EFFECT OF PLANT DENSITY AND CALCIUM NUTRITION ON GROWTH AND YIELD OF SOME FABA BEAN VARIETIES UNDER SALINE CONDITIONS

N. A. Khalil, W. A. Al-Murshidy, A. M. Eman, R. A. Badawy

Agronomy Department, Faculty of Agriculture, Cairo University, Egypt

Abstract

The alleviation of adverse salinity effects to increase faba bean productivity is an important agronomic practice. Two field experiments were conducted in the Desert Experimental Station of the Faculty of Agriculture, Cairo University in Wadi El-Natroon, El-Beheira Governorate, Egypt, during the two winter seasons of 2012/13and 2013/14 to investigate the effect of three treatments of calcium nutrition (0, 1 and 2g Ca/liter) and two plant densities (26 and 52 plant/m^2) on three faba bean varieties (Sakha-1, Sakha-2 and Nubaria-2) under saline soil conditions. A split-spilt plot design with four replications was used. The main plots consisted of calcium treatments, sub-plots were allocated to varieties, while sub-sub plots were devoted to plant densities (26 and 52 plant/m^2). The obtained results could be summarized as follows: calcium application as foliar spray was significantly increased number of branches and pods/plant, weight of seeds/plant, seed index, seed yield and harvest index. In general, sakha-1 cv. recorded the highest seed yield/hectare. The plant density of 52 plants/m^2 recorded the highest seed yield and harvest index. The interaction between calcium nutrition and varieties had a significant effect on weight of seeds/plant, seed index and harvest index, in both seasons. The highest seed yield/ hectare was obtained from calcium application at 2 g/liter combined with Sakha-1 and 52 plants/m^2.

Key words: *vicia faba, salinity, calcium, density, variety, Egypt*

1. INTRODUCTION

Faba bean is the most important annual pulse crops grown in the world. It is one of the promising pulse crops which can play an important role in increasing legume production in Egypt. Its seeds are used for human consumption. Seeds have 35% protein, 45% carbohydrate and 2 % fat. The cultivated area of faba bean decreased in the last 3th years in Egypt from 34871 to 26700 ha (FAO, 2013).

Salinity is one of the main factors that limit the productivity of faba bean. Salinity problem in Egypt has a special importance for both of the old cultivated area and the newly reclaimed soils (Hellal *et al*., 2012). (Ahmed 2003) reported that 60% of the cultivated lands of Northern Delta region are salt-affected, 20% of the Southern Delta and Middle Egyptian region and 25% of the Upper Egypt region are salt-affected soils.

(Saxena *et al.* 1994) stated that problems of adverse salinity conditions are more complex than drought in crop × soil × climate interaction and must give a research attention to understanding of crop responses to these soil conditions. The major constraints for plant growth and productivity are ion toxicity with excessive uptake of mainly Cl^- and Na^+, as well as, nutrients imbalance caused by disturbed uptake of essential mineral nutrients (Hu and Schmidhalter, 2005). Salt in soil water inhibits plant growth and it reduces the plant's ability to take up water. The salt in the soil solution reduces leaf growth, lesser extent and root growth (Munns, 2003). Meristematic tissues are fed largely in the phloem, from which salt is effectively excluded, and rapidly elongating cells can accommodate the salt that arrives in the xylem within their expanding vacuoles (Rana, 2005). Continuing efforts must be taken to apply the best practices to alleviate salinity effects. It is well known that Ca^{2+} alleviates the adverse effects of salinity on many plant species (Ebert *et al.*, 2002 and Munns, 2002). Properly adequate levels of calcium will keep Na and Cl out of the cell. This function is extremely critical for the development of strong root cells and selectivity of Ca over Na at the root level (Hayward and Spurr, 1944).

On the other hand, faba bean varieties varied in its salinity tolerance. So we need more research to investigate the performance of these varieties. Also, plant density plays an important role to alleviation of salinity stress.

The objective of this study was to examine the effects of Ca application, variety, plant density and their combinations on growth, yield and yield components of faba bean grown under salinity stress in newly planted sandy soils in Egypt.

2. MATERIALS AND METHODS

2.1. Experimental site and treatments

Two field experiments were laid out under drip irrigation in the Desert Experimental Station, Fac. of Agric., Cairo Univ. in Wadi El-Natroon, El-Beheira Governorate (located between 30º32'30" and 30º 33'0" N and between 29º 57'15" and 29º58'15" E with an altitude of 45 meters) during winter seasons of 2012-13 and 2013-14. Soil and irrigation water properties are presented in Table (1). Soil of the experimental site was sandy, saline and poor in nutrients, as well as, organic matter. Irrigation water was saline. There were little differences in the soil properties between the two years of the study. Most cultivars of faba bean are sensitive of salinity.

