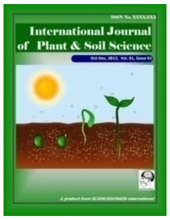

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Interactive Effects of Calcium and Boron Application on Nutrient Content, Growth and Yield of Faba Bean Irrigated by Saline Water

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Faba bean (*Vicia faba* L. var. Nobaria 12) was grown under saline irrigation water (1.0% Sea salt EC_{iw} = 15.2dS m^{-1}) and none saline water (Control, EC_{iw} = 0.64dS m^{-1}) and subjected to soil application of calcium (0,100 and 200ppm Ca as Calcium hydroxide) and foliar application of boron (0, 5 and 10ppm as boric acid). Results indicated that the reduction in growth and yield was found proportional with increasing salinity of irrigation water at all studied parameters but application of calcium and boron minimized the deleterious effects of salinity up to various extents. The significant improvement was observed in the shoot and root weight, chlorophyll content of leaves, due to the application of 200ppm calcium combined with foliar application of 5ppm boron under both non saline and saline conditions of irrigation water. Also, Pod and seed yield was increased as affected by Ca and B application under both saline and none saline irrigation water. In general, K^+/Na^+ and Ca^{2+}/Na^+ ratios of faba bean shoot was lower under saline irrigation water condition as compare to none saline water. Foliar spray of Boron at 5ppm was found much effective to minimize K^+/Na^+ and Ca^{2+}/Na^+ ratios and alleviating salinity hazard. Excess of Boron caused deleterious effects on plant growth indicating Boron toxicity at 10ppm B applied as foliar application.

Keywords: Saline water; calcium; boron; chlorophyll; potassium to sodium ratio.

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1. INTRODUCTION

Agriculture with high water requirements under increased occurrence of extreme drought events have forced irrigation with poor quality water from both irrigation drainage and groundwater sources, causing processes of degradation, reduction of the production capacity, and soil salinization [1,2]. Salinization affects about 30% of the irrigated land at world level [3]. Apart from naturally existing saline lands, a significant proportion of recently cultivated agricultural land has become saline due to secondary salinity as a result of the human activity. Soil salinity affects plants in two ways viz., high concentrations of salts in the soil make it harder for roots to extract water while high concentrations of salts within the plant become toxic for growth [4]. To cope with toxic effect of salts, plants develop biochemical and molecular mechanisms which include compartmentalization of ions at cellular and whole-plant level, synthesis of compatible solutes, change in photosynthetic pathway, alteration in membrane structure, induction of anti oxidative enzymes and plant hormones [5,6].

Faba bean (*Vicia faba L.*) is an important food crop in Egypt grown in winter season. It is a good source of protein for human food and animal feeding which contain most of the necessary amino acids for human and animal nutrition and low sulphur amino acids concentrations. Faba bean is often grown on saline soils in Egypt, yet few studies have been published on its response to salinity. On the other hands, the susceptibility of faba bean to salinity [7,8] will restrict or even prevent its cultivation in such newly reclaimed area in which the use of saline water or even diluted seawater become the only source of irrigation. Excessive sodium present in the rhizosphere, apart from its own toxic behavior in plant metabolism, causes physiological droughts. Being antagonistic to other cations, sodium inhibits their entry in root system; hence plants suffer deficiency of other mineral elements, which are essential for growth [9].

Excessive salinity is one of the most important environmental stress factors that greatly affect the nutrition of plant in arid and semiarid regions. Salinity disturbs the mineral-nutrient relations in plants through their effects on nutrient availability, transportation, and partitioning [10]. Additionally, salt stress also induces ions deficiency or imbalance of nutrients since the accumulation of high Na concentrations in tissues of plants growing in saline media restricts the uptake of essential nutrients in many species [11].

