Effect of Mineral Fertilization and Plant Density on Faba Bean (*Vicia faba*) Production in Siwa Oasis

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ABSTRACT

Throughout two successive years (2009 and 2010), field experiments in three completely randomized replications for each treatment were carried out in Tegzerty region at Siwa Oasis, which located at 29° 11' 34" N and 25° 32' 11" E. This soil was irrigated by flooded system and affected by irrigation water which was slightly saline (1.83 dS/m) while the soil salinity was 4.12 dS/m. Mineral fertilization were, 0, 30, 45 and 60 kg P_2O_5/fed, 0, 40, 60 and 80 kg K_2O/fed, while one rate of N as 60 kg N/fed for all treatments except treatment of control. Phosphorus was mixed with organic manure (10 m^3/fed) and supplied as a single application, whereas N and K fertilizers were split into three equal doses that were applied after 20, 40 and 60 days from sowing. Seeds of faba (*Vicia faba*) Rebaya were cultivated in three spaces 15, 20 and 25cm between plants and 40 cm within rows. The obtained results showed that faba bean gave the highest response to increasing rates of P and K fertilizers application when compared with the control (non-fertilized) treatment for all cultivation spaces during the two seasons. The same trend achieved to nutrients content and uptake in shoots and seeds of faba bean in each of cultivation spaces. When the cultivation spaces decreased the yield quantity/fed increased while yield quality/plant increased. The optimum fertilizers treatment for faba bean crop in three cultivation spaces was NP_3K_3 (60:60:80kg/fed) which recorded 3.77 and 1.99 ton/fed in cultivation $space_1$, 3.30 and 1.65 ton/fed in cultivation $space_2$, 2.93 and 1.51 ton/fed in cultivation $space_3$ for shoots and seeds, respectively. Moreover, the fertilizer treatments in cultivation $space_3$ achieved higher yield quality than another in $space_2$ and $space_1$. The results in this study showed that the optimum fertilizer treatment (NP_3K_3) with cultivation $space_2$ (20cm x 40cm) achieved suitable quality and quantity yield of faba bean under conditions of the studied soil. Deriving multiple regression equations proved to be an effective tool for predicting the seeds and shoots production of faba bean plants in different cultivation spaces under Siwa Oasis conditions

Key words: NPK fertilizers, faba bean, yield, density plant, Salinity, mineral content.

INTRODUCTION

Salinity is an adverse environmental factor and is major problem that negatively impacts agricultural activities in newly reclaimed areas of Egypt, especially the soils with high water table in Siwa Oasis.

Regarding the effect of fertilization on yield parameter of faba bean, Gremigni *et al.* (2004) reported that P supply increased seed N, P and Zn concentrations of sweet and bitter legume plants. In contrast, seed K concentrations increased and P concentrations decreased with increasing K supply. These findings suggest that P fertilizer should be supplemented with K to avoid high seed alkaloid concentrations stimulated by asymptomatic K deficiency at high P levels. At another view, Thalooth *et al.* (2006) reported that the K application had a positive effect on growth parameters, yield and yield components of Mung-bean Plants. Also, El Habbasha *et al.* (2007) reported that application of P fertilizer at 30 or 45 kg P_2O_5/faddan associated with rhizobium gave the highest value of most yield parameters of faba bean. With regard to seed quality, they observed the highest N, P and K contents and uptake in both seeds and shoots. With regard to compound fertilization, Prusiński (2007) reported that soil application of 90 kg N/ha as ammonium nitrate, 30-90 kg N/ha as urea, and 60-180 kg N/ha as a mix of ammonium nitrate and urea resulted in a significant increase in yield parameters, N concentration, and N uptake of faba bean plants. Ihsanullah *et al.* (2008) stated that the suitable N rate was 200 kg/ha which achieved maximum grain yield and shoot dry weight of faba bean. Crous *et al.* (2008) decided that application of 50 kg K/ha and 50 kg P/ha increased the N, P and K concentrations and uptake by legumes plants. El-Gizawy and Mehasen (2009) reported that application of 30 kg P_2O_5/fed mixed with phosphate dissolving bacteria (PDB) under sprayed of 0.04% Zn EDTA (14% Zn) was the recommended treatment for improving the productivity of faba bean crop. Mona *et al.* (2011) reported that application of 50kg K_2SO_4 /fed to faba bean after 4 weeks of sowing and beginning of flowering stage increased all yield parameters and K uptake by faba bean. Hamid *et al* (2011) reported that the application of N fertilizer (60 kg/ha) and foliar Zn increased all the yield parameters of faba bean.