Three Egyptian cultivars of faba bean (Sakha-1, Sakha-2 and Nubaria-2) were planted on 1st November in both seasons. Single super-phosphate fertilizer (15.5% P_2O_5) at the rate of 24 kg P_2O_5 fed^{-1} was added during soil preparation as basal application. Nitrogen was added at rate of 30 kg N ha^{-1} in the form of ammonium nitrate (33.5% N). Potassium sulphate (48% K_2O) was applied at the rate of 48 kg K_2O ha^{-1}. Application of both of N and K fertilizers was started at 15 days from planting through six equal doses at 7-day intervals.

Table 1. Soil and irrigation water properties at the experimental site in 2013 and 2014 seasons.

Soil analysis	**2012-13**	**2013-14**
Physical properties		
Sand %	94.85	92.50
Silt %	4.00	4.78
Clay %	1.15	2.72
Texture	Sandy	Sandy
Chemical properties		
Soil (pH)	7.89	7.53
Ec (ds/m)	5.23	5.36
Organic Matter (%)	0.30	0.25
Total $CaCo_3$ (%)	2.55	5.96
Available N (mg kg^{-1})	0.63	8.6
Available P (mg kg^{-1})	1.45	2.24
Available K (mg kg^{-1})	150	180

Chemical properties of irrigation water

Season	**pH**	**EC**		**Ions concentration meq/L**						
		ds/m	**PPM**	**HCO_3^-**	**Cl^-**	**$SO_4^=$**	**Ca^{++}**	**Mg^{++}**	**Na^+**	**K^+**
2012-13	7.6	4.1	2624	2.9	30.1	9.0	3.9	4.3	33.3	0.64

2013-14	7.8	4.2	2688	3.5	28.8	7.7	5.5	4.5	31.6	0.54

Fertigation system was used. A mixture of micronutrients (Fe, Zn, Mn, Cu and B) was also sprayed three times at 21-day intervals as foliar application, at the rate of 1000 ppm, after thinning. All the required agronomic practices were adopted uniformly as necessary during the two growing seasons. The preceding crop of faba bean experimental fields was sesame and sunflower during first and second seasons, respectively.

2.2. Experimental design and statistical analysis

The experimental design was a spilt-spilt plot arrangement in randomized complete blocks design, with four replications. The main plot consisted of three foliar application of calcium (0, 1 and 2 g/L.). The sub-plots were devoted to three faba bean variety and two plant densities (26 and 52 plant/m^2) on sub-sub plot. Each sub-sub plot consisted of 3 rows of 3 m in length and 0.50 m in width with an area of 4.5 m^2. The layout was cleared in Figure (1). Seeds were sown in hills 15 and 30 cm apart on both sides of row, thereafter were thinned to 2 plants $hill^{-1}$ to give 52 and 26 plant m^{-2}. Data were analyzed according to procedures outlined by Steel *et al.*, 1997 using MSTAT-C computer package Freed *et al.*, 1989. The differences among treatment means were compared by Least Significant Differences test (LSD) at 0.05 level of probability.

