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Study effects of super absorbent application, saline water and irrigation management on yield and yield components of peanut (*Arachis hypogaea* L.)

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ABSTRACT

In order to study effects of super absorbent polymer application, irrigation management and irrigation with saline water on peanut (Arachis hypogaea L.) an experiment in factorial format based on randomized complete block design (RCBD) with three replications in Astaneh Ashrafiyeh Township (north of Iran) in 2011 was conducted. The factors of experiment was consists of super absorbent polymer application with two levels (A_1: control (without application) and A_2: 200 kg/ha application), irrigation management with 3 levels (I_1: control (dry farming condition), I_2: 7 days interval irrigation and I_3: 14 days interval irrigation) and irrigation with saline water with 4 levels (S_1: 0, S_2: 2, S_3: 4 and S_4: 6 ds/m concentration). Measured traits were consists of seed yield, biomass yield, pod yield, number of branches per plant and 100 seeds weight. Obtained results showed that, the effect of super absorbent application, irrigation management and irrigation with saline water on all studied traits was significant at 1% probability level. Almost, more interaction effect levels on measured traits showed significant differences. The highest seed yield in current study was obtained from 200 kg super absorbent/ha, 7 days interval irrigation and without saline water irrigation.

Key words: Super absorbent polymer, Irrigation, Saline water, Peanut, Iran.

INTRODUCTION

Peanut (Arachis hypogaea L.) is one of the most important leguminous crops. It is a leguminous crop which is grown in all tropical and subtropical countries, up to 40° N and S. of the equator [44]. The peanut seed contains about 25% to 30% digestible protein, 45 to 50% oil, 20% carbohydrate and 5% fiber and ash which make a substantial contribution to human nutrition [5, 16, 24]. Water conservation is a key step to attaining sustainable agriculture growth and development and productivity. In many regions of the world, including Iran, drought stress is one of the most important factors that decrease agricultural crop production [45]. The available water in soil is one of the most important factors of increasing crop yields [18]. So improving the effectiveness of water application and optimum use of water source as one of the main axis of stable agriculture in dry and semi-dry regions is on the agenda. According to this basis one of the ways to increase the water supply in soil is applying super absorbent polymer that supplies water for crop roots [30]. Super absorbent polymers or hydrogels are loosely cross-linked, three-dimensional networks of flexible polymer and because of few numbers of widthwise connections [21] are able to absorb and store water hundreds times of their dry weight [2]. Super absorbents, depending on their source and

structure are divided in two main groups of natural and synthesis. Synthesis super absorbent polymers depending on the type of used monomer in their synthesis usually are divided in three groups: 1-cross linked 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 [46]. They are applied in gardens, landscapes and agriculture to protect and store humidity in soils and release water slowly through soil [27]. Super absorbent polymers by increasing the capacity of water storage in soil [6, 14, 35], reduction of wasting water and nutrition materials of soil, reduction of water evaporation from the surface of soil [3, 6, 35] and increasing the aeration of soil [27] causes the best growth and enlargement of plants and as a result, increase the yield under normal irrigation and water stress condition. These materials decrease number of irrigation times by increasing the gaps of irrigation, therefore water cost and energy will be saved [3, 40].

Peanut yield was influenced by the availability of soil moisture on both vegetative and generative plant growth phases. Sufficient water availability for plants during peanut growth will produce a lot of pods. Peanuts grown under an optimal environment conditions during the vegetative phase but experiencing drought during the generative phase, starting from pod filling to harvest, experienced a yield decrease of up to 15%. Optimal water availability during the vegetative and generative phases, beginning from the flowering phase to early pod filling, after which the plants left to dry without additional watering until harvest caused yield decrease by 41% [37, 32]. The decline in the pod yield is due to the reduction in the seed yield, as expressed by the decrease in weight ratio of the seeds and the pods [19, 23, 32, 41]. The drought that occurred in the pod filling phase, i.e. from 62 to 90 days after sowing (DAS), significantly reduced the seed pithy (full out), compared to that of crop experiencing drought at the end of the generative phase, from 76 to 95 DAS [32].

