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INVESTIGATIONS ON FOLIAR SPRAY OF BORON AND MANGANESE ON OIL CONTENT AND CONCENTRATIONS OF FATTY ACIDS IN SEEDS OF SUNFLOWER PLANT RAISED THROUGH SALINE WATER IRRIGATION

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□ *The objective of this experiment was to evaluate the effect of foliar fertilization of some micronutrients [i.e., manganese (Mn) and boron (B)] on reproductive yield and fatty acid concentrations of a standard sunflower hybrid ('NuSun 636') irrigated with different concentrations of saline water made by dissolving sea salt. Reproductive yield showed a significant decrease with the increase in salt in the rooting medium. However, foliar sprays of boric acid (H_3BO_3) and manganese chloride ($MnCl_2$) showed a significant increase in seed number, seed weight, and oil content of seeds in the nonsaline control, which persisted even under saline water irrigation. An increase under the $MnCl_2$ spray was more than with H_3BO_3 irrespective of non saline or saline water irrigation. Increasing levels of salinity appeared to be responsible for a decrease in oleic monounsaturated fatty acid concentration and an increase in the linoleic polyunsaturated, palmitic and stearic saturated fatty acid content whereas no significant change was found in linolenic polyunsaturated fatty acid content. Foliar applications of H_3BO_3 and $MnCl_2$ brought some beneficial alteration in fatty acid concentrations of sunflower. Foliar application of H_3BO_3 caused a significant increase in palmitic and stearic saturated fatty acids and linoleic polyunsaturated fatty acids in control as well as under saline conditions. Oleic monounsaturated fatty acid concentration showed a decline under H_3BO_3 treatment irrespective to nonsaline or saline conditions. Foliar applications of $MnCl_2$ increased the concentration of palmitic saturated fatty acid and oleic monounsaturated fatty acid irrespective to the plant growth under non saline or saline conditions. While stearic saturated fatty acid, linoleic and linolenic polyunsaturated fatty acid decreased with the application of manganese as compared to the non sprayed control.*

Keywords: fatty acid, foliar fertilization, micronutrients, oil yield, salinity stress

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INTRODUCTION

Sunflower is cultivated primarily for its seeds, which is one of the world's most important sources of edible oil. It is currently cultivated in dry areas where salinity can be a threat, but has the possibility of its adaptation in the near future for the saline soils in the USA and other parts of the world (Flagella et al., 2004).

Sunflower seed produces oil up to 50% by weight. The quality of sunflower oil is determined by the content of oil and its composition, which includes amounts of saturated fatty acids (stearic and palmitic) and unsaturated fatty acids (oleic, linoleic and linolenic). The concentrations of fatty acids differ in seeds of various sunflower cultivars. Since the main component are oleic and linoleic acids, they could be classified as high linoleic acid, high oleic acid and mid oleic acid producing varieties. High linoleic sunflower oil typically has at least 69% linoleic acid. High oleic sunflower oil has 82% oleic acid. Efforts are being made to develop high oleic sunflower varieties in oil that may approach or exceed 90% oleic fatty acid content. Oil containing higher monounsaturated (oleic) fatty acid does not polymerize as readily under high-temperature regimes in comparison to the oil containing higher amount of polyunsaturated fatty acid (linoleic and linolenic). The oil with high monounsaturates has a very neutral taste and provides excellent stability without hydrogenation. Variation in unsaturated fatty acids profile is strongly influenced by both genetics and climate (Knowles, 1989; Petcu et al., 2001). Fertilizing management also affect fatty acid composition of oil seed crops (Bybordi and Mamedov, 2010).

The literature revealed the effects of salinity on the yield and fatty acid composition of oil (Bassil and Kaffka, 2002; Heuer et al., 2002; Parti et al., 2003; Flagella et al., 2004). Flagella et al. (2004) reported a significant increase in oleic acid and decrease in oil yield and linoleic acid of high oleic sunflower hybrid under saline conditions. Baldini et al. (2002) reported an increase in oleic acid in high oleic sunflower hybrids and decrease of it in standard hybrids under water stress.

