacity, improving soil structure and reducing bulk density, so in current study SAP led to increase corn height by increasing the availability of water and nutrients in the soil. Nazarli *et al*. (2010) reported that the highest plant height was obtained by using 300 kg.ha^{-1} of SAP, but Memar and Mojaddam (2015) reported use 150 kg.ha^{-1} led to achieve the maximum plant height. Compare interaction effect of treatments maximum and minimum amount of the plant height belonged to use 150 kg.ha^{-1} SAP with 1 L.ha^{-1} Nitroxin (185 cm) and control (140 cm) (Fig. 2).

4.2. Stem diameter

Result of ANOVA revealed effect of different level of SAP on stem diameter was significant at 5% probability level, but effect of Nitroxin and interaction effect of treatments was not significant (Table 3). According result of mean comparison maximum amount of stem diameter (2.5 cm) was obtained for 150 kg.ha^{-1} SAP and minimum of that (2 cm) was for control treatment (Fig. 3).

Table 3. Result analysis of variance of measured traits

S.O.V	df	Plant height	Stem diameter	Ear diameter	Ear length	Seed yield
Replication	3	987.55**	0.06^{ns}	0.037^{ns}	17.59*	5830277**
Super absorbent polymer (S)	2	1853.03**	0.09*	0.033^{ns}	14.97*	9210172**
Nitroxin (N)	2	340.36^{ns}	0.004^{ns}	0.058*	2.15^{ns}	4474239**
S×N	4	412.03*	0.01^{ns}	0.027^{ns}	3.20^{ns}	1218965^{ns}
Error	24	146.47	0.02	0.15	3.73	1108197
CV (%)	-	14.13	15.6	16.23	12.23	12.34

$^{ns, *\ and\ **}$: no significant, significant at 5% and 1% of probability level, respectively.

Continue Table 3.

S.O.V	df	Biologic yield	Harvest index	No. seed per row	No. row per ear	100-seed weight
Replication	3	2887144^{ns}	207.9**	20.18^{ns}	0.63^{ns}	8.25*
Super absorbent polymer (S)	2	9578926*	76.8*	104.86**	1.02^{ns}	6.69*
Nitroxin (N)	2	8189055*	15.3^{ns}	43.69*	4.19*	10.53**
S×N	4	920789^{ns}	33.2^{ns}	5.11^{ns}	0.53^{ns}	4.19^{ns}
Error	24	1887471	20.1	12.26	1.01	1.87
CV (%)	-	11.38	14.56	13.85	14.3	16.2

$^{ns, *\ and\ **}$: no significant, significant at 5% and 1% of probability level, respectively.

Yousefi *et al*. (2010) reported use super absorbent of polymer led to increase corn stem diameter. In SAP application treatments, this material has helped release more water and nutrients from soil to plant. The stored water and nutrients released for improve biomass and increased stem diameter.

4.3. Ear diameter

According the result of analysis of variance effect of different level of Nitroxin on ear diameter was significant at 5% probability level, but effect of SAP and interaction effect of treatments was not significant (Table 3).

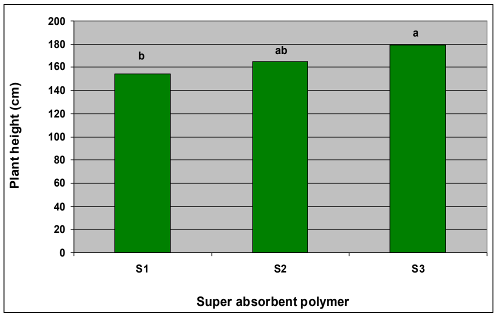

Fig.1. Mean comparison effect of different level of SAP on plant height by Duncan test at 5% probability level.

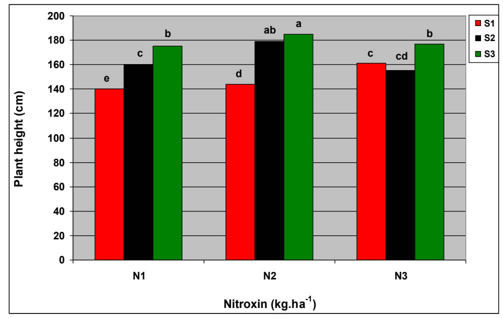

Fig.2. Mean comparison interaction effect of treatments on plant height by Duncan test at 5% probability level.