Salinity is an important index of low soil quality reducing crop production and gradually decreases the area under cultivation. Irrigated agriculture using saline water in the arid and semi-arid region can lead to salt accumulation in soil profile, reduction in yield and deterioration in soil resource, if proper management practices are not adapted [28]. An attempt to meet world food demands accompanied with decline in availability in fresh water has resulted in using water of poor quality for crop irrigation. It is known that horticultural production is dependent on soil and water quality. Use of saline water may alter soil's physical and chemical properties, which consequently may lead to decrease in crop yield [34]. Crops generally suffer from high salinity level of irrigation waters because of high osmotic pressure that inhibits water suction. Crops symptoms from high salinity are generally the same as symptoms of moisture stress from dry conditions. The salinity problem arises from the fact that irrigation water from any source contains a certain amount of soluble salts. During irrigation, as a portion of the water evaporates, these salts accumulate in the soil and adversely affect the growing conditions and crop yields. Considering the need for increasing the crop yield, as well as the decline of good quality irrigation water, crop salt tolerance assessment can be a useful tool. It may provide information needed for deciding either to expose plants to moderate salt stress or to moderate water stress [22]. Furthermore, increased root zone salinity can affect plant element uptake. In the context of nutrient uptake, it reflects on fertilizers application. In addition, possible toxic element food chain intrusion is already recognized in a saline environment [26].

The aim of current study was study effects of super absorbent polymer application, irrigation interval management and irrigation with saline water on yield and yield components of peanut in north Iran condition.

MATERIALS AND METHODS

In order to evaluation response of peanut crop to super absorbent application, irrigation management and irrigation with saline water an experiment in factorial format based on randomized complete block design (RCBD) with three replications in Astaneh Ashrafiyeh Township located in 37° 16' latitude and 49° 56' longitude (north of Iran) in 2011 was conducted. Factors of experiment was consists of super absorbent polymer application with two levels (A_1: control (without application) and A_2: 200 kg/ha application), irrigation management with 3 levels (I_1: control (dry farming condition), I_2: 7 days interval irrigation and I_3: 14 days interval irrigation) and third factor was consists of irrigation with saline water with 4 levels (S_1: 0, S_2: 2, S_3: 4 and S_4: 6 ds/m concentration). Soil analysis results show that (Table 1), the soil texture was loam and pH, 7.5. The location of experiment was showed in figure1. During growth period, cultivate cares such as weeding and combating with pests were done ordinarily. In maturity time, Measured traits were consists of seed yield, biomass yield, pod yield, number of branches per plant and also 100

seeds weight. The data was analyzed using MSTAT-C software. The Duncan's multiple range tests (DMRT) was used to compare the means at 5% of significant.

Table 1. Physical and chemical properties of experimental filed soil

Soil characteristics	Amount
Sand (%)	35.5
Silt (%)	44
Clay (%)	20.5
Soil texture	Loam
pH	7.5
Nitrogen (%)	0.02
Phosphorus (%)	39.19
Potassium (%)	340.53
EC (ds m^{-1})	8.5

