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The Effect of Water Stress and Salinity on the Yield and Yield Components of Canola in the West Region of Urmia Lake Basin, Iran

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Abstract

Due to the drying trend of Urmia Lake, climate change and frequent occurrence of droughts in the region. The water resources have a declining trend and soils are being saline. Consequently in order to investigate the canola yield under simultaneously existence of salinity and drought stress conditions, an experiment in the factorial from and completely randomized blocks format was designed in 3 replications and done in research field of water engineering group of Urmia University during 2012-13 year in 10 months. The water levels included 3 irrigation treatments: up to field capacity (FC), 75% of FC and 50% of FC and salinity treatment were also exerted in 3 levels: salinity of field soil (without salinity stress), 7 and 14 ds/m. The results showed that the seed yield top dry matter and the weight of 1000 seeds were decreased under water and salinity stresses condition. Naturally using more water mitigates greatly the product declines due to salinity stresses. The obtained result illustrated that dry matter with the maximum production amount of 16.9 Mgr/ ha, is more sensitive to salinity stress. Also the weight of 1000 seeds with the yield of 3.4 gr is more sensitive to the water shortage than salinity stress. The evaluations showed that the interaction and salinity has reduced impressively the canola yield.

Keyword: Canola, Salinity Stress, Urmia Lake, Water stress, Yield.

INTRODUCTION

Canola is adaptive in many regions not only as a source of comestible oil, but also for many other purposes such as biodiesel production. Canola is the third most important comestible oil source in the world, after soybean and sunflower; it is the top ranking oilseed crop of Iran covering 40.74 of the total oilseed production, out of 4.6 million hectares of the coastal and outsource landmass, out of which about 0.83 meter ha are affected by limitation of water resources and different degrees of soil salinity in Iran. Water deficit and salinity is a main environmental restriction to crop productivity in the arid and semiarid regions of the World. Due to this, large areas of arable lands are significantly or partially unfruitful. There is warrant that irrigation systems and type of irrigation water have contributed to a large extent in converting arable lands to saline lands [3]. As an outcome of these firstly effects, a secondary stress such as oxidative harm often happens. High salinity stress disrupts balance in water potential and ion distribution. This disruption of balance occurs at both the cellular and the all plant levels. Drastic changes in ion and water balance lead to molecular harm, growth detention and even death [27].

Since 90% of oil consumption is supplied by imports in Iran, therefore, in recent years oilseed production has been important [22]. Drought and salinization of soil and water resources, as the environmental restrictions, has devastating effects on crop productivity that occurs annually in many parts of the world. In addition, farmers use the water Excessive, regardless to water resources to produce more [19]. Environmental stresses are major factors that affect many stages of crop growth and make it difficult to achieve the desired results, such as drought and salinity stresses. Generally can be divided into three mechanisms the behavior of plants against drought stress, include water shortages, growing compliance and tolerance to water deficit. Salinity reduces crops yield that this will cause damage to agriculture and the economy at large scale. According to studies, the average annual yield loss due to water shortages is 17% in the world that this amount can reach more than 70 percent per year [12]. Crop production would be difficult due to declining water resources and salinization of agricultural land in Urmia Lake region. To be able to manage the problems caused by these factors it is essential to identify products compatible with these conditions and also explore ways to maximize productivity of these products. Canola is a suitable plant for oil production and also is concerned due to production in terms of forage production for domesticated animals [5].

Clarke and Simpson [9] showed that irrigating the canola increases the number of pods due to prolonging the flowering stage and also increases seed in pod due to create higher leaf area at flowering period. Vafabakhsh et al. [24] reported that increases the water use efficiency for dry matter in water deficit condition; but this efficiency decreased for oil production. Pazeki et al. [20] concluded that increased the water use efficiency for seed yield and biologic yield by shortening the irrigation intervals and reduction amount of water to 60% of A class pan evaporation. Dadivar and Kodshenas [10] resulted that it is significant irrigation treatments on yield and yield components thus the interaction of irrigation and year had significant effect on the number of pods per plant. Shabani et al. [22] found that irrigation of Canola makes the highest seed yield and oil in during of growing season and also found that there is an inverse relationship between water stress and seed protein. Krogman and Hobbs [17] reported that canola plant height increases with shortening the irrigation periods up to 7 days. Zamani et al. [25] evaluated the effects of salinity stress on autumn canola varieties and concluded that increasing salinity decreases yield and yield components of autumn canola cultivars. Francois [13] showed that seed yield decreases with increasing salinity.