Compare different level of Nitroxin showed that the maximum and the minimum amount of ear diameter belonged to 1 L.ha^{-1} (4.9 cm) and control (4 cm) treatments (Fig. 4). Fathi (2010) and Kalantari Khandani (2010) mentioned similar result.

4.4. Ear length

Result of analysis of variance revealed effect of different level of SAP on ear length was significant at 5% probability level, but effect of Nitroxin and interaction effect of treatments was not significant (Table 3). According result of mean comparison maximum amount of ear length (19 cm) was obtained for 150 kg.ha^{-1} SAP and minimum of that (16 cm) was for control treatment (Fig. 5). Another researcher such as Dragicevic *et al*. (2011) and Hasanzadeh and Farajzadeh Memari Tabrizi (2011) reported same result. SAP, due to accelerating growth and cell division led to increase leaf growth and compatibility of environmental conditions. So by increasing allocation of photosynthetic materials to the reproductive organs led to increase the ear length.

4.5. Seed yield

According result of ANOVA effect of different level of SAP and Nitroxin on seed yield was significant at 1% probability level but interaction effect of treatments was not significant (Table 3). Compare different level of SAP indicated that maximum seed yield (8455 kg.ha^{-1}) was noted for use 150 kg.ha^{-1} SAP and minimum of that (6765 kg.ha^{-1}) belonged to control (Fig. 6). Yousefi Fard and Asareh (2013) reported the use of super adsorbent polymer increased the irrigation interval from 4 to 5 days to 8 days, reduced the number of irrigation from 29 times to 76 times, increased water use efficiency by 38% and reduced the volume of consumed water to 42%, as well The corn seed yield increased by 11% compared to deficit irrigation treatment. Fazeli Rostampour and Mohebbian (2012) reported application of 90 kg.ha^{-1} SAP under drought stress increased grain yield of corn. Between different levels of Nitroxin the maximum seed yield (8426 kg.ha^{-1}) was observed in 1 L.ha^{-1} and the lowest one (7248 kg.ha^{-1}) was found in control treatment (Fig. 7).

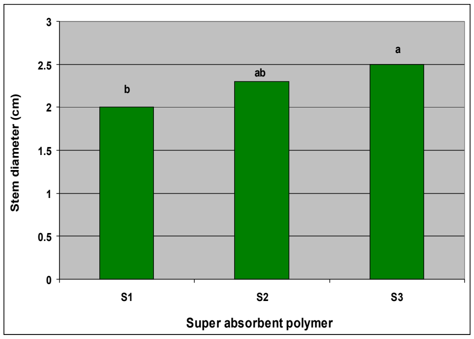

Fig.3. Mean comparison effect of different level of SAP on stem diameter by Duncan test at 5% probability level.

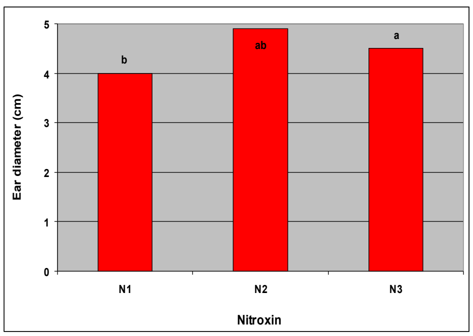

Fig.4. Mean comparison effect of different level of Nitroxin on ear diameter by Duncan test at 5% probability level.

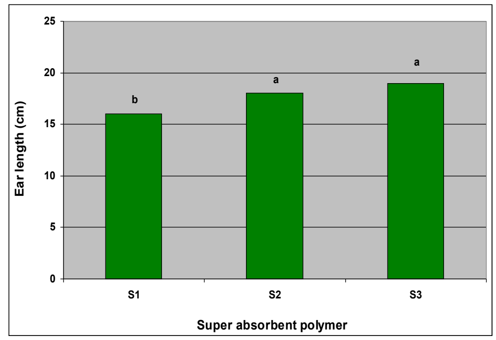

Fig.5. Mean comparison effect of different level of SAP on ear length by Duncan test at 5% probability level.