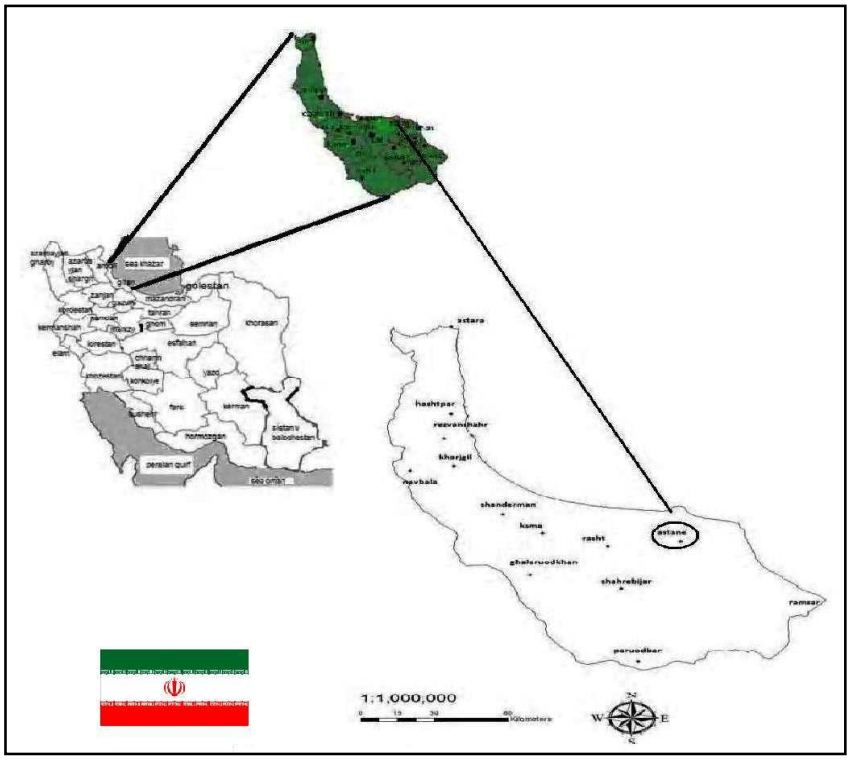


Fig 1. The location of experiment site

RESULTS AND DISCUSSION

Seed yield

With attention to variance analysis table (Table 2), the effect of super absorbent application, irrigation management and irrigation with saline water on seed yield of peanut was significant at 1% probability level. Application of super absorbent had a positive and significant effect on seed yield increasing. Among super absorbent application levels the highest seed yield with 2001 kg/ha was obtained by consumption of 200 kg super absorbent polymer/ha. On the other hand, the lowest seed yield was recorded from control (without super absorbent application) treatment with 1556 kg/ha (Table 3). PourEsmaeil (2007) with studying the use of water super absorbent polymer to increase the yield and activity of antioxidant enzymes in red bean varieties under drought stress was reported that consumption of super absorbent polymer significantly increased some traits such as grain yield and harvest index in this plant [31]. Jouyban et al., (2011) with study seed yield and nitrogen use and agronomic efficiency of sesame as affected

by irrigation levels, nitrogen and super absorbent similar results were reported [20]. In total, the results revealed that water-deficit stress adversely impacted seed yield. Between irrigation management treatments, the highest amount of seed yield with 2285 kg/ha was recorded from 7 days interval irrigation management. Also, the lowest seed yield between irrigation treatments was recorded from dry farming condition (without irrigation). Nye et al., (1971) outlined conditions needed for pollination and fertilization. A large number of cultural practices and environmental conditions are suspected of reducing seed yields. Of concern to this study are the effects of high temperature and water stress during pollination and seed development. Pollen viability and stigma receptivity can be adversely affected, leading to poor fertilization or abortion of developing seeds [25]. Among treatments of irrigation with saline water, the maximum values of seed yields was recorded from control (without irrigation with saline water) treatment with 2202 kg/ha. Also, the minimum amount of this trait with 1401 kg/ha was recorded from saline water irrigation with 6 ds/m concentration (Table 3). With regards to variance analysis table (Table 2), the interaction effect of super absorbent application and irrigation management and also, the interaction effect of irrigation management and irrigation with saline water on seed yield of peanut was significant at 5% probability level. But, the interaction effects of super absorbent application and irrigation with saline water and also, the interaction of super absorbent application and irrigation management and irrigation with saline water on this trait was non significant. With attention to comparison of mean table (Table 6), among the interaction effect levels of super absorbent application and irrigation management, the highest amount of seed yield with 2617 kg/ha was recorded from interaction effect of 200 kg super absorbent/ha and 7 days interval irrigation management (A_2I_2). On the other hand, the lowest seed yield with 1064 kg/ha was recorded from interaction effect of without super absorbent application and dry farming condition (A_1I_1). With attention to comparison of mean table (Table 4), between the interaction effect of irrigation management and irrigation with saline water levels, the highest seed yield with 2924 kg/ha was recorded from interaction effect of 7 days interval irrigation and without saline water irrigation (I_2S_1). Also, the minimum amount of seed yield with 908.3 kg/ha was obtained from interaction level of dry farming condition (without irrigation) and saline water irrigation with 6 ds/m concentration (I_1S_4). Bassil and Kaffka (2002) with study response of safflower (*Carthamus tinctorius* L.) to saline soils and irrigation similar results were reported [10].

Table 2. Analysis of variance studied trait of peanut under super absorbent application, irrigation management and irrigation with saline water

Source of variance	df	Seed yield	Biomass yield	Pod yield	No. of branches per plant	100 seeds weight
		Ms				
Replication	2	74277.125^{ns}	269735.181^{ns}	12282.889^{ns}	0.254^{ns}	4.909^{ns}
Super absorbent (A)	1	3560446.125**	21358558.681**	9489546.125**	1.227**	492.823**
Irrigation (I)	2	6222528.667**	56043652.097**	20730934.056**	5.802**	1465.259**
A×I	2	245862.167*	1461203.931*	289108.500*	0.009^{ns}	51.690*
Saline water (S)	3	2207740.681**	9718790.125**	9415590.088**	3.774**	514.840**
A×S	3	10897.792^{ns}	31034.606^{ns}	724224.458**	0.055^{ns}	48.530**
I×S	6	138366.278*	248522.653^{ns}	608144.907**	0.302**	25.175*
A×I×S	6	25417.333^{ns}	265150.412^{ns}	381456.722*	0.070^{ns}	29.539*
Error	46	58176.821	450294.557	126245.831	0.091	10.864
Cv%		13.56	9.80	10.31	5.96	6.24

