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Increasing growth and production of faba bean (*Vicia faba* L.) by nitrogen and potassium fertilization

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ABSTRACT

Two field experiments were carried out in newly cultivated sandy land at New Salheyia Region, Al Sharkia Governorate in winter seasons of 2014/2015 and 2015/2016 on two faba bean cultivars (Sakha-3 and Nubaria-1) to study improving faba bean (*Vicia faba* L.) growth and productivity by increasing the effect of nitrogen using potassium fertilization. The results could by summarized as follows: Faba bean cultivars (Sakha-3 and Nubaria-1) significantly differed in growth characters at different stages of growth, photosynthetic pigments content per green leaves at 100 days after sowing, as well as, yield and its components and total carbohydrate and crude protein per dry seed, also. Sakha-3 cultivar surpassed Nubaria-1 cultivar concerning No. of branches, leaves and pods/plant, leaves area/plant and LAI at 95 and 105 days age, meanwhile,Nubraia-1 gave the tallest plant, branches, leaves and pods dry wt./plant compared with Sakha-3 cultivar in these growth stages. With respect of yield and its component, Sakha-3 cultivar significantly outweighed Nubaria-1 in yield and its components except plant height, seed index, straw yield/plant and or/fed, biological yield /fed and RPP $_{veg}$ where Nubria-1 gave the highest values from these estimated characters. There was a considerable and significant increase in growth characters at 95 and 110 days after sowing, also Chl. A+ Chl. b, Chl. A + Chl. b ,carotenoids and Chl. A+ Chl. b , Chl./ carotenoids at 100 days age, as well as, yield and its components except (crop index and harvest index) with increasing nitrogen fertilizer rate up to 60 Kg N/fed. Regarding the effect of potassium rates on faba bean plants; growth characters at 95 and 110 days age, photosynthetic pigments content except (Chl. a + Chl. b)/carotenoids), yield and its components except (crop index and harvest index), total carbohydrate and crude protein percentages per dry seeds responded significantly to potassium fertilization. Moreover, maximum values from previous estimated characters was achieved under 52 kg K_2O/fed.. The effect of the interaction between cultivars *x* nitrogen, cultivar *x* potassium, nitrogen *x* potassium and the three way interaction cultivar *x* nitrogen *x* potassium fertilization rates were discussed. Generally, Sakha-3 cultivar under 60 Kg nitrogen /fed. and 52 Kg K_2O/fed produced the highest values from seed yield per plant and or/fed and its components, whereas ,Nubaria-1 under fertilization with 60 Kg N/fed.+52 Kg K_2O/fed. characterized with the greatest straw yield per plant and biological yield/fed..

Key words: Faba bean (*Vicia faba* L.), nitrogen and potassium fertilization, sandy land,

Introduction

Legume food crops even with high levels of agricultural technology, exhibit relatively low yields. Yield records such as those achieved in cereals during the green revolution have not occurred in legume crops. *Vicia faba* L. is one of the principal winter food legume crops in Egypt as a source of vegetable proteine, To improve faba bean productivity many efforts have been made (Mohamed *et al .,* 2006; El-Habbasha *et al.,* 2007; El-Gizawy *et al.*, 2009; El-Fouly *et al.*, 2010; Bozorgi *et al*, 2011, Khalil *et al*., 2012; Abdallh, 2014; Ashoori, 2014 and Man Rasul, (2017).

The increase in harvest yield of faba bean in Egypt can be achieved by the introduction of new series cultivars and the development of improved cultural practices (Ahmed *et al*.,1997; Hussien *et al*., 2012, Bucheyeki *et al*, 2013).

The objective of this study was to investigate increasing faba bean (*vicia faba* L.) productivity by improving the effect of nitrogen fertilizer using potassium fertilization. The study include two faba

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bean cultivars as a genetic factors and four rates of nitrogen ,as well as, thee different rates from potassium fertilizer as example of edaphic factor.

Materials and Methods

Two field experiments were carried out at newly cultivated sandy land at new Salheyia Region, Sharkia Governorate , during the two winter successive seasons 2014/2015 and 2015/2016 to study improving faba bean (*Faba faba* L.) growth and productivity by increasing the effect of nitrogen fertilizer by potassium application. Each experiment included 24 treatments wich were the combination of two faba cultivars (Sakha 3 and Nubaria 1), four levels of nitrogen fertilizer (15, 30, 45 and 60 Kg N/fed), and three level of potassium fertilizer (0,26,and 52 Kg K_2O/fed.) as soil application, in a split-split plot design with three replications, where, faba bean cultivars occupied the main plots while those of nitrogen fertilizer were allocated at random in the sub-plots and potassium fertilizer in sub - sub plots. The experimental unit consisted of seven ridges, four meters in length and 60 cm-apart. Michcanecal and chemical analysis of the soil (0-30vn) was done according to Black, (1983). The experimental soil (0-30) had 9.68 percent clay, 1.60 percent silt, and 88.72 percent sand and loamy sand texture. Available N ppm was 10.60 and 11.70, available P ppm was 16.0 and 15.0, whereas; available K ppm was 78.0 and 63.0, in 2014/2015 seasons, respectively. On the other hand the pH of the site in the soil was 8.10 and 8.55 during the two seasons of this investigation, respectively. Seeds of faba bean (Sakha 3 and Nubaria 1) cultivars were planted on November 8th and 11th in 2014 and 2015 respectively, in hills 15 cm apart at a seeding rate of 40 Kg/fed.. Then ; 31 Kg P_2O_5 /fed. as calcium super phosphate (15.5% P_2O_5) were applied, Normal cultural practices were followed as usual in faba bean fields. Nitrogen fertilizer was applied as ammonium sulphate 20% N at the rate of : (A) 15 Kg N/fed. an early dose only after thinning,(B) 30 Kg N/fed., as A + 15 Kg N/fed , 20 days later, (C) 45 Kg N/fed. as B+ 15 Kg N/fed., 20 days later and (D) 60 Kg N/fed. as (C) and 15 Kg N/fed. a second time 20 days later. Potassium fertilizer was applied in two equal doses, where, the first half was applied after thinning and the rest second half after 20 days from onset of poddidng.

Plant height, number and dry weight of branches; leaves and pods/plant were estimated at 95 and 110 days after planting by harvesting five guarded plants as random from the middle rows of every plot. In addition, leaves area cm^2 /plant was computed according to Bremner and Taha (1966), where as leaf area index (LAI) was determined according to Watson (1952). Photosynthetic pigments content in faba bean leaves (mg/g dry weight) were extracted by aqueous solution of 85% aceton and calculated using Van Wetistein formula (Van Wetistein, 1957) at 100 days after sowing date.

At full maturing, plant height, number of branches and pods /plant, weight of 100 seeds (seed index) and weight of pods/plant, seed and straw yield g/plant. Moreover, seed, straw and biological yield Ton/fed. were determined a cording to the all plants of each plot and the converted to ton /fed. Crop index and harvest index were estimated a cording to Abdel-Gawad *et al* (1987). Relative photosynthetic potential (RPP) for seeds and biological yields, as well as, Vegetative organs were calculated according to the method described by Vidovic and Pokorny (1973), where, $RPP_{seed} = Y_{seed}$ per plant /LAI , $RPP_{bio} = y_{bio}$ per plant/LAI, whereas ,$RPP_{veg} = RPP_{bio} - RPP_{bio}$. The dried seeds were finally ground and keep for carbohydrate and protein determinations ,using phenol-sulphoric acid method (Dubois *et al* ,1956) in case of carbohydrate, and the method described by A.O.A.C (1980) in case of crude protein, whereas, protein was estimated by multiplying total nitrogen by the factor 6.25.