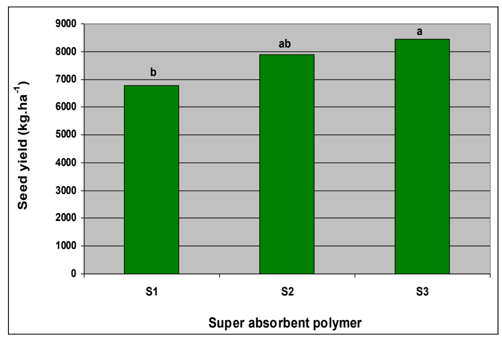

Fig.6. Mean comparison effect of different level of SAP on seed yield by Duncan test at 5% probability level.

It seems like that increase of seed yield is due to positive effect of nitrogen and receiving light and increase of photosynthesis, CGR, LAI, and LAD. The results are consistent with finding of Nawas Nazanat *et al.* (2005). In another study Garg *et al.* (2005) reported increasing nitrogen to soil led to increase plant photosynthetic efficiency and ultimately increased the seed yield and growth rate. On the other hand, since the rate of light absorption by leaves and converting it into photosynthetic materials are the other factors affecting plant growth and production, increase of LAI in farm lead to increase of light absorption and ultimately leads to the increase of seed yield.

Khadem *et al*. (2011) reported that the application of manure and superabsorbent with improved soil conditions increased seed yield by 15.9% compared to the control. Charkhab and Mojaddam (2018a) reported consumption 150 Kg.ha^{-1} nitrogen fertilizer with 1 L.ha^{-1} Nitroxin led to achieve maximum seed yield (350 gr.m^{-2}) and it can be advice to producers.

4.6. Biologic yield

Result of analysis of variance revealed effect of SAP and Nitroxin on biologic yield trait was significant at 5% probability level but interaction effect of treatments was not significant (Table 3).

Compare different level of SAP maximum biologic yield (13266 kg.ha^{-1}) was obtained for 150 kg.ha^{-1} SAP (also it doesn't have significant difference with 100 kg.ha^{-1} SAP treatment) and minimum of that (11566 kg.ha^{-1}) was for control (Fig. 8). Ganbari and Mir (2013) reported use of SAP under mild and severe stress reduced effects of drought stress on corn yield, so that increasing amount of SAP from control level to 100 kg.ha^{-1} in mild stress caused a 21% increase in seed and biological yield, which was 5% in severe stress. Compare different level of Nitroxin indicated maximum biologic yield (13437 kg.ha^{-1}) was noted for use 1 L.ha^{-1} Nitroxin and minimum of that (11790 kg.ha^{-1}) belonged to control treatment (Fig. 9). Similar result observed by Tarang *et al.* (2013), they reported application of 1 L.ha^{-1} Nitroxin bio-fertilizer with chemical fertilizer had a strong effect on productivity, serves to reduce environmental pollution and led to achieve maximum amount of biologic yield. Azimi *et al.* (2013a) found that application of super nitroplass bio-fertilizer with Phosphate barvar2 treatment has the highest seed yield (7.6 t.ha^{-1}) and non-application of bio-fertilizers treatment has the Pishtaz cultivar has the lowest seed yield (6.3 t.ha^{-1}). Azimi *et al.* (2013b) was reported seed and biomass yield increasing with the bio fertilizer application, also which account important benefit, causing decreasing in the inputs of production because of economizing much money to the chemical fertilizers and increasing in seed yield and biological yield.

