Middle East Journal of Agriculture Research **Volume : 09 | Issue : 04| Oct.-Dec. | 2020**
EISSN: 2706-7955 ISSN: 2077-4605 **Pages: 1088-1100**
DOI: 10.36632/mejar/2020.9.4.85

Impact of Salinity Levels and Varietal Differences on some Growth Characters, Yield and Yield Attributes of Canola Genotypes

[1]El Habbasha S.F., Til Fieke[2], Ibrahim ElMetwaly[3], Faten M. Ibrahim[4], Mohamed E. El-Awdi[3], Mona G. Dawood[3] and Dima Sabboura[2]

[1]Filed Crops Research Field Department, National Research Centre, Dokki, Cairo, Egypt
[2]Institute for Strategies and Technology Assessment, JKI, Germany
[3]Botany Department, National Research Centre, Dokky, Cairo, Egypt
[4]Medicinal and Aromatic Plants Research Department, National Research Centre, Cairo, Egypt

Received: 10 Nov. 2020 / Accepted 20 Dec. 2020 / Publication date: 30 Dec. 2020

ABSTRACT

Greenhouse pot experiment was conducted to evaluate the effect of salinity levels (Tap water, 1500 ppm , 3000 ppm and 4500 ppm) on growth, yield, yield attributes and some chemical composition for some canola genotypes (Agamax, Trapper, Serw 4 and Serw 6). Statistical analysis results revealed that the factors salinity, genotypes and their interaction had significant effect on most of growth, yield, yield attributes and some chemical composition characters. Increasing the salinity levels in the irrigation water to 4500 ppm tended to significantly decrease in most of studied growth characters. In this connection, Agamax variety surpassed significantly in most of studied characters i.e., plant height, number of leaves plants^{-1}, number of branches plants^{-1}, fresh weight plant^{-1}, dry weight plant^{-1} and Chb as well as seed yield plant^{-1}. Results also indicated that the treatments tap water + Agamax, 1500 ppm + Trapper and 3000 ppm + Serw 4 recorded the highest pod yield plant^{-1} and seed yield plant^{-1} with no significant differences among them.

***Keywords*:** Salt stress; Canola; Yield; Amino acid; Fatty acid

Introduction

Salinity is one of the environmental factors that threaten agricultural production, affecting more than 800 million ha worldwide (Munns and Tester, 2008). Salinity stress is one of the most important abiotic stresses, and its negative impacts on crop's growth led to increase in research in the field of tolerance to salinity with the objective of improving plant's tolerance (Zhao *et al.,* 2007). Salinity with sodium chloride caused decrease in sugars that is necessary for cells growth and main steps of photosynthesis process and its velocity. Sugars supported main steps of photosynthesis process and its velocity, and usually the lowest of photosynthesis rate has been observed in plants under salinity stress, especially with salinity of sodium chloride (Parida and Das, 2005). The negative impacts of salinity reported for the different stages of plant growth include a reduction in photosynthetic activity, changes in carbohydrate and protein metabolism, while the accumulation of organic acids and osmolytes is the means of plant response to salinity stress (Elkelish, *et al.,* 2019 and Soliman *et al.,* 2018). The first biochemical sign of salinity is the generation of ROS (Elkelish *et al.,* 2020), their harmful effects such as protein degradation, DNA mutation, and lipid peroxidation (El-Esawi *et al.,* 2017), which result in oxidative damage and the down-regulation of CO_2 fixation, leading to physiological dysfunctions and programmed cell death (Mosaad *et al.,* 2020). Salinity reduces the germination percentage (Kaveh *et al.,* 2011), cell expansion and plant growth and speeds up leaf senescence, adding to losses in yield (Zörb *et al.,* 2019). It causes alteration and imbalances in the nutrient content, as well as their partitioning within the plant (Grattan and Grieve, 1998). In addition, the content of sodium (Na^+) and chloride (Cl^-) is increased under saline conditions, which leads to ion toxicity (Dawood and El-Awadi, 2015), Na^+ reduces calcium and potassium (K^+) uptake and their transport to growing parts, while Cl^- reduces nitrate uptake, a combination of complex interactions that affect the plant metabolism and susceptibility to injury (Ahanger *et al.,* 2017). Plants improve their tolerance to salinity through decreasing salt accumulation as they reduce salt transport to aerial parts, ion compartmentation, osmotic adjustment, and the induction of antioxidant enzymes (Munns and Tester, 2008). Many approaches have

Corresponding Author: El Habbasha S.F., Filed Crops Research Field Department, National Research Centre, Dokki, Cairo, Egypt

been adopted to overcome salinity, including soil reclamation programs, which probably represents the most effective and long-lasting method to minimize the hazards of salinity (Machado *et al.,* 2017). Also, cultivation of plant species tolerant of salt such as canola.

Increasing plant productivity is one of the main targets of the Ministry of Agriculture and Land Reclamation in Egypt. This could be achieved through the suitable agricultural practices, i.e. using promising cultivars under different salinity conditions. Salinity is a well-known problem in most of arid and semi-arid areas of the world especially in irrigated areas. Salinity limits yield of irrigated soils in vast areas of the world (Homaee *et al.,* 2002). Over 400 Mha across the world is affected by either salinity or sodicity which accounts for about 6% of the world's land. However, of the current 230 Mha of irrigated land in the world, 45 Mha are salt-affected (19.5%), and of the 1,500 Mha under dryland agriculture 32 Mha (2.1%) are salt-affected land to varying degrees (Ghassemi *et al.,* 1995).

In general, salinity is excess existing the soluble salts and mineral maters in water and soil solution that resulted in accumulation salt in rhizosphere and plant can't enough water uptakes from soil (Shannon *et al.,* 1994). Much salinity resulted from NaCl cause at least three problems: (1) Osmotic pressure of external solution become more than osmotic pressure of plant cells which is require to regulating osmotic pressure to preventing dehydration by plant cells, (2) Uptake and transform of nutrition ions such as potassium and calcium, by excess sodium would make problems. (3) High Na and Cl rates would cause to direct toxic effects on enzymic and membranous systems.

Canola (*Brassica napus*) is one of the most essential oilseed plants that have high compatibility in resistance to drought and salinity stresses. After soybean, the largest cultivation area of oilseed plants is accounted to canola, and in terms of oil providing, after soybean and oil palm it is in third place (FAO, 2016). Canola oil is consider as an important source of vegetable oil, the level of erucic acid and glucosinolate in seed may limit its usage. Oil is considered as very healthy edible oil (Baux, et al.,2008) with a low content of saturated fatty acids (5-7%) and a high content of polyunsaturated fatty acids with about 7-10% linolenic and 17-21% linoleic acids. Erucic acid and glucosinolate are considered toxic for both human and animal's health, and reduce oil quality in addition to its bitter taste (Muhammad *et al.,* 1991).