*Ns, ** and * respectively: non significant, significant in 1% and 5% area*

Biomass yield

With regard to results of variance analysis (Table 2), the application of super absorbent polymer, irrigation management and irrigation with saline water showed significant effect at 1% probability level on biomass yield of peanut. Application of super absorbent polymer significantly increases the biomass yield in current study. Moreover, the application of super absorbent polymers can help in maintaining and storing the water in soil and can prevent moisture stress in arid and semiarid regions by improving soil physical conditions. Comparison of mean between super absorbent application levels showed that (Table 3), the highest amount of biomass yield was obtained from 200 kg super absorbent application/ha with 7390 kg/ha. On the other hand, the lowest amount of biomass yield among super absorbent levels with 6301 kg/ha was recorded from control treatment (without super absorbent application). Aghashiry et al., (2012) with study effects of different levels of potassium soleplate and super absorbent on yield and yield components of wheat in the Boyerahmad region similar results were reported [4]. Between irrigation management treatments, the highest amount of biomass yield was obtained from 7 days interval irrigation with 8284 kg/ha. And also, the lowest biomass yield with 5241 kg/ha was recorded from dry farming condition (without irrigation) treatment (Table 3). Comparison of mean between irrigation with saline water levels showed that (Table 3), the maximum amount of biomass yield with 7742 kg/ha was recorded from control (without

irrigation with saline water) treatment. On the other hand, the minimum amount of biomass yield with 6023 kg/ha was recorded from saline water irrigation with 6 ds/m concentration. Feizi (2004) with evaluation effects of saline irrigation water on sunflower yield similar results was reported [17]. Results of variance analysis showed that (Table 2), the interaction effect of super absorbent application and irrigation management had a significant effect on biomass yield at 5% probability level. On the other hand, the interaction effect of super absorbent application and irrigation with saline water also, the interaction effect of irrigation management and irrigation with saline water and also, the interaction of super absorbent application and irrigation management and irrigation with saline water on trait of biomass yield was non significant. Comparison of mean between interaction effect of super absorbent application and irrigation management levels showed that (Table 4), the highest amount of biomass yield with 8819 kg/ha was recorded from interaction effect level of 200 kg super absorbent application/ha and 7days interval irrigation (A_2I_2). Also, the lowest biomass yield with 4445 kg/ha was obtained from interaction level of without super absorbent application and dry farming condition (A_1I_1). Some studies showed similar results with results of current study [29, 33, 39].

Table 3. comparison of mean effect of super absorbent application, irrigation management and irrigation with saline water on studied traits in peanut.

Treatments	Seed yield (kg/ha)	Biomass yield (kg/ha)	Pod yield (kg/ha)	No. of branches per plant	100 seeds weight (g)
Super absorbent					
A1	1556b	6301b	3084b	4.93b	50.17 b
A2	2001a	7390a	3810a	5.19a	55.40 a
Irrigation					
I1	1267c	5241c	2394c	4.57c	44.25 c
I2	2285a	8284a	4152a	5.55a	59.59 a
I3	1784b	7011b	3796b	5.05b	54.52 b
Saline water					
S1	2202a	7742a	4402a	5.65a	58.87a
S2	1905b	7071ab	3568b	5.16b	54.94b
S3	1606c	6548bc	3087c	4.83c	50.93c
S4	1401d	6023d	2731d	4.60d	46.40d

Within each column, means followed by the same letter do not differ significantly at P<0.05