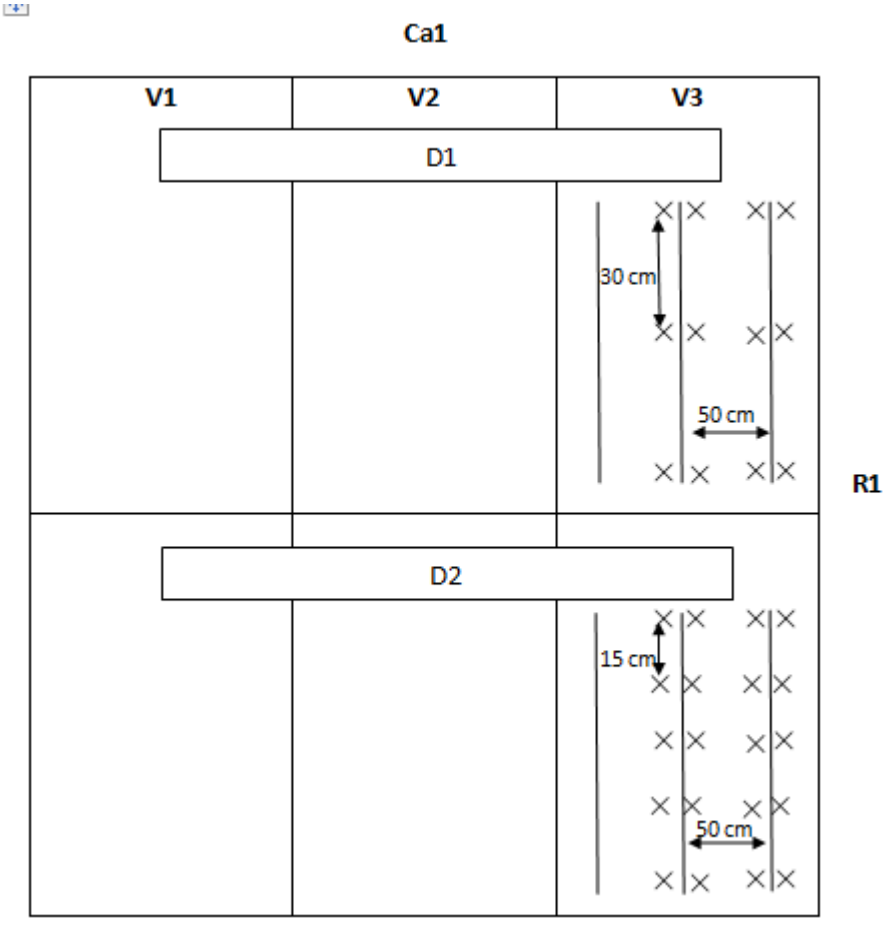

Fig. 1. Layout of the treatments

2.3. Recorded data

At harvest, ten guarded plants were randomly taken from each sub-sub plot to estimate the following traits: number of branches, number of pods/plant, weight of seeds/plant, seed index. Also, seed yield (ton Ha^{-1}) was weighed from the whole area of each sub-sub plot and adjusted to yield per hectare. Harvest index (%) was calculated by divided seed yield $ha.^{-1}$ on biological yield $ha.^{-1}$ * 100

3. RESULTS AND DISCUSSION

3.1. Effect of calcium nutrition

Data presented in table 2. revealed that calcium as foliar application had a significant effect on number of branches and pods/plant, as well as, seed yield/ha. and harvest index in both seasons except seed index which is not significantly affected by calcium nutrition in 2012/2013 season Meanwhile calcium nutrition had significant affect on seed index in 2013/2014 season.

calcium nutrition	No. of branches/ plant		No. of pods/plant		Seed yield/plant (g)		Seed index (g)		Seed yield (ton/Ha.)		Harvest index%	
	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14
Ca 0 gm/L	1.99	2.24	7.73	9.89	17.38	21.32	91.16	87.81	2.271	2.901	32.4	32.6
Ca 1 gm/L	2.39	2.90	7.93	10.05	19.34	23.96	89.01	93.33	2.397	2.938	33.1	33.0
Ca 2 gm/L	2.75	2.93	8.43	10.93	22.58	26.70	91.97	89.65	2.699	3.159	35.1	34.3
LS.D at 0.05	0.27	0.29	0.53	0.35	0.58	0.69	ns	2.53	0.17	0.16	2.22	2.35

Table 2. Yield and yield components of tow faba bean varieties as affected by calcium nutrition during 2012/2013 and 2013/2014 seasons

The highest number of pods/plant was recorded by calcium as foliar application 2gm/L. in both seasons (Table 2). Such increase may be due to the important role of calcium in plant growth and nutrition, as well as in cell wall deposition. These findings are in harmony with those obtained by Ahmad and (Jabeen, 2005; Munns & Tester, 2008; Hellal *et al.*, 2012 and Hellal *et al*., 2014).

Also, data showed that the highest seed yield/plant was obtained by calcium foliar application of 2 gm/L. in both seasons (Table 2). Such increase may be due to increase in number of pods/plant. Similar findings were obtained by (Ahmad & Jabeen, 2005 and Munns & Tester, 2008).

Data in table (2) indicated that the highest seed yield (2.699 and 3.159 ton/ha. in 2012/13 and 2013/14 season, respectively) was recorded from calcium application 2 gm/L. Such increase may be due to increasing in yield components meanwhile, the lowest seed yield (2.271and 2.901ton) was recorded with zero Ca in both seasons. Such decrease may be due salinity effect and decreasing yield components. These results are in general agreement with those obtained by (Hellal *et al.*, 2014; Hellal *et al.*, 2012; Ahmad & Jabeen, 2005 and Munns and Tester, 2008).

3.2. Effect of cultivars

In regard to the cultivars effect, the results in table (3) showed that Sakha-1 surpassed all other cultivars in number of pods/plant, seed yield/plant, seed yield/ha. and harvest index in the second season. Nubaria-2 had a highest seed index in both seasons. Genotypic differences for this characteristics were also recorded by(El-Tuhami & Hussien, 1986; Weil & Kalil, 1986 and Abdalla *et al*., 2000).

Varieties	No. of branches/ plant		No. of pods/plant		Seed yield/plant (g)		Seed index (g)		Seed yield (ton/Ha.)		Harvest index%	
	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14
Sakha 1	2.38	2.38	7.78	11.97	21.54	27.28	88.80	84.89	2.68	3.37	33.27	39.66
Sakha 2	2.31	2.93	8.38	9.03	17.69	21.70	84.36	86.10	2.39	2.83	35.08	29.25
Nubaria 2	2.45	2.76	7.92	9.88	20.08	23.01	98.98	99.79	2.30	2.80	32.29	30.98
LS.D at 0.05	0.33	ns	0.49	0.29	0.53	0.61	2.59	2.40	0.15	0.14	0.99	1.20

Table 3. Yield and yield components of three faba bean varieties during 2012/13 and 2013/14 seasons

3.3. Effect of plant densities

Concerning the effect of plant spacing or plant density data in table (4) indicated significant effects of plant density on number of branches, pods and seeds/plant, as well as, seed yield/ha. and harvest index except seed index, of faba bean during both seasons.