Importance of Boron is also well documented for great variety of physiological processes in plants and it seems to exert different effects such as root elongation, indole-3-acetic acid oxidase, sugar translocation, carbohydrate metabolism, nucleic acid synthesis and pollen tube growth [12,13]. Moreover, more than 90% of the boron is found in cell walls. Its functions are also related to cell wall synthesis, lignifications and maintenance of cell wall structure [14]. Its deficiency predominantly damages actively growing organs such as shoot and root tips and effects flower retention, pollen formation, pollen tube growth or germination, nitrogen fixation and nitrate assimilation [15].

The aim of present research work is to increase the level of salinity tolerance of faba bean above their threshold value by application of essential minerals such as calcium and boron, so that they could be grown under a bit higher level of salinity up to profitable extent.

2. MATERIALS AND METHODS

2.1 Plant Material and Growth Condition

This research work was conducted at the wire house of National Research Centre, Dokki, Cairo, Egypt (29.77 N, 31.3 E), from 15 November 2012 to 20 March 2013 to study the effect of calcium and boron application on growth and yield of faba bean irrigated by saline and none saline water. Faba bean (*Vicia faba* L. cv. Nobaria 12) seeds were selected for uniformity by choosing those of equal size and with the same color. The selected seeds were washed with distilled water, sterilized with 1% sodium hypochlorite solution for 2 minutes and washed 3 times with tap water, then allowed to imbibe in distilled water for one hour. Five seeds of faba bean were sown in plastic pots containing about 10Kg of clay loams soil, pH (8.02) and EC (5.13 dS m^{-1}). A hole was made in base for leaching purpose. Thinning of seedlings was done at three leaf stage by leaving a single well developed seedling of approximately same size in each pot.

2.2 Experimental Setup

The pots were subjected to salinity treatments for creating saline substrate through irrigation water as: None saline control irrigated with tap water

(EC_{iw} = 0.64dS m^{-1}) and saline water as 1.0% sea salt solution (EC_{iw} = 15.22dS m^{-1}). These two sets were supplyied with: Soil applications of calcium as: Control, 100 and 200 ppm calcium as calcium hydroxide applied during seedling stage, named as Ca_0, Ca_1 and Ca_2, respectively. Foliar application of Boron as: control, 5 and 10 ppm B as Boric acid at 30 and 60 day of sowing, named as B_0, B_1 and B_2, respectively. This factorial experiment was laid out in randomized block design with four replicates. Analysis of irrigation water presented in Table 1.

2.3 Measurements

The plant samples were collected from each treatment randomly at 40, 80 days after sowing and at harvest. Fresh and dry biomass of root and shoot was recorded. Pod fresh and dry weight and 100 seed weight was also estimated. The chlorophyll a, b and carotene were estimated in the fresh leaves as described by [16]. Total sodium, potassium and calcium of root and shoot were estimated in the plant digest according to the method described by [17].

2.4 Statistical Analysis

The data observed from experiment were subjected to the analysis of variance (ANOVA) appropriate to the randomized complete block design. The means were compared with the critical difference test at 5% probability level by the Duncan's Multiple Range Test according to [18].

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Data in Table 2 revealed that fresh and dry root and shoot of faba bean plant at 40 and 80 day after sowing significantly reduced due to irrigation by saline water as compare to irrigation by none saline water. There appeared significant decrease in vegetative biomass of root and shoot raised under irrigation by none saline water as well as irrigation by saline water sprayed with only foliar application of boron (B) but the increase due to application of Calcium (Ca) was comparatively greater.

Foliar application of 5ppm Boron (B) significantly increased fresh and dry weight of root and shoot as compared to 10ppm Boron applied as boric acid at 40 and 80 day after sowing in both saline and none saline irrigation water. Various plants are sensitive to higher Boron concentration up to different extent. Excessive boron can cause deleterious effects on plant growth. In present experiment spray of 10ppm H_3BO_3 appears not suitable concentration for faba bean plant. According to [19] excess exogenous B concentration (10 and 15ppm) and salinity (4 and 8 dS m^{-1}) interact to limit growth, decrease all the vegetative growth parameters resulting decrease in yield components of wheat. Hence it appears that critical value of the toxicity of boron vary in different crops depending upon the physiology of their growth.