Pod yield

Results of variance analysis showed that (Table 2), the effect of super absorbent application, irrigation management and irrigation with saline water on pod yield of peanut was significant at 1% probability level. Comparison of mean between pod yield showed that (Table 3), the highest pod yield with 3810 kg/ha was recorded from 200 kg super absorbent application/ha. On the other hand, the lowest amount of this trait with 3084 kg/ha was recorded from control (without super absorbent application) treatment. With attention to table 3, among irrigation management levels, the maximum amount of pod yield was recorded from 7 days interval irrigation treatment with 4152 kg/ha. Also, the minimum amount of this trait was recorded from dry farming condition (control treatment) with 2394 kg/ha. Shakoor Khanday et al, (2012) with study effect of different fertilizer and irrigation management systems on soil physico-chemical properties and pod yield of garden pea (*Pisum sativum* L) were reported that, irrigation improved pod yield and increased it significantly [38]. Between levels of irrigation with saline water, the highest pod yield was recorded from control treatment (without irrigation with saline water) with 4402 kg/ha (Table 3). On the other hand, the lowest pod yield with 2731 kg/ha was obtained from saline water irrigation with 6 ds/m concentration. With regard to results of variance analysis (Table 2), the interaction effect of super absorbent application and irrigation with saline water and also, the interaction effect of irrigation management and irrigation with saline water on pod yield was significant at 1% probability level. On the other hand, the interaction effect of super absorbent application and irrigation management and also, the interaction of super absorbent application and irrigation management and irrigation with saline water on trait of pod yield was significant at 5% probability level. Between the interaction effect of super absorbent application and irrigation with saline water levels the highest pod yield was recorded from interaction level of 200 kg super absorbent/ha and without irrigation with saline water (A_2S_1) treatment with 5063 kg/ha. Also, the lowest pod yield was obtained from interaction level of without super absorbent application and saline water irrigation with 6 ds/m concentration (Figure 2). Among the interaction effect of irrigation management and irrigation with saline water levels, the maximum amount of pod yield was recorded from interaction level of 7 days interval irrigation and without irrigation with saline water (I_2S_1) with 5581 kg/ha (Table 5). Also, the lowest pod yield with 1766 kg/ha was obtained from interaction level of dry farming and saline water irrigation with 6 ds/m concentration. Among the interaction effect of super absorbent application and

irrigation management levels the highest pod yield was recorded from interaction level of 200 kg/ha super absorbent application and 7 days interval irrigation (A_2I_2) with 4639 kg/ha (Table 4). On the other hand, the lowest pod yield was found from interaction level of without super absorbent application and dry farming condition (A_1I_1) with 2071 kg/ha. Between the interaction of super absorbent application and irrigation management and irrigation with saline water levels, the highest amount of pod yield was recorded from the interaction level of $A_2I_2S_1$ with 6690 kg/ha (Table 6). Also, the lowest pod yield was found from $A_1I_1S_4$ level with 1422 kg/ha. Cookson et al. (2001) evaluated the effect of hydrophilic polymer application and irrigation rates on yield of field grown okra cv. *Pusa Sawani* and reported that polymer treated crops required 25 and 50 per cent less water in summer and winter, respectively as compared to control condition [21]. While, Azevedo et al. (2002) studied the effects of levels of super absorbent polymer, irrigation interval on coffee growth and concluded that the polymer increased irrigation interval without damaging coffee plant [8].

Table 4. Comparison mean between interaction effect levels of super absorbent application and irrigation management

Treatments	Seed yield (kg/ha)	Biomass yield (kg/ha)	Pod yield (kg/ha)	No. of branches per plant	100 seeds weight (g)
A1I1	1064d	4445e	2071e	4.46a	39.96e
A1I2	1953b	7749b	3665c	5.41a	57.56b
A1I3	1651c	6708c	3516c	4.91a	52.99c
A2I1	1469c	6038d	2716d	4.68a	48.54d
A2I2	2617a	8819a	4639a	5.70a	61.62a
A2I3	1916b	7314b	4075b	5.20a	56.05b

Within each column, means followed by the same letter do not differ significantly at P<0.05

Number of branches per plant

With regard to results of variance analysis (Table 2), the application of super absorbent polymer, irrigation management and irrigation with saline water showed significant effect at 1% probability level on number of branches per plant. Comparison of mean between super absorbent application levels showed that (Table 3), the highest number of branches per plant with 5.19 was obtained from 200 kg super absorbent application/ha. On the other hand the lowest number of branches per plant with 4.93 branches was recorded from control treatment (without super absorbent application). The large quantities of water retained by the polymer provide extra available water to plants which facilitates better plant growth. More available water in the soil also means less frequent watering or irrigation. SAP reduces watering frequency of container or field grown crops. It also reduces irrigation amount from 100 to 85% of the crop water requirements and increase crop yield [14]. Among the irrigation management levels the highest number of branches per plant with 5.55 branches was obtained from 7 days interval irrigation (Table 3). On the other hand, the lowest number of branches per plant was obtained from dry farming condition with 4.57 branches per plant. Between the irrigation of saline water levels the highest number of branches per plant was recorded from control (without irrigation with saline water) treatment with 5.65 branches. Also, the lowest number of branches per plant with 4.60 branches was recorded from saline water irrigation with 6 ds/m concentration. Results of variance analysis showed that (Table 2), the interaction effect of irrigation management and irrigation with saline water on number of branches per plant was significant at 5% probability level. On the other hand, the interaction effect of super absorbent application and irrigation management, the interaction effect of super absorbent application and irrigation with saline water, and also, the interaction effect of super absorbent application and irrigation management and irrigation with saline water on number of branches per plant was non significant. Between the interaction effect of irrigation management and irrigation with saline water levels the highest amount of number of branches per plant with 6.43 branches was recorded from interaction effect level of 7 days interval irrigation and without irrigation with saline water (Table 5). On the other hand, the lowest number of branches per plant with 4.3 branches was recorded from interaction effect level of dry farming condition and saline water irrigation with 6 ds/m (I_1S_4). Abdulaziz and Al-Harbi (1996) observed that the addition of hydrophilic polymer was more effective when cucumber plants were grown under the lowest soil moisture level (25% field capacity) [1]. Soil surface, subsoil and plant temperatures were reduced when soil was treated with polymer. These results were in accordance with the earlier findings of Svenson (1993) in mahogany plant [42]. Polymers in soil were also able to reduce the amount of water lost from soil through evaporation [7, 40].