Plant density	No. of branches/ plant		No. of pods/plant		Seed yield/plant (g)		Seed index (g)		Seed yield (ton/Ha.)		Harvest index%	
	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14
D1	2.63	3.11	8.77	11.31	21.33	26.44	91.17	90.32	2.22	2.68	32.90	31.21
D2	2.12	2.27	7.28	9.27	18.20	21.55	90.25	90.21	2.69	3.32	34.20	35.38
LS.D at 0.05	**	**	**	**	**	**	ns	ns	**	**	**	**

Table 4. Yield and yield components of two faba bean varieties as affected by plant density during during 2012/2013 and 2013/2014 seasons

D_1= 26 plants/m^2 D_2= 52plants/m^2

Data showed that the lowest plant density (26 plants/m^2) gave the highest number of branches/plant in both seasons. This result may be due to wide spaces between the plants, ascribed to decreased inter

plant competition that leads to increased plant capacity for utilizing the environmental inputs in building great amount of metabolites to be used in developing new tissues and increasing its yield components. Generally, these results are on line with those obtained by (Ibrahem, 2000; Mohamed, 2000; Bakheit *et al.*, 2001; Mokhtar, 2001; Abd Alla, 2002 and Al-Suhaibani *et al*., 2013).

Results in table (4) showed that number of pods/plant and seed yield/plant, were significantly increased with decreasing plant density from 52 to 26 plants/m^2 in both seasons. The greatest number of pods/plant and seed yield/plant was recorded from plant density 26 plants/m^2 in both seasons. The reduction in number of pods/plant with increasing plant density may be due to plant competition in hills or due to reduction in number of branches/plant. The decrease in seed yield/plant may be due to decreasing number of branches/plant and number of pods/plant.These results go in line with those of (Mohamed, 2000; Bakheit *et al*., 2001; Mokhtar, 2001; Abd Alla, 2002; Abdel Latif, 2008 and Al-Suhaibani *et al*., 2013).

The data also showed that seed index was not significantly affected by plant density in the two seasons. these results are in line with those of (Metwally, 1997 and Hassan & Hafiz, 1998).

Results showed that seed yield of 52 plant/m2 was significantly higher than 26 plant/m2, in the both seasons. This increase in seed yield under higher density may be due to the increase in plant population. Raising seed yield by increasing plant density was frequently reported by several workers among them (Quagliotti *et al*., 1994; El-Douby *et al*., 1996; Hassan & Hafiz, 1998; Loss *et al*., 1998; Mohamed, 2000 and Hussein *et al*., 2002) who found that the seed yield increased by increasing plant density.

Harvest index is ranked as the second physiological –genetic component, after biomass, for a crop yield. It is considered the end point measure the partitioning of photesynthates toward the reproductive organ during actual accumulation of the yield. So, its represent the portion of net accumulated biomass partitioned to reproductive organs. Therefore, measuring it become of great importance for determining the yielding ability of a crop variety. The better harvest index was obtained from plant density 44 plant/m^2 in both seasons (Table 4). (El-Metwally *et al*., 2003; Abdel-Aziz & Shalaby, 1999 and Mohamed, 2000) supported these results. However, (El-Tuhami and Hussein, 1986) reported that harvest index was decreased by increasing plant density.

3.4. Effect of the interactions

Data in table 5, showed that number of branches/plant was significantly affected by calcium and varieties interaction in the first season only. Sakha-1 variety sprayed by the highest dose of calcium gave the highest number of branches/plant. while, the same variety gave the lowest branches with zero calcium. Meanwhile, number of pods/plant was significantly affected by calcium and varieties interaction in the second season only.

interaction	No. of branches/ plant		No. of pods/plant		Seed yield/plant (g)		Seed index (g)		Seed yield (ton/Ha.)		Harvest index%	
	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14
Ca0 - V1	1.83	2.04	7.25	11.23	15.90	19.87	88.64	67.46	2.482	3.227	34.93	36.10
Ca0 - V2	2.04	2.50	8.38	8.55	17.02	21.01	84.73	95.50	2.229	2.800	33.62	32.06
Ca0 - V3	2.08	2.17	7.55	9.90	19.23	23.09	100.08	100.46	2.102	2.675	28.82	29.53
Ca1 - V1	2.25	2.59	7.45	11.48	20.30	27.17	86.21	95.14	2.593	3.120	31.66	38.26
Ca1 - V2	2.13	3.17	8.10	8.58	18.06	22.11	81.11	85.47	2.341	2.893	35.01	28.30
Ca1 - V3	2.79	2.96	8.23	10.10	19.66	22.62	99.69	99.35	2.257	2.800	32.53	32.43
Ca2 - V1	3.04	2.50	8.65	13.20	28.42	34.81	91.53	92.05	2.950	3.747	33.23	44.60
Ca2 - V2	2.75	3.12	8.68	9.98	17.98	21.98	87.22	77.33	2.597	2.795	36.62	27.38
Ca2 - V3	2.46	3.17	7.98	9.63	21.34	23.31	97.14	99.55	2.550	2.934	35.52	30.99
LS.D at 0.05	0.47	ns	ns	0.59	1.02	1.19	4.49	4.3	ns	ns	2.22	1.83