The use of foliar fertilizing in agriculture has been a popular practice with farmers since the 1950s, when it was considered most effective and economical. Recent research has shown that very small amount of nutrients, like zinc (Zn), iron (Fe), boron (B), and manganese (Mn) applied by foliar spraying increases significantly the yield of the crops (Sarkar et al., 2007; Wissuwa et al., 2008). In an open field conditions, where the factors like salinity, that influence the uptake of the nutrients, foliar fertilization can get considerable importance. Foliar application of sodium antagonistic minerals could be an alternative strategy for coping with salinity and providing plants balanced nutrients. It partially overcomes the negative effect of stress condition influencing root growth and absorption capacity. In this respect, El-Fouly and El-Sayed (1997) have recommended foliar fertilization of both macro- and micronutrients whenever, nutrient uptake through the root system is restricted due to salt stress.

The purpose of this study is to evaluate the betterment, if any, in oil yield and fatty acid concentration of a standard sunflower hybrid ('NuSun 636'), subjected to the foliar spray of micronutrients (i.e., B and Mn) under different salinity levels (ECiw 6.1 and 10.8 dS m^{-1}).

MATERIALS AND METHODS

A set of 45 plastic pots were used in the experiment. These pots were of 0.28 m in diameter, and 0.30m deep, having basal holes for leaching irrigation water, filled with 20 kg of sandy loam soil and cow dung manure (9:1) having pH 7.4. The seeds of single head Sunflower ('NuSun 636') were sown in second week of November, 2008. The nitrogen (N)-phosphorus (P)-potassium (K) ratio of 4:3:2 was provided through application of urea, DAP and sulphates of potash (SOP) in soil as recommended by Nawaz et al. (2003), which amounts to 0.744 g N, 0.558 g P, and 0.372 g K per pot, given at the time of sowing and at the time of flowering. Micronutrients were given in soil via Hoagland's solution (Hoagland and Arnon, 1938) twice along with irrigation water.

A randomized complete block design with five replications was used. Forty-five pots were divided in three sets comprising of 15 pots of each set, i.e., non spray control, foliar spray with boric acid (H_3BO_3), and foliar spray with manganese chloride ($MnCl_2$), respectively. Out of 15 pots of each set, five of each were subjected to different levels of saline irrigation, i.e., non saline water (control: EC_{iw} 0.5 dS m^{-1}), 0.4% sea salt solution (EC_{iw} 6.1 dS m^{-1}) and 0.8% sea salt solution (EC_{iw} 10.8 dS m^{-1}) respectively. Sea salt solutions for irrigation were prepared by adding required amount of sea salt in tap water per liter. Sea salt is available in crude form in market. About 4% of its concentration was found equivalent to concentration of salts in the water of Indian Ocean. Sea water contains about 85% of sodium chloride (NaCl) and remaining percent may be of other elements (Castro and Huber, 2005).

Since seed germination and establishment of seedling of sunflower plant were found highly irregular even at lower level of salinity and it was not possible to start the experiment with seedlings of the same age having same height and number of leaves in this experiment, hence it was decided to sow them in pots under non saline condition and start saline water irrigation after two and a half weeks of germination. Seedling of equal height containing three leaves excluding cotyledonary leaves were selected for further work. This practice would be equivalent to transfer of young seedling at saline soils raised separately under non saline conditions. Only one seedling was kept in each pot. They were irrigated with gradual increasing sea salt concentration weekly up to reaching the desired salinity levels of the experiment mentioned above. To maintain the required soil medium salt levels the EC of the soil medium was measured periodically by portable EC meter. Foliar applications of the mineral solution (H_3BO_3 and $MnCl_2$) were given thrice, 45, 75 and 95 days after planting (during seedlings establishment, incipient of floral heads and start of seed formation, respectively) at the rate of 5ppm. The concentration of B and Mn in their respective solution, applied to the plants through foliar application was 0.85 ppm and 2.2 ppm, respectively. Tween-20 (0.1%) was used as a wetting agent for each treatment. A volume 300 mL plant^{-1}, of the solution was sprayed on all pots with a manual sprayer. Spray was carried out between 09:00 and 11:00 AM. The plants were sprayed with H_3BO_3 and $MnCl_2$ solutions with uniform coverage until the leaves were completely wet and the solution ran off the leaves. At the time of spray other plants were covered with plastic sheet to prevent the contamination of sprayed nutrients.

Control (non-saline) plants were irrigated with 3.5 L of tap water and plants under saline treatments were irrigated with 3.5 L of their respective sea salt solution twice a week ensuring about 40% leaching. Pest management was carried out during the growth season according to local practice.