Table 5. Comparison mean between interaction effect levels of irrigation management and saline water irrigation

Treatments	Seed yield (kg/ha)	Biomass yield (kg/ha)	Pod yield (kg/ha)	No. of branches per plant	100 seeds weight (g)
I1S1	1561efg	6132a	3004e	4.83ef	50.05ef
I1S2	1398gh	5592a	2568f	4.66efg	46.87fg
I1S3	1199h	5119a	2237f	4.50fg	43.32g
I1S4	908.3i	4123a	1766g	4.30g	36.76h
I2S1	2924a	9315a	5581a	6.43a	68.45a
I2S2	2467b	8417a	4337b	5.60bc	61.42b
I2S3	1967cd	7865a	3500cd	5.26cd	56.52cd
I2S4	1782def	7540a	3190de	4.93de	51.95e
I3S1	2122c	7778a	4622b	5.70b	58.11bc
I3S2	1850ced	7203a	3799c	5.23cd	56.52cd
I3S3	1651efg	6659a	3526cd	4.73ef	52.95de
I3S4	1513fg	6404a	3237de	4.56efg	50.50ef

Within each column, means followed by the same letter do not differ significantly at P<0.05

100 seeds weight

With attention to variance analysis table (Table 2), the effect of super absorbent application, irrigation management and irrigation with saline water on 100 seeds weight of peanut was significant at 1% probability level. With regard to comparison of mean table (Table 3), among super absorbent application treatments the highest 100 seeds weight was obtained from 200 kg super absorbent application/ha with 55.40 g. also, the lowest 100 seeds weight was recorded from control treatment (without super absorbent application) with 50.17 g. Baasiri et al. (1986) studied the influence of Aquastock (polymer) on yield of cucumber and reported that the cucumber yield was significantly increased as the rate increased from 0 to 2 kg/m^3, though further yield increased upto 4 kg/m^3. However, increase over 2 kg was non-significant, when polymer was applied to a depth of 20 cm into the soil. They found similar trend in fruit number [9]. Sivalapan (2001) found that soybean cv. Stephens grown in soil treated with 0.05, 0.1and 0.2 per cent Polyacrylamide (PAM) achieved grain production which was about 6, 9 and 14 times greater, respectively than that in control soil under 3 days of irrigation interval [40]. Similarly, Sendur Kumaran *et al.* (2001) found increased number of fruits, fruit weight and yield per plant in tomato when soil was treated with polymer [36], which were in accordance with Dhumal (1993) observed in chilli and tomato [13] and Cookson *et al.*(2001) in okra cv. *Pusa Sawani* [12]. Combined action of hydrogel and controlled released fertilizers (CRF) on growth of tomato plants studied by Chatzoudis and Rigas (2003) reported that polymer increased yield by 17.5 to 27.9 per cent over control condition [11]. Similar results were also observed in okra and squash by Tayel (2003) [43]. Between irrigation management levels, the highest amount of 100 seed weight was recorded from 7 days interval irrigation with 59.59 g (Table 3). On the other hand, the lowest 100 seeds weight was obtained from dry farming condition with 44.25 g. Results of comparison of mean between irrigation peanut with saline water showed that (Table 3), the maximum amount of 100 seeds weight with 58.87 g was recorded from control treatment (without irrigation with saline water). Also, the minimum amount of 100 seeds weight with 46.40 g was recorded from saline water irrigation with 6 ds/m concentration. With regards to variance analysis table (Table 2), the interaction effect of super absorbent application and irrigation with saline water on 100 seeds weight showed significant differences at 1% probability level. On the other hand, the interaction effect of super absorbent application and irrigation management and also, the interaction effect of irrigation management and irrigation with saline water and interaction effect of super absorbent application and irrigation management and irrigation with saline water on 100 seeds weight was significant at 5% probability level. Among the interaction effect of super absorbent application and irrigation with saline water levels, the highest 100 seeds weight was recorded from interaction level of 200 kg super absorbent/ha and without irrigation with saline water (A_2S_1) with 63.73 g (Figure 3). Also, the lowest 100 seed weight with 45.07 g was recorded from interaction level of without super absorbent application and saline water irrigation with 6 ds/m concentration. With attention to table 4, between the interaction effect of super absorbent application and irrigation management, the highest 100 seeds weight with 61.62 g was recorded from interaction effect of 200 kg/ha super absorbent application/ha and 7 days interval irrigation (A_2I_2). Also, the lowest 100 seeds weight with 39.96 g was recorded from interaction effect level of without super absorbent application and dry farming condition (A_1I_1). Among the interaction effect of irrigation management and irrigation with saline water, the highest 100 seeds weight with 68.45 g was recorded from 7 days interval irrigation and without irrigation with saline water (Table 5). On the other hand, the lowest 100 seeds weight with 36.76 g was recorded from dry farming condition and saline water irrigation with 6 ds/m concentration. Between the interaction effect of super absorbent application and irrigation management and irrigation with saline water, the highest 100 seeds weight with 75.97 g was recorded from interaction level of $A_2I_2S_1$