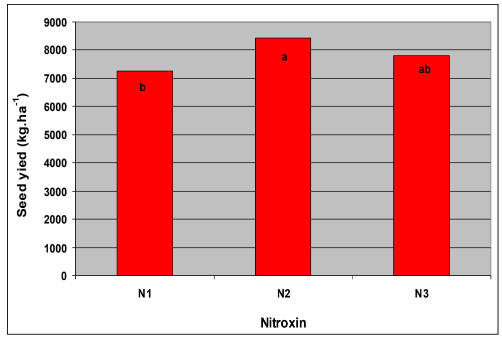

Fig.7. Mean comparison effect of different level of Nitroxin on seed yield by Duncan test at 5% probability level.

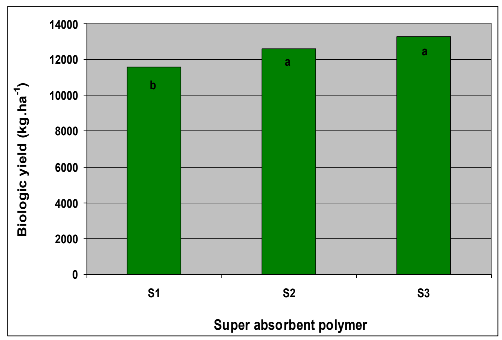

Fig.8. Mean comparison effect of different level of SAP on biologic yield by Duncan test at 5% probability level.

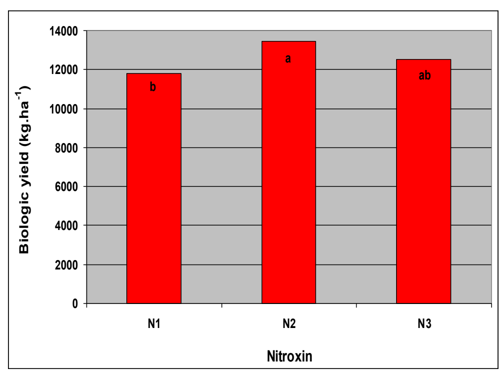

Fig.9. Mean comparison effect of different level of Nitroxin on biologic yield by Duncan test at 5% probability level.

4.7. Harvest index

Result of ANOVA revealed effect of different level of SAP on harvest index was significant at 5% probability level, but effect of Nitroxin and interaction effect of treatments was not significant (Table 3). According result of mean comparison maximum amount of harvest index (60%) was obtained for 150 kg.ha^{-1} SAP and minimum of that (58%) was for control treatment (Fig. 10). Another researcher such as Jahan *et al*. (2013) and Ghanbari and Mir (2013) reported same result. The variability of the harvest index in the plants depends on the difference in the production of the assimilates during the seed filling and re-transplantation of assimilates before the pollination of each genotype and the strength of the reservoir (Charkhab and Mojaddam, 2018b). Han and Lee (2006) attributed the increase in corn harvest index in biofertilizer treatment to better absorb nutrients. Because the plant with better absorption of nutrients and increasing leaf area index can use better solar radiation and send more photosynthetic materials to seed and thus increase dry matter.

4.8. Number of seed per row

Result of analysis of variance revealed effect of different level of SAP and Nitroxin on number of row per ear was significant at the 1% and 5% probability level, respectively but interaction effect of treatments was not significant (Table 3). Mean comparison result of different level of SAP indicated that maximum number of row per ear (27) was noted for use 150 kg.ha^{-1} SAP and minimum of that (21) belonged to control treatment (Fig. 11). Khadem *et al*. (2011) also reported that SAP increased the number of seed per ear row compared to control.

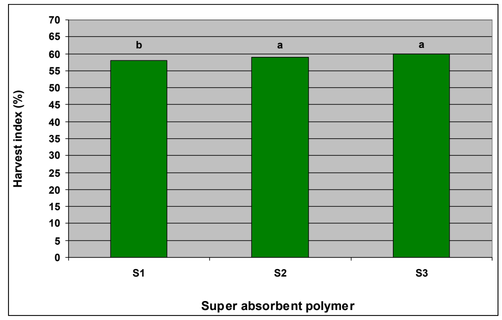

Fig.10. Mean comparison effect of different level of SAP on harvest index by Duncan test at 5% probability level.