Redmann et al. [21] and Charzoulakis and Loupassaki [8] illustrated that plant height decreases with increasing salinity in separate tests on canola, eggplant and sunflower. Also charzoulalcis and Loupassaki [8] showed that number of canola leaf is reduced by increasing salinity. Abdolzade et al. [1] conducted an experiment with sand culture in the greenhouse with treatment of salinity in three levels, included zero, 50 and 100 mM of sodium chloride and three levels of fertilizer included nitrate, ammonium and nitrate plus ammonium. They resulted that decreases plant growth in salinity conditions but the growth rate is much better than the conditions of without fertilizer in the use of nitrogen fertilizer. Bottela et al. [6] concluded that chlorine reduces the nitrogen uptake in the form salt stress. Other research has been done in this case; such as Zarei et al. [26], Istanbulluoglu et al. [16], Sinaki et al. [23], Howell [15]. The water scarcity and developing rate of salinity in soil and water resources have undesirable effects on the quality and quantity of crop products especially oily seeds as important food in Urmia lake region. Therefore this study examines the combined effect of salinity and water stress on yield and yield components of winter variety of canola.

MATERIALS AND METHODS

The study area

This study was done in the Experimental Farms of Water Engineering Department of Agriculture Faculty of Urmia University, west Azerbaijan province, Iran on Okapi cultivar of canola and during 2012-2013 year. The west Azerbaijan, including the area of Urmia Lake in approximately 43660 km2. This province is located in North West of Iran and comprises about 2.65 percent of the total areas of country. This province is located between 35˚, 58' and 39˚, 46' N latitude and between 44˚, 03' to 47˚, 23' E longitude, and about 1276 meters height from sea level.

The experimental design

This factorial experiment in the form of randomized complete black design (RCBD) has been planned in 3 replications. Winter type canola of common variety in the region has been cultivated in from with the area about 1000 m2, in the experimental Farms of Water Engineering Department of Urmia University in October 2013. The furrows width was 0.5(m) in the plots of 4 meters length and 3 meters width, including 6 rows of canola with density of 80 plants per m2 (5 cm intervals). The used seed for planting have been prepared from the Karaj Plant and Seed Research Center.

In the experimental design, the water treatments have been exerted in 3 levels: FC (field capacity), 75% of FC and 50% of FC, respectively. The field capacity was considered as control treatment and 2 other levels were considered as 25% and 50% water stress applied in comparison with control treatment. The water treatments were defined in 2 ways: water volume and water deficit, that were calculated considering the plot areas and were exerted to noted periods. The farm irrigation water was provided plumbing supply of Urmia University. Three levels of salinity, normal salinity of irrigation water, 1.5, 7 and 14 ds/m were applied along with irrigation water. To apply the salinity stress was used with the dominance of sodium chloride of Urmia Lake salts. According to fertilizer requirement for canola, were used the amount of 100 kg per hector phosphate fertilizer while farm preparing and 180 kg N/ha urea fertilizer in 2 steps, after rosette and while flowering for all treatments. Considering the type of experimental design, a combinations of water and salinity stresses levels (IiSi i=1,2,3) in factorial form were selected for each experimental unit. Each experimental unit has received water and salinity various levels up to the harvesting time. The levels and combinations of treatments are shown in table (1). Field capacity (FC) moisture was measured in samples that were taken from field by use of pressure plates. The amount of volumetric soil water content in different treatments and depths was measured by TDR (PR2 type) considering the plan rooting depth in each period. Irrigation intervals for all of the treatment were chosen 10 days due to local conditions. Table (2) illustrated the results of soil texture analysis, electrical conductivity of irrigation water (ECiw). The electrical conductivity of soil saturation extract (ECe), FC and permanent wilting point (PWP). Considering the EC amounts of water and soil saturation extract, it can be said that primary conditions of grows is acceptable. The weight of 1000 seeds, top dry matter, yield, plant height, stem diameter, total number of pods in each plant, average of seeds in each pod and also number of branches in plant at the end of growing period were evaluated using the statistical software like SAS 9.1 and SPSS 21.