Concerning to the effect of cultivation spaces on yields of faba bean, Munir and Abdel-Rahman

(2002) reported that faba bean yields can be increased substantially with early seeding (14 January), high seeding rate (100 plant/m^2), and P band application (52.5 kg P/ha) drilled with the seed after cultivation. Talal (2006) reported that the higher row spacing (50-70 cm2) resulted in a positive impacts on nodules traits and yield performance of faba beans. The application of urea at pod filling stage produced the best yield attributes and highest yields of broad bean, especially under densely seeded plants at 50plant/m^2, Bahr (2007). Ali *et al.* (2010) stated that number of pods and seed yield per plant and 100-seed weight significantly increased with increasing the spacing's among rows. Amer *et al.* (2012) reported that the yield of faba beans at three different planting distances, including 20, 25and 30 cm was increased with decreased planting distances. Therefore, the objective of this study was to achieve highest quality and quantity yields of faba bean crop using suitable cultivation spaces and best combination of NPK fertilizers to decrease the harmful effect of salinity stress in the studied soil at Siwa Oasis.

MATERIALS AND METHODS

Throughout two successive years (2009 and 2010), field experiments in three completely randomized replications for each treatment were carried out in Tegzerty region at Siwa Oasis, which located at 29° 11' 34" N and 25° 32' 11" E. This soil was affected by flooded irrigation with slight water salinity (1.83 dS/m) while the soil salinity was 4.63 dS/m. The data of the studied soil and irrigation water are presented in Tables (1and 2) and analyses were determined the methods described by Page, *et al.* (1984) and Klute, (1986). In early November, seeds of faba (*Vicia faba*) var. Rebaya cultivated in three spaces of 15, 20 and 25cm between plants and 40 cm within rows. Before sowing, faba bean seeds were treated with rhizobium bacteria according to El Habbasha et al (2007).

With regard to the soil applied treatments, faba bean received 0, 30, 45 and 60 kg P_2O_5/fed, 0, 40, 60 and 80 kg K_2O/fed with one rate of N as 60 kg N/fed for all treatments. In addition, the fertilizers treatments were replaced in three cultivation spaces (15x40, 25x40 and 25x40 cm^2) per plant. The plants number of cultivation spaces were 70000, 52500 and 42000 plant/fed for space$_1$ (15x40), space$_2$ (25x40) and space$_3$ (25x40) respectively. There was a non-fertilized treatment (control) in each space. Phosphorus was added as calcium superphosphate (15.5 % P_2O_5) and incorporated with the soil and organic matter (10m^3/fed) during seedbed preparation. Nitrogen was added as ammonium nitrate (33.5 % N). Potassium was added as potassium sulphate (48.5% K_2O). In addition, N and K fertilizers were split into three equal doses that were applied after 20, 40 and 60 days from sowing.

Plant samples were collected at harvest stage. At the end of each experiment, the number Pods/plant, number Seeds/pod, weight pods/plant, weight seeds/plant, weight biological yield/plant and weight shoots/fed were recorded in both seasons. Plant samples were analyzed for N, P, and K according to Cottenie *et al.* (1982). Obtained data were statistically analyzed (Gomez and Gomez 1984).

RESULTS AND DISCUSSION

Effect of fertilization and cultivation plant spaces on yields:

Data in Table (3) showed the highest response of faba bean to increased rates of P and K fertilizers when compared with the control (non-fertilized) treatment for all studied cultivation spaces in both seasons. The optimum treatment for faba bean crop in three cultivation spaces was NP_3K_3 which recorded 3.77 and 1.99 ton/fed in cultivation space$_1$, 3.30 and 1.65 ton/fed in cultivation space$_2$, 2.93 and 1.51 ton/fed in cultivation space$_3$ for shoots and seeds, respectively.

Table 1: Some chemical and physical properties of the studied soil.