Combined analysis of the data for two growing seasons was carried out according to the procedure outlined by Snedecor and Cochran (1990). For comparison between means L.S.D. test was used.

Results and Discussion

A: Cultivar differences:

Data illustrated in Table (1) show clearly that there were significant differences between the faba bean cultivars Sakha-3 and Nubaria-1 in growth characters, i.e. plant height, number and dry weight of each one from branches; leaves and pods/plant, leaves area cm^2 /plant and LAI at 95 and 110 days

after sowing. In addition, it is clear that Sakha-3 cultivar significantly surpassed Nubaria-1 cultivar in all previous growth estimated characters except in plant height, leaves area cm^2 /plant and consequently LAI; where; Nubaria-1 had the tallest faba bean plant. Moreover, Sakha-3 cultivar significantly outweighed Nubaria-1 cultivar in photosynthetic pigments content (i.e Chl.a, Chl.b, Chl a+b and carotenoids in green leaves at 100 days after sowing, as well as, total carbohydrate and crude protein percentages per dry seeds at harvest date (table 4). Regarding yield and its components; the two faba bean cultivars under study Sakha-3 and Nubaria-1 significantly differed in plant height, number of branches and pods/plant, seed index(100 seeds wt./g),seed and straw yields per plant and /or per faddan, biological yield per faddan, crop indx, harvest index, RPP_{seed} , RPP_{bio} and RPP_{veg} .Furthermore,Sakha-3 cultivar had the highest significant values from number of branches and pod/plant, seed yield/plant and or /fed., crop index, harvest index, RPP_{seed} , RPP_{bio}, whereas,Nubaria-1 harvested the great mean values from plant height, seed index, straw yield/plant and or /fed, biological yield/fed. and RPP_{veg} compared with Sakha-3 cultivar (Table 7).

On the other hand; from Table (1); plant height, number of pods/plant and pod dry weight/plant tended to increase with advance in plant age until 110 days after sowing, meanwhile, number of branches and number of leaves/plant, branches and leaves dry weight /plant, leaves area/plant and LAI were decreased with advance plant age from 95 to 110 days age. The markedly decrements of branches and leaves dry weight/plant with advancing the plant age towards maturity stage were corresponded with substantial increment in pods dry weight/plant up to physiological maturity stage. This could be mainly attributed to translocation of photosynthetic assimilates from vegetative to productive organs (i.e. pods and seeds).

It is worthy to mention that the cultivars differences between faba bean cultivars in growth and yield and its components might to the cultivar differences in partition and migration of photosynthates, where faba bean cultivars differed in carbon equivalent of vegetative components, seeds and straw, number of glucose g required to from 1gm of vegetative matter, seeds, straw, yield energy per plant, as well as, coefficient energy of crop index, harvest index and migration coefficient (Ahmed *et al,1997)*and again, to the differences among faba bean cultivars in number of nodules formed by each cultivar and consequently growth of each cultivar depended mainly on nitrogen fixation(Tawfic *et al,*1991 and Ahmed *et al*,1997). Also, Singh *et al* (1992) and Ahmed *et al* ,(1997),reported that dry matter accumulation was significant differed between faba bean cultivars.

It is worthy ,the superiority of Sakha-3 cultivar among Nubaria-1 cultivar in economic yield (seeds and or /fed.) may be due to its greatest mean values from number of branches; leaves and pods/plant (Table-1), photosynthetic pigments content per green leaves(Table 4),as well as, number of branches and pods/plant, crop index, harvest index, RPP_{seed} , RPP_{bio} at harvest date compared with Nubaria-1 cultivar, meanwhile the highest values from straw yield/plant and /or fed. of Nubaria-1 compared with Sakha-3 cultivar could be attributed to its greatest values from plant height, branches dry wt., leaves dry wt. at 95 and 110 days age (Table 1) and plant height (Table 7).

Our results are confirmed with results obtained by Ahmed *et al.* (1997); Abo-ElKheir *et al* (2008), Alghamdi and Ali (2004); Ahmed and El-Abagy (2007); Alghamdi (2007); Afifi *et al*., (2010) Fivawo and Msolla (2012) and Bucheyeki *et al* (2013).

B-Nitrogen fertilization rates:

Nitrogen fertilization significantly increased growth characters (i.e. plant height, number of branches, leaves and pods/plant, dry weight of branches; leaves and pods/plant),leaves area/plant and LAI)of faba bean plants. Data observed that adding nitrogen fertilizers at the rate of 60 Kg/fed. produced the maximum values from the previous growth characters studied compared with 15,30 and 45 kg N/fed. rates and this was true under newly cultivated sandy lands in New salheyia Region, Sharkia Governorate ,Egypt. On the other hand ,plant height, number and dry weight of pod/plant increased with advancing age from 95 to 110 days age ,whereas, number and dry weight of branches and leaves/plant, leaves area/plant and LAI were decreased with advancing plant age from 95 to 110 days after sowing (Table 1).With respect of photosynthetic pigments content in green leaves at 100 days after sowing and total carbohydrate and crude protein percentages per dry seeds at harvest date were significantly affected by nitrogen fertilization rates, where, 60 kg N/fed treatment had the highest

Table 1: Effect of cultivars, nitrogen and potassium fertilization rates on growth characters of faba bean plants (Average of 2015/2016 and 2016/2017 seasons).

Growth characters / Treatments	Plant height cm		No. of branches/ plant		No. of leaves / plant		No. of pods / plant		Branches dry wt. g/ plant	
	95	110	95	110	95	110	95	110	95	110
	Cultivars									
Sakha – 3	123.79	128.55	5.03	4.62	126.48	110.7	21.06	24.65	15.01	13.34
Nubaria – 1	128.96	139.78	4.45	4.11	107.10	96.02	18.65	22.50	17.23	16.01
L.S.D at 5%	1.04	2.10	0.21	0.13	2.61	1.02	1.42	0.40	0.47	0.71
Nitrogen fertilization rates										
15 Kg N/ fed	122.55	128.44	4.14	3.60	108.55	95.92	16.26	20.5	14.04	13.11
30 Kg N/ fed	124.77	130.9	4.61	4.21	1165.00	99.99	18.79	22.79	15.72	14.20
45 Kg N/ fed	127.29	135.49	4.95	4.71	118.61	105.54	21.24	24.92	16.76	15.17
60 kg N/ fed	130.89	140.75	5.27	4.85	124.00	112.0	23.18	26.09	17.57	16.24
L.S.D at 5%	1.05	1.31	0.21	0.07	0.91	1.22	0.34	0.04	0.52	0.37
	Potassium fertilization rates									
Control (unfertilized plant)	123.77	131.79	4.39	4.10	111.81	99.30	17.16	21.38	15.01	13.61
26 kg K_2 O / fed	126.23	134.53	4.77	4.39	118.05	103.69	19.56	24.16	16.12	14.58
52 kg K_2 O / fed	129.12	136.54	5.07	4.66	120.77	107.43	22.93	25.94	17.17	15.53
L.S.D AT 5%	1.17	0.39	0.17	0.15	1.92	0.54	0.43	0.12	0.37	0.70