Like many of the oilseed plants, canola is affected stress caused by the salinity. Studies by Ahmadi and Ardekani (2006) revealed that increasing the salinity level from 1 to 12 dS m^{-1} decreased the germination rate. The results also showed that salinity had a significant reducing effect on seed yield but no significant effect on seed oil content, while the cultivar factor had a significant effect on seed oil content. Zamani *et al.,* (2010) demonstrated that, different salinity stress levels had significant effect on germination percentage, germination speed, shoot and root length. Also, in pot experiment there was significant effect on plant height, leaf area, dry matter percentage, and seed yield due to salinity stress. In addition, they observed that, there was significant different among canola cultivars traits. Shirzi *et al.,* (2018) they studied the effect of salinity on some types of brassicaceae who reported that the physiological studies with respect to osmotic adjustment showed that almost all the genotypes had enhanced proline accumulation however in tolerant genotypes the relative increase (%) was higher. Also, the tolerant genotypes had high K/Na ratio as compared to sensitive ones. Rameeh *et al.,* (2012) illustrated that plant height, pods $plant^{-1}$, 1000- seed weight, seed yield, Ca, K and Na, indicating a significant differences of salinity levels for these traits. The genotypes had significant differences for all the studied traits except Ca. Significant positive correlations were detected among plant height and seed yield and other yield associated traits including number of pods $plant^{-1}$, 1000-seed weight and K, therefore the genotypes with high plant height in saline environment will have high seed yield and yield associated traits. The present research work was carried out to assess the interactive effect of salinity levels on growth, yield and yield attributes of canola genotypes under salinity conditions.

Material and Methods

Experimental procedure

Pot experiment was carried out in December 17, 2018 season at the greenhouse of the National Research Centre (NRC), Egypt. During this period, temperature ranged from 11–30 ºC. Relative humidity ranged from 25–85 %, Pottery pots (30cm in diameter and $0.07m^2$) were fallen with equal amount of sieved sandy-loam soil. Physical and chemical characters of soil in the pot were as follows: sand 52.2%, silt 13.7%, clay 34.1%, PH 7.8, organic matter 2.3 %, CaCO3, 1.6%, EC 0.3 ds/m, soluble

N 8.5 ppm and available P 4.1 ppm, soil measured as described by Chapman and Pratt (1978). The pots were arranged in split plot experiment in complete block design with six replicates. The main plots included four canola genotypes, two German genotypes (Agamax and Trapper) and two Egyptian canola genotypes (Serw 4 and Serw 6) while sub-plots comprised salinity levels (Tap water, 1500 ppm , 3000 ppm and 4500 ppm). All experimental pots received the same fertilization rates as followed: calcium super phosphate (15.5% P_2O_5) before planting at the rate of 3 g pot^{-1}, representing sources of P, ammonium sulfate (20% N) at the rate of 2 g pot^{-1} and potassium sulphate (48%, K_2O) at the rate of 1 g pot^{-1}, representing sources of N and K, respectively, were added 30 days after seeds planting. The seeds of canola were sown at the rate of five seeds pot^{-1}. Starting from day 15th, plants were irrigated with the three levels of diluted seawater mentioned above. Irrigation was carried out as follows, 3 times with diluted seawater followed by irrigation with tap water once and so on till the end of experiment.

Data recorded

Growth characters

At 80 days after sowing, three plants were randomly taken from each pot to determine plant height (cm), number of leaves $plant^{-1}$, number of branches $plant^{-1}$, fresh and dry weight $plant^{-1}$ (g).

Yield and yield attributes

At harvest, five plants were sampled randomly to estimate, plant height, number of siliqua $plant^{-1}$, number of seeds $siliqua^{-1}$, 1000-seed weight (g), and seed yield $plant^{-1}$ (g).

Chemical analysis

Photosynthetic pigments (chlorophyll a, chlorophyll b and carotenoids) were determined using method described by Lichtenthaler and Buschmann (2001).

The content of Sodium, Potassium, Calcium and Magnesium determined in the digested material using Jenway flame photometer as described by Eppendrof and Hing (1970). The dried plants thoroughly ground to fine powder and total N, P and K percentage determined according to the method described by A.O.A.C. (1982). Seed protein content calculated by multiplying N (%) by 6.25 tripthi *et al.,* 1971. Seed oil content will estimate by using Soxhelt apparatus and petroleum ether 60-80°C as a solvent A.O.A.C. (1982). Esterification was performed by the determination through gas chromatography (AOAC, 1993). Total amino acids was measured according to (Bailey, 1967).

Statistical analysis

The analysis of split plot experiment in complete block design was used using MSTAT-C Program (MSTAT-C 1988). LSD5% was used to compare means

Results and Discussion

A- Effect of salinity levels and varietal differences on growth characters of some canola genotypes

The results in (Table 1) clearly indicate that water salinity levels caused a significant effect on plant height, number of leaves $plants^{-1}$, number of branches $plants^{-1}$, fresh weight $plant^{-1}$, dry weight $plant^{-1}$, Cha., Chb., Car., total pigments and proline after 80 DAS. Where, increasing the salinity levels in the irrigation water to 4500 ppm tended to significantly decrease most of studied characters, i.e., plant height, number of leaves $plant^{-1}$, fresh weight $plant^{-1}$, dry weight $plant^{-1}$, Cha and proline concentration. While, number of branches $plant^{-1}$, Chb., Car., and total pigments decreased by increasing salinity levels but did not reach to the level of significance. Thus, by increasing salinity stress, plant height intensively decreased. Plant height reduction due to salinity stress can be attributed to disruption at photosynthesis through the water deficit and decreasing of photo-assimilates production for transfer to growing parts of plant.

According to some researchers under salinity stress, the abscisic acid leads to induction of shoot growth due to cessation of protons secretion of the auxin induce (Rao and Mendham, 1991). Because reduction in plant height is the effect of salinity on leaf area, this reduction is particularly evident at the end of vegetative growth, and after entering the plant to flowering stage, the leaves have started to fall gradually from the down (Nabizadeh marost, 2002). Salinity stress led to reduction of chlorophyll content, and this reduction could be due to destruction of chloroplasts structure and photosynthetic

apparatus, chlorophylls photo-oxidation, their reaction with singlet oxygen, demolition of chlorophyll synthesis precursors, prevention of chlorophyll biosynthesis, prevention of the new chlorophylls biosynthesis and activating the chlorophyll-degrading enzymes such as including chlorophyllase and hormonal disruptions (Neocleous and Vasilakakis, 2007). Similar trends were noticed by (Rameeh *et al.,* 2012, Rameeh, 2013 and Toderich *et al.,* 2020).