Soil depth (cm)	pH	EC dS/m	OM %	C.E.C meq /100g	CaCO$_3$ %	Sand %	Silt %	Clay %	Soil texture
0-30	8.26	4.12	1.57	7.57	6.67	79.95	10.53	9.52	L.S
30-60	8.53	5.48	1.26	8.38	8.35	71.63	18.42	9.95	L.S

Available nutrients in soil (ppm)							
Soil depth (cm)	N	P	K	Fe	Mn	Zn	Cu
0-30	38.4	3.26	37.2	2.64	1.16	0.62	0.29
30-60	25.6	1.96	41.5	3.57	1.48	0.81	0.36

Table 2: Soluble cations and anions of soil and irrigation water.

Soluble cations and anions in water irrigation (meq/L)								
pH	**EC dS/m**	**Na**	**K**	**Ca**	**Mg**	**HCO3^{-1}**	**Cl^{-1}**	**SO4^{-2}**
7.92	1.83	9.4	0.28	5.4	3.2	1.26	11.22	5.82
depth (cm)		Soluble cations and anions in soil (meq/L)						
0-30		21.3	2.33	12.3	5.3	2.14	30.83	8.23
30-60		26.7	3.67	15.7	8.7	2.92	39.21	12.67

Table 3: Effect of mineral fertilization and plant spaces on the yields of faba bean through two seasons.

Treatments	No. Pods /plant	No. Seeds /pods	Weight Pods (gm/ plant)	Weight Seeds (gm/ plant)	Weight Shoots (ton/fed)	Weight Seeds (ton/fed)
15 cm between plants, 40cm between lines (70000 plant/fed)						
Control	2.87	2.26	10.3	9.1	1.35	0.64
NP_1K_1	3.25	3.32	16.3	14.7	1.80	1.03
NP_1K_2	3.75	3.81	20.2	18.2	2.44	1.27
NP_1K_3	4.31	4.18	23.9	21.6	2.75	1.51
NP_2K_1	3.93	3.39	19.5	17.4	2.38	1.22
NP_2K_2	4.42	3.96	24.3	21.7	3.25	1.52
NP_2K_3	4.65	4.41	28.5	25.7	3.44	1.80
NP_3K_1	4.14	3.49	22.7	20.2	2.95	1.41
NP_3K_2	4.69	4.20	27.9	24.7	3.51	1.73
NP_3K_3	4.88	4.63	31.7	28.4	3.77	1.99
20 cm between plants, 40cm between lines (52500 plant/fed)						
Control	3.18	2.46	12.6	11.2	1.27	0.59
NP_1K_1	3.72	3.72	19.5	17.6	1.69	0.92
NP_1K_2	4.25	4.12	24.6	22.1	2.33	1.16
NP_1K_3	4.68	4.48	27.0	24.4	2.46	1.28
NP_2K_1	4.18	3.80	22.2	19.9	1.94	1.05
NP_2K_2	4.56	4.28	28.4	25.3	2.66	1.33
NP_2K_3	4.99	4.72	32.0	28.9	3.05	1.52
NP_3K_1	4.61	3.91	26.2	23.3	2.46	1.23
NP_3K_2	5.18	4.54	31.2	27.6	3.18	1.45
NP_3K_3	5.43	4.96	35.1	31.4	3.30	1.65
25 cm between plants, 40cm between lines (42000 plant/fed)						
Control	3.51	2.69	16.6	12.8	1.14	0.54
NP_1K_1	4.08	3.97	21.6	19.5	1.46	0.82
NP_1K_2	4.46	4.38	27.8	25.0	2.06	1.05
NP_1K_3	4.98	4.87	30.2	27.3	2.14	1.15
NP_2K_1	4.58	4.05	25.0	22.4	1.79	0.94
NP_2K_2	4.86	4.56	31.2	27.9	2.43	1.17
NP_2K_3	5.13	5.13	36.3	32.7	2.69	1.37
NP_3K_1	4.94	4.17	30.0	26.7	2.29	1.12
NP_3K_2	5.23	4.83	35.6	31.5	2.79	1.32
NP_3K_3	5.61	5.38	40.0	35.9	2.93	1.51
$LSD_{0.05}$ Treat	0.014	0.015	0.154	0.140	0.015	0.008
$LSD_{0.05}$ Spaces	0.008	0.008	0.084	0.077	0.008	0.004
$LSD_{0.05}$ Inter.	0.025	0.027	0.266	0.243	0.027	0.013

But, the optimum treatment (NP_3K_3) in cultivation $space_3$ achieved higher quality of yield parameters than it is in $space_2$ and $space_1$ cultivation. This is due to improvement of the plant growth and yield quality parameters in large agriculture area when compared with small agriculture area. The above results agree with those obtained by El Habbasha *et al.* (2007), Prusiński (2007) El-Gizawy and Mehasen (2009).