Data on reproductive growth was recorded at harvest in terms of number of seeds produced on single floral head of Sunflower ('NuSun 636') along with their weight. Oil from the seed samples was extracted with petroleum ether using Soxhlet apparatus and the fatty acid composition was determined by using a CLARUS model GC-500 (Perkin Elmer Company, Waltham, MA, USA) gas chromatograph according to AOCS (2004) using facilities of the OIL and FATS department of Pakistan Council of Scientific and Industrial Research (PCSIR). To measure the electrical conductivity of soil extract (ECe), soil samples were collected from the rhizophere of all the plants undergoing various treatments at the end of the harvest, saturated with deionized water and filtered under vacuum as outline in USDA Handbook 60 (Richards, 1954). Electrical conductivities of the extracts (ECe) were measured by Rocker (Model 300).

Statistical analyses were carried out using SPSS version 13 (SPSS, Chicago, IL, USA). Data sets were subjected to two-way analysis of variance (ANOVA). Significant differences among the mean values were calculated using Duncan Multiple Range Test (Duncan, 1955).

RESULTS

Seed Number and Weight/Plant

Effect of foliar application of H_3BO_3 and $MnCl_2$ on number and weight of seeds/head of sunflower plant under different salinity levels (i.e., 0.4% and 0.8% conc. of sea salt) is presented in Table 1. Number and weight of seeds per plant significantly ($P < 0.05$) decreased with increasing concentrations of sea salt solutions. Foliar application of nutrient solution partially

TABLE 1 Effect of foliar application of H_3BO_3 and $MnCl_2$ on reproductive yield of sunflower plant under irrigation of different salinity levels

Sea salt concentration (%)	Foliar application	No. of seeds/ plant	Weight of seeds/ plant (g)	Amount of oil in seeds/ plant (g)	Oil content in seeds (%)
0 Control (ECiw:0.5dS/m, ECe:1.8dS/m)	Non-spray Control -1	$384.0^{ab} \pm 6.55$	$19.97^{ab} \pm 0.80$	$8.90^{b} \pm 0.41$	$44.90^{ab} \pm 0.42$
	H_3BO_3	$512.0^{a} \pm 9.81$ (+25 %)	$29.69^{a} \pm 0.76$ (+32.7%)	$13.34^{a} \pm 0.34$ (+ 33.3 %)	$48.50^{a} \pm 0.28$ (+7.4 %)
	$MnCl_2$	$528.0^{a} \pm 10.50$ (+27.3 %)	$30.62^{a} \pm 0.75$ (+34.8%)	$13.77^{a} \pm 0.47$ (+ 35.4 %)	$48.80^{a} \pm 0.46$ (+8.0 %)
0.4 (ECiw:6.1dS/m, ECe:7.4 dS/m)	Non spray Control -2	$332.0^{bc} \pm 6.93$ (−13.5%)	$14.94^{ab} \pm 0.62$ (−25.2%)	$7.70^{b} \pm 0.29$ (−13.5 %)	$38.90^{b} \pm 0.40$ (−13.4 %)
	H_3BO_3	$458.0^{b} \pm 2.73$ (+27.5%)	$23.91^{b} \pm 0.25$ (+37.5%)	$12.00^{ab} \pm 0.14$ (+ 35.8%)	$43.50^{ab} \pm 0.37$ (+10.6 %)
	$MnCl_2$	$474.0^{ab} \pm 8.66$ (+30.0%)	$24.74^{b} \pm 0.77$ (+39.6%)	$12.39^{ab} \pm 0.31$ (+ 37.9%)	$43.90^{ab} \pm 0.25$ (+11.4 %)
0.8 (ECiw:10.8 dS/m, ECe:12.2 dS/m)	Non spray Control -3	$242.0^{c} \pm 8.87$ (−37%)	$7.86^{c} \pm 0.97$ (−60.6%)	$5.58^{c} \pm 0.35$ (−37.3 %)	$28.00^{c} \pm 0.38$ (−37.6 %)
	H_3BO_3	$338.0^{bc} \pm 6.87$ (+28.4%)	$13.11^{abc} \pm 0.43$ (+40%)	$9.00^{bc} \pm 0.18$ (+ 38.0%)	$33.00^{bc} \pm 0.86$ (+15.2 %)
	$MnCl_2$	$348.0^{bc} \pm 4.07$ (+30.5%)	$13.50^{abc} \pm 0.21$ (+41.8%)	$9.25^{bc} \pm 0.06$ (+ 39.7%)	$33.40^{bc} \pm 0.27$ (+16.2 %)
LSD at level 0.05	Salt	6.070	0.514	0.239	0.336
	Spray	7.009	0.594	0.276	0.388
	Interaction (Salt × Spray)	***	***	**	*