Data presented in (Table 2) shows the effect of varietal differences i.e., Agamax, Trapper, Serw 4 and Serw 6 varieties on plant height, number of leaves plants^{-1}, number of branches plants^{-1}, fresh weight plant^{-1}, dry weight plant^{-1}, Cha, Chb, Car, total pigments and proline. Where, Agamax surpassed significantly in most of studied characters i.e., plant height, number of leaves plants^{-1}, number of branches plants^{-1}, fresh weight plant^{-1}, dry weight plant^{-1} and Chb. While, Chb and Car., did not different significantly among the different varieties. Trapper variety surpassed in Cha, Car, total pigments and proline parameters. These differences between varieties may be due to genetic differences between varieties. These results are in general agreement with those recorded by (Rameeh, 2013 and Toderich *et al.,* 2020).

Data illustrated in (Table 3) indicates that the effect of interaction between salinity water, tap water, 1500, 3000 and 4500 ppm and varietal differences i.e., Agamax, Trapper, Serw 4 and Serw 6 varieties on plant height, number of leaves plant^{-1}, number of branches plant^{-1}, fresh weight plant^{-1}, dry weight plant^{-1}, Cha, Chb, Car, total pigments and proline. However, the different treatments show significant difference in most studied characters except, number of leaves plant^{-1}, number of branches plant^{-1}, Chb and Car., where, Agamax records the highest values for plant height (47.38, 46.76, 46.95 and 46.67 cm), fresh weight plant^{-1} (18.92, 17.89, 18.41 and 16.57 g plant^{-1}), dry weight plant^{-1} (4.98, 4.43, 5.23 and 4.24 g plant^{-1}) and total pigments (2.80, 2.63, 2.57 and 2.63) for tap water, 1500, 3000 and 4500 ppm, respectively), with no significant differences among this treatment and the treatments 1500, 3000 and 4500 ppm with the same cultivars (Agamax) in characters pant height, number of leaves plant^{-1}, fresh weight plant^{-1} dry weight plant^{-1} and total pigments. No significant differences between Agamax and Trapper with the different levels of salinity water were observed in characters, pant height, number of leaves plant^{-1}, number of branches plant^{-1}, fresh weight plant^{-1}, Chb and Car. The lowest values of the studied characters were recorded by cultivar Serw 6 with the different levels of salinity water, however, the lowest values were recorded by the treatment Serw 6 + 4500 ppm for plant height (36.03 cm), fresh weight plant^{-1} (12.11 g) and dry weight plant^{-1} (4.12 g).

Salinity stress is an important factor in preventing or delaying seed germination and seedling establishment. Some researchers have reported negative effects of salinity stress on seed germination and crop production. NaCl salinity affects ion transport processes in plants, which may change the nutritional status and ion balance .Under salt stress, plants have evolved complex mechanisms allowing for adaptation to osmotic and ionic stress caused by high salinity. These mechanisms include the lowering of the toxic ions concentration in the cytoplasm by restriction of Na^+ influx or its sequestration into the vacuole and/or its extrusion. Obviously, acceptable growth of plants in arid and semiarid lands which are under exposure of salinity stress is related to ability of seeds for best germination under unfavorable conditions, so necessity of evaluation of salinity resistance genotypes is important at primary growth stage. To find the best tolerant genotype to such conditions, taking all traits into account in this study, we found that among that two cultivar canola, regent cobra is the resistant the salinity stress. Similar findings confirming these results were reported by (Ahmadi *et al.,* 2013 and Sharif, 2013).

B- Effect of salinity levels and varietal differences on some yield, yield attributes and some chemical analysis of some canola genotypes

Salt stress had significant effect on yield, yield attributes and chemical analysis of some canola cultivars (Table 4), where the tap water treatment records the highest values for plant height (68.93 cm), straw yield plant^{-1} (26.14 g), seed yield plant^{-1} (6.55 g) , Fe, Mn and Zn with no significant differences with the treatments, 1500 and 3000 ppm in characters, 1000-seed weight, straw yield plant^{-1}, pod yield plant^{-1} , seed yield plant^{-1}, protein %, oil %, N , P and K %. The treatment 4500 ppm records the lowest values of the most studied characters i.e., plant height, straw yield plant^{-1}, pod yield plant^{-1}, seed yield plant^{-1}, P% and Fe %. Data also showed that the treatment 4500 ppm records the maximum values of protein %. Many researchers studied the effect of salinity on the canola crop and its components and found that salinity causes a decrease in silliqua number is associated to the increase of ABA and pollen

Table 1: Effect of salinity levels on the growth characters of some canola genotypes

Salinity	Plant Height (cm)	No. of leaves	No. of branches	Fresh weight (g)	Dry weight (g)	*Cha	*Chb	*Carot.	Total pigments	Proline
Tap Water	44.36	3.57	1.83	15.52	4.41	1.56	0.47	0.31	2.35	167.80
1500 ppm	43.94	3.30	1.79	15.14	4.27	1.53	0.51	0.31	2.35	183.10
3000 ppm	43.50	3.49	1.76	15.95	4.12	1.19	0.38	0.25	1.84	188.71
4500ppm	42.29	3.40	1.74	11.07	3.36	1.20	0.38	0.25	1.75	240.10
LSD0.05	1.77	0.19	NS	1.30	0.31	0.19	NS	NS	0.28	14.29

***Cha:** Chlorophyll a**, *Chb:** Chlorophyll b, ***Carot.:** Carotenoids

Table 2: Effect of varietal differences on the growth characters of some canola genotypes

Varieties	Plant Height (cm)	No. of leaves	No. of branches	Fresh weight (g)	Dry weight (g)	*Cha	*Chb	*Carot.	Total pigments	Proline
Agamax	47.19	3.82	1.95	16.24	4.62	1.54	0.49	0.30	2.35	201.10
Trapper	45.11	3.58	1.74	15.78	4.45	1.59	0.48	0.33	2.41	311.50
Serw 4	43.07	3.40	1.84	15.84	4.49	1.24	0.39	0.25	1.90	108.27
Serw 6	38.71	2.96	1.60	13.53	4.00	1.10	0.37	0.23	1.62	158.83
LSD0.05	1.37	0.31	0.22	2.50	0.29	0.16	NS	NS	0.24	16.40