Regarded to the effect of the cultivation spaces on yield parameters of faba bean, the quality yields of faba bean increased with increasing cultivation spaces/fed but the yield's quantities were decreased. Moreover, the density of plants in $space_1$ gave higher yield quantities of seeds and shoots/fed than other cultivation spaces, while the $space_3$ gave the highest quality yields, which where; $space_3$, increased by about 5.5, 6.9, 12.1, and 11.5% over $space_2$ for No. pods/plant, No. seeds/pod, weight pods/plant and weight seeds/plant, respectively, and about 13.7, 14.5, 23.4 and 22.9 % over $space_1$ in the same quality yield parameters. Moreover, the $space_1$ increased over $space_2$ in weight shoots/fed and weight seeds/fed by 11.9 and 13.7% respectively, and over $space_3$ by 21.4 and 22.2% in the same yield parameters. This fact may be due to density of number plants/fed in each cultivation space. The above results agree with those obtained by Bahr (2007), Ali *et al* (2010) and Amer et al. (2012).

The interactions between fertilizer treatments and the different cultivation spaces showed significant effects. This refers to that the same combination treatment could significantly prove to be the optimum treatment to all applied treatments in all cultivation spaces during both seasons in a consistent mode. The above results assure role of cultivation spaces in increasing yield quality and quantity which was achieved at cultivation $spaces_2$. The above results agree with those obtained by Munir and Abdel-Rahman (2002) and Talal (2006).

Effect of fertilization and cultivation plant spaces on NPK concentration:

Table (4) showed that the concentrations of N, P, and K nutrients in the shoots and seeds of faba bean plants at the harvest stage were significantly increased with increasing rate of P and K fertilizers applications in all cultivation spaces. These results assure that faba bean plants have higher response to NPK fertilizers under condition of salinity stress especially K fertilizers. The (NP_3K_3) treatment for the three cultivation spaces of faba bean crop was significantly better in the concentration of NPK compared with other treatments in the studied two seasons. The cultivation $space_3$ gave higher significant effect for NPK content in shoots and seeds of faba bean than $space_2$ and $space_1$, as follows; 4.6 and 3.7 % for N; 7.7 and 4.7% for P; 4 and 5.7% for K in the shoots and seeds over $space_2$ respectively, while being 11.1 and 10.4% for N; 13.2 and 8.6% for P; 9.82 and 9.85% for K over $space_1$.

Table 4: Effect of mineral fertilization and plant spaces on NPK present in faba bean through two seasons.