Figures in parenthesis indicate % promotion (+) and reduction (−) over control.
Reduction percentage due to different salinities of irrigation water in non spray plants has been calculated in comparison with non saline control. Whereas promotion due to foliar spray has been calculated over their respective non spray control undergoing various saline irrigatio).
± indicate standard error of mean.
ECiw: Electrical conductivity of irrigation water.
ECe: Electrical conductivity of soil extract.
LSD: Least significant difference.
Different letters indicate significant differences among treatments at 5% level of significance in Duncan's Multiple Range Test.

overcame salt-induced detrimental effects and significantly increased the number and weight of seeds per plant irrespective to their growth under non saline or saline water irrigation. Plants sprayed with $MnCl_2$ produced significantly higher seed yield as compare to those plants sprayed with H_3BO_3.

Seed Oil Content and Yield

Table 1 shows a significant reduction in oil content of seeds and oil yield per plant with the increasing concentration of sea salt solutions. Spray with H_3BO_3 and $MnCl_2$ exerted a significant effect and increased seed oil content and oil yield per plant irrespective to their growth under different saline irrigation water. Mn is found to have more stimulatory effect on oil yield than boron.

Oil Fatty Acids Composition

Sunflower ‘Nusun 636’ is a standard hybrid as it shows 71.05% oleic acid content and 20.26% linoleic acid content. Significant changes are recorded in fatty acid profile with the increase in salinity levels (Table 2). The oil saturated fatty acids, palmitic and stearic one and polyunsaturated fatty acid, the linoleic one increased with increasing levels of salinity. However, linolenic acid is found unaffected at low salinity level but decreased at highest salinity level, i.e., 0.8% sea salt solution. The monounsaturated, oleic acid is found decreased with the increasing concentration of saline irrigation water.

The data in Table 2 reveal that foliar application of H_3BO_3 caused a significant increase in palmitic acid, stearic acid, linoleic acid in control as well as under saline conditions, except linolenic acid which shows a slight increase in control but decrease under saline condition. Oleic acid concentration shows a decline under H_3BO_3 treatment irrespective to nonsaline or saline conditions. Foliar applications of $MnCl_2$ positively affect the concentration of palmitic acid and oleic acid and increased their amount irrespective to the plant growth under non saline or saline conditions. Whereas stearic acid, linoleic acid and linolenic acid decreased with the application of manganese as compare to non-sprayed control.

DISCUSSION

In present investigation it was observed that sea salt salinity significantly depressed number and weight of seeds of sunflower plant and as a result, decreased the reproductive growth of plants. The obtained data of seed yield (in terms of seed weight) showed 60.6% reduction at ECe 12.2dS m^{-1} as compared to non saline control. Abd El- Kader et al. (2006) found 50% reduction in yield at soil EC 9.4 dS m^{-1} in ‘fedok’ sunflower cultivar. The results were also similar to those of Rehman and Hussain (1998), who observed a negative relationship between achene yield and salinity stress. The decrease in seed yield and oil yield with increasing salinity also confirms the findings of other workers (El-Kheir et al., 2000, Flagella et al., 2004, Abd El-Kader et al., 2006; Di Caterina et al., 2007). Reduction in seed number by exposure to salt may be due to either lesser number of ovule formation per ovary or failure in fertilization (Uma and Patil, 1996). The reduction in seed oil content may probably be due to the retarded development of seed and early maturity of plants on high salinity treatments (Akhtar et al., 2002). The depressing effects of salt may be due to the disturbance in photosynthesis, enzyme activities, protein synthesis energy and lipid metabolism (Parvaiz and

TABLE 2 Effect of foliar application of H_3BO_3 and $MnCl_2$ on fatty acid composition of sunflower oil obtained from the plants irrigated with water of different salinity levels