Table 1. The identification of water and salinity treatment levels

Levels	Irrigation treatments	Salinity treatments (ds/m)
1	Irrigation at field capacity (I_1)	1.5 (EC_{iw}) (S_1)
2	Irrigation at 75% of field capacity (I_2)	7 (S_2)
3	Irrigation at 50% of field capacity (I_3)	14 (S_3)

Table 2. The general characteristics of soil and water

Average volumetric soil water content, %		EC (ds/m)		Soil texture
Permanent wilting point	Field capacity	EC_e	EC_{iw}	
22	39	3.5	1.5	Clay

RESULTS AND DISCUSSION

After analysis of the 8 studied characters the analysis of variations table was prepared for all of the traits and the effects of water and the effects of water and salinity treatments and also the interacted effects of them were evaluated. Also the average amounts for all of the characters considering the levels of water and salinity treatments separately and in combination with each other were obtained. Table (3) illustrates the obtained results from yield and yield components analysis of variances. Also the comparison between the average amount of yields and yield components are shows in table (4) under separately exertion of water and salinity stresses.

The seed yield

The analysis of variances results showed that the effect of irrigation and salinity levels were significant in 1% level on the seed yield. The interacted effect of water and salinity on this character was not signification. The effect of replication was significant in 5% level on the seed yield (Table 3). The maximum seed yield among irrigation treatments was obtained in the first treatment (I1) and the minimum of it (I3) was obtained in irrigation at field capacity 3.57 Mgr/ha and 1.57 Mgr/ha, respectively. Considering the salinity levels the maximum and minimum amounts of seed yield was obtained is without salinity stress treatment (S1) 3.62 Mgr/ha and in severe salinity stress (S3) equal to 1.91 Mgr/ha respectively (Figure 1). The maximum amount of seed yield in interacted treatments of water and salinity was obtained 4.45 Mgr/ha in I1S1 treatment. Hamzei et al. [14] reported the seed yield about 1-5.3 Mgr/ha. Bagheri et al. [4] reported 4.5 Mgr/ha as the maximum seed yield in Karaj. The minimum amounts of seed yield were obtained under the most severe stresses in I3S2 and I3S3 treatment, respectively equal to 1.34 and 0.9 Mgr/ha. The interaction of highest salinity level (14 ds/m) with the lowest amount of water (50% of soil field capacity) in I3S3 treatment caused the maximum reduction in crop production. The comparison between I1S3 and I3S1 treatments respectively with the seed yield 2.97 and 2.47 Mgr/ha, showed that using more water in saline soils the canola yield was mitigated acceptably (Figure 2).

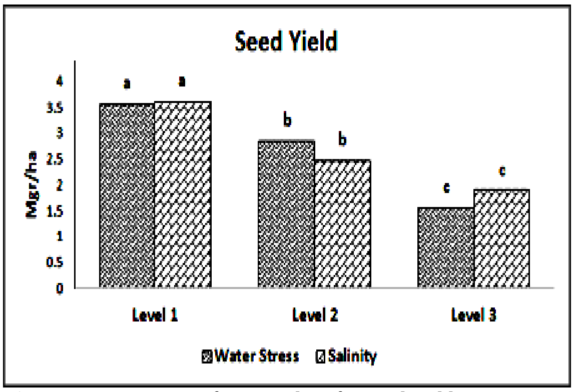

Figure 1. Comparison of mean values for Seed yield in water and salinity levels

Table 3. The table of yield and yield components variance analysis

Source of variation		df	MS						
		Seed Yield	Top Dry matter	Weight of 1000Seed	Plant Height	Stem Diameter	Number of Branch	Number of Pods	Seed in Pod
R	2	0.46*	0.72**	0.12**	0.08**	0.04**	0.44^{ns}	230^{ns}	1.7^{ns}
I	2	9.31**	9.7**	0.31**	0.005^{ns}	0.27**	14.7**	5780**	52.46**
S	2	6.82**	11.26**	0.16**	0.06**	0.22**	4.7**	4058**	49**
I×S	4	0.06^{ns}	0.3*	0.003^{ns}	0.002^{ns}	0.004^{ns}	0.05^{ns}	161^{ns}	0.85^{ns}
Error	16	0.11	0.09	0.002	0.004	0.004	0.4	175	1.8
Stress × Salinity sliced by Stress for Salinity									
I_1	2		22.3**						
I_2	2		22.7**						
I_3	2		7.82**						
CV		12.52	5.18	1.76	6.21	6.75	13.93	13.26	7.28