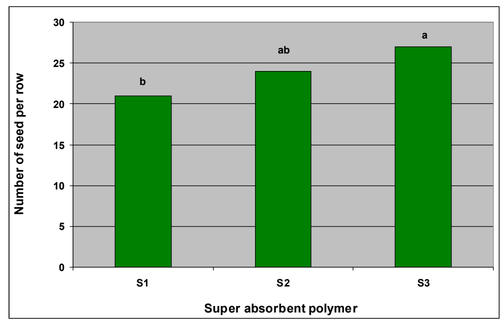

Fig.11. Mean comparison effect of different level of SAP on number of seed per row by Duncan test at 5% probability level.

An experiment on maize showed that the number of seeds per plant was not affected by the minimum use of super absorbent, but at moderate and higher levels of super absorption, number of seed per plant increased by 31% and 45%, respectively (Islam *et al*., 2011b). Compare different level of Nitroxin indicated the maximum number of row per ear (28) was noted for use 1 L.ha^{-1} Nitroxin and minimum of that (23) belonged to the control treatment (Fig. 12). Dadiyan *et al*. (2013) and Fathi (2010) reported use Nitroxin fertilizer led to increase the number of seed per row.

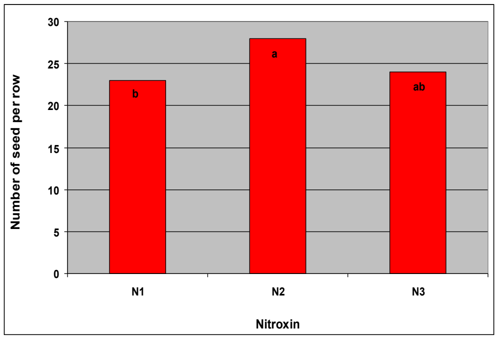

Fig.12. Mean comparison effect of different level of Nitroxin on number of seed per row by Duncan test at 5% probability level.

4.9. Number of row per ear

According the result of analysis of variance effect of different level of Nitroxin on number of seed per row was significant at 5% probability level, but effect of SAP and interaction effect of treatments was not significant (Table 3). Compare different level of Nitroxin showed that the maximum and the minimum amount of number of seed per row belonged to 1 $L.ha^{-1}$ (17) and control (15) treatments (Fig. 13). Dadiyan *et al.* (2013) and Fathi (2010) reported similar result.

4.10. 100-seed weight

Result of analysis of variance revealed effect of different level of SAP and Nitroxin on 100-seed weight was significant at 5% and 1% probability level, respectively but interaction effect of treatments was not significant (Table 3). Mean comparison result of different level of SAP indicated that maximum 100-seed weight (23 gr) was noted for use 150 $kg.ha^{-1}$ SAP and minimum of that (20 gr) belonged to control treatment (Fig. 14). Yosefifard and Asareh (2013) reported similar result.

Use of SAP increases current photosynthesis at grain filling period by providing moisture, nutrients and reducing leaf senescence. Compare different level of Nitroxin indicated maximum seed weight (24 gr) was noted for use 1 $L.ha^{-1}$ Nitroxin and minimum of that (19 gr) belonged to control (Fig. 15).

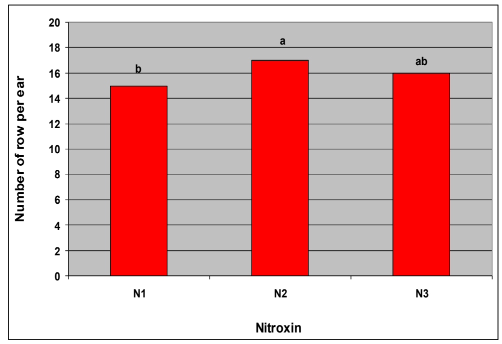

Fig.13. Mean comparison effect of different level of Nitroxin on number of row per ear by Duncan test at 5% probability level.