Table 1: *Cont.*

Growth characters / Treatments	Leaves dry wt. g/ plant		Pods dry ut. g/ plant		Leaves area Cm^2/ pant		LAI	
	95	110	95	110	95	110	95	110
	Cultivars							
Sakha – 3	14.27	12.78	27.60	32.71	1847.98	1707.64	2.05	1.09
Nubaria – 1	16.02	14.21	28.88	35.11	1945.00	1782.41	2.16	1.98
L.S.D at 5%	0.85	0.26	0.08	1.13	12.10	15.80	0.01	0.03
	Nitrogen fertilization rates							
15 Kg N/ fed	13.21	12.10	24.30	29.37	1796.61	1687.77	2.00	1.88
30 Kg N/ fed	14.86	13.32	27.02	33.49	1849.18	1717.99	2.05	1.91
45 Kg N/ fed	16.00	14.11	30.33	35.69	1918.68	1758.16	2.13	1.95
60 kg N/ fed	16.48	14.46	31.31	37.10	2021.5	1820.19	2.25	2.02
L.S.D at 5%	0.14	0.09	0.58	1.17	11.38	13.45	0.13	0.02
	Potassium fertilization rates							
Control (unfertilized plant)	14.32	12.70	25.27	30.47	1845.13	1695.22	2.05	1.88
26 kg K_2 O / fed	15.13	13.62	28.30	34.14	1893.71	1748.76	2.10	1.94
52 kg K_2 O / fed	15.97	14.52	35.08	38.66	1950.21	1794.09	2.17	1.99
L.S.D AT 5%	0.5	0.12	1.79	0.38	4.15	6.78	0.01	0.02

significant values from Chl.a, Chl.b and Chl.a+b, carotenoids, and((Chl.a + Chl.b) /carotenoids)per green leaves at 100 days age and total carbohydrate and crude protein percentages per dry seeds at harvest date (Table 4).Consequently, yield and its components of faba been plant significantly responses to nitrogen fertilization rate, i.e., plant height, number of branches and pods/plant, seed index, seed yield per plant and/or per fed., above ground biomass/fed., RPP_{seed}, RPP_{bio} and RPP_{veg} . Moreover added 60 kg N/fed. rate to faba bean plant produced the greatest mean values from yield and its components compared with 15,30 and 45 kg N/fed. rates. On the other hand the effect of nitrogen fertilization rates on crop index and harvest index failed to reach the significant level at 5% (Table 7).

It is worthy that, plants required nitrogen element in comparatively large amounts than other elements for plant growth. An essential component of many compound of the plant is nitrogen such as chlorophyll, carotenoids, protein, alkaloids, enzymes, hormones and vitamins (Marschner, 1995). For harvesting an optimal yield, must be in sufficient to improving plant yield, where, nitrogen deficiency generally results in growth parameters, chlorotic leaves because the lack of nitrogen limits the synthesis of proteins and chlorophyll (Ihsanullah *et al,* 2008).In addition, nitrogen application with

proper amount of nitrogen can case to increase plant growth, chlorophyll content and yield and yield attributes (Man Rasul, 2017).

Generally, our obtained results of the positive response of faba bean plants to nitrogen fertilizer, i.e. growth characters, photosynthetic pigments and yield as well as , yield attributes are confirmed with results reported by Saaba *et al.* (2006); Ihsanullah *et al.* (2008); Bozorgi *et al* (2011); Khalil *et al*. (2012); Ashoori (2014) and Mam Rasul (2017).

C-Effect of Potassium rates:

Adding potassium fertilizer plants caused an significant effects on growth attributes at 95 and 110 days after sowing (Table 1), on photosynthetic pigments content per green leaves at 100 days after sowing (except(Chl.a + Chl.b) /carotenoids);as well as ;total carbohydrates and crude protein percentages per dry seeds (Table 4)and yield and its components (except crop index and harvest index)(Table 7).

Adding 52 kg K_2O/fed. to faba bean plants outyielded the greatest significant values from plant height; number and dry weight of branches; leaves; and pods/plant, leaves area/plant and LAI at 95 and 110 days after sowing date (Table 1), from Chl.a, Chl.b, Chl.a + Chl.b and carotenoids per green leaves at 100 days age; also, total carbohydrates and crude protein percentage per dry seeds at harvest date (Table 4),and from plant height, number of branches and pods /plant, seed index, seed and straw yields per plant and/or per fed., biological yield/fed., RPP_{seed} ,RPP_{bio} and RPP_{veg} (Table 7) compared with control treatment (unfertilized plants) and 26 kg K_2O /fed. The positive effect of potassium fertilizer on growth parameters, photosynthetic pigments content, yield and its components, as well as, total carbohydrate and crude protein per dry seeds at harvest date may be due to K ion which considered as one of the main factors affecting the growth characters, chemical constituents and yield its components through its effect on sugar content, respiration rate, and the absorption capacity for different nutrients (Ahmed *et al*, 1994). Moreover, potassium is the third major element taken up by the plant and plants absorb it in large amount as compared to other minerals except nitrogen, also, potassium has utmost importance for imparting drought and disease resistance and synergistic effect with nitrogen and phosphorus (Zaki *et al*,2013,Mufilinge *et al*, 2014,and Ahmed *et al*, 2015).In addition, potassium influences the water economy and crop growth through its effects on water up*take,* root growth, maintenance of turgor, transpiration and stomatal regulation (Mfiling *et al*,2013).Furthermore ,Raza *et al*(2013) reported that potassium improve physiological and nutrient uptake performances of wheat.

It is worthy to mention that many other investigators confirmed with our finding of the positive effect of potassium fertilizer on faba bean plants growth such as Zaho *et al*., (2001); Kuradali *et al.* (2002); Akhtar *et al.* (2003); Singh and Kuhad (2005); Asgh*ar et al.* (2007); Shrma *et al*. (2008); Jin *et al* (2011); Kilavat and Modi (2012); Zaki *et al* (2013); Mfiling *et al (2014)* and Ahmed *et al.* (2015), with Collins *et al*. (1981); Zaho *et al.* (2001); Jin *et al*. (2011) and Mfilinge (2014) in the effect of potassium fertilization on photosynthetic pigments content and photosynthesis of plants ;as well as; with Bansal *et al.* (2001); Kurdali *et al.* (2002); Akhtar *et al* (2003); Amjad *et al.* (2004); Boulbaba *et al*. (2005); Singh and Kuhad (2005); Asghar *et al* (2007); Sharma *et al*. (2008); Kilavat and Modi (2012); Zaki *et al.* (2013) and Ahmed *et al*. (2015) in the effect of potassium fertilization for improving yield and its components and seed quality.

D-Effect of the interaction

D1-The interaction cultivars x nitrogen rates

Table (2) observed clearly that plan height, number and dry weight of each one from branches; leaves and pods/plant, leaves area plant and LAI significantly responses by the interaction between faba bean cultivars and nitrogen fertilization rates at 95 and 110 days after sowing. Moreover plant height, number of pods/plant and pods dry weight/plant tended to increase with advancing plant age up to 110 days after sowing date, whereas; number and dry weight of branches and leaves/plant, leaves area/plant and LAI were decreased with advancing plant age from 95 to 110 days after sowing.

Table 2: Effect of the interaction between cultivars * N, cultivars * K, and N * K fertilization rates on growth characters of faba bean plants. (Average of 2014/2015 and 2015/2016 seasons).