Table 5. Yield and yield components of two faba bean varieties as affected by the interaction between calcium nutrition (Ca*) and varieties(V*) during 2012/2013 and 2013/2014 seasons

**Ca0= Ca 0gm/L Ca1= Ca 1gm/L Ca2= Ca 2gm/L V1=Sakha-1 V2= Sakha-2 V3= Nubaria-2*

The interaction between calcium date and varieties (Table 5.) had a non-significant effect on seed yield/ha. in both seasons. Meanwhile, harvest index was significantly affected by the interaction of calcium and varieties in both seasons, as well as, seed yield/plant and seed index.

The highest harvest index recorded by Sakha-2 with calcium dose 2gm/L. in the first season, While, Sakha-1 with calcium dose 2gm/L. gave the highest harvest index in the second season. Sakha-1 with calcium dose 2gm/L. recorded the highest seed yield/plant in 2012/13 and 2013/14 seasons (28.42 and 34.81 respectively) (Table 5). khalil *et al.* (2001) found that the highest dose of calcium (2gms/L at blooming stage + 2gms/L at pod formation) to Giza 716 faba bean cultivar gave the highest seed yield.

Data in table 6, showed that number of branches/plant and number of pods/plant was significantly affected by calcium and plant density interaction in the second season only. Meanwhile, seed yield/plant was significantly affected by this interaction in the first season only. The highest number of branches/plant, number of pods/plant and seed yield/plant was obtained from 2gm Ca/L. with plant density 26 plants/m^2.

interaction	No. of branches/ plant		No. of pods/plant		Seed yield/plant (g)		Seed index (g)		Seed yield (ton/Ha.)		Harvest index%	
	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14
Ca0 - D1	2.20	2.50	8.60	11.15	19.03	24.01	93.31	85.57	1.996	2.544	31.34	29.43
Ca0 - D2	1.78	1.97	6.85	8.63	15.74	18.64	89.01	90.05	2.546	3.257	33.57	35.70
Ca1 - D1	2.56	3.25	8.35	11.00	20.41	26.22	88.49	93.56	2.176	2.656	33.09	31.67
Ca1 - D2	2.22	2.56	7.50	9.10	18.27	21.71	89.52	93.09	2.618	3.220	33.04	34.33
Ca2 - D1	3.14	3.58	9.37	11.78	24.56	29.11	91.72	91.82	2.492	2.841	34.27	32.52
Ca2 - D2	2.36	2.28	7.50	10.08	20.60	24.29	92.22	87.48	2.906	3.476	35.98	36.12
LS.D at 0.05	ns	0.40	ns	0.48	0.83	ns	ns	3.5	ns	ns	1.61	ns

Table 6. Yield and yield components of two faba bean varieties as affected by the interaction between calcium nutrition(Ca*) and plant density (D*)during 2012/2013 and 2013/2014 seasons

**Ca0= Ca 0gm/L Ca1= Ca 1gm/L Ca2= Ca 2gm/L D1= 26 plants/m2 D2= 52plants/m2*

Data showed that seed index and seed yield/ha. not affected by the interaction between calcium and plant density in both seasons. while harvest index was significantly affected by this interaction in the first season only. The highest harvest index obtained from calcium dose 2gm/L. with plant density 52 plants/m^2, and the lowest harvest index recorded by plant density 26 plants/m^2 with zero calcium (table 6).

The interaction between variety and plant densities (Table 7) had a significant effect on seed yield/plant, seed index and harvest index in both seasons . Meanwhile, number of pods/plant found to be markedly affected by variety and plant density interaction in the second season only. The remaining traits were not affected by the interaction between planting date and plant density.

Data in table 7. showed that Sakha-1 under the lowest plant density possessed the greatest number of pods/plant and seed yield/plant. while, Nubaria-2 with the lowest plant density recorded the highest seed index in both seasons.

Number of branches/plant and seed yield/ha. were not significantly affected by varieties and plant density interaction in both seasons (table 7).