The combined effect from application of 200ppm Ca + 5ppm B in case of irrigation by none saline water (0.64dS m^{-1}) gave the highest values of root fresh weight (1.96 and 4.14) and shoot fresh weight (15.13 and 55.38) at 40 and 80 day of sowing, respectively. Whereas, in case of faba bean irrigated by saline water (15.22dS m^{-1}) significant increased was observed in fresh weight of faba bean root (1.58 and 3.61) and shoot (13.99 and 39.29) at 40 and 80 day of sowing as influenced by the combine treatment of 200ppm Ca + 5ppm B as compare to control treatments of saline and none saline irrigation water. Total leaf area and biomass of cotton was decreased at EC = 6.2 and 10.8dS m^{-1} of irrigation water [20]. The dry biomass of shoot followed same trend as shown by fresh shoot biomass.

3.2 Biochemical Parameters

Data presented in Table 3 showed significant decreased in chlorophyll content due to the deleterious effect of irrigation by saline water due to higher accumulation of salts in plant parts. Data presented here shows the concentration of Chlorophyll a, b and carotene kept on increasing by foliar spray of B in plants growing under none saline conditions over irrigation by saline water treatment. In Case of irrigation by none saline water, application of 5ppm boron proved better in increasing Chlorophyll content at 40 and 80 day of sowing over application of 10ppm Boron.

Table 1. Analysis of irrigation water used in the experiment

Irrigation Water	pH	EC dS m^{-1}	Cations (me l^{-1}) Ca^{2+}	Mg^{2+}	K^+	Na^+	Anions (me l^{-1}) CO_3^{2-}	HCO_3^-	Cl^-	SO_4^{2-}	SAR (%)
None saline	7.2	0.64	2.08	4.82	0.27	3.13	0.00	4.28	4.20	1.82	1.68
Saline	6.8	15.22	5.00	138.75	0.83	87.39	0.00	5.13	131.25	95.60	10.31

Table 2. Effect of calcium and boron application on root and shoot weight (g $plant^{-1}$)

Treatments		Root fresh weight		Root dry weight		Shoot fresh weight		Shoot dry weight	
		40 day	80 day	40 day	80 day	40 day	80 day	40 day	80 day
None saline water	Ca_0 B_0	1.10f	2.17h	0.123g	0.73h	9.57d	31.13e	1.29e	8.02g
	Ca_0 B_1	1.52c	3.17f	0.144de	1.13e	13.96c	37.90d	1.93b	12.28a
	Ca_0 B_2	1.11f	2.80g	0.128f	0.89f	12.06c	26.88f	1.34e	9.06ef
	Ca_1 B_0	1.24e	3.55e	0.156d	0.81g	11.64bc	39.26d	1.89b	8.74f
	Ca_1 B_1	1.79b	3.84e	0.183b	1.63b	14.48ab	46.58b	2.42a	11.31b
	Ca_1 B_2	1.31d	3.66c	0.146e	1.31c	14.32a	31.38e	1.42d	10.25c
	Ca_2 B_0	1.29d	3.82b	0.173c	1.16e	12.62a	43.04c	1.93b	9.20de
	Ca_2 B_1	1.96a	4.14a	0.198a	1.77a	15.13a	55.38a	1.33e	10.40c
	Ca_2 B_2	1.09f	3.61d	0.145de	1.22d	14.70a	41.10c	1.58c	9.67d
Saline water	Ca_0 B_0	0.53g	1.65h	0.044h	0.33h	6.13d	24.88f	0.83f	7.22e
	Ca_0 B_1	0.95c	1.85g	0.096d	0.52e	9.69c	32.00cd	0.95e	8.02d
	Ca_0 B_2	0.74e	2.18f	0.073g	0.44f	8.31d	19.20g	0.99e	7.25e
	Ca_1 B_0	0.77e	2.68e	0.087ef	0.65d	10.95e	27.76e	1.33b	8.18cd
	Ca_1 B_1	1.33b	3.50b	0.139b	0.84b	13.86a	35.66b	1.80a	10.05b
	Ca_1 B_2	0.76e	2.67e	0.097e	0.65d	8.64ed	27.19e	1.12cd	8.04d
	Ca_2 B_0	0.81d	3.09c	0.112c	0.71c	10.83b	32.48c	1.38b	7.99d
	Ca_2 B_1	1.58a	3.61a	0.144a	0.92a	13.99a	39.29a	1.10d	10.62a
	Ca_2 B_2	0.57f	2.83a	0.087c	0.42g	8.70cd	30.33a	1.17c	8.59c