Interaction		Plant height cm		No. of branches/ plant		No. of leaves / plant		No. of pods / plant		Branches dry wt. g/ plant	
		95	110	95	110	95	110	95	110	95	110
		Interaction Cultivars * N rates									
Sakha – 3	15 kg N	121.10	125.88	4.56	3.94	118.18	100.83	17.27	21.67	13.21	11.26
	30 Kg N	123.03	127.00	4.83	4.45	124.71	105.3	20.33	23.5	14.52	12.51
	45 Kg N	124.57	128.65	5.17	4.88	127.36	114.0	22.35	25.92	15.86	14.04
	60 Kg N	126.45	132.67	5.57	5.22	135.67	122.67	24.27	27.5	16.27	15.45
Nubaria – 1	15 Kg N	124.0	131.0	3.72	3.45	98.92	91.00	15.25	19.33	15.43	14.85
	30 Kg N	126.5	134.8	4.39	3.97	107.28	94.67	17.25	22.08	16.91	15.88
	45 Kg N	130.0	144.33	4.72	4.53	109.86	97.86	20.08	23.92	17.65	16.3
	60 Kg N	135.33	149.00	4.97	4.47	112.33	101.33	22.08	24.67	18.87	17.02
L.S.D at 5%		1.47	1.83	0.29	0.06	1.27	1.71	0.48	0.06	0.73	0.52
	Interaction between cultivars * K rates										
Sakha – 3		121.66	126.48	4.59	4.25	119.00	104.56	17.94	22.5	13.97	12.61
	26 Kg	123.45	128.36	5.08	4.61	128.92	111.44	20.73	24.19	15.15	13.43
	521 kg	126.23	131.58	5.42	4.92	131.78	116.13	24.5	27.5	15.82	14.42
Nubaria -1	0.0	125.88	137.1	4.19	3.94	104.61	94.03	16.38	20.25	16.04	14.61
	26 kg	129.00	140.75	4.46	4.17	107.17	95.94	18.38	24.13	17.08	15.73
	52kg	132.00	141.50	4.71	4.40	109.76	98.73	21.35	24.38	18.51	16.63
L.S. D at 5%		1.70	0.57	0.25	0.22	2.82	0.79	0.63	0.18	0.54	1.03
	interaction between N* K rates										
15 kg N	0	120.63	126.05	3.84	3.25	104.25	91.63	14.00	18.50	12.87	11.66
	26	122.3	128.38	4.09	3.75	109.34	95.38	16.78	19.5	14.52	13.16
	25	124.65	130.9	4.50	4.09	112.01	100.75	18.00	23.0	15.68	14.34
30 kg N	0	122.65	128.35	4.17	3.96	109.95	96.5	16.00	21.50	14.81	12.88
	26	125.8	132	4.75	4.25	118.0	100.5	18.00	23.13	15.77	14.09
	52	127.3	135.25	4.92	4.59	120.05	103.0	22.48	25.5	16.57	14.85
45 kg N	0	123.95	135.75	4.59	4.42	114.52	102.4	18.13	22.5	14.23	15.69
	26	127.4	138.0	5.00	4.63	119.5	106.5	20.4	27.5	16.69	14.97
	52	130.5	137.25	5.25	4.84	122.32	109	25.13	26.75	16.91	14.97
60 kg N	0	126.5	136.5	4.96	4.75	118.5	106.67	20.5	24.25	16.65	15.73
	26	130.0	140.5	5.25	4.92	125.34	112.38	23.03	26.5	17.49	16.50
	52	132.5	143.0	5.59	5.13	128.67	116.95	26.00	28.5	18.5	16.74
L.S.D AT 5% level		1.46	0.49	0.21	2.40	0.68	0.54	0.15	0.46	0.88	1.75

Table 2: *Cont.*

Interaction		Leaves dry ut. g/ plant		Pods dry wt. g/ plant		Leaves area Cm2/ pant		LAI	
		95	110	95	110	95	110	95	110
		Interaction Cultivars * N rates							
Sakha - 3	15 kg N	12.53	11.46	23.75	28.06	1768.52	1644.33	1.96	1.83
	30 Kg N	13.70	12.44	26.48	32.81	1807.78	1675.85	2.00	1.86
	45 Kg N	15.27	1342	29.66	33.95	1869.58	1732.12	2.08	1.90
	60 Kg N	15.5	13.81	30.51	36.00	1946.02	1786.25	2.16	1.98
Nubaria – 1	15 Kg N	13.89	12.73	24.85	30.67	1824.69	1731.21	2.03	1.92
	30 Kg N	16.02	14.20	27.56	34.17	1890.57	1960.12	2.10	1.96
	45 Kg N	16.72	14.79	30.99	37.43	1967.77	1784.19	2.19	1.98
	60 Kg N	17.46	15.11	32.12	38.19	2096.97	1854.13	2.33	2.06
L.S.D at 5% level		0.20	0.13	0.81	1.64	15.93	18.83	0.18	0.03
	Interaction between cultivars * K rates								
Sakha – 3		13.61	11.8	24.43	29.40	1806.68	1670.81	2.01	1.87
	26 Kg	14.35	12.76	27.83	33.66	1840.28	1716.96	2.04	1.91
	521 kg	14.79	13.65	30.55	36.14	1895.98	1741.10	2.11	1.93
Nubaria -1	0.0	15.03	13.59	26.10	31.54	1883.57	1719.62	2.09	1.91
	26 kg	15.91	14.48	28.77	34.62	1947.14	1780.55	2.16	1.98
	52kg	17.15	15.38	39.6	39.18	2004.43	1847.07	2.23	2.05
L.S. DAT 5%		0.74	0.18	2.63	0.56	6.10	9.97	0.015	0.03
	interaction between N*X rates								
15 kg N	0	11.97	10.67	21.21	26.4	1769.85	1639.24	1.97	1.82
	26	13.37	12.24	25.063	28.79	1786.06	1682.65	1.98	1.87
	25	14.29	13.38	26.64	32.91	1833.65	1739.92	2.04	1.93
30 kg N	0	14.05	12.25	25.00	29.66	1802.09	1731.63	2.00	1.92
	26	14.74	13.26	27.11	33.18	1884.7	1731.13	2.09	1.92
	52	15.79	14.19	28.96	37.84	1898.8	1753.23	2.11	1.94
45 kg N	0	15.31	12.86	26.60	32.49	1857.05	1703.03	2.06	1.89
	26	15.88	14.46	30.13	37.01	1928.65	1764.21	2.14	1.96
	52	16.30	15.00	34.24	39.73	1970.03	1807.24	2.19	2.01
60 kg N	0	15.90	13.37	28.26	33.33	1951.25	1769.48	2.17	1.97
	26	16.54	14.53	30.9	37.60	2015.48	1816.17	2.24	2.02
	52	17.00	15.49	34.8	40.36	2097.83	1874.45	2.33	2.08
L.S.D AT 5% level		0.15	2.24	0.05	n.s	5.19	8.48	0.013	0.03

Again; S akha-3 cultivars plants fertilized with 60 kg N/fed. out yield the greatest mean values from number of branches/plant, number of leaves/plant and number of pod/plant, meanwhile, Nubaria-1 cultivars when treated with 60 Kg N/fed., also, characterized by its highest values from plant height, branches; leaves and pods dry weight/plant, leaves area/plant and LAI at 95 and 110 days age.