***Cha:** Chlorophyll a**, *Chb:** Chlorophyll b, ***Carot.:** Carotenoids

Table 3: Effect of salinity levels and varietal differences interaction on the growth characters of some canola genotypes

Salinity	Varieties	Plant height (cm)	No. of leaves	No. of branches	Fresh weight (g)	Dry weight (g)	*Cha	*Chb	*Carot.	Total pigments	Proline
Tap Water	Agamax	47.38	4.04	1.93	18.92	4.98	1.86	0.58	0.35	2.80	58.33
	Trapper	46.36	3.20	1.78	18.13	4.10	1.30	0.38	0.27	1.96	105.32
	Serw 4	44.40	3.98	2.14	14.72	4.15	1.58	0.51	0.33	2.43	207.51
	Serw 6	39.62	3.07	1.49	13.32	3.83	1.49	0.41	0.31	2.21	361.22
1500 ppm	Agamax	46.76	3.46	2.09	17.89	4.43	1.72	0.57	0.33	2.63	158.89
	Trapper	46.23	3.74	1.81	17.04	4.84	1.51	0.46	0.31	2.30	135.98
	Serw 4	42.64	3.38	1.64	14.33	4.12	1.58	0.50	0.30	2.39	92.63
	Serw 6	39.11	2.63	1.62	13.29	3.70	1.30	0.50	0.28	2.09	367.35
3000 ppm	Agamax	46.95	4.04	2.14	18.41	5.23	1.14	0.38	0.23	2.57	139.24
	Trapper	43.87	3.98	1.49	15.69	4.51	1.71	0.50	0.34	1.75	91.13
	Serw 4	42.09	2.89	1.78	14.31	3.99	1.05	0.33	0.22	1.60	208.84
	Serw 6	40.10	3.07	1.65	15.39	4.37	0.87	0.33	0.21	1.42	231.98
4500 ppm	Agamax	46.67	3.74	1.64	16.57	4.24	1.46	0.44	0.30	2.63	76.63
	Trapper	43.30	3.40	1.88	15.66	4.36	1.84	0.58	0.39	2.21	302.89
	Serw 4	43.16	3.38	1.81	14.74	4.70	0.77	0.25	0.16	1.18	295.43
	Serw 6	36.03	3.07	1.65	12.11	4.12	0.75	0.25	0.14	0.77	285.47
LSD0.05		2.73	NS	NS	1.10	0.57	NS	NS	NS	0.48	NS

***Cha:** Chlorophyll a**, *Chb:** Chlorophyll b, ***Carot.:** Carotenoids

Table 4: Effect of salinity levels on yield, yield attributes and chemical analysis of some canola genotypes

Salinity	Plant height (cm)	1000-seed weight (g)	Straw yield/ Plant (g)	Pod yield/ Plant (g)	Seed yield/ Plant (g)	Protein	Oil	N	P %	K	Fe	Mn	Zn
									(%)			(ppm)	
Tap Water	68.93	3.01	26.14	14.57	6.55	22.43	45.64	3.59	0.58	0.92	71.24	13.27	28.42
1500 ppm	51.95	3.11	25.42	14.68	6.48	22.62	45.42	3.62	0.57	0.91	59.58	11.75	26.24
3000 ppm	45.72	3.14	24.80	14.79	4.30	23.25	45.08	3.72	0.55	0.92	56.96	11.42	26.54
4500 ppm	44.54	3.04	22.15	12.13	3.32	23.62	44.78	3.78	0.53	0.98	44.76	12.15	28.07
LSD0.05	3.18	NS	3.62	2.14	2.77	1.07	NS	0.53	NS	NS	NS	NS	NS

death. In canola plants, time of flowering is a critical stage, on the other hand, salinity stress decreases growth period and consequently, plants decrease the silique number to attain survival (Lin (2004). According to the results of Sinaki *et al.,* (2007) salinity stress at flowering stress, decreases silique number. It seems that the most important reason for silique number reduction is low tolerance of canola plants to low salinity level. According to the results, it seems that one of the reasons of seed number decrease is silique size reduction. Sakr *et al.,* (2007) reported that major of growth parameters, such as seed number decreased by salinity stress. Decrease in seed weigh can be due to prevention of assimilate transport to the seeds and decrease in growth during seed filling stage. Gradual decrease in seed weight at low salinity levels than high salinity levels was due to the low sensitivity of canola to salinity during the vegetative growth stage. Canola is sensitive to salinity at seedling and early vegetative stage and this sensitivity decreases at the end of the growth stage, such as seed filling stage (Francois, 2007). The decrease in yield components due to salinity stress lead to loss of final yield. It seems that ions accumulation in plant tissues at different growth stages is the main reason of yield decrease. According to the results of 1000 seeds weight and number of silique in plants, these parts of yield components are more sensitive to salinity. Similar results were obtained by (Shirazi *et al.,* 2018 and Toderich *et al.,* 2020).

Data presented in Table (5) show that the effect of varietal differences on yield, yield attributes and chemical analysis of some canola cultivars, where the different genotypes differed significantly in most of studied characters. However, Agamax cultivar surpassed in plant height, straw yield plant^{-1}, seed yield plant^{-1}, protein %, N% and Mn. While, Serw 4 surpassed in pod yield plant^{-1} and Fe, with no differences between the two cultivars in 1000-seed weight, straw yield plant^{-1}, pod yield plant^{-1}, seed yield plant^{-1}, N%, Fe and Zn. Also, Serw 4 surpassed in 1000-seed weight. These differences between varieties may be due to genetic differences between varieties. Similar findings confirming these results were reported by (Zamani*et al.,* 2010 and Shirazi *et al.,* 2018).

Effect of salinity levels and varietal differences interaction on yield, yield attributes and chemical analysis of some canola genotypes

Significant interactions were found between salinity levels (tap water, 1500, 3000 and 4500 ppm) and varietal differences (Agamax, Trapper, Serw 4 and Serw 6 genotypes) interaction on yield, yield attributes and chemical analysis of some canola genotypes (Table 6), where the treatment tap water with cultivar Agamax or Trapper record the highest plant height with no significant differences between the two treatments. No significant differences were observed in 1000-seed weight, N% and P%. The treatment tap water + Agamax , 1500 ppm + Trapper and 3000 ppm + Serw 4 record the highest pod yield plant^{-1} and seed yield plant^{-1} with no significant differences among them. Keshta *et al.,* (1999) examined the salinity stress on different canola cultivars on a farm experiment. By increasing soil salinity from 2.5 to 6.5 mmohs flowering, number of racemes plant^{-1}, number of silliqua plant^{-1}, 1000-seed weight, seed yield he^{-1}, oil content, total dry matter and harvest index showed significant decrease. This reduction is due to increase in soil solution osmotic pressure and the imbalances in needed elements.