Table 7. Yield and yield components of two faba bean varieties as affected by the interaction between variety(V*) and plant density (D*)during 2012/2013 and 2013/2014 seasons

interaction	No. of branches/ plant		No. of pods/plant		Seed yield/plant (g)		Seed index (g)		Seed yield (ton/Ha.)		Harvest index%	
	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14	Season 12/13	Season 13/14
V1-D1	2.70	2.70	8.58	13.33	23.85	31.00	90.79	82.83	2.422	3.031	32.24	37.37
V1-D2	2.06	2.06	6.98	10.60	19.22	23.56	86.81	86.95	2.928	3.698	34.31	41.94
V2-D1	2.64	3.53	9.15	10.17	18.86	23.50	82.91	87.24	2.174	2.567	33.79	27.50
V2-D2	1.97	2.33	7.62	7.90	16.52	19.89	85.81	84.97	2.605	3.092	36.37	31.00
V3-D1	2.56	3.11	8.58	10.43	21.29	24.83	99.82	100.89	2.069	2.443	32.66	28.75
V3-D2	2.33	2.42	7.25	9.32	18.87	21.18	98.13	98.70	2.537	3.163	31.91	33.22
LS.D at 0.05	**ns**	**ns**	**ns**	**0.48**	**0.83**	**0.97**	**3.67**	**3.58**	**ns**	**ns**	**1.60**	**1.61**

**D_1= 26 plants/m^2 D_2= 52plants/m2 V1=Sakha-1 V2= Sakha-2 V3= Nubaria-2*

The interaction between calcium nutrition and varieties and plant density (Fig. 2) had a significant effect on seed yield/ha. in both season, as well as seed yield/plant in season 2012/13 (Fig. 2). Meanwhile, number of pods/plant, seed index, number of branches/plant and harvest index was not significantly affected by the interaction between calcium nutrition, varieties and plant density in both seasons.

The highest seed yield/ha. (3.224 and 4.064 ton/ha.) in both seasons was obtained from planting Sakha-1 cultivar under the plant density 52 plants /m^2 when calcium sprayed by the rate of 2 gm/L. Meanwhile, the lowest seed yield (1.824 and 2.289 ton in 2012/13 and 2013/14 season, respectively) was recorded at planting Nubaria-2 cultivar under the plant density 26 plants/m^2 with no calcium application.