Table 3. Effect of Ca and B application on pigments content (mg g^{-1} fresh weight)

Treatments		Chlorophyll a		Chlorophyll b		Carotene	
		40 day	80 day	40 day	80 day	40 day	80 day
None saline water	Ca_0 B_0	0.911ab	2.267c	1.213a	0.442c	0.799a	0.902a
	Ca_0 B_1	0.933ab	2.289c	1.321a	0.459c	0.823a	0.933a
	Ca_0 B_2	0.814c	2.123d	1.204a	0.435c	0.745a	0.891a
	Ca_1 B_0	0.924ab	2.384b	1.540cd	0.643ab	0.843a	0.912a
	Ca_1 B_1	0.950a	2.511a	1.605ce	0.711a	0.854a	0.941a
	Ca_1 B_2	0.847bc	2.133a	1.465d	0.532bc	0.766a	0.899a
	Ca_2 B_0	0.962a	2.451ab	1.945a	0.675a	0.872a	0.917a
	Ca_2 B_1	0.971a	2.471ab	1.880a	0.723a	0.891a	0.952a
	Ca_2 B_2	0.911ab	2.401b	1.671b	0.533bc	0.755a	0.909a
Saline water	Ca_0 B_0	0.674c	2.061d	1.002c	0.354bc	0.674b	0.811a
	Ca_0 B_1	0.817ab	2.244b	1.121c	0.433ab	0.816ab	0.823a
	Ca_0 B_2	0.750ec	1.911e	1.078c	0.321c	0.715ab	0.813a
	Ca_1 B_0	0.842ab	2.158c	1.412b	0.387bc	0.771ab	0.826a
	Ca_1 B_1	0.827ab	2.441a	1.399b	0.442ab	0.807ab	0.833a
	Ca_1 B_2	0.786abc	2.018d	1.116c	0.352bc	0.721ab	0.822a
	Ca_2 B_0	0.913a	2.262b	1.617a	0.423ab	0.764ab	0.872a
	Ca_2 B_1	0.902a	2.102cd	1.409b	0.486a	0.832a	0.891a
	Ca_2 B_2	0.856ab	2.037d	1.085c	0.410abc	0.741ab	0.835a

Significant increased of chlorophyll a and b in plants was found only under application of 100ppm Ca and 5ppm B mixture as compare to control treatment of Ca_0B_0. Application of Ca along with B was the most effective in enhancing the chlorophyll and carotene content which may have resulted in increased photosynthetic rate. Significant differences from B application were obtained for the chlorophyll a and b content due to irrigation with saline water. Application of 100ppm Ca combined with 5ppm B increased Chlorophyll a (0.902 and 2.102) and chlorophyll b (1.409 and 0.486) as compare to application Ca or B individually at 40 and 80 day of sowing. High salinity degrades chlorophyll, thus concentrations of chlorophyll components of the photosynthetic apparatus are normally used to quantify leaf senescence in salt-stressed plants [21]. Positive and significant correlation was observed between fresh shoot weight and Chlorophyll content at 40 and 80 day of sowing.