		Fatty acids (%)				
Sea salt concentration (%)	Foliar application	Palmitic (C16:0)	Stearic (C18:0)	Oleic (C18:1)	Linoleic (C18:2)	Linolenic (C18:3)
0 Control (ECiw:0.5dS/m, ECe:1.8dS/m)	Non-spray Control -1	4.38 ± 0.13	2.61 ± 0.05	71.05 ± 0.35	20.26 ± 0.22	0.22 ± 0.01
	H_3BO_3	4.40 ± 0.07(+4.5%)	2.68 ± 0.15(+2.6%)	70.86 ± 0.57(−2.7%)	20.35 ± 0.54(+4.4%)	0.24 ± 0.01(+8.3%)
	$MnCl_2$	4.62 ± 0.21(+5.2%)	1.96 ± 0.03(−24.9%)	71.69 ± 0.62(+9.0%)	19.58 ± 0.57(−3.4%)	0.10 ± 0.01(−54.5%)
0.4 (ECiw:6.1dS/m, ECe:7.4 dS/m)	Non-spray Control -2	4.40 ± 0.04(+4.5%)	3.48 ± 0.07(+25%)	68.60 ± 0.28(−3.4%)	21.92 ± 0.57(+7.6%)	0.22 ± 0.02
	H_3BO_3	4.60 ± 0.10(+4.3%)	3.59 ± 0.07(+3.1%)	61.78 ± 0.43(−9.9%)	28.61 ± 0.36(+23.4%)	0.20 ± 0.01(−9.1%)
	$MnCl_2$	5.36 ± 0.02(+17.9%)	2.96 ± 0.21(−14.9%)	69.23 ± 0.38(+9.1%)	21.00 ± 0.27(−4.2%)	tr
0.8 (ECiw:10.8 dS/m, ECe:12.2 dS/m)	Non-spray Control -3	4.55 ± 0.12(+3.7%)	3.86 ± 0.11(+32.4%)	67.28 ± 0.53(−5.3%)	23.32 ± 0.43(+13.1%)	0.21 ± 0.01(−4.5%)
	H_3BO_3	4.74 ± 0.07(+4%)	3.95 ± 0.70(+2.3%)	60.44 ± 0.27(−10.2%)	28.93 ± 0.38(+19.4%)	0.19 ± 0.02(−9.5%)
	$MnCl_2$	4.67 ± 0.03(+2.6%)	3.26 ± 0.15(−15.5%)	67.93 ± 0.57(+9.6%)	22.18 ± 0.35(−4.9%)	tr
LSD at level 0.05	Salt	0.103	0.256	0.456	0.421	0.012
	Spray	0.104	0.255	0.456	0.423	0.012
	Interaction (Salt × Spray)	***	ns	***	***	***

Figures in parenthesis indicate % promotion (+) and reduction (-) over control.
Reduction or promotion percentage in fatty acids concentrations due to different salinities of irrigation water in non spray plants has been calculated in comparison with non saline control. Whereas reduction or promotion in fatty acid concentration due to foliar spray has been calculated over their respective non-spray control undergoing various saline irrigation.
± indicate standard error of mean.
ECiw: Electrical conductivity of irrigation water.
ECe: Electrical conductivity of soil extract.
LSD: Least significant difference.
ns: Not significant.

Satyawati, 2008), which effects the metabolites transportation to the grains and hence lead to decreased yield, as found in the present study. It was also observed in present study, however, that these detrimental effects of sea salt on growth yield could be partially alleviated by the application of nutrient solution (B and Mn) through decreasing the nutrient demand in salt affected plants. When nutrients are applied to the leaves, the nutrient elements might penetrate into the leaves and restrict the inhibition due to toxic effects of Na^+ and Cl^- or minimizes the salinity induced nutrient deficiency. These nutrients increased photosynthetic and enzymatic activities and an effective translocation of assimilate to reproductive parts resulting in higher yield (Mengel, 1976; Sarkar and Malik, 2001). Kassab (2005) also observed a significant effect of micronutrients in growth parameters including yield in mung bean plants by foliar application of zinc, manganese and iron under soil moisture stress. Such enhancement effect might be attributed to the favorable influence of these nutrients on metabolism and biological activity and its stimulating effect on photosynthetic pigments and enzymes activity, which in turn encourage growth of plants (Michail et al., 2004). In present investigation manganese (Mn) was found to have more stimulatory effect on seed and oil yield than boron (B).