Concerning photosynthetic pigments content per green leaves at 110 days age and carbohydrate as well as crude protein percentages per dry seeds at harvest date, data illustrated in Table (5) indicate that the effect of the interaction between faba bean cultivars and nitrogen fertilization rates was significant. In addition, adding, 60 k N/fed. to Sakha-3 plants harvested the greatest mean value from Chl.a, Chl.b, Chl.(a+b), carotenoids per green leaves and from total carbohydrate and crude protein per dry seeds.

With respect of yield and its components, Table (8) show clearly that the effect of the interaction between faba bean cultivars and nitrogen fertilization rates was significant except on crop index. Generally, soil application with 60 k N/fed. to Nubaria-1 cultivars produced the greatest mean values from plant height, seed index, straw yield per plant and/or fed.; as well as; biological yield/fed., RPP $_{bio}$ and RPP $_{veg}$, while adding 60 kg N/fed. to Sakha-3 cultivars gave the highest values from number of branches and pods/fed., seed yield/plant and or/fed. and RPP $_{seed}$ at harvest date.

Table 3: Effect of interaction between faba bean cultivars, nitrogen and potassium fertilization rates on growth characters of faba bean plants (Average of 2011/2015 and 2015/2016 seasons).

Cultivars	N Kg/fed	K20 Kg/fed.	Plant height cm		No. of branches/ plant		No. of leaves / plant		No. of pods / plant		Branches dry ul. g/ plant	
			95	110	95	110	95	110	95	110	95	110
Sakha - 3	15	0	119.25	124.1	4.17	3.33	111.75	94.25	15.00	19.00	11.92	11.07
		26	120.6	125.75	4.50	4.00	119.67	100.75	17.8	21.00	13.78	11.95
		52	123.3	127.8	5.00	4.5	123.13	107.5	19.00	25.00	14.12	12.87
	30	0	120.8	125.3	4.33	4.17	115.9	100.0	17.00	21.50	13.75	11.42
		26	122.5	1267	5.00	4.50	128.0	106.0	19.00	23.00	14.82	12.91
		52	125.3	129.0	5.17	4.67	130.25	110.0	25.00	27.00	15.00	13.21
	45	0	121.9	127.5	4.67	4.5	120.00	109.0	18.75	24.00	14.87	13.12
		26	124.8	129.0	5.33	4.75	129.0	115.0	21.8	25.75	15.92	13.65
		52	127.0	132.5	5.5	5.00	132.75	118.0	26.5	28.0	16.78	15.34
	60	0	124.7	129.0	5.17	5.00	128.0	115.0	21.00	25.50	15.33	14.91
		26	125.9	132.0	5.5	5.17	139.0	124.0	24.3	27.00	16.08	15.19
		52	1288	1370	6.00	5.5	141.0	129.0	27.5	30.00	17.39	16.25
Nubaria – 1	15	0	122	128	3.5	3.7	96.75	89.0	13.00	18.00	13.81	12.24
		26	124	131	3.67	3.5	99.00	90.0	15.75	18.00	15.26	14.37
		52	129	138	4.67	4.5	109.85	96.0	19.75	24.00	18.13	16.48
	30	0	124.5	131.1	4.00	3.75	104.0	93.0	15.0	19.0	15.87	14.34
		26	126	135	4.5	4.0	108.0	95.0	17.0	23.25	16.72	15.26
		52	129	138	4.67	4.5	109.85	96.0	19.75	24.00	18.13	16.48
	45	0	126	144	4.5	4.33	108.7	95.8	17.5	21.00	16.5	15.33
		26	130	147	4.67	4.5	11.0.	98.0	19.00	25.25	17.45	16.28
		52	134	147	5.00	4.67	111.85	100	23.75	25.5	18.92	17.00
	60	0	131	145	4.75	41.5	109	98.33	20.0	23.0	17.96	16.54
		26	136	150	5.00	4.67	111.67	100.75	21.75	26.0	18.9	17.00
		52	139	152	5.17	4.75	116.33	104.9	24.5	27.00	19.74	17.213
		.83	1.81	0.61	0.27	0.23	3.00	0.84	0.67	0.19	0.58	1.09

Table 3: Cont.

Cultivars	N Kg/fed	K20 Kg/fed.	Leaves dry wt. g/ plant		Pods dry wt. g/ plant		Leaves area Cm2/ pant		LAI	
			95	110	95	110	95	110	95	110
Sakha - 3	15	0	11.53	10.29	20.15	25.88	1747.5	1600.0	1.94	1.79
		26	2.84	11.51	25.00	28.11	1762.85	1647.0	1.96	1.83
		52	13.21	12.58	26.09	30.20	1795.2	1686.0	1.99	1.87
	30	0	13.20	11.61	24.23	28.7	1768.4	1637.8	1.95	1.82
		26	13.72	12.00	26.71	32.94	1607.95	1889.75	2.00	1.88
		52	14.18	13.17	28.51	36.78	1847.0	17.000	2.05	1.89
	45	0	14.71	12.30	25.78	31.00	1813.3	1700.19	2.02	1.89
		26	15.34	13.90	29.59	36.60	1873.5	1733.7	2.08	1.93
		52	15.75	14.06	33.66	38.56	1921.95	1762.48	2.14	1.96
	60	0	15.00	12.98	27.54	32.00	1897.5	1745.25	2.11	1.94
		26	15.49	13.64	30.00	37.0	1920.8	1797.6	2.13	1.99
		52	16.00	14.8	34.00	39.00	2019.76	1815.9	2.24	2.02
Nubaria – 1	15	0	12.41	11.05	22.27	26.92	1792.69	1678.5	1.99	1.87
		26	13.89	12.97	25.11	29.47	1809.27	1718.3	2.01	1.91
		52	17.39	15.21	29.41	38.50	1950.6	1806.45	2.17	2.01
	30	0	16.9	12.89	25.76	30.6	1835.77	1700.1	2.04	1.89
		26	153.76	14.51	27.51	33.41	1885.35	1773.5	2.09	1.98
		52	17.39	15.21	29.341	38.50	1950.6	1806.45	2.17	2.01
	45	0	15.90	13.41	27.41	33.97	1900.8	1705.86	2.11	1.90
		26	16.41	15.01	30.67	37.42	1983.8	1794.71	2.20	1.99
		52	17.85	15.94	34.88	40.9	2018.7	1852.0	2.33	2.06
	60	0	16.80	13.75	28.97	34.655	2005.0	1793.7	2.23	1.93
		26	17.59	15.41	31.8	38.19	2110.15	1935.7	2.34	2.04
		52	18.00	16.17	35.6	41.72	2175.9	1933.0	2.42	2.15
		0.83	0.78	0.19	2.79	0.59	6.47	10.58	0.02	0.03

D2: Effect of interaction between cultivars and potassium rat:

The interaction between faba bean cultivars and potassium fertilization rates caused an significant effects on growth parameters at 95 and 110 days after sowing. In addition, Sakha-3plants gave the greatest values from number of branches, leaves and pods/plant, while; Nubaria-1 cultivar plants yielded the tallest faba bean plant, branches, leaves and pods dry weight/plant, leaves area/plant and LAI at 95 and 110 days after sowing under 52 kg K_2O/fed. fertilization rate. However, number and dry weight of branches and leaves/plant, leaves area/plant and LAI were decreased with advancing plant age from 95 to 110 days age. On the contrary; plant height, number and dry weight of pods/plant were increased after 95 days after sowing date (Table 2).