Table 4. Table of the comparison between yield and yield components under separately exertion of water and salinity stresses

	Weight of 1000Seed	Diameter	Number of Branch	Number of Pods	Seed in Pod
I_1	3.26a	1.19a	5.77a	116.5a	20.75a
I_2	3.09b	0.96b	4.66b	108.8a	18.56b
I_3	2.89c	0.85c	3.22c	69.3b	15.93c
S_1	3.21a	1.16a	5.22a	122.2a	20.75a
S_2	3.1b	0.99b	4.66a	90.7b	18.41b
S_3	2.94c	0.84c	3.77b	81.7b	16.08c

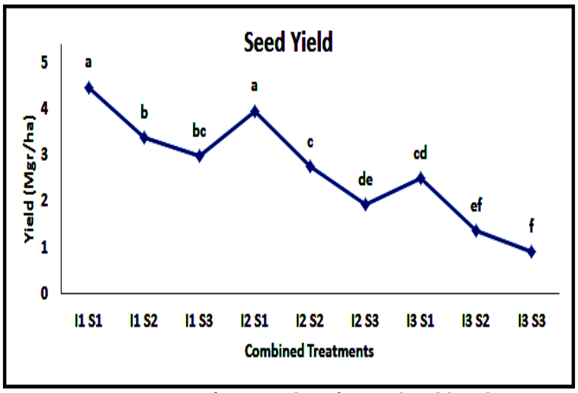

Figure 2. Comparison of mean values for Seed yield in the treatments

Top dry matter

The obtained result from analysis of variances illustrated that the effects of replication, water and salinity levels on top dry matter was significant in 1% level. But the interacted effect of water and salinity was significant in 5% level on this character. This can be due to antagonism of salinity, by water in treatments or could be due to their consistent performance in decrease or increase the amount of top dry matter. The slicing of the interacted water and salinity levels on irrigation treatments level showed that the effects of interaction on irrigation levels were in 1% signification on top dry matter (Table 3). The maximum and minimum amount of dry matter corresponding to water treatments were observed in irrigating up to field capacity (I1) and the maximum water stress; irrigating up to 75% of field capacity treatments (I3), respectively equal to 7.05 and 4.97 Mgr/ha. The maximum and minimum top dry matter amount according to maximum and minimum salinity stresses (S1 and S3) were 3.62 and 1.91 Mgr/ha (Figure 3). In combined treatments of water and salinity stresses, the maximum top dry matter was obtained 8.49 Mgr/ha from I1S1 treatment. Nazemi et al. [19] reported the amount of 9.87 Mgr/ha maximum top dry matter in full irrigation treatment. It means that the power of top dry matter production is maximum under without stress conditions. The I1S2 and I2S1 treatments with yield of 6.94 and 6.93 Mgr/ha, respectively was located in the same statistical level. According to the a above two important results are concluded; first the product reduction under salinity stress with sufficient amounts of water is more than water stress condition second applying sufficient amounts of water can largely mitigate the reductive of salinity stress on crop production the above concept was proved by the

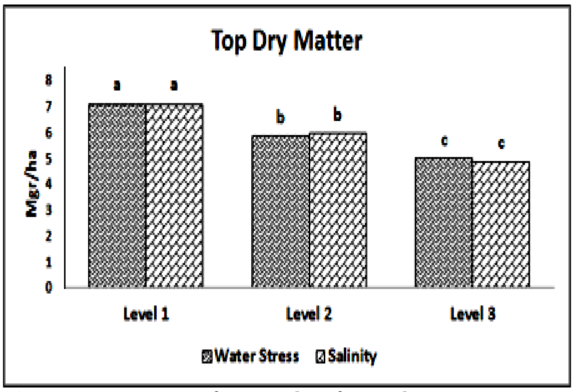

Figure 3. Comparison of mean values for top dry matter in water and salinity levels

same statistical levels of I1S3 and I2S2 treatments. The minimum amount of dry matter was observed in I3S3 treatments 4.21 Mgr/ha, where water and salinity stresses are maximum. Some treatments are at same level statistically, such as I1S2 with I2S1 and I1S3 with I2S2 and I3S1. This means that application of more water is compensates, the damaging effects of salinity stress (Figure 4).