Rameeh, (2013) reported that a significant positive correlation was determined between K and seed yield, therefore concentration of this ion can be considered as a good indicator for seed yield increasing at saline condition. Similarly, in the earlier studies (Ashaf and McNeilly, 2004 and Bandeh-Hagh *et al.,* 2008) the important effect of K for salinity tolerance was found. High absorption of Cl^- makes low influx of other toxic ions like Na in saline environment, therefore the genotypes with high amounts of Cl^- had also high amount of seed yield at high salinity levels. In general, increasing of salinity levels had significant decreasing effects on yield, yield components and also all the shoot ions concentrations except Cl^-. Pods plant^{-1} and Mg had lowest variations among the genotypes at the high salinity levels. Although with result of salt increasing level most of shoot ions concentrations were decreased, but their increments of reductions were varied for different genotypes

There was a significant effect of the interaction between salinity levels (Tap water, 1500, 3000 and 4500 ppm) and varietal differences (Agamax, Trapper , Serw 4 and Serw 6 genotypes) on some chemical characters for number of canola varieties, where with tap water treatment, Agamax and Serw 6 records the highest values of the of the studies elements (Table 6). While when we increased the level of salinity to 1500 ppm Serw 4 cultivar appear good response and records the highest values of the studied elements. Increasing the salinity levels to 4500 ppm tended to decrease in the contents of the

Table 5: Effect of varietal differences on yield, yield attributes and chemical analysis of some canola genotypes

Varieties	Plant height (cm)	1000-seed weight (g)	Straw yield/ Plant (g)	Pod yield/ Plant (g)	Seed yield/ Plant (g)	Protein	Oil	N	P	K	Fe	Mn	Zn
								(%)				(ppm)	
Agamax	68.04	2.92	27.04	14.79	6.74	23.43	44.96	3.75	0.56	0.98	61.57	13.12	27.90
Trapper	50.84	3.15	23.44	13.10	3.62	22.43	45.35	3.59	0.54	0.93	57.14	11.87	28.12
Serw 4	60.45	3.03	25.08	15.12	6.46	22.81	45.83	3.65	0.57	0.92	65.63	12.83	27.28
Serw 6	41.82	3.29	22.95	13.87	3.83	23.31	44.80	3.73	0.56	0.90	48.20	10.75	25.97
LSD 0.05	3.08	0.26	2.62	1.28	0.57	NS	NS	NS	NS	NS	NS	NS	1.70

Table 6: Effect of salinity levels and varietal differences interaction on yield, yield attributes and chemical analysis of some canola genotypes

Salinity	Varieties	Plant height (cm)	1000-seed weight (g)	Straw yield/ plant (g)	Pod yield/ plant (g)	Seed yield/ Plant (g)	Protein	Oil	N	P	K	Fe	Mn	Zn
									(%)				(ppm)	
Tap Water	**Agamax**	76.02	2.96	29.78	16.02	6.34	25.25	44.15	4.04	0.65	0.94	67.58	13.96	30.41
	Trapper	79.35	3.13	25.29	13.85	4.01	19.87	46.12	3.18	0.53	0.91	87.69	14.11	31.10
	Serw 4	72.87	2.93	25.08	13.56	6.22	20.56	47.25	3.29	0.51	0.94	71.04	13.56	25.48
	Serw 6	47.48	3.04	28.41	16.84	4.61	24.18	45.05	3.87	0.62	0.89	58.67	11.44	26.69
1500 ppm	**Agamax**	72.87	2.93	25.08	13.56	6.22	20.56	45.52	3.29	0.51	0.94	71.04	13.56	25.48
	Trapper	50.62	3.09	29.46	16.18	4.90	23.12	45.12	3.70	0.61	0.92	72.18	11.80	26.32
	Serw 4	47.48	3.04	28.41	15.84	4.61	24.18	45.68	3.87	0.62	0.89	58.67	11.44	26.69
	Serw 6	36.84	3.39	18.73	12.17	3.20	22.75	45.35	3.64	0.53	0.89	36.42	10.19	26.48
3000 ppm	**Agamax**	49.32	3.07	25.07	16.51	4.78	23.62	45.61	3.78	0.50	0.95	57.97	12.48	29.13
	Trapper	36.84	3.39	18.73	12.17	3.20	22.75	44.89	3.64	0.53	0.89	36.42	10.19	26.48
	Serw 4	50.62	3.09	29.46	16.18	4.90	23.12	45.21	3.70	0.61	0.92	72.18	11.80	26.32
	Serw 6	46.11	3.00	25.96	14.32	4.32	23.50	44.61	3.76	0.57	0.92	61.29	11.19	24.24
4500ppm	**Agamax**	43.94	2.72	24.21	15.06	3.40	24.37	44.57	3.90	0.56	1.08	49.72	12.48	26.58
	Trapper	36.55	3.00	20.30	10.20	2.38	23.93	45.28	3.83	0.50	0.99	32.28	11.38	28.56
	Serw 4	70.84	3.05	25.38	13.91	4.32	23.50	45.19	3.76	0.54	0.94	60.61	14.53	30.65
	Serw 6	36.84	3.39	18.73	12.17	3.20	22.75	44.18	3.64	0.53	0.89	36.42	10.19	26.48
LSD 0.05		6.15	NS	3.25	2.56	2.14	2.16	NS	NS	NS	0.15	NS	NS	NS

studied minerals. In response to salinity stress, endogenous Na concentration increased in the various Brassica genotypes whereas K concentration decreased. Saline soils and saline irrigation waters present potential hazards to canola production. Calcium (Ca) and K ameliorate the adverse effects of salinity on plants (Murillo-Amador *et al.,* 2007). Salinity impairs the uptake of Ca by plants, possibly by displacing it from the cell membrane or in some way affecting membrane functions (Mandhania *et al.,* 2010). Gorham (1993) claimed that all plants discriminate to some extent between Na and K. Na can be substituted for K for uptake, and it is supposed that similar mechanisms of uptake may operate for both ions. High level of K in young expanding tissue is related to salt tolerance in many plant species (Ashaf and McNeilly, 2004; Bandeh-Hagh *et al.,* 2008). Tie and Cramer (1992) reported that Ca could play a regulatory role in the responses of Brassica species to saline environments. These results are in good harmony with those of Rameeh *et al.,* (2012).