(Table 6). On the other hand, the lowest 100 seeds weight with 31.63 g was obtained from interaction level of $A_1I_1S_4$.

Table 6. comparison mean between interaction effect levels of super absorbent application and irrigation management and irrigation with saline water

Treatments	Seed yield (kg/ha)	Biomass yield (kg/ha)	Pod yield (kg/ha)	No. of branches per plant	100 seeds weight (g)
A1I1S1	1400a	5423a	2720 klm	4.73a	45.43ijk
A1I1S2	1262a	4800a	2377Lmn	4.53a	43.07jk
A1I1S3	932a	4198a	1767no	4.40a	39.72k
A1I1S4	663.3a	3360a	1422o	4.20a	31.63L
A1I2S1	2500a	8953a	4472cd	6.20a	60.94bc
A1I2S2	2120a	7973a	3867defg	5.53a	58.92bcde
A1I2S3	1708a	7210a	3260ghijk	5.13a	56.53cdef
A1I2S4	1483a	6860a	3060hijk	4.80a	53.83efg
A1I3S1	1968a	7280a	4034de	5.53a	55.67cdefg
A1I3S2	1760a	6673a	3630efghi	4.86a	54.33defg
A1I3S3	1531a	6527a	3354fghijk	4.73a	52.20fgh
A1I3S4	1345a	6353a	3047ijk	4.53a	49.75ghi
A2I1S1	1722a	6840a	3289fghijk	4.93a	54.67defg
A2I1S2	1533a	6383a	2760jkl	4.80a	50.67fghi
A2I1S3	1467a	6040a	2707klm	4.60a	46.92hij
A2I1S4	1153a	4887a	2110mn	4.40a	41.90jk
A2I2S1	3348a	9677a	6690a	6.66a	75.97a
A2I2S2	2813a	8860a	4807bc	5.66a	63.93b
A2I2S3	2227a	8520a	3740efgh	5.40a	56.50cdef
A2I2S4	2080a	8220a	3320fghijk	5.06a	50.07ghi
A2I3S1	2275a	8277a	5209b	5.86a	60.55bcd
A2I3S2	1940a	7733a	3967def	5.60a	58.70bcde
A2I3S3	1771a	6791a	3697efghi	4.73a	53.71efg
A2I3S4	1680a	6455a	3427efghij	4.60a	51.25fghi

Within each column, means followed by the same letter do not differ significantly at P<0.05

Fig 2. Interaction effect of super absorbent application and irrigation with saline water on pod yield