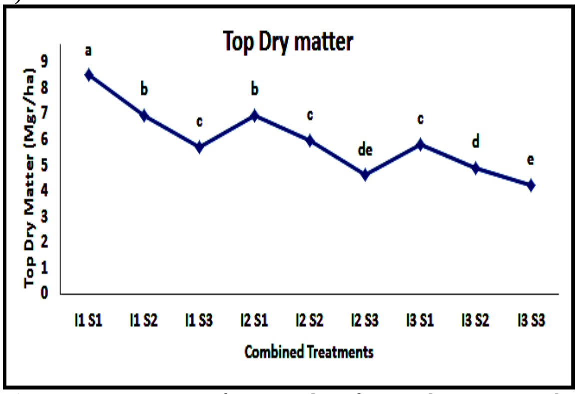

Figure 4. Comparison of mean values for top dry matter in the treatments

The weight of 1000 seeds

The analysis of variances showed that the effects of water and salinity levels were in 1% level significant on the weight of 1000 seeds. But the interacted effect of water stress in salinity stress was not significant. Also the effect of replication was in 5% level significant in this trait. This illustrated that some physical and chemical properties of soil, changes in different parts of the farm (Table 3).The maximum weight of 1000 seeds in different levels of water and salinity were obtained 3.26 and 3.21 gr respectively by applying maximum amount of water (I1) and last salinity (S3). The minimum weight of 1000 seeds under the most severe water and salinity stress (I3 and S3) were 2.89 and 2.94 respectively that they did not have any statistical significant difference together (Table 4). Shabani et al. [22] reports 3.4 for maximum weight of 1000 seeds. Nasri et al. [18] sated the maximum weight of 1000 seeds equal to 4.2 gr and also showed that increscent of drought stress causes the reduction of the weight of 1000 seeds. The minimum weight of 1000 seeds was 2.79 gr in I3S3 treatment. The range of obtained data in water and salinity levels shows that the weight of 1000 seeds is more sensitive to water shortage in comparison with salinity; it means that if there is sufficient amount of water the effect of salinity on this character will be less. Not being significant differences between I2S3 and I3S1 treatments in this trait shows that using more water under the most severe salinity conditions produces the equal weight of 1000 seeds with the condition with least amounts of water and salinity. This result demonstrates the further importance of water (Table 5).

The plant height

The analysis of variances showed that the water treatment levels did not have any significant effect on the plant height. The salinity levels and replication were in 1% level significant. The interacted effect of water and salinity was not significant on this character. It means that, the plant height was so sensitive to salinity, but the different levels of water did not have any significant effect (Table 3). The maximum plant height was 1.04 m in the first irrigation level (I1), but it did not have any statistical

Table 5. Table of the comparison of average of measured characters in combined treatment of water and salinity

	Weight of 1000Seed	Diameter	Number of Branch	Number of Pods	Seed in Pod
I_1S_1	3.4a	1.32a	6.33a	134a	22.8a
I_1S_2	3.3ab	1.22ab	6ab	106b	20.96a
I_1S_3	3.09c	1.02c	5bcd	109b	18.46b
I_2S_1	3.24b	1.15b	5.33abc	135a	21.4a
I_2S_2	3.1c	0.94c	4.67cd	105b	17.9b
I_2S_3	2.94d	0.78d	4de	85b	16.36b
I_3S_1	2.98d	1c	4de	97b	18b
I_3S_2	2.9d	0.82d	3.33ef	60c	16.36b
I_3S_3	2.79e	0.73d	2.33f	50c	13.43c