Data presented in (Table 7) show the effect of salinity levels (Tap water, 1500, 3000 and 4500 ppm) on fatty acids composition of some canola genotypes, Serw 4, Serw 6, Agamax and Trappar. Where in this investigation we determined saturated fatty acids, palmitic, stearic, arachidic and behenic, as well as unsaturated fatty acids, oleic, linoleic, linolneic and erusic acid. Where increasing the salinity levels to 4500 ppm tend to decrease the fatty acids content however, the tap water records the highest content of different fatty acids and the salinity level 4500 ppm records the lowest fatty acids. These results are in general agreement with those recorded by (Toderich *et al.,* 2020).

Bybordi *et al.,* (2010) demonstrated that salt stress, like many other abiotic stresses, inhibits plant growth and is one cause of growth rate reduction. Under salt stress inadequate photosynthesis is owing due to stomatal closure and consequently limited carbon dioxide uptake. Several earlier reports indicate that saline conditions cause restricted branch number, decreased leaf size, poor root development, reduction in fruit size, lower fresh and dry weights of various plants, a decrease in number and size of seeds and evaluation of the total fatty acids (TFA) content in canola seeds subjected to increasing NaCl levels. He added NaCl treatments induced marked changes in fatty acid composition of seeds. In summary, low (50 mM), moderate (100 mM) and high (200 mM) NaCl levels decreased the degree of fatty acid unsaturation. This fact could be explained by a possible reduction of the desaturase activity which appeared as an adaptive feature to salinity, since some plants could be protected against the oxidative effects of salt ions through restructuring membranes with less polyunsaturated fatty acids. Moreover, this low unsaturation degree limited the membrane fluidity 23-25 and restricted permeability to Na and Cl^- ions.

Data illustrated in (Table 8) show the effect of salinity levels on the amino acids composition of Serw 4, Serw 6, Agamax and Trapper genotypes. Where, the tap water with different studied genotypes records the highest values of different amino acids except proline acids where it increased by increasing the salinity levels up to 4500 ppm with different studied canola genotypes, where Serw c.v. records the highest proline content with the level of salinity 4500 ppm followed by Agamax cultivar and Serw 6. Toderich *et al.,* 2020 found that a positive relationship was found between Ala, Gly, Pro, Ile, and Unk and a negative relationship between Glx, His, Asx, and Lys content in quinoa seeds and the content of sodium, chloride, and sulfate ions in soil. Despite the negative correlation between total amino acids in quinoa seeds and the content of sodium, chloride, and sulfate ions in soil), no significant differences were found between the content of total amino acids under salinity and under control conditions.

Acknowledgment

The authors gratefully acknowledge Science, Technology and Innovation Funding Authority (STIFA), Egypt for funding the bilateral GERF project number (23149) which gave us the opportunity for carried out this research. Also, special appreciation extend to National Research Center (NRC), Egypt for offering the facilities through the project and this research.

Table 7: Effect of salinity levels on the fatty acids composition of some canola genotypes

		SERW 4				SERW 6				AGAMAX				TRAPPER			
		Tap water	1500 ppm	3000 ppm	4500 ppm	Tap water	1500 ppm	3000 ppm	4500 ppm	Tap water	1500 ppm	3000 ppm	4500 ppm	Tap water	1500 ppm	3000 ppm	4500 ppm
Saturated	**Palmitic**	5.32	3.65	3.58	3.88	5.46	4.51	4.37	3.24	5.73	6.06	5.04	4.49	4.58	4.43	4.61	3.89
	Stearic	1.84	1.2078	1.218	1.22	1.68	1.26	1.36	1.63	1.76	1.84	1.55	1.38	1.41	1.38	1.43	1.21
	Arachidic	2.47	2.1384	1.89	1.61	2.604	2.24	2.08	2.50	2.73	2.86	2.40	2.14	2.18	2.11	2.20	1.86
	Behenic	1.38	1.1583	1.04	1.04	1.42	1.21	1.49	1.79	1.49	1.57	1.31	1.15	1.19	1.52	1.58	1.33
Unsaturated	**Oleic**	70.03	58.9743	52.52	53.85	71.59	61.92	57.32	68.74	75.16	78.72	66.15	58.87	60.13	58.10	60.53	51.13
	Linoleic	25.59	20.14	17.93	18.07	24.73	21.15	19.66	23.60	25.96	27.20	22.85	20.33	20.77	19.93	20.77	17.54
	Linolneic	10.99	8.19	7.75	8.68	10.53	8.60	8.23	9.87	11.06	11.58	9.73	8.66	8.85	8.34	8.69	7.34
	Erucic	1.93	1.752	1.261	1.441	1.94	1.83	1.54	1.85	2.04	2.13	1.79	1.59	1.63	1.56	1.63	1.38

Table 8: Effect of salinity levels on the amino acids composition of some canola genotypes