Treatments	N %		P %		K %	
	Shoots	Seeds	Shoots	Seeds	Shoots	Seeds
15 cm between plants, 40cm between lines (70000 plant/fed)						
Control	0.65	1.14	0.058	0.135	0.25	0.87
NP_1K_1	1.12	2.13	0.121	0.216	0.47	1.67
NP_1K_2	1.16	2.16	0.129	0.223	0.53	1.76
NP_1K_3	1.19	2.18	0.136	0.229	0.58	1.83
NP_2K_1	1.16	2.17	0.148	0.242	0.52	1.71
NP_2K_2	1.18	2.21	0.153	0.249	0.59	1.82
NP_2K_3	1.21	2.24	0.159	0.256	0.67	1.91
NP_3K_1	1.19	2.2	0.173	0.276	0.58	1.78
NP_3K_2	1.22	2.25	0.181	0.281	0.66	1.89
NP_3K_3	1.25	2.29	0.190	0.288	0.75	1.97
20 cm between plants, 40cm between lines (52500 plant/fed)						
Control	0.68	1.22	0.060	0.142	0.26	0.91
NP_1K_1	1.19	2.27	0.128	0.225	0.49	1.78
NP_1K_2	1.21	2.29	0.131	0.231	0.55	1.84
NP_1K_3	1.24	2.33	0.139	0.238	0.59	1.92
NP_2K_1	1.22	2.31	0.162	0.257	0.57	1.82
NP_2K_2	1.25	2.37	0.168	0.263	0.65	1.89
NP_2K_3	1.28	2.43	0.173	0.269	0.74	1.96
NP_3K_1	1.26	2.37	0.185	0.284	0.62	1.89
NP_3K_2	1.29	2.46	0.193	0.292	0.71	1.95
NP_3K_3	1.32	2.49	0.201	0.297	0.78	2.04
25 cm between plants, 40cm between lines (42000 plant/fed)						
Control	0.71	1.30	0.062	0.149	0.27	0.96
NP_1K_1	1.27	2.33	0.143	0.237	0.53	1.86
NP_1K_2	1.29	2.39	0.149	0.243	0.59	1.93
NP_1K_3	1.32	2.42	0.156	0.251	0.64	2.02
NP_2K_1	1.31	2.40	0.174	0.273	0.59	1.91
NP_2K_2	1.34	2.46	0.181	0.281	0.66	1.99
NP_2K_3	1.37	2.52	0.189	0.288	0.73	2.09
NP_3K_1	1.35	2.50	0.197	0.292	0.65	2.03
NP_3K_2	1.38	2.53	0.206	0.299	0.74	2.11
NP_3K_3	1.41	2.55	0.211	0.307	0.81	2.19
$LSD_{0.05}$ Treat	0.004	0.007	0.0009	0.0009	0.003	0.007
$LSD_{0.05}$ Spaces	0.002	0.004	0.0005	0.0005	0.002	0.004
$LSD_{0.05}$ Inter.	0.006	0.012	0.0015	0.0016	0.005	0.011

This result refers to plants density at the same rate of fertilizers at different cultivation spaces. Our findings agree with those obtained by Crous *et al.* (2008) and Mona *et al.* (2011).

Effect of fertilization and cultivation plant spaces on NPK uptake:

Data representing the combined NPK fertilizers effect on nutrients uptake in shoots and seeds of faba bean crop are shown in Table (5). NPK uptake increased with increasing the rates of fertilizers application for faba bean during the two seasons.

Moreover, the NP_3K_3 treatment was optimum treatment for all measurements of this study: yields nutrients concentration uptake of faba bean in the three cultivation spaces. However, the first cultivation space gave higher increases of NPK uptake was found than other cultivation spaces. The values of increases were 7.26 and 7.3 % for N; 6.6 and 10.8% for P; 6.4 and 10.3% for K in the shoots and seeds over $space_2$ respectively, while being 11.5 and 13.3% for N; 9.9 and 15.6% for P; 13.3 and 13.9% for K over $space_3$ cultivation.

This result was due to plants density in different cultivation spaces and total yield of shoots and seeds. Our findings agree with those obtained by Chandrasekhar and Bangarusamy (2003), Gremigni, *et al.* (2004) and Thalooth, *et al.* (2006).

Regression equations:

Regression equations proved to be an effective tool for predicting the seeds and shoots production of faba bean plants. Multiple regression equations were calculated for crop response in the form seeds and shoots yield in ton/fed to the input of N, P and K in the three cultivation spaces (Tables 6 and 7).

Table 5: Effect of mineral fertilization and plant spaces on NPK removal (Kg/fed) by faba bean through two seasons.