significant difference with the other irrigation levels. The maximum plant height among salinity level was obtained 1.1 m in without salinity stress conditions (S1) that had significant difference with the two other salinity levels (Figure 5). In combined treatments of water and salinity the maximum plant heights were 1.13 and 1.11 meters respectively corresponds to I1S1 and I3S1 treatments. As mentioned before reduction of available water for plant under the same salinity conditions don't have significant effect on the plant height decrement. It proves the lack of sensitivity of this trait to water shortages. Bybordi [7] reported the maximum planet height 79 cm in without salinity stress condition. In the same irrigation levels but different salinity condition the planet height is reduced significantly. As an example, the plant height in I3S1, I3S2 and I3S3 treatments were 1.11, 0.97 and 0.95 meters, respectively that it showed that signification reduction trend between treatments (Figure 6).

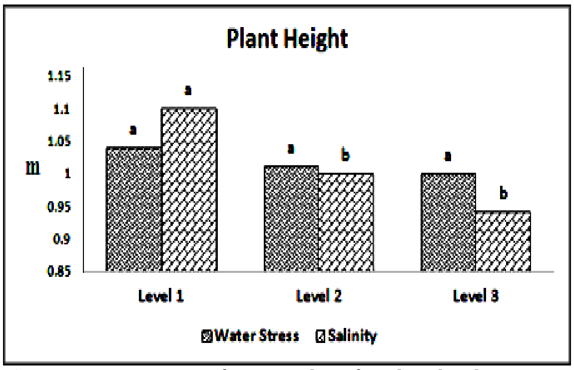

Figure 5. Comparison of mean values for plant height in water and salinity levels

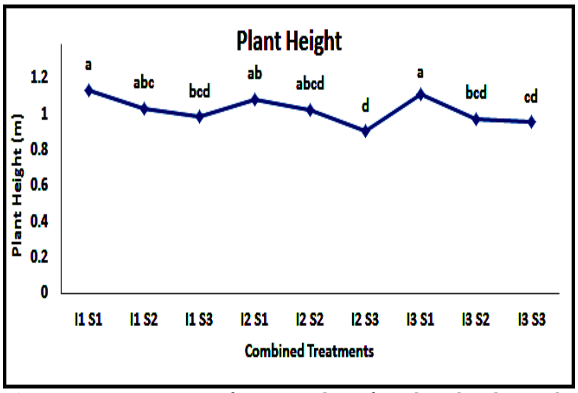

Figure 6. Comparison of mean values for plant height in the treatments

The stem diameter

The analysis of variances in different levels of water and salinity showed that the effects of water and salinity levels and replication were in 1% significant. But the interacted effect of water and salinity did not cause any significant differences between treatments (Table 3). The maximum stem diameter in water and salinity treatments was 1.19 and 1.16 cm, respectively in stress free levels (I1 and S1) that did not have any statistically significant difference. The stem diameter had significant differences among each of the water or salinity treatments (Table 4). The maximum stem diameter, in combined treatments was 1.32 cm in I1S1 that water and salinity stresses are lowest. Al-Barrack [2] reported 2.5 cm as the maximum stem diameter. The minimum stem diameters were obtained 0.82, 0.78 and 0.73 cm respectively from I3S2, I2S3 and I3S3 treatment that did not have any significant difference with each other. I1S3, I2S2 and I3S1 treatments were located at the same statistical level, so it can said that the stem diameter has the similar sensitivity to both water shortage and salinity levels and both of these stresses make a significant reduction in this characters amounts.

Number of Branches in each stem

According to the analysis of variances table, it is obvious that the effects of water and salinity levels were significant in 1% levels on this trait. The interacted effects of water and salinity and also the replication didn't have any significant effect on the number of branches. The water stress caused separately statistical significant difference between all levels; so that, the maximum number of branches in each stem in irrigation treatments, was obtained in first irrigation level (I1) equal to 5.77 branches in main stem. Also the minimum number of branches was obtained in irrigation up to 50% of field capacity treatment (I3) equal to 3.22 branches. The salinity levels did not cause significant differences in the first two levels but these levels had a significant difference with the third level. The maximum number of branches in two the first two levels of salinity, respectively 5.22 for first level (S1) and 4.66 for second level (S2) were obtained. The minimum number of this trait was obtained in the highest salinity stress treatment (S3) equal to 3.77 branches. According to the above it can be said that the number of branches in each stem is more sensitive to the water shortage in comparison to salinity levels. It means that water amount reduction affects the number of branches more than salinity increscent do (Table 4). The maximum number of branches in combined treatments was 6.33 in the without stress treatment (I1S1). The fewest number of branches was 2.33

and obtained from I3S3 treatment (Table 5). The concluded ideas of the present study are in agreement with the research that was done by Darjani et al. [11]. They reported the number of 6.33 as the maximum number of branches.