	SERW 4				SERW 6				AGAMAX				TRAPPER			
	Tap water	1500 ppm	3000 ppm	4500 ppm	Tap water	1500 ppm	3000 ppm	4500 ppm	Tap water	1500 ppm	3000 ppm	4500 ppm	Tap water	1500 ppm	3000 ppm	4500 ppm
Aspartic	1.48	1.23	1.25	1.12	1.35	1.10	1.26	1.05	1.26	1.00	1.24	0.99	1.35	1.13	1.21	1.07
Threonine	0.67	0.56	1.22	1.58	0.56	0.50	1.23	1.26	0.57	0.45	1.29	1.18	0.49	0.51	1.26	1.28
Serine	0.74	0.66	0.35	0.59	0.69	0.59	0.35	0.47	0.66	0.54	0.37	0.44	0.61	0.61	0.36	0.47
Glutamic	4.10	3.55	4.11	3.66	4.33	3.19	4.15	2.92	4.23	2.90	4.35	2.75	3.99	3.28	4.27	2.97
Glycine	0.53	0.65	0.65	0.69	0.49	0.58	0.65	0.55	0.54	0.53	0.68	0.52	0.58	0.60	0.67	0.56
Alanine	1.18	0.98	0.68	0.68	1.21	0.88	0.68	0.54	1.23	0.80	0.72	0.51	1.35	0.90	0.70	0.55
Valine	0.47	0.65	0.77	1.03	0.39	0.58	0.78	0.82	0.42	0.53	0.81	0.77	0.49	0.60	0.80	0.83
Methonine	0.2	0.35	0.35	0.53	0.24	0.31	0.35	0.42	0.26	0.28	0.37	0.39	0.36	0.32	0.36	0.43
Isoleucine	0.44	0.51	1.02	0.96	0.39	0.459	1.03	0.76	0.36	0.41	1.08	0.72	0.41	0.47	1.06	0.77
Leucine	1.34	1.09	0.68	0.68	1.36	0.98	0.68	0.54	1.41	0.89	0.72	0.51	1.52	1.00	0.70	0.55
Tyrosine	0.38	0.44	0.85	0.78	0.41	0.39	0.85	0.62	0.51	0.36	0.90	0.58	0.65	0.40	0.88	0.63
Phenylalanine	0.63	0.53	0.67	0.72	0.66	0.47	0.67	0.57	0.59	0.43	0.71	0.54	0.46	0.49	0.69	0.58
Histdine	0.54	0.65	1.03	0.99	0.56	0.58	1.04	0.79	0.61	0.53	1.09	0.74	0.58	0.60	1.07	0.80
Lysine	1.02	0.99	1.24	1.32	1.12	0.89	1.25	1.05	1.21	0.81	1.31	0.99	1.31	0.91	1.28	1.07
Arginine	0.94	0.85	0.58	0.66	0.96	0.76	0.58	0.53	0.89	0.69	0.61	0.49	0.98	0.78	0.60	0.53
Proline	16.59	23.54	28.65	36.35	17.21	24.21	27.35	28.65	15.25	22.21	26.35	29.24	16.25	22.56	23.35	27.56

References

Ahanger, M.A., N.A. Akram, M. Ashraf, M.N. Alyemeni, L. Wijaya, and P. Ahmad, 2017. Plant Responses to Environmental Stresses—from Gene to Biotechnology. AoB Plants 9: 1-17., plx025. [CrossRef]

Ahmadi, S.H., and J.N. Ardekani, 2013. The effect of water salinity on growth and physiological stages of eight Canola (Brassica napus) cultivars. Irrig. Sci., (2006) 25: 11–20.

Ahmadi, S.H., and N.A. Æ Janebollah, 2006.The effect of water salinity on growth and physiological stages of eight Canola (*Brassica napus*) cultivars. Irrig. Sci., 25: 11–20.

Angadi, S.V., and H.V. Cutforth, 2003. Yield adjustment by canola grown at different by plant population under semiarid condition. Crop Sci., 43:1357–1366.

A.O.C.S., 1982. Official and Tentative Methods of American Oil Chemists Society. Published by the American Oil Chemists Society 35; East. Wacker Drive; Chicago; U.S.A

A.O.C.S., 1993. Official methods and recommended practices of the American oil Chemists Society. 27th ed. Arlington: A.O.C.S. Official Method Ce. American Oil Chemists Society, 1–62

Ashraf, M., and T. Mcneilly, 2004. Salinity tolerance in Brassica oilseeds. Critical Reviews in Plant Sciences, 23(2): 157-174.

Bailey, J.L., 1967. Techniques in Protein Chemistry. Elsevier Publishing Co., London, UK

Bandeh-Hagh A., M. Toorchi, A. Mohammadi, N. Chaparzadeh, G.H. Salekdeh, and H. Kazemnia, 2008. Growth and osmotic adjustment of canola genotypes in response to salinity. Journal of Food Agriculture and Environment, 6(2): 201-208.

Baux, A., T. Hebeisen and D. Pellet, (2008). Effects of minimal temperatures on low-linolenic rapeseed oilfatty-acid composition. European Journal of Agronomy, 29: 102-107.

Bybordi, A., S.J. Tabatabaei and A. Ahmedov, 2010. Effects of salinity on fatty acid composition of canola (*Brassica napus* L.). Journal of Food, Agriculture & Environment, 8 (1): 11 3 -115.

Chapman, H.D. and R.F. Pratt, 1978. Methods analysis for soil, plant and water. Univ. of California, Div. Agric. Sci., 16-38.

Corwin, D.L., J.D. Rhoades, and P.J. Vaughan, 1996. GIS applications to the basin-scale assessment of soil salinity and salt loading to groundwater. SSSA Spec. Publ., 48:295–313.

Dawood, M.G., and M.E. El-Awadi, 2015. Alleviation of salinity stress on Vicia faba L. plants via seed priming with melatonin. Acta Biol. Colomb., 20: 223–235. [CrossRef]

El-Esawi, M.A., A. Elkelish, H.O. Elansary, H.M. Ali, M. Elshikh, J. Witczak, and M. Ahmad, 2017. Genetic transformation and hairy root induction enhance the antioxidant potential of Lactuca serriola L. Oxid. Med. Cell. Longev., 5604746. [CrossRef]

Elkelish, A.A., H.A.S. Alhaithloul, S.H. Qari, M.H. Soliman, and M. Hasanuzzaman, 2020. Pretreatment with *Trichoderma harzianum* alleviates waterlogging-induced growth alterations in tomato seedlings by modulating physiological, biochemical, and molecular mechanisms. J. Environ. Exp. Bot., 171, 103946. [CrossRef]

Elkelish, A.A., M.H. Soliman, H.A. Alhaithloul, and M.A. El-Esawi, 2019. Selenium protects wheat seedlings against salt stress-mediated oxidative damage by up-regulating antioxidants and osmolytes metabolism. Plant Physiol. Biochem., 137: 144–153. [CrossRef]

Eppendrof, N. and G. Hing, 1970. Interaction manual of flame photometer B 700-E. Measuring method, Description of apparatus and Instructions for use.

FAO, 2016.www.fao.org/faostat/en/

François, B.B., 2007. Effect of salinity on germination and seedling growth of canola (*Brassica napus* L.). The degree of Master of Agricultural Sciences at the University of Stellenbosch.

Ghassemi, F., A.J. Jakeman, and H.A. Nik, 1995. Salinisation of land and water resources. Human causes, extent, management and case studies. University of New South Wales Press, Sydney, 526

Gorham, J., 1993. Genetics and physiology of enhanced K/ Na discrimination. In: Genetic aspects of plant mineral nutrition. Randall P. (Ed.). Kluwer Academic Publishers, Dordrecht, the Netherlands, 151-159.

Grattan, S., and C. Grieve, 1998. Salinity–mineral nutrient relations in horticultural crops. Sci. Hortic., 78: 127–157.[CrossRef]

Homaee, M., C. Dirksen, and R.A. Feddes, 2002. Simulation of root water uptake I. Non-uniform transient salinity using different macroscopic reduction functions.