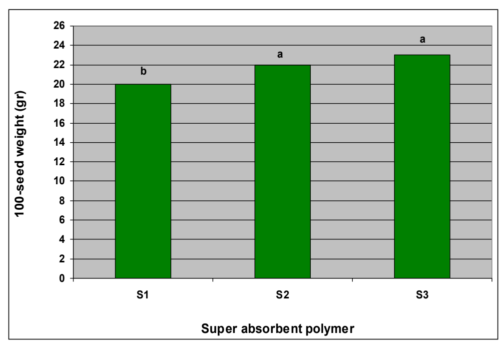

Fig.14. Mean comparison effect of different level of SAP on 100 seed weight by Duncan test at 5% probability level.

5. CONCLUSION

Generally result of current study indicated consumes 150 $kg.ha^{-1}$ SAP and 1 $L.ha^{-1}$ Nitroxin led to improve seed yield, its components, harvest index and morphological traits from aspect economically and it can be advised to producers.

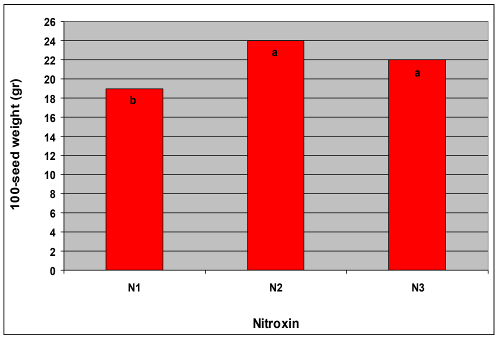

Fig.15. Mean comparison effect of different level of Nitroxin on 100 seed weight by Duncan test at 5% probability level.

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FOOTNOTES

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REFRENCES

Abedi-Koupai, J. and J. Asadkazemi. 2006. Effects of a hydrophilic polymer on the field performance of an ornamental plant (*Cupressus arizonica*) under reduced irrigation regimes. Iranian Polym. J. 15(9): 715-725.

Abedi Koupai, J. and F. Sohrab. 2006. Effect evaluation of Superabsorbent application on water retention capacity and water potential in three soil textures. J. Sci. Tech. Polymer. 17(3): 163-173. (Abstract in English)

Akabarynia, A. 2004. Evaluation effect of chemical fertilizer, poultry, and intergradient fertilizer management on yield and concentration seed essence of Trachyspermum. Second Conf. Medicinal Plants. Shahed Univ. Tehran. Iran. (Abstract in English)

Ansari, P. and M. Rousta. 2008. The effect of application of biological fertilizer of Nitroxin on some vegetative growth indices of maize. 1st Natl. Conf. Manage. Develop. Sust. Agri. Iran. 120 pp. (Abstract in English)

Azimi, S. M., A. Farnia, M. Shaban. and M. Lak. 2013a. Effect of different bio-fertilizers on seed yield of barley, Bahman cultivar. Intl. J. Adv. Biol. Biomedical Res. 1(5): 538-546.

Azimi, S. M., E. Nabati, M. Shaban. and M. Lak. 2013b. Effect of N and P bio fertilizers on yield components of barley. Intl. J. Adv. Biol. Biomedical Res. 2(2): 365-370.

Biari, A., A. Gholami. and H. A. Rahmani. 2008. Growth promotion and enhanced nutrient uptake of corn by application of plant growth promoting rhizobacteria in arid region of Iran. J. Biol. Sci. 8: 1015-1020.

Boraste, A. 2009. Bio-fertilizer: a novel tool for agriculture. Intl. J. Microbial. Res. 1(2): 23-31.

Charkhab, A. and M. Mojaddam. 2018a. Evaluation of seed yield, its component and nitrogen use efficiency of sorghum in response to nitrogen and Nitroxin fertilizers. J. Crop. Nutr. Sci. 4(2): 1-19.

Charkhab, A. and M. Mojaddam. 2018b. Investigation growth Indices analysis and Sorghum (*Sorghum bicolor* L.) crop production affected different level of nitrogen and Nitroxin bio-fertilizer. J. Crop. Nutr. Sci. 4(3): 1-14.