Number of pods

The analysis of variances showed that the effects of irrigation and salinity levels were in 1% level significant on the number of pods. The interaction between treatments and also the replication did not have statistically significant effect (Table 3). According to the table of not combined treatments averages, the second and third salinity levels had the same reductive effects on the number of pods. Also the salinity stress changes had more reductive effect on the number of pod in comparison the effect of water stress. The maximum number of pods among the irrigation levels was 116.5 for irrigating up to field capacity (I1) that was in the same level with the obtained data from the second irrigation level (I2) equal to 108.8. The minimum number of pods was obtained in third irrigation level (I3) equal to 81.7. The obtained results are in agreement with the research that was done by Dadivar and Khodshenas [10]. They reported the maximum number of 244 pods under normal irrigation condition and without salinity stress. Nasri et al. [18] found the maximum number of 184.2 pods in each plant. The maximum and minimum number of pods in salinity levels were resulted in no stress treatment (S1) and high salinity stress (irrigation with water at a 14 ds/m concentration) equal to 122.2 and 81.7, respectively (Table 4). The maximum number of pods in combined treatment was 134 that obtained from I1S1 treatment. The I1S3,I1S2, I2S2, I3S1 and I2S3 treatments had the number of pods equal to 106, 109, 105, and 97 and 85 , respectively that were located in the same statistical level and there were no signification differences between them. The minimum number of pods in each plant was seen in I3S2 and I3S3 treatments equal to 60 and 50, respectively without any statistically significant difference (Table 5).

The average seeds in a pod

The analysis of variances illustrated that the effects of water and salinity levels were in 1% level significant on the number of seeds in each pod. The interacted effects of water and salinity and also the effect of replication were not significant on this trait (Table 3).The maximum number of seeds in pod in water and salinity levels was 20.75 that was produced in without stress treatment (I1 and S1). Also minimum amount of this trait were 15.93 and 16.08 that were produced under severe stresses of water and salinity (I3 and S3 respectively) (Table 4). According to the obtained data from combined treatments it was obvious that the reduction of the seeds number was more due to water shortage and the salinity stress affected this trait less than water shortage. From the statistical point of view the maximum number of seeds in a pod was obtained in I1S1, I1S2 and I2S1 treatments equal to 22.8, 20.96 and 21.4, respectively. The I1S3, I2S2, I2S3, I3S1 and I3S2 treatments were located in the same statistical levels with the number of seeds equal to18.46, 17.9, 16.36, 18 and 16.36, respectively in each pod. The fewest number of seeds was seen in I3S3 treatment equal to 13.34 seeds in a pod (Table 5). Darjani etal. [11] stated the number of 23.01 as the maximum number of seeds in a pod.

The table of correlation between traits

Table (6) illustrates the correlation coefficients between different traits. There was a direct correlation between measured characters. The correlation between traits can be positive or negative. A positive correlation shows that increasing one trait leads to the increscent of another. Also negative correlation shows that the increscent of one trait caves another's reduction. The table of correlations between measured traits of the present study illustrated that all of the correlations were positive and the relations were direct. The maximum correlation was seen between the weight of 1000 seeds and number of branches, equal to 0.98 that was signification in 1% level. The lowest correlation was observed between the planet height and the number of branches equal to 0.599. The top dry matter and seed yield had a high correlation with all of the other traits that shows that whatever the planet general characteristics are better the seed yield and the top dry matter yield will be more. The weight of 1000 seeds had also high correlation with the other traits.