Kaveh, H., H. Nemati, M. Farsi, and S.V. Jartoodeh, 2011. How salinity a_ect germination and emergence of tomato lines. J. Biol. Environ. Sci., 5: 159–163.

Keshta, M.M., K.M. Hammad and W.A.I. Sorour, 1999. Evaluation of rapeseed Genotypes in saline soil. In: "New Horizons for An Old Crop" Peroceedings of The 10th International Rapeseed Congress. Canbera. Australia.

Lichtenthaler, H.K., and C. Buschmann, 2001. Chlorophylls and carotenoids: measurement and characterization by UV-VIS spectroscopy. In: Wrolstad RE, Acree TE, An H, Decker EA, Penner MH, Reid DS, Schwartz SJ, Shoemaker CF, Sporns P (eds) Current protocols in food analytical chemistry (CPFA). John Wiley and Sons, New York, pp: F4.3.1–F4.3.8

Lin, F., C.R. Gensen and M.N. Andersen, 2004. Drought stress effect on carbohydrate concentration in soybean leaves and pods during early reproductive development. Its implication in altering pod set. Field crops res., 86: 1-13.

Machado, R., and R. Serralheiro, 2017. Soil salinity: E_ect on vegetable crop growth. Management practices to prevent and mitigate soil salinization. Horticulturae, 3: 30. [CrossRef]

Mandhania, S., S. Madan, and S. Sheokand, 2010. Differential response in salt tolerant and sensitive genotypes of wheat in terms of ascorbate, carotenoids proline and plant water relations. Asian Journal of Experimental Sciences, 1(4):792-797

MSTAT-C, 1988. MSTAT-C, a microcomputer program for the design, arrangement and analysis of agronomic research. Michigan State University, East Lansing.

Muhammad, S., I.A. Khalil, and S. Khan, 1991. Fatty acid composition of rape and mustard oilseed cultivars. Khyber Science Journal, Peshawar, 4(1):29-36.

Munns, R., and M. Tester, 2008. Mechanisms of salinity tolerance. Annu. Rev. Plant Biol., 59: 651–681.

Murillo-Amador, B., S. Yamada, T. Yamaguchi, E. RuedaPuente, N. Avila-Serrano, J.L. Garcia-Hernandez, R. Lopez-Aguilar, E. Troyo-Dieguez, and A. Nieto-Garibay, 2007. Influence of calcium silicate on growth, physiological parameters and mineral nutrition in two legume species under salt stress. Journal of Agronomy and Crop Science, 193: 413-421.

Nabizadeh Marost, M.R., 2002. Effects of salinity on yield, growth and solutes accumulation and oil essential of cumin. Master Thesis, Ferdowsi University of Mashhad.

Neocleous, D., and M. Vasilakakis, 2007. Effects of NaCl stress on red raspberry (Rubus idaeus L. ''Autumn Bliss''). Sci. Hortic., 112:282–289.

Parida, A.K., and A.B. Das, 2005. Salt tolerance and salinity effects on plants: a review. Ecotoxicol. Environ. Saf., 60: 324–342.

Rameeh, V., A. Cherati and F. Abbasside, 2012. Salinity effects on yield, yield components and nutrients ions rapeseed genotypes. Journal of Agricultural Sciences, 57(1): 19-29.

Rameeh, V., 2013. Effect of Salinity Stress on Yield, Component Characters and Nutrient Compositions in Rapeseed (Brassica napus L.) Genotypes. Agricultural Tropica Et Subtropica, 46(2): 58-63.

Rao, M.S.S., and N.J. Mendham, 1991. Soil–plant–water relations of oilseed rape (Brassica napus and B. campestris). J. Agric. Sci., 117: 197–205

Sakr, M.T., M.E. EL-Emery, R.A. Fouda and M.H. Mowufy, 2007. Role of some antioxidants in alleviating soil salinity stress. J. Agric. Missouri Univ., 32: 9751-9763.

Shannon, M.C., C.M. Grieve and L.E. Francois, 1994. Whole-plant response to salinity, In: R.E. Wilkinson (ed). Plant environment interaction. Marcel Dekker, New York, 199-224.

Sharif, P., M. Seyedsalehi, O. Paladino, P. Van Damme, M. Sillanpa and A.A. Shari, 2017. Effect of drought and salinity stresses on morphological and physiological characteristics of canola. Int. J. Environ. Sci. Technology

Shirazi, M.U., R.U. Ansari, M.A. Khan, S.S., Tahir, M.T. Rajput, A.S. Hereen and M. Ali, 2018. Salinity response of some amphidiploids species of brassica (Brassicaceae) at seedling and maturity stages. Pak. J. Bot., 50(6): 2113-2122.

Sinaki, J.M., E. Majidi, A.L. Shirani-Rad, G. Moormohammadi and G. Zarei, 2007. The effectet of water deficit during growth stage of canola (Brassica napus L). American joumal of Agric. and Environ. Sci., 2(4):417-422.

Soliman, M.H., A.A. Alayafi, A.A. El Kelish, and A.M. Abu-Elsaoud, 2018. Acetylsalicylic acid enhance tolerance of phaseolus vulgaris l. to chilling stress, improving photosynthesis, antioxidants and expression of cold stress responsive genes. Bot. Stud., 59, 6. [CrossRef]

Tie H., and G.R. Cramer 1992. Growth and mineral nutrition of 6 rapid-cycling Brassica species in response to seawater salinity. Plant and Soil, 139 (2): 285-294.

Toderich , N.K., A.A. Mamadrahimov, B.B. Khaitov, A.A. Karimov, A.A. Soliev, K. Nanduri , and E.V. Shuyskaya, 2020. Differential Impact of Salinity Stress on Seeds Minerals, Storage Proteins, Fatty Acids, and Squalene Composition of New Quinoa Genotype, Grown in Hyper-Arid Desert Environments. Front Plant Sci., 7(11):607.

Zamani, S., M.T. Nezami, D. Habibi, and M.B. Khorshidi, 2010. Effect of quantitative and qualitative performance of four canola cultivars (Brassica napus L) to salinity conditions. Advances in Environmental Biology, 4(3): 422-427.

Zhao, G.Q., B.L. Ma, and C.Z. Ren, 2007. Growth, gas exchange, chlorophyll fluorescence and ion content of naked oat in response to salinity.Crop Sci., 47:123–131.

Zörb, C., C.M. Geilfus, and K.J. Dietz, 2019. Salinity and crop yield. Plant Biol., 21: 31–38.[Cross Ref]