Data illustrated in Table (5) observed that photosynthetic pigments content per green leaves at 100 days age (except (Chl. a +Chl. b)/carotenoids)) and total carbohydrate as crude protein percentages per dry seeds significantly responses to the interaction between cultivars and potassium fertilization

rate. Furthermore, Sakha-3 cultivars fertilized with 52 kg K_2O/f ed. produced the greatest values from the previous estimated parameters in comparison with other treatments under study.

Regarding yield and its components; Table (8) gave an evidence that the effect was significant on estimated yield and its components except crop index, also; Sakha-3 plants; characterized by its greatest values from number of branches, pods/plant, seed yield/plant and/or fed., RPP_{seed} and RPP_{bio} when fertilized with 52 kg K_2O/fed. whereas; Nubaria-1 cultivar had the highest mean values from plant height, seed index, straw yield per plant and/or fed., biological yield/fed., and RPP_{veg} under 52 kg K_2O/fed., also, compared with other treatments under study.

Table 4: Effect of cultivars, nitrogen and potassium fertilization rates on photosynthetic pigments control per green leaves, and chemical constituents per dry seeds (Average of 2014/2015 and 2015/2016 seasons).

Cultivars	N Kg/ fed.	K kg/ fed.	Photosynthetic pigments content per green leaves mg/gm dry weight at 100 days after sowing					Total carbohydrates % per seeds	Crude protein % per seeds
			Chl. a	Chl. b	Chl.a+b	Carotenoids	(chl. a + chl. b) / carotenoids		
Sakha - 3			4.05	1.55	5.60	3.13	1.79	23.91	68.67
Nubaria 1			3.97	1.48	5.45	3.04	1.79	23.73	68.00
L.S.D at 5% level			0.02	0.05	0.08	0.04	n.s	0.09	0.14
	15		3.91	1.43	5.34	3.00	1.78	23.57	67.33
	30		3.99	1.47	5.46	3.08	1.77	23.66	68.44
	45		4.05	1.54	5.59	3.10	1.80	23.94	68.75
	60		4.10	1.63	5.73	3.15	1.82	24.12	68.82
L.S.D at 5% level			0.03	0.06	0.09	0.02	0.02	0.14	0.01
		0.0	3.98	1.48	5.46	3.04	1.80	23.74	67.90
		26	4.01	1.52	5.53	3.09	1.79	23.80	68.39
		52	4.05	1.56	5.61	3.13	1.79	23.92	68.72
L.S.D at 5% level			0.01	0.04	0.07	0.03	n.s	0.11	0.20

D3- Effect of the interaction between nitrogen and potassium fertilization rates:

The interaction between nitrogen and potassium fertilization rates was significant on growth characters at 95 and 110 days age (Table 2),photosynthetic pigments content per green leaves at 100 days after sowing date/and total carbohydrate; crude protein percentages per dry seeds, also; (Table 5), and yield and its components except, crop index at harvest date (Table 8). Generally; adding 60 Kg N/fed. + 52 Kg K_2O /fed. to faba bean plants was the most favorable fertilization rates to produce the greatest growth characters (Table 2), photosynthetic pigments content per green leaves at 100 days age, as well as; total carbohydrate and protein percentages per dry seeds (Table 5), in addition; each of plant height, number of branches and pods/plant, seed index, seed and straw yields/plant and/or fed. and biological yield/fed. at harvest (Table 8). On the other hand, 15 Kg N/fed. +26 Kg K_2O/fed., 60 Kg N/fed. + 26 Kg K_2O/fed., 45 Kg N/fed. + 26 Kg K_2O/fed and 60 N /fed.+ 0.0 K_2O/fed. gave the highest harvest index, RPP_{seed} RPP_{bio} and RPP_{veg} at harvest date, respectively.

*D4- Effect of the three way interaction cultivars * nitrogen * K_2O*

It is worthy mention that the three way interaction between faba bean cultivars, nitrogen and potassium fertilization rates had an significant effects on growth characters at 95 and 110 days age (Table 3), photosynthetic pigments content per green leaves at 100 days age except (Chl. a + Chl. b/carotenoids and each of total carbohydrate and crude protein percentages per dry seeds (Table 6),and yield and its components except crop index and harvest index (Table 9). Generally, Sakha-3 cultivar fertilized with 60 Kg N/fed. + 26 Kg K_2O/fed. was the most favorable treatment to gave the greatest value from number of branches, leaves and pods/plant at 95 and 110 days age (Table 3); photosynthetic pigments per green leaves; and total carbohydrate and crude protein per dry seeds(Table 6), in addition; number of branches , pods/plant, seed yield / plant and/or fed. at harvest date. On the other hand, Sakha-3 cultivar plants fertilized with 45 Kg N + 52 Kg K_2O/fed. outyielded the highest RPP_{seed} and RPP_{bio}. With respect of Nubaria-1 cultivars, it has the highest plant height,

dry weight of branches, leaves and pods/plant, leaves area/plant and LAI at 95 and 110 days age (Table 3), and plant height, seed index straw yield per plant and/ or fed. and biological yield/fed. under 60 Kg N +52 K_2O/fed. fertilization rate and RPP $_{veg}$ when fertilized with 60 Kg N/fed. |+ 0.0 K+ 0.0 K_2O/fed..

Table 5: Effect of the interactions between cultivars * N, cultivars *K and N*k per fertilization rates on photosynthetic pigments content per green leaves, and chemical constituents of seeds (Average of 2014/2015 and 2015/2016 seasons).

Treatments		Photosynthetic pigments content per green leaves mg/gm dry weight at 100 days after sowing					Total carbohydrates % Per seeds	Crude protein % per seeds
		Chl. a	Chl. b	Ch.la & chl. b	(chl.a + ch.lb)/ carotenoids			
		Interaction of cultivars *N rates						
Sakha-3	15 kg	3.94	1.46	5.40	3.06	1.76	23.66	67.50
	30 kg	4.02	1.49	5.52	3.11	1.68	23.76	68.68
	45 kg	4.08	1.56	5.64	3.13	1.80	24.05	69.21
	60 kg	4.15	1.68	5.83	3.20	1.82	24.17	69.28
Nubaria-1	15 kg	3.87	1.39	5.26	2.93	1.80	23.48	67.15
	30 kg	3.95	1.44	5.39	3.05	1.77	23.55	68.20
	45 kg	4.01	1.52	5.53	3.07	1.80	23.82	68.29
	60 kg	4.05	1.58	5.63	3.10	1.82	24.06	68.36
L.S.D at 5% level		0.04	0.08	0.13	0.03	0.03	0.20	0.014
		Interaction of cultivars * K rates						
Sakha-3	0.0	4.02	1.50	5.52	3.10	1.78	23.81	68.15
	26	4.05	1.55	5.60	3.12	1.79	23.89	68.82
	52	4.08	1.58	5.66	3.16	1.79	24.04	69.03
Nubaria -1	0.0	3.94	1.45	5.39	2.98	1.81	23.66	67.64
	26	3.96	1.48	5.44	3.05	1.78	23.70	67.90
	52	4.01	1.53	5.54	3.09	1.79	23.80	68.41
L.S.D at 5% level		0..01	0.06	0.10	0.04	n.s	0.16	0.29
		Interaction of N* K rates						
15 kg N	0.0	3.88	1.40	5.28	2.97	1.78	23.5	66.68
	26	3.90	1.43	5.33	3.00	1.78	23.53	67.78
	52	3.95	1.44	5.39	3.02	1.78	23.69	67.78
30 kg N	0.0	3.95	1.41	5.36	2.99	1.79	23.56	67.95
	26	3.94	1.47	5.41	3.04	1.78	23.62	68.45
	52	4.02	1.50	5.52	3.13	1.76	23.79	68.93
45 kg N	0.0	4.01	1.50	5.51	3.6	1.80	23.86	68.42
	26	4.04	1.54	5.58	3.11	1.79	23.91	68.79
	52	4.08	1.66	5.74	3.15	1.82	24.04	69.06
60 kg N	0.0	4.07	1.58	5.65	3.11	1.82	24.04	68.53
	26	4.10	1.62	5.72	3.14	1.82	24.12	68.79
	52	4.14	1. 90	5.83	3.20	1.82	24.16	69.14
L.S.D at 5% level		0..01	0.05	0.09	0.04	0.07	0.14	0.25