3.3 Nutrient Composition

Concerning the effect of salinity on nutrients concentration, the high values of Na concentrations were recorded in root and shoots growing by saline irrigation water when compared with control plants grown by none-saline irrigation water at 40 and 80 day after sowing Fig. 1. Sodium content was higher in plants grown under saline soil condition; however B application significantly reduced Na content in shoot and root of faba bean plants. The reduction of Na in root and shoot was more pronounced at higher salinity level as affected by 100 ppm Ca and 5ppm B application through different growth stages.

These results were agreed with those reported by [22] on wheat. Potassium concentration in Fig. 2 was lower in plants root and shoot grown under saline irrigation water conditions than those grown in normal none saline irrigation water. The significant improvement of potassium content of faba bean plants due to foliar application of boron and soil application of Ca under saline irrigation water conditions was noticed. Increased K content and reduced Na in root and shoot during growth stages may be one of the possible mechanisms of increased salinity tolerance by combined application of 200ppm Ca and 5ppm B to faba bean plants.

Higher values of Ca content of faba bean root were detected in saline stressed plants over Ca content in root irrigated by none saline water Fig 3. Application of 200ppm Ca combined with 5ppm B significantly increased Ca content of root and shoot during growth stages over the rest of the treatments this may decrease the deleterious effect of salinity on faba bean growth. Calcium accumulation in root could ameliorate the inhibitory salt effects on growth since they regulate many physiological processes that influence both growth and responses to environmental stresses [21].

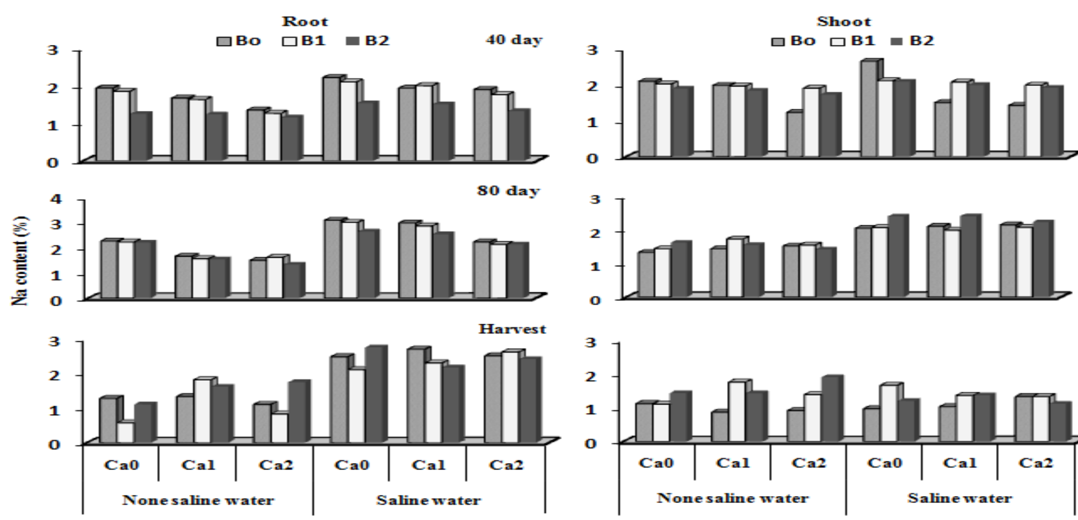

Fig. 1. Effect of Ca and B application on Na content in root and shoot at different growth stages