Dadiyan, A., Sh. Khaghaniorcid. and M. Changizi. 2013. The effect of Nitroxin and different levels of nitrogen application on yield and yield components of maize (Hybrid Maximas) in Markazi Province. New Finding Agri. 7(2): 211-225. (Abstract in English)

Defreitas, J. R. 2000. Yield and N assimilation of winter wheat (*Triticum aestivum* L.) inoculated with rhizobacteria. Pedobiologia. J. 44: 97-104.

Dragicevc, V., M. Simic, S. Sredojevic, B. Kresovic, B. Saponjic. and Z. Jovanovic. 2011. The effect of super-hydro-grow polymer on soil moisture, nitrogen status and maize growth. J. Fresenius Environmental Bulletin. 20: 1013-1019.

Fallahi, J., A. Koocheki. and P. Rezvani-Moghaddam. 2008. Effects of bio-fertilizers on quantitative and qualitative yield of chamomile as a medicinal plant. J. Agri. Res. 7: 127–135.

Fathi, A. 2010. Effect of biologic fertilizer on morphophysiological traits of corn under Darrehshar condition. Msc. Thesis. Islamic Azad University. Brojerd Branch. 111 pp. (Abstract in English)

Fazeli Rostampour, M. and S. M. Mohebbian. 2012. Studying the effects of irrigation deficit and superabsorbent polymer on remobilization of assimilates in corn (*Zea mays* L.). Environmental Stresses Crop Sci. 4(2): 127-138.

Ganbari, M. and B. Mir. 2013. Evaluation effect of super adsorbent polymer on corn yield under drought stress. Second Natl. Conf. Sust. Develop. Agri. Environ. Karaj. Iran. pp: 304-311. (Abstract in English)

Gardner, F. P., R. B. Pearce. and R. L. Mitchell. 1985. Physiology of crop plants. Ames, IA: Iowa State Univ. Press. USA. 121 pp.

Garg, B. K., S. Kathju. and S. P. Vyas. 2005. Salinity-fertility interaction on growth. Photosynthesis and nitrate reductase activity in sesame. Indian J. Plant Physiol. 10: 162-167.

Ghanbari, M. and B. Mir. 2013. Evaluation response of corn to apply SAP under drought stress. Second Natl. Conf. Sustainable Agri. Environ. Karaj. Iran. pp: 304-311. (Abstract in English)

Gilik, B. R., D. Penrose. and M. Wenbo. 2001. Bacterial promotion of plant growth. Bio-tech. Advance. J. 19: 135–138.

Gunes, A., N. Kitir, M. Turan, E. Elkoca, E. Yildirim. and N. Avci. 2016. Evaluation of effects of water-saving superabsorbent polymer on corn (*Zea mays* L.) yield and phosphorus fertilizer efficiency. Turk. J. Agri. For. 40: 365-378.

Han, H. S. and K. D. Lee. 2006. Effect of inoculation with phosphate and potassium co-in solubilizing bacteria on mineral uptake and growth of pepper and cucumber. Plant, Soil and Environ. 52: 130-136.

Hasanzadeh, A. and A. Farajzadeh Memari Tabrizi. 2011. Evaluation eco-physiologic different corn hybrid under different level of irrigation and super absorbent. J. Crop Eco-physiology. 71: 757-766. (Abstract in English)

Islam, M. R., Y. Hu, Ch. Fei, X. Qian, A. E. Eneji. and X. Xue. 2011a. Application of superabsorbent polymer: A new approach for wheat (*Triticum aestivum* L.) production in drought-affected areas of northern China. J. Food. Agric. Environ. 9(1): 304-309.

Islam, M. R., Y. Hu, S. Mao, J. Mao, A. E. Eneji. and X. Xue. 2011b. Effectiveness of a water-saving superabsorbent polymer in soil water conservation for corn (*Zea mays* L.) based on eco-physiological parameters. J. Sci. Food Agri. 91(11): 1998-2005.