Table 6: Effect of the interactions between cultivars * N*K, fertilization rates on photosynthetic pigments content per green leaves, and chemical constituents of seeds (Average of 2014/2015 and 2015/2016 seasons).

Cultivars	N Kg/ feed	K20 kg/ feed	Photosynthetic pigments content per green leaves mg/gm dry weight, at days after sowing (Average of					Total carbohydrates, % per seeds	Crude protein % per dry seeds
			Chl. a	Chl.b	Chl. a+ b	Carotenoids	(chl.a + chl.b) / carotenoids		
Sakha - 3	15	0.0	3.91	1.43	5.34	3.05	1.75	23.57	66.72
		29	3.43	1.46	2.39	3.05	1.77	23.61	67.85
		52	3.98	1.48	5.46	3.09	1.77	23.81	67.92
	30	0.0	3.98	1.45	5.43	3.08	1.76	23.64	68.11
		26	4.02	1.49	5.51	3.12	1.77	23.75	68.76
		52	4.05	1.52	5.57	3.14	1.77	23.88	69.16
	45	0.0	4.05	1.51	5.56	3.11	1.79	23.96	68.84
		26	4.08	1.56	5.64	3.13	1.80	24.00	69.00
		52	4.10	1.62	5.72	3.16	1.81	24.19	69.45
	60	0.0	4.12	1.62	5.74	3.16	1.82	24.07	68.92
		26	4.16	1.67	5.83	3.19	1.83	24.18	69.35
		50	4.18	1.74	5.92	3.24	1.83	24.27	69.57
Nubaria- 1	15kg	0.0	3.84	1.37	5.21	2.89	1.80	23.42	66.64
		26	3.86	1.39	5.25	2.95	1.78	23.45	67.19
		52	3.91	1.42	5.33	2.96	1.80	23.56	67.63
	30kg	0.0	3.92	1.40	5.32	2.98	1.79	23.47	67.78
		26	3.95	1.45	5.40	3.07	1.76	23.48	68.14
		52	3.90	1.47	5.46	3.11	1.76	23.69	68.69
	45kg	0.0	3.96	1.48	5.44	3.00	1.81	23.76	68.00
		26	4.00	1.52	5.52	3.08	1.79	23.82	68.25
		52	4.06	1.57	5.63	3.13	1.80	23.89	68.61
	60kg	0.0	4.02	1.53	5.55	3.06	1.81	24.00	68.13
		26	4.03	1.57	5.60	3.09	1.81	24.05	68.25
		52	4.09	1.64	5.73	3.15	1.82	24.13	68.70
L.S.D at 5% level			0.02	0.06	0.11	0.05	n.s	0.17	0.31

Table 7: Effect of cultivars, nitrogen and potassium fertilization rates on yield and its components of faba bean plants (Averages of 2014/2015 and 2015/2016 seasons).

Yield and its components / Treatments	Plant height cm	No. of branches/ plant	No. of pods/ plant	Seed index g	Seed yield g/ plant	Straw yield g/ plant	Seed yield Ton/ feed
	Cultivars						
Sakha – 3	128.07	4.42	33.68	83.37	64.13	72.58	1.63
	139.24	3.94	30.75	91.40	62.56	77.84	1.55
L.S.D at 5% level	2.67	0.30	1.45	2.96	1.25	0.86	0.04
	Nitrogen fertilization rates						
15 kg N/ feed	`127.80	3.56	28.66	82.74	58.39	70.02	1.54
30 kg N/ feed	129.77	4.0	30.17	86.64	61.70	72.24	1.57
45 kg N/ feed	138.75	4.48	33.92	88.97	65.6	77.93	1.60
60 kg N/ feed	139.92	4.69	36.38	91.19	67.69	80.71	1.65
L.S.D at 5% level	0.24	0.01	1.47	1.35	0.45	1.30	0.04
	Potassium fertilization rate						
Control (unfertilized plants)	129.16	3.90	30.17	84.30	59.91	72.86	1.55
26 kg k_20 / feed	133.71	4.19	32.31	87.02	64.02	75.16	1.59
52 kg k_20 / feed	136.26	4.48	34.37	90.92	66.04	77.73	1.63
L.S.D AT 5% level	0.69	0.18	1.22	1.23	0.49	1.27	0. 03

Table 7: Cont.

Yield and its components / Treatments	Straw yield Ton/ feed	Biological yield Ton/ feed	Crop index	Harvest index	RPP $_{seed}$ g/ LAT	RPP $_{bio}$ g/ LAT	RPP $_{bio}$ g/ LAT
Sakha – 3	Cultivars						
	1.99	3.62	0.45	0.82	33.70	71.81	38.11
	2.15	3.70	0.42	0.72	31.61	70.96	39.35
L.S.D at 5% level	0.03	0.05	0.02	0.11	1.01	0.46	0.21
	Nitrogen fertilization rates						
15 kg N/ feed	1.87	3.41	0.45	0.82	31.12	68.3	37.18
30 kg N/ feed	2.04	3.61	0.43	0.77	32.30	70.07	37.77
45 kg N/ feed	2.15	3.75	0.43	0.74	33.55	73.41	39.86
60 kg N/ feed	2.24	3.89	0.42	0.74	33.65	73.77	40.12
L.S.D at 5% level	0.07	0.06	n.s	n.s	0.09	0.13	0.16
	Potassium fertilization rate						
Control (unfertilized plants)	2.02	3.57	0.43	0.77	31.89	70.63	38.74
26 kg k_20 / feed	2.08	3.67	0.43	0.76	32.95	71.74	38.79
52 kg k_20 / feed	2.12	3.75	0.43	0.77	33.14	72.00	38.86
L.S.D AT 5% level	0.04	0.02	n.s	n.s	0.11	0.12	0.05

Table 8: Effect of the interaction between faba bean cultivars x nitrogen fertilization rats, and nitrogen x potassium fertilization rates on yield and its components of faba bean plants (Average of 2014/2015 and 2015/2016 seasons).