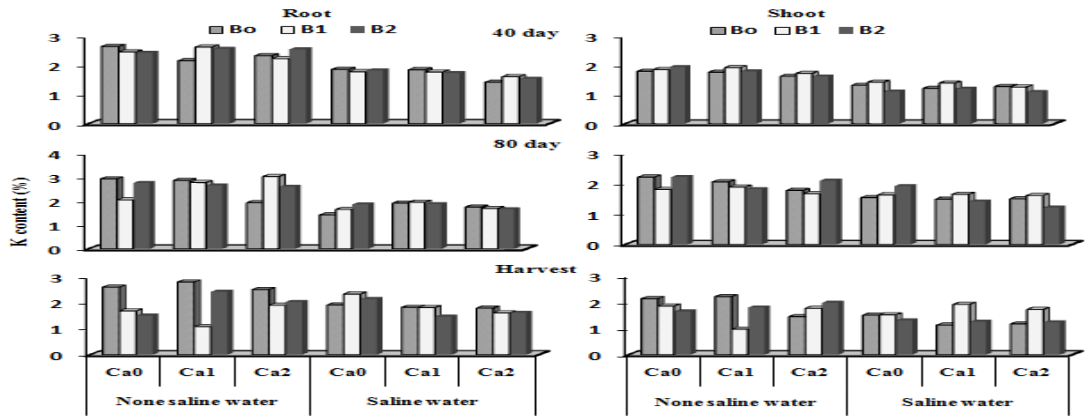

Fig. 2. Effect of Ca and B application on K content in root and shoot at different growth stages

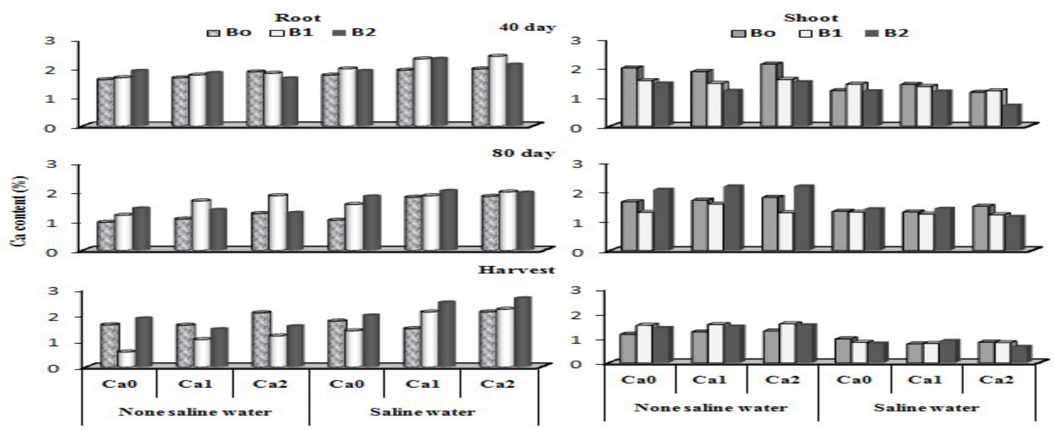

Fig. 3. Effect of Ca and B application on Ca content in root and shoot at different growth stages

Potassium: sodium ratio in Table 4 significantly increased in shoot at 120 over 40 and 80 day after sowing in both none saline and saline irrigation water condition. These results suggest a preferential transportation of K to faba bean leaves as a mechanism of salt tolerance. K is responsible for stomata regulation, which is principal mechanism controlling water balance and nutrient transportation in plants [23]. High K/Na ratio in root and shoot of faba bean irrigated by saline water due to application of Calcium and Boron leads to a favorable ionic balance with increased K uptake. Selectivity for K instead of Na could play an important role in salt tolerance because a high K/Na ratio is much more important than a low Na concentration in many species [24]. The metabolic toxicity of Na^+ is largely a result of its ability to compete with K^+ for binding sites essential for cellular function [25].

Data in Table 5 stated that Ca/Na ratio in root and shoot showed significantly higher values in response to faba bean irrigation by none saline water over irrigation by saline water in the three studied stages. Application of Boron increased Ca/Na ratio in faba bean root and shoot as compare to control treatment. The combined application of 200ppm Ca and 5ppm B significantly increased Ca/Na in root (1.36, 0.93 and 0.84) at 40, 80 day of sowing and at harvest as compare to individual application of Ca and B and control under irrigation with saline water. Salinity dominated by Na^+ salt not only reduces Ca^{2+} availability but also reduces Ca^{2+} transport and mobility to growing regions of the plant, which affect the quality of both vegetative and reproductive organs [26].