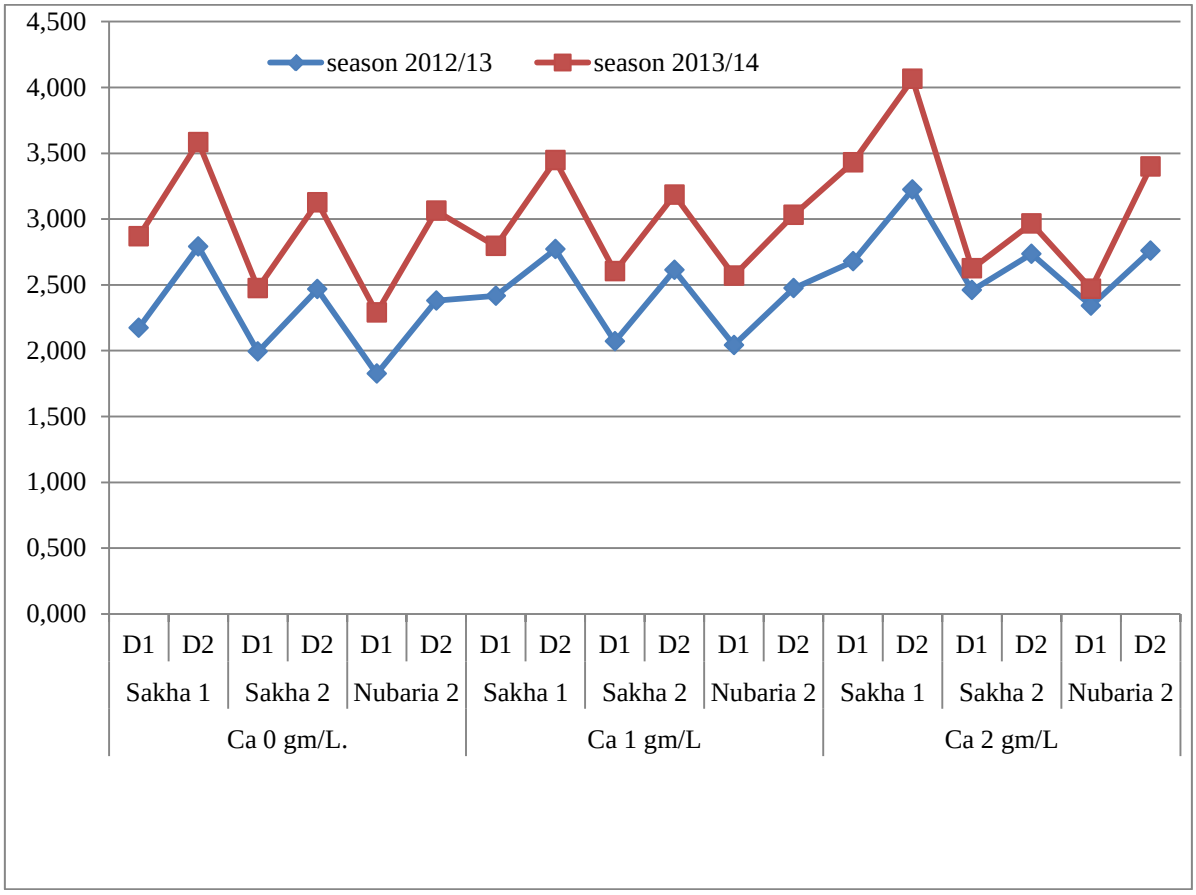

Fig. 2. Seed yield/ha (ton) of faba bean as affected by the interaction between calcium nutrition, cultivar and plant density(D*) at harvest, in 2012/2013 and 2013/2014 seasons

**D_1= 26 plants/m^2* *D_2= 52plants/m^2*

4. CONCLUSION

Results of this research under saline conditions in North Egypt refer that seed yields of faba bean variety were increased by spraying calcium as foliar 2gm/L, and the increasing in plant density from 26 to 52 plants/m^2. Sakha-1 is recommended under this conditions. Which surpassed all other cultivars in seed yield. The highest seed yield/ha. was obtained from planting Sakha-1 cultivar under the plant density 52 plants /m^2 when calcium sprayed by the rate of 2 gm/L.

5. REFERENCES

Abd Alla, AA & Omran, MM 2002. Response of some faba bean varieties to irrigation intervals and plant spacing in the new sandy reclaimed lands. *Munufiya J. Agric. Res*. 27: 525- 540

Abdel Latif, YI 2008. Effect of seed size and plant spacing on yield and yield components of faba bean (*Vicia faba* L.). *Res. J. Agric. Biol. Sci.* vol. 4, no. 2, pp. 146-148.

Abdel-Aziz, EA & Shalaby, FH 1999. Physiological studies on response of new released faba bean varieties to different plant populations. *Zagazig J. Agric. Res.* vol. 26, no. 5, pp. 1229-1244.

Ahmad, R & Jabeen, R. **2005**. Foliar spray of mineral elements antagonistic to sodium: A technique to induce salt tolerance in plants growing under saline conditions. *Pak J Bot*; vol. 37, pp. 913-920.

Ahmed, G 2003. Deteriorated Soils in Egypt: Management and Rehabilitation. *Ministry of Agricultur and Land Reclamation. Executive Authority for Land Improvement Projects* (EALIP): 36 p.

Al-Suhaibani, N, El-Hendawy, S, & Schmidhalter, U 2013. Influence Of Varied Plant Density On Growth, Yield And Economic Return Of Drip Irrigated Faba Bean (Vicia Faba L.) *Turkish Journal of Field Crops*, vol. 18, no. 2, pp. 185-197.

Ebert, G, Eberele, J, Ali-dinar, H & Ludders, P 2002. Ameliorating effects of Ca $(NO_3)_2$ on growth, mineral uptake and photosynthesis of NaCl-stresses guava seedlings (*Psidium guajava* L.). *Sci. Hortic*. 93 125-135.

El-Douby, KA, El-Habbak, KE, El-Nasr, FMS, Basal, SA & Sef El-Nasr, FM 1996. Effect of tillage system and plant density under different phosphoric fertilization level on the productivity of faba bean (*Vicia faba,* L.). *Annals Agric. Sci. Moshtohor*. vol. 34, no. 3, pp. 907-916.

El-Metwally, El-MA, Abdalla, MMF, Darwish, DS & Waffa, KM 2003. Performance of two faba bean cultivars under different plant distribution patterns. *Abstract of Proc. 10th National Conf. Agron., 7-10 Oct., El-Arish, Egypt*.pp. 24-25.

Abdalla, MMF, Darwish, DS, Ali AA, & El-Emam EAA 2000. Investigation on faba bean (*Vicia faba*. L).*15. Variability and clustering of faba bean Land Races . Egypt. J. Plant Breeding* 4pp. 257-272.

El-Tuhami, MMK, & Hussien TA 1986. Evaluating an British elite of faba bean (*Vicia faba* L.) varieties at different plant densities and distributions. 2. Seed yield per plant and some related characters. *Ann. Agric. Sci., Moshtohor*, vol. 24, no. 4, pp. 1881–1896.

FAO, 2013. *Statistical year book, World food and agriculture. Food and Agriculture Organization of the United Nations*, Rome, 567 p,

< http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor>,

Freed, RSP, Einensmith, S, Gutez, S, Reicosky, D, Smail, VW & Wolberg P 1989. MSTAT-C analysis of agronomic research experiments. *Michigan Univ. East Lansing*, USA.

Hassan, AA, & Hafiz SiI 998. Agronomic characteristics, yield and its components of some field bean cultivars as affected by planting methods and plant spacing . *Proc. 8th Conf. Agron., Suez Canal Univ., Ismalia, gypt*, 28-29 Nov.,pp. 317 – 325.