Treatments	N		P		K	
	Shoots	Seeds	Shoots	Seeds	Shoots	Seeds
15 cm between plants, 40cm between lines (70000 plant/fed)						
Control	8.3	7.3	0.7	0.9	3.2	5.6
NP_1K_1	20.2	21.9	2.2	2.2	8.5	17.2
NP_1K_2	28.3	27.4	3.1	2.8	12.9	22.4
NP_1K_3	32.7	32.9	3.7	3.5	16.0	27.6
NP_2K_1	27.6	26.5	3.5	3.0	12.4	20.9
NP_2K_2	38.4	33.6	5.0	3.8	19.2	27.7
NP_2K_3	41.6	40.3	5.5	4.6	23.0	34.4
NP_3K_1	35.1	31.0	5.1	3.9	17.1	25.1
NP_3K_2	42.8	38.9	6.4	4.9	23.2	32.7
NP_3K_3	47.1	45.6	7.2	5.7	28.3	39.2
20 cm between plants, 40cm between lines (52500 plant/fed)						
Control	8.2	7.2	0.7	0.8	3.1	5.4
NP_1K_1	20.1	20.8	2.2	2.1	8.3	16.4
NP_1K_2	28.3	26.5	3.1	2.7	12.8	21.3
NP_1K_3	30.5	29.8	3.4	3.0	14.5	24.6
NP_2K_1	23.7	24.2	3.1	2.7	11.1	19.1
NP_2K_2	33.3	31.6	4.5	3.5	17.3	25.1
NP_2K_3	39.0	36.9	5.3	4.1	22.6	29.8
NP_3K_1	31.0	29.2	4.6	3.5	15.3	23.2
NP_3K_2	41.0	35.7	6.1	4.2	22.6	28.3
NP_3K_3	43.6	41.2	6.6	4.9	25.7	33.7
25 cm between plants, 40cm between lines (42000 plant/fed)						
Control	8.1	7.0	0.7	0.8	3.1	5.2
NP_1K_1	18.5	19.1	2.1	1.9	7.7	15.3
NP_1K_2	26.6	25.1	3.1	2.6	12.2	20.3
NP_1K_3	28.2	27.8	3.3	2.9	13.7	23.2
NP_2K_1	23.4	22.5	3.1	2.6	10.6	18.0
NP_2K_2	32.6	28.8	4.4	3.3	16.0	23.3
NP_2K_3	36.9	34.5	5.1	3.9	19.6	28.6
NP_3K_1	30.9	28.0	4.5	3.3	14.9	22.7
NP_3K_2	38.5	33.4	5.7	3.9	20.6	27.9
NP_3K_3	41.3	38.5	6.2	4.6	23.7	33.1
$LSD_{0.05}$ Treat	0.24	0.22	0.04	0.03	0.15	0.19
$LSD_{0.05}$ Spaces	0.13	0.12	0.02	0.01	0.08	0.10
$LSD_{0.05}$ Inter.	0.41	0.37	0.07	0.05	0.27	0.33

Table 6: Regression equations for seeds yield of faba bean at three cultivation spaces under optimum treatment.

Multiple regression equations					
Density plants	**Total N**	**Total P**	**Total K**	**Ton/fed**	R^2
No. plants/fed		Ton/fed		Seeds	
Seeds = -0.010+ 0.007*Total N + 0.255*Total P+ 0.007*Total K					0.992
70000	98.4	63.3	117.2	1.99	***
Seeds = -0.011+ 0.219*Total N - 0.037*Total P - 0.150*Total K					0.984
52500	98.4	63.3	117.2	1.65	***
Seeds = -0.031+0.128*Total N - 0.136*Total P -0.021*Total K					0.987
42000	98.4	63.3	117.2	1.51	***

Table 7: Regression equations for shoots yield of faba bean at three cultivation spaces under optimum treatment.

Multiple regression equations					
Density plants	**Total N**	**Total P**	**Total K**	**Ton/fed**	R^2
No. plants/fed		Ton/fed		Shoots	
Shoots =0.002+ 0.078*Total N+0.255*Total P -0.171*Total K·					0.976
70000	98.4	63.3	117.2	3.77	***
Shoots = -0.001+ 0.159*Total N + 0.231*Total P -0.230*Total K					0.987
52500	98.4	63.3	117.2	3.30	***
Shoots =-0.012+0.092*Total N+0.492*Total P-0.317*Total K					0.981
42000	98.4	63.3	117.2	2.93	***

This input included native and applied nutrients to the soil. This emphasizes the importance of (NP_3K_3), i.e. the highest soil application rates of fertilization for faba bean grown on sandy loam soil. The obtained multiple regression equations may merely be used in the detection of maximum yields of both shoots and seeds of faba bean crop for the treated soil in Siwa Oasis. The obtained results agree with the findings of Abdel Monem *et al.* (1988), Bushels and Brown (1999), FAO and IFA (2000), and Davis *et al.* (2002).