Table 4. Effect of Ca and B application on K/Na ratios of faba bean

Treatments		K/Na in root			K/Na in shoot		
		40 day	80 day	Harvest	40 day	80 day	Harvest
None saline water	Ca_0 B_0	1.36f	1.30f	2.04a	0.62e	1.68a	1.90bc
	Ca_0 B_1	1.33g	0.92fg	2.94b	0.66de	1.26a	1.68b
	Ca_0 B_2	1.95c	1.25c	1.36e	0.73b	1.38a	1.15cd
	Ca_1 B_0	1.29g	1.73g	2.10b	0.64de	1.44a	2.54a
	Ca_1 B_1	1.61e	1.78e	0.60e	0.70bc	1.10a	0.55e
	Ca_1 B_2	2.08b	1.73b	1.50d	0.68cd	1.18a	1.26bcd
	Ca_2 B_0	1.72d	1.29d	2.27a	0.80a	1.18a	1.58bc
	Ca_2 B_1	1.76d	1.88d	2.31b	0.64de	1.08a	1.27bcd
	Ca_2 B_2	2.21a	1.96a	1.16c	0.64de	1.49a	1.04d
Saline water	Ca_0 B_0	0.84d	0.46f	0.77cd	0.38e	0.76bc	1.55a
	Ca_0 B_1	0.85cd	0.55e	1.11cd	0.49c	0.79bd	0.91e
	Ca_0 B_2	1.19a	0.71bc	0.78a	0.39e	0.80c	1.09d
	Ca_1 B_0	0.95b	0.64d	0.68cd	0.53b	0.71c	1.09d
	Ca_1 B_1	0.89cd	0.68c	0.79c	0.49c	0.83a	1.40b
	Ca_1 B_2	1.15a	0.74b	0.68b	0.43d	0.59c	0.92e
	Ca_2 B_0	0.75e	0.79a	0.72a	0.58a	0.70c	0.88e
	Ca_2 B_1	0.92ec	0.79a	0.62a	0.45d	0.78b	1.30c
	Ca_2 B_2	1.16a	0.78a	0.67b	0.40e	0.55b	1.11d

Table 5. Effect of Ca and B application on Ca/Na ratios of faba bean

Treatments		Ca/Na in root			Ca/Na in shoot		
		40 day	80 day	Harvest	40 day	80 day	Harvest
None saline water	Ca_0 B_0	0.82h	0.42g	1.26g	0.70f	0.87c	1.47d
	Ca_0 B_1	0.90g	0.54de	0.99c	0.56e	1.06be	1.17d
	Ca_0 B_2	1.52a	0.65e	1.68b	0.55cd	0.87d	1.45c
	Ca_1 B_0	0.99f	0.64f	1.19f	0.68b	0.88b	1.97a
	Ca_1 B_1	1.07e	1.08b	0.58a	0.53de	0.90b	0.90cd
	Ca_1 B_2	1.48b	0.90c	0.90d	0.46ec	0.95bc	1.53e
	Ca_2 B_0	1.38c	0.84d	1.87e	1.05a	0.85a	1.97a
	Ca_2 B_1	1.43c	1.15c	1.43e	0.60cd	1.02a	0.93c
	Ca_2 B_2	1.43d	0.97a	0.89a	0.60b	1.07c	1.15f
Saline water	Ca_0 B_0	0.79g	0.33f	0.71e	0.36e	0.47abc	1.37a
	Ca_0 B_1	0.94f	0.52e	0.66d	0.50d	0.40a	0.79d
	Ca_0 B_2	1.24e	0.70c	0.72b	0.42d	0.33c	1.18c
	Ca_1 B_0	0.99f	0.61d	0.54e	0.63a	0.36abc	1.28b
	Ca_1 B_1	1.15d	0.65c	0.91f	0.48c	0.40a	0.91e
	Ca_1 B_2	1.54a	0.80b	1.14a	0.43c	0.37bc	1.04e
	Ca_2 B_0	1.03f	0.83b	0.84c	0.53a	0.39abc	1.13d
	Ca_2 B_1	1.36c	0.93a	0.84e	0.44c	0.39ab	0.91c
	Ca_2 B_2	1.60b	0.93a	1.09a	0.26b	0.29a	1.03c