Hayward, HE, & Spurr, WB 1944. The tolerance of flax to saline conditions: Effect of sodium chloride, calcium chloride, and sodium sulfate. *J. Amer. Society Agron*., 36, pp. 287-300.

Hellal, FA, El-Sayed, SAA, Zewainy RM, & Abdelhamid, M 2014. Interactive Effects of Calcium and Boron Application on Nutrient Content, Growth and Yield of Faba Bean Irrigated by Saline Water. *International Journal of Plant & Soil Science* vol. 4, no. 3, pp. 288-296, 2015; Article no.IJPSS.2015.030 ISSN: 2320-7035

Hellal, FA, Abdelhamid, MT, Doaa M, Abo-Basha & Zewainy RM 2012. Alleviation Of The Adverse Effects Of Soil Salinity Stress By Foliar Application Of Silicon On Faba bean (Vica faba L.) *Journal of Applied Sci. Res.* vol. 8, no. 8, pp. 4428-4433

Hu, Y, & Schmidhalter, U 2005. Drought and salinity: A comparison of their effects on mineral nutrition of plants. *J. Plant Nutr. Soil Sci.,* 168, pp. 541-549.

Hussein, AH, El-Deeb AMA & El-Yamani 2002. Response of new faba bean genotypes to different sowing dates and plant densities in the newly reclaimed lands in Upper Egypt. *National Ann. Coordination meeting, ICARDA/EC. Cairo,* pp. 70-74.

Ibrahem, NT 2000. Spectral reflectance of faba bean plants in relation to growth and yield. M.Sc. Thesis, Fac. Agric. Ain Shams Univ., Egypt.

Khalil, NA, Shafik, MM, Yones, AE and EL-Zokaki, AN 2001.improving faba bean productivity in salt affected soils through calcium nutrition. *M.Sc. thesis, Agronomy Dep. Fuc. of Agric. Cairo Univ.*

Loss, SP, M .Siddique, KH, Martin, LD & Crombie A 1998. Response of faba bean (*Vicia faba,* L.) to sowing date in South Western Australia. I. Seed yield and economic plant density. *Aust. J. Agric. Res.* vol. 49, no.6, pp. 989-997.

Metwally, IOE 1997. Performance of faba bean as affected by preceding summer crops,nitrogen levels and plant density. *J. Agric. Sci., Mansoura Univ.*, vol. 22, no. 99, pp. 2779-2788.

Mohamed, WKH 2000. Response of two faba bean varieties to different plant densities and distributions. *Proc. 10th conf. Agron. –Suze Canal. Univ. Fac Environ. Agric. Sci. (El Arish) Egypt*. pp. 759-773.

Mokhtar, SA 2001. Response of yield and yield components of faba bean (*Vicia faba*.) to increasing levels of nitrogen phosphorus under two level of plant density. *Egypt. Annals Agric. Sci., Ain Shams Univ*. 46 (1): 143-154.

Munns, R, & Tester, M 2008. Mechanism of salinity tolerance. *Annl Rev Plant Biol*.;59, pp. 651-681. **Bakheit, BR, Allam, AY, & Galal, AH 2001**. Response of some faba bean (*Vicia faba* L.) cultivars to planting dates and population densities. *Assiut J. Agric. Sci*. vol. 32, no. 2, pp. 85-101.

Munns, R 2002. Comparative physiology of salt and water stress. *Plant Cell & Environment*. vol. 25, pp. 239-250.

Munns, R 2003. Physiological processes limting plant growth in saline soils. Some dogmas and hypotheses. *Plant Cell and Environment,* 16, pp. 15-24.

Quagliotti, L, Lotito, S, Belletti, P, & Nada E 1994. Environmental effects on flowering and seed setting in *Vicia faba* Equine pers. Int. Symp. on Agrotechnics and Storage of Vegetable and Ornamental Seeds. *Bari, Italy. Act Hort*., 362, pp. 105-122. (C. a. CAB Abste.:1995).

Rana, M 2005. Genes and salt tolerance: bringing them together. *CSIRO Plant Industry, GPO Box 1600, Canberra ACT 2601, Australia.*

Saxena, NP, Saxena, MC, Ruckenber, P, Rara, RS, El-Fouly, MN & Shabana R 1994. Screening techniques and sources of tolerance to salinity and mineral nutrient imbalances in cool season food legumes. *Euphytica,* 73, pp. 85-93.

Steel, RGD, Torri, JH, & Dickey, DA 1997. Principles and Procedures of Statistics: *A Biometrical Approach, 3rd ed,. Mc Graw-Hill, New York.* 666p.

Weil, RR & Khalil, NA 1986. salinity tolerance of winged bean as compared to that of soybean. *Agronomy J. vol. 78, pp. 67-70.*