In conclusion, the mineral fertilization had improved the plant growth, nutrients contents and yield quality parameters in large agriculture area as compared with small agriculture area. On the other hand, the yield quantity and nutrients uptake, the small agriculture area gave the highest. The most effective treatment in three cultivation spaces was, NP_3K_3 which recorded 3.77 and 1.99 ton/fed in cultivation $space_1$, 3.30 and 1.65 ton/fed in cultivation $space_2$, 2.93 and 1.51 ton/fed in cultivation $space_3$ for shoots and seeds, respectively. The optimum treatment NP_3K_3 in cultivation $space_3$ achieved higher quality of yield parameters than it is in $space_2$ and $space_1$ cultivation.

Generally, the suitable fertilization treatment and cultivation space in this study was NP_3K_3 treatment in cultivation $space_2$ which achieved suitable quality and quantity of faba bean yield. In addition, deriving regression equations proved to be an effective tool for predicting the seeds and shoots production of faba bean plants cultivated at three cultivation spaces under saline conditions of soil at Siwa Oasis.

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الملخص العربى

تأثير التسميد المعدنى وكثافة النباتات على إنتاجية الفول البلدى فى واحة سيوة

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أقيمت تجارب حقلية خلال عامين متتالين فى ثلاثة مكرارات كاملة العشوائية لكل معاملة فى منطقة تجزرتى بواحة سيوة (عند الاحداثيات "34 '11 °29 شمالاً و '11 °32 "25 شرقا) تروى هذه الأرض بنظام الرى الغمر وتتاثر بمياة الرى ذات الملوحة الحفيفة(1.83dS/m) بينما كانت ملوحة التربة مرتفعة(4.12dS/m).

زرعت بذور الفول البلدى صنف ريبايا فى ثلاثة مسافات بين النباتات وهى ١٥ ، ٢٠ ، ٢٥ سم وكانت المسافة بين الخطوط ٤٠ سم.

وقد اشتملت معاملات التسميد على أربع مستويات من الفوسفور وهى صفر، ٣٠، ٤٥، ٦٠ كجم P_2O_5 كجم/فدان وكذلك أربع مستويات من البوتاسيوم وهى ٤٠، ٦٠، ٨٠ K_2O كجم/فدان. بينما أضيف النتروجين بمعدل ٦٠ كجم N فدان لجميع المعاملات ماعد معاملة الكنترول. كما أضيف السماد البلدى بمعدل ١٠ م^3/فدان لجميع المعاملات. وتهدف هذه الدراسة إلى إحراز أعلى محصول من الفول البلدى نوعا وكما باستخدام المناسب من مسافات الزراعة والأفضل من تركيبات الاسمدة لتقليل الاثر الضار من إجهاد الملوحة فى الأرض المختبرة بواحة سيوة.

أظهرت النتائج المتحصل عليها أن الفول البلدى أعطى أعلى إستجابة لزيادة معدلات إضافة الفوسفور والبوتاسيوم مقارنة بمعاملة عدم الاضافة عند جميع الكثافات النباتية خلال موسمى الدراسة. كما أعطت النتائج نفس الاتجاة فى محتوى العناصر الغذائية والممتص منها فى القش والبذور للفول البلدى عند جميع مسافات الزراعة. كما تبين أن عند تقليل مسافات الزراعة تزداد كمية المحصول/فدان بينما تنخفض جودة المحصول/نبات. والمعاملة السمادية المثلى لمحصول الفول البلدى فى مسافات الزراعة الثلاثة هى NP_3K_3 (60:60:80kg/fed) والتى سجلت فى المسافة الاولى للزراعة(3.77 and 1.99 ton/fed) وفى الثانية (3.30 and 1.65 ton/fed) وفى الثالثة (2.93 and 1.51 ton/fed) للقش والبذور على التوالى. بالاضافة الى المعاملات السمادية فى المسافة الثالثة أعطت أعلى جودة فى المحصول عن مثيلتها فى المسافة الأولى والثانية.

نتائج هذة الدراسة توصى باستخدام المعاملة السمادية المثلى NP_3K_3 مع المسافة الثانية للزراعة(20cm x 40cm) والتى حققت محصول مناسب كما ونوعا من الفول البلدى تحت ظروف الأرض المختبرة. وقد أثبت إشتقاق معادلات الانحدار المتعدد أهميته في التنبؤ بمحصول البذور والقش للفول البلدي فى مختلف مسافات الزراعة تحت ظروف هذه الدراسة.