3.4 Yield Parameters

Data in Table 6 indicated that root and shoot weight, pods weight and 100 seeds weight at harvest significantly reduced under saline water as compare to none saline water conditions. Foliar application of boron minimizes the adverse effects from salinity on the studied yield parameters under irrigation of faba bean by saline water of 1% sea salt. Application of 200ppm Calcium in combination with 5ppm boron significantly increased root fresh weight (3.22), shoot fresh weight (30.67), pods fresh weight (54.91) and 100 seed weight (84.92g) as compare to the rest of the treatment applied as affected by irrigation by saline water. Similar trend was observed in case of irrigation by none saline water but the values were higher as compare to irrigation by saline water. Increased dry matter yield due to application of Ca and B

Table 6. Effect of Ca and B application on yield (g plant^{-1}) at faba bean harvest

Treatments		Root		Shoot		Pods		100 seeds weight (g)
		fresh weight	dry weight	fresh weight	dry weight	fresh weight	dry weight	
None saline water	Ca_0 B_0	3.90b	0.603a	38.40b	5.77a	71.71d	14.23ab	108.49g
	Ca_0 B_1	4.78c	0.682c	40.85d	6.16c	82.36e	15.77d	129.18f
	Ca_0 B_2	4.66c	0.673e	40.56e	6.12d	81.11i	15.72e	125.43e
	Ca_1 B_0	4.02a	0.627d	38.96a	6.08b	72.62c	14.79bc	109.59e
	Ca_1 B_1	5.35d	0.725g	47.31f	6.20e	85.77g	18.15cd	138.50c
	Ca_1 B_2	4.81c	0.691e	44.97e	6.17d	82.7h	17.84e	136.12c
	Ca_2 B_0	4.18b	0.664c	39.91bc	6.10b	77.28a	15.13a	112.87d
	Ca_2 B_1	5.94a	0.983b	49.63a	7.32b	96.71b	22.19ab	150.87b
	Ca_2 B_2	5.48c	0.881f	48.34c	6.85c	95.63f	18.97d	143.25a
Saline water	Ca_0 B_0	1.07b	0.163g	11.75d	2.11e	22.01e	4.19c	54.33h
	Ca_0 B_1	2.72cd	0.433f	26.57g	3.72f	41.33f	8.18d	67.40g
	Ca_0 B_2	2.71b	0.337d	23.66c	3.71c	40.5g	8.18d	66.16g
	Ca_1 B_0	2.17a	0.294b	21.56c	2.59b	37.92a	6.63a	63.67f
	Ca_1 B_1	2.95d	0.476a	28.31a	4.31a	46.65d	10.51c	74.23e
	Ca_1 B_2	2.76e	0.463h	27.93b	3.98a	43.92f	8.31d	72.74c
	Ca_2 B_0	2.69c	0.314e	21.96f	3.36e	38.06b	8.12ab	65.02d
	Ca_2 B_1	3.22b	0.483d	30.67e	4.40d	54.91c	11.6b	84.92b
	Ca_2 B_2	3.17d	0.474c	29.92g	4.32g	53.42g	10.58d	74.36a

could be attributed to enhanced photosynthetic activity, and increased production and accumulation of carbohydrates have favorable effect on vegetative growth. The osmotic stress induced by salinity was responsible for the reduction in fresh and dry biomass in canola and wild mustard [27]. Positive and significant correlation was found between K/Na (0.807**), Ca/K (0.422*) and total dry weight of faba bean plants.

4. CONCLUSION

The combined effect Ca and B enhanced at all vegetative, and biochemical parameters of faba bean plants under irrigation by saline water. This combined treatment is more effective than individual application of Ca or B. The deleterious effect of excessive sodium was significantly inhibited due to the application of above mentioned minerals and if brought into practice could increase productivity of faba bean under saline water environment.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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