Path analysis

Using correlation and multiple regression analysis were preparing and filing, directly or indirectly relationship between yield components and seed yield. The strictest regression model was created between yield and yield components with r = 1 and Error = 0. The results of path analysis showed that number of pods per plant, have the highest incremental effect on grain yield, with a regression coefficient of 0.624. After that, the amount of dry matter and stem diameter, with coefficients of 0.322, 0.303, respectively to have the greatest effect on seed yield. Among the traits, plant height and number of branches; have decreasing effect on seed yield. Salinity stress causes loss of seeds and pods on branches are poor; for this reason, vegetative growth in salinity stress conditions is inversely related to yield (Figure 7).

Table 6. The comparison between correlation of yield and yield components concluding comments

	Seed Yield	Top Dry matter	Weight of 1000Seed	Plant Height	Diameter	Number of Branch	Number of Pods	Seed in Pod
Seed Yield	1							
Top Dry matter	0.952**	1						
Weight of 1000Seed	0.966**	0.964**	1					
Plant Height	0.743*	0.824**	0.681*	1				
Diameter	0.952**	0.975**	0.968**	0.8**	1			
Number of Branch	0.953**	0.915**	0.98**	0.599ns	0.938**	1		
Number of Pods	0.977**	0.874**	0.899**	0.697*	0.874**	0.906**	1	
Seed in Pod	0.974**	0.963**	0.977**	0.748*	0.970**	0.959**	0.922**	1

Table 7. Indirect effects yield components on seed yield

	Top Dry matter	Weight of 1000seed	Plant height	Diameter	Branches	Pods	Seed in pod
Top Dry matter	-	0.03	-0.12	0.3	-0.15	0.55	0.03
Weight of 1000seed	0.31	-	-0.1	0.29	-0.16	0.56	0.03
Plant height	0.27	0.02	-	0.24	-0.1	0.43	0.02
Diameter	0.31	0.03	-0.12	-	-0.15	0.55	0.03
Branches	0.29	0.03	-0.09	0.28	-	0.57	0.03
Pods	0.28	0.03	-0.1	0.26	-0.15	-	0.03
Seed in pod	0.31	0.03	-0.11	0.29	-0.16	0.58	-

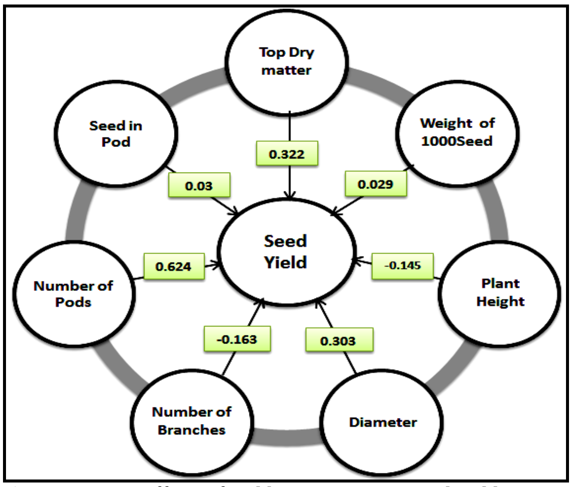

Figure 7. Direct effects of yield components on seed yield

Among the indirect effects, the number of pods per plant with increasing all the traits, increases seed yield. Most of the indirect effect of number of pods per plant with a coefficient of 0.58 is through number of seeds per pod. The stem diameter improves the seed yield, by increasing the amount of dry matter by a factor of 0.3. Plant height has the greatest lowering effect on yield through the amount of dry matter and stem diameter. Also, the number of branches reduces yield, through reducing grain weight and number of seeds per pod. These results suggest that salt stress reduces the seed yield through, shedding weaker pods and also the pods that have been created in the reproductive stage. The 1000 seed weight and number of seeds per pod have incremental effect on seed yield as expected (Table 7).

CONCLUDING COMMENTS

According to the obtained result from analysis of variances the comparison between average and also the table of correlation between traits it is clear that the seed yield and other yield components will be decreased under water and salinity stresses and the interaction of them. The evaluation of results shows that it is possible to mitigate the reduction of canola production due to saline conditions, by using more water. The number of pods is more sensitive to salinity in comparison with water shortage while the number of seeds in each pod, the weight of 1000 seeds and the number of branches are more sensitive to the amount of water. Plant height compared is sensitive to salinity stress and is not sensitive to changes in water. The plant height has the least correlation with the other traits.

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