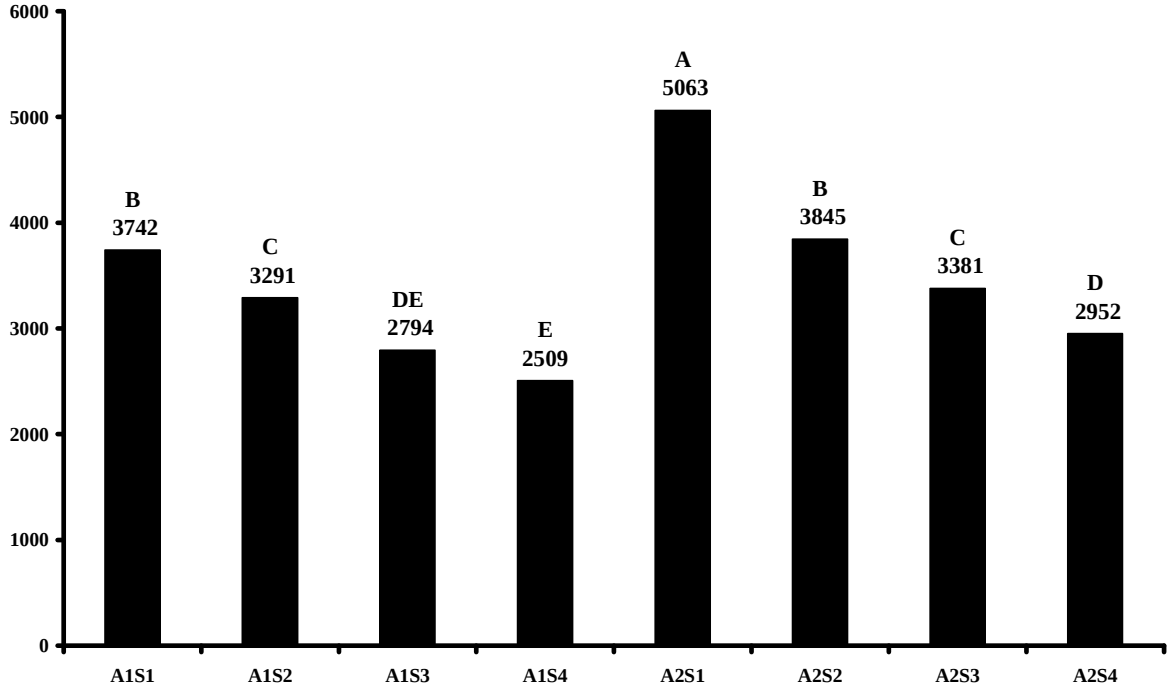
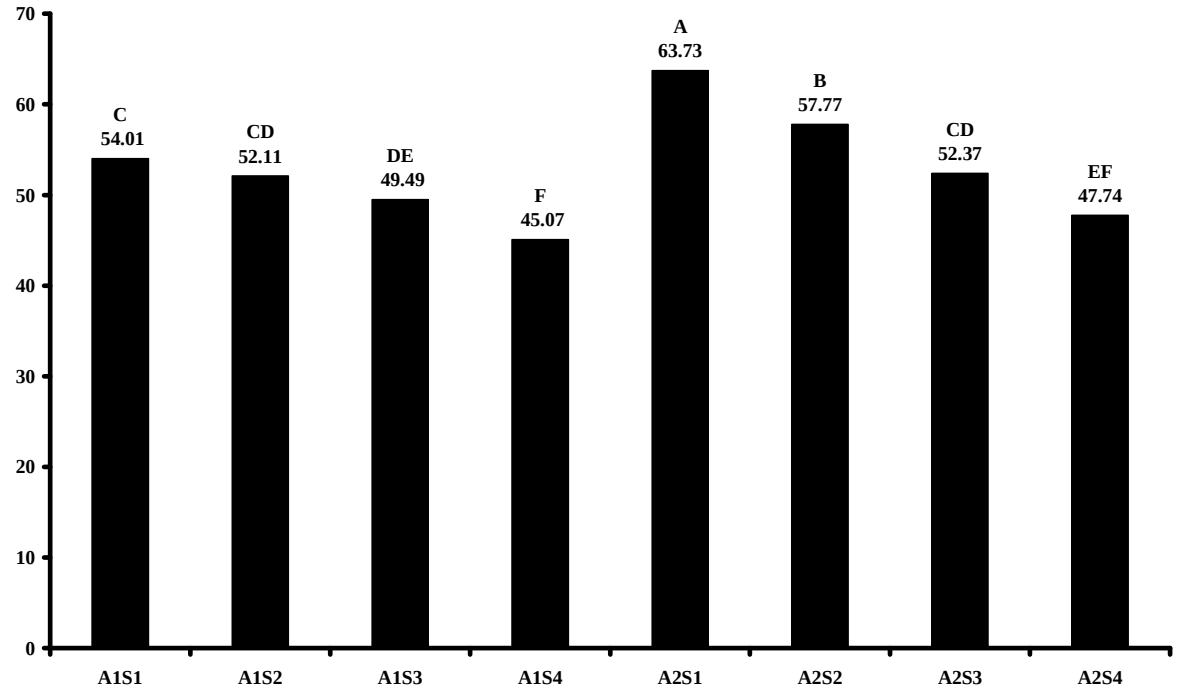


Fig 3. Interaction effect of super absorbent application and irrigation with saline water on 100 seeds weight



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