Jahan, M., N. Kamayestani. and F. Ranjbar. 2013. Assay for applying SAP in a low input corn (*Zea mays* L.) production system aimed to reduce drought stress under Mashhad conditions. Agro-ecology. 5(3): 272-281. (Abstract in English)

Kalantari Khandani, S. 2010. Effect of chemical and biologic fertilizer on seed yield and its components of corn. Msc. Thesis. Ferdosi Mashhad University. 114 pp. (Abstract in English)

Karimi, A., M. Noshadi. and M. Ahmadzadeh. 2009. Effects of superabsorbent polymer (igeta) on crop, soil water and irrigation interval. J. Sci. Tech. Agri. Nat. Resour. 12: 415-420.

Khadem, S. A., M. Ramroudi, M. Galavi. and M. Javad Rousta. 2011. The effect of drought stress and different rates of animal manure with SAP on grain yield and yield components of Corn (*Zea mays* L.). Iranian J. Field Crop Sci. 42(1): 115-123. (Abstract in English)

Kiatkamjornwong, S. 2007. Super absorbent polymers and super absorbent polymer composites. Sci. Asia. 33(1): 39-43.

Memar, M. R. and M. Mojaddam. 2015. The effect of irrigation intervals and different amounts of super absorption on the on yield and yield components of sesame in hamidiyeh weather conditions .Indian J. Fundamental and Appl. Life Sci. 5 (3): 350-365.

Moslemi, Z., D. Habibi, A. Asgharzadeh, M. R. Ardakani, A. Mohammadi. and A. Sakari. 2011. Effects of SAP and plant growth promoting rhizobacteria on yield and yield components of maize under drought stress and normal conditions. African J. Agri. Res. 6(19): 4471-4476.

Nawas-Nazanat, G., M. Sawar, T. Yousaf. and A. Nasseb. 2005. Yield and yield component of sunflower as affected by various NPK levels. Asian J. Plan Sci. 2(7): 561-562.

Nazarli, H., M. R. Zardashti, R. Darvishzadeh. and S. Najafi. 2010. The effect of water stress and polymer on water use efficiency, yield and several morphological traits of sunflower. Notulae Sci. Biol. 2(4): 53-58.

Poormeidany, A., and H. Khakdaman. 2006. Study of Aquasorb polymer application on irrigation of *Pinus eldarica*, *Olea europea* and *Atriplex canescens* seedlings. Iranian J. Forest and Poplar Res. 13: 79-92.

Rafiei, F., Gh. Nourmohammadi, R. Chokan, A. Kashani. and H. Haidari Sharif Abad. 2013. Investigation of superabsorbent polymer usage on maize under water stress. Global J. Medicinal Plant Res. 1(1): 82-87.

Rahi, A. R. 2013. Effect of nitroxin biofertilizer on morphological and physiological traits of *Amaranthus retroflexus*. Iranian J. Plant Physiol. 4(1): 899-905.

Shaukat, K., S. Affrasayab. and S. Hasnain. 2006. Growth responses of *Helianthus annuus* to plant growth promoting rhizobacteria used as a bio-fertilizer. J. Agric. Res. 1(6): 573-581.

Tarang, E., M. Ramroudi, M. Galavi, M. Dahmardeh. and F. Mohajeri. 2013. Effects of nitroxin bio-fertilizer with chemical fertilizer on yield and yield components of grain corn (cv. Maxima). Intl. J. Agri. Sci. 3(5): 400-405.

Vadivel, N., P. Subbian. and A. Velayantham. 1999. Effect of sources and levels of N on the dry matter production and nutrient uptake in rainfed corn. Madras Agri. J. 86: 498-499.

Yousefi, K., M. Galavi, M. Ramroudi. and M. A. Javaheri. 2010. Investigation of Biological phosphate fertilizer-2 fertilized with foliar applications of micronutrient elements on dry matter accumulation and yield components of corn. 11th Iranian Crop Sci. Cong. Shahid Beheshti Univ. Iran. (Abstract in English)

Yosefifard, Y. and A. Asareh. 2013. Influence of superabsorbent and solo potash on irrigation intervals of corn crop. Second Natl. Conf. Sustainable Agri. Environ. Karaj. Iran. pp: 304-311. (Abstract in English)

Zohuriaan-Mehr, M. J. and K. Kabiri. 2008. Superabsorbent polymer materials: a review. Iranian Poly. J. 17(6): 451-477.