In the present work significant changes were recorded in fatty acid profile of the sunflower with the increase in salinity levels. Palmitic and stearic saturated fatty acids were increased at all salinity levels. A similar increasing trend was also recorded in linoleic polyunsaturated fatty acid with increasing salinity. Whereas oleic monounsaturated fatty acid showed a gradual decrease with increasing salinity levels. Petcu et al. (2001) observed similar changes in fatty acid composition in seeds of five Romanian sunflower hybrids under water stress. They observed a significant increase in linoleic acid and a decrease in oleic acid (about 4 to 14%) under water stress. According to the findings of Baldini et al. (2002), water stress caused an increase in oleic acid in high oleic (higher than 82%) sunflower hybrids and also caused a reduction of it in standard hybrids (72% oleic acid). They observed 15% reduction in the concentration of oleic acid in standard sunflower hybrid under water stress. Parti et al. (2003) also reported decreased oleic acid in polar lipid and increased linoleic acid in both polar and neutral lipid in seeds of mustard plant exposed to 4, 8, and 12dS/m ECe salinity levels. At 12 ECe an approximately 1.3-fold increase was registered in linoleic acid over the control for both polar and neutral lipid fractions, which indicate that with increasing salinity, the level of unsaturation increased. Similar to the present work, polyunsaturated fatty acids showed an increase which seems logical as these are primarily membrane lipid components that get altered so as to maintain the polarity and integrity of membrane. All these changes induced in the fatty acid profile may be considered to be adaptations, which increase the chance of the plant to endure salinity (Sukhija et al., 1983). Foliar application of H_3BO_3 caused a significant increase in saturated fatty acids and linoleic polyunsaturated fatty acids and a decrease in linolenic polyunsaturated and oleic monounsaturated fatty acids under non saline control as well as saline water irrigation. Whereas Bellaloui et al. (2009) reported a significant increase in oleic monounsaturated fatty acid in soybean with the foliar application of H_3BO_3 at 0.45 kg ha^{-1}, in comparison with non spray control plant.

Low content of saturated fatty acids is desirable for edible oil. Enzyme Δ-9 desaturase is reported to be responsible for the biosynthesis of oleic acid (18:1) through desaturation of stearic acid (18:0) (Baldini et al., 2002), whereas oleic acid (18:1) is desaturated by Δ-12 for producing linoleic acid (18:2) (Garees and Mancha, 1991). Higher levels of linoleic and oleic acids improve oil quality (Downey and Rimmer, 1993). Linoleic acid is found in abundant among unsaturated fatty acid. The stimulatory effect of boron spray on linoleic polyunsaturated fatty acid is probably due to its availability in fundamental metabolic reactions, which have direct impact in bringing out distinct changes in seed oil quality. Some of the changes may affect fatty acid composition of seed oil by activation of enzymes, which catalyze the biosynthesis of the unsaturated fatty acids.

Foliar applications of $MnCl_2$ have shown an increase in concentration of palmitic saturated acid and oleic monounsaturated fatty acid and decrease in stearic saturated fatty acid, linoleic and linolenic polyunsaturated fatty acids (Table 2). This result is in agreement with the findings of Wilson et al. (1982), as they observed an increase in oleic monounsaturated fatty acid with the increasing levels of leaf manganese associated with the decrease in linoleic polyunsaturated fatty acid and other certain fatty acids in soybean oil. This effect was attributed to the higher rates of photosynthesis due to Mn supplement, which becomes responsible for greater supply of carbon skeletons in fatty acid synthesis. Direct involvement of manganese as a component of the biotic enzyme might be a contributing factor in the biosynthesis of the fatty acids. A significant increase in unsaturated fatty acids was also reported by Bybordi and Mamedov (2010) in canola, and Zakaria et al. (2001) in cotton with the foliar application of essential micronutrients, which include Fe and Zn.

The resultant EC of soil (ECe) due to saline water irrigation of different concentration is included in Tables 1 and 2. Which is about 1 and a half times more than that of irrigation water in spite of practicing 40% leaching. Hence these results could be interpreted on the basis of EC of saline soil (ECe) as well and effect of salinity in rooting medium either through saline water irrigation or through saline soil will remain the same.

The results of the present study show that though salinity has reduced growth but at the same time brought some useful alteration in fatty acid profile as it increased the level of unsaturation. Polyunsaturated fatty acids are primarily membrane lipid components that get altered under salinity to maintain the polarity and integrity of membrane, which may be considered to be adaptations, which increase the chance of the plant to endure salinity (Sukhija et al., 1983). Whereas foliar spray of boron and manganese has offset the negative effects of salinity up to various extant, increased plants yield, and brought some beneficial changes in oil profile of fatty acids. Foliar application of manganese was found to increase oleic monounsaturated fatty acid and boron was found to increase linoleic polyunsaturated fatty acids, which are required to maintain the quality of edible oil.

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