		Plant height cm	No. of branches/ plant	No. of pods/ plant	Seed index gm	Seed yield g/ plant	Straw yield g/ plant	Seed yield Ton/ feed
		Interaction of cultivars x nitrogen fertilization rates						
	15 N	125.15	3.84	30.24	81.27	59.33	67.88	1.58
	30 N	126.02	4.28	31.5	82.39	62.62	70.22	1.61
Sakha – 3	45 N	128.92	46.2	35.33	84.11	66.27	74.90	1.64
Cultivar	60 N	132.17	4.94	37.67	85.72	68.3	77.33	1.68
	15.N	130.44	3.28	27.07	84.21	57.45	72.16	1.49
	30N	133.52	3.72	28.83	90.88	60.78	74.26	1.53
Nubaria-1	45N	145.33	4.33	32.5	93.84	64.93	80.96	1.55
Cultivar	60N	147.67	4.44	35.08	96.66	67.07	84.08	1.62
L.S.D at 5% level		0.34	0.14	2.06	1.89	0.63	1.82	0.06
		Interaction of cultivars x potassium fertilization rates						
	0.0	125.9	4.04	31.52	79.85	60.77	70.18	1.59
Sakha – 3	26	127.73	4.46	33.69	82.99	64.93	72.33	1.64
Cultivar	52	130.56	4.75	35.85	87.27	66.69	75.25	1.67
	0.0	136.08	3.75	28.83	88.75	59.05	75.55	1.51
Nubaria-1	26	139.69	3.96	30.92	91.04	63.16	77.88	1.54
Cultivar	52	141.95	4.13	32.88	94.41	65.47	80.22	1.58
L.S.D at 5% level		1.01	0.26	1.79	1.81	0.72	1.87	0.04
		Interaction of Nitrogen x potassium fertilization rates						
	0.0	125.47	3.17	26.57	80.31	56.48	67.98	1.48
15 kg N	26	28.0	3.59	28.84	82.25	58.39	69.57	1.55
	52	129.93	4.07	30.58	85.65	60.3	72.52	1.58
	0	127	3.75	28.25	83.79	58.1	69.88	1.54
30 kgN	26	129.95	4.00	30.5	86.46	62.25	72.35	1.58
	52	132.35	4.25	31.75	89.66	64.76	74.5	1.60
	0	135	4.25	31.88	85.8	61.4	75.09	1.56
45 kgN	26	137.38	4.50	33.88	88.66	66.65	77.84	1.59
	52	139.0	4.68	36.00	92.47	68.75	80.95	1.63
	0	136.5	4.42	34.0	87.31	63.65	78.5	1.62
60 kgN	26	139.5	4.75	36.0	90.69	68.8	80.66	1.65
	52	143.75	4.92	39.13	95.98	70.35	82.95	1.70
L.S.D at 5% level		0.86	0.23	1.53	1.54	0.61	1.59	0.04

Table 8: *Cont.*

		Straw yield Ton/ feed	Biological yield Ton/ feed	Crop index	Harvest index	RPP $_{seed}$ g/ LAT	RPP $_{bio}$ g/ LAT	RPP $_{veg}$ g/ LAT
		Interaction of cultivars x nitrogen fertilization rates						
Sakha – 3 Cultivar	15 N	1.82	3.4	0.46	0.87	32.41	69.32	36.91
	30 N	1.97	3.58	0.45	0.82	33.60	71.28	37.68
	45 N	2.05	3.69	0.44	0.80	34.38	73.24	38.86
	60 N	2.13	3.81	0.44	0.77	34.42	73.41	38.99
Nubaria-1 Cultivar	15.N	1.91	3.40	0.44	0.78	29.82	67.28	37.46
	30N	2.11	3.64	0.42	0.73	31.00	68.86	38.86
	45N	2.24	3.79	0.41	0.69	32.72	73.58	40.86
	60N	2.34	3.96	0.41	0.69	32.88	74.13	41.25
L.S.D at 5% level		0.10	0.08	n.s	0.04	0.13	0.18	0.22
		Interaction of cultivars x potassium fertilization rates						
Sakha – 3 Cultivar	0.0	1.94	3.53	0.45	0.82	32.66	70.37	37.71
	26	1.99	3.63	0.45	0.82	34.02	71.90	37.88
	52	2.05	3.72	0.45	0.81	34.44	73.18	38.73
Nubaria-1 Cultivar	0.0	2.09	3.60	0.42	0.72	31.11	70.87	39.73
	26	2.16	3.70	0.42	0.71	31.87	71.17	39.30
	52	2.19	3.77	0.42	0.72	31.83	70.83	30.0
L.S.D at 5% level		0.06	0.03	n.s	0.01	0.16	0.18	0.07
		Interaction of Nitrogen x potassium fertilization rates						
15 kg N	0.0	1.79	3.27	0.45	0.82	30.89	68.03	37.13
	26	1.85	3.40	0.46	0.84	31.26	68.44	37.18
	52	1.96	3.54	0.45	0.81	31.22	68.45	37.23
30 kgN	0	1.98	3.52	0.44	0.78	31.34	69.01	37.67
	26	2.07	3.65	0.43	0.76	32.30	69.78	37.48
	52	2.09	3.69	0.43	0.77	33.26	71.43	38.17
45 kgN	0	2.10	3.66	0.43	0.74	32.41	72.02	39.61
	26	2.15	3.74	0.43	0.74	34.02	74.51	40.49
	52	2.20	3.83	0.43	0.74	34.23	74.51	40.28
60 kgN	0	2.19	3.81	0.43	0.74	32.90	73.47	40.57
	26	2.23	3.88	0.43	0.74	34.21	74.21	40.00
	52	2.24	3.94	0.43	0.76	33.86	73.60	39.74
L.S.D at 5% level		0.05	0.03	n.s	0.01	0.14	0.15	0.06

Table 9: Effect of the three way interactions between cultivars * N, * K fertilization rates on yield and its components of faba bean plants (Average of 2014/2015 and 2015/2016 seasons).

Cultivars	Nitrogen rates kg/ feed	Potassium rates kg/ feed	Plant height cm	No. of branches/ plant	No. of pods/ plant	Seed index gm	Seed yield g/ plant	Straw yield g/ plant	Seed yield Ton/ feed
Sakha3	15	0.0	123.66	3.33	27.33	78.50	57.16	65.71	1.52
		26	125.0	3.85	30.50	80.00	59.43	67.13	1.60
		52	126.85	4.33	32.90	85.30	61.40	70.80	1.63
	30	0.0	124.0	4.00	29.00	79.23	59.0	68.47	1.58
		26	126.15	4.33	32.0	81.85	63.50	70.39	1.62
		52	127.90	4.50	33.50	86.10	65.37	71.80	1.64
	45	0.0	127.0	4.33	33.75	80.24	62.80	71.53	1.60
		26	128.75	4.67	35.25	84.15	67.00	74.18	1.63
		52	131.0	4.85	37.00	87.93	69.00	79.00	1.69
	60	0.0	129	4.50	36.00	81.44	64.1	75.00	1.64
		26	131	5.00	37.00	85.97	69.8	77.60	1.69
		52	136.5	5.33	40.00	89.76	71.00	79.38	1.72
Nubaria-1	15	0.0	127.33	3.00	25.80	82.12	55.8	70.24	1.44
		26	131.00	3.33	27.17	84.50	57.35	72.00	1.50
		52	133.0	3.50	28.25	86.00	59.0	74.25	1.52
	30	0.0	130.0	3.5	27.50	88.35	57.2	71.29	1.49
		26	133.75	3.67	29.00	91.07	61.00	74.30	1.54
		52	136.80	4.00	30.00	93.22	64.15	77.2	1.55
	45	0.0	143.0	4.17	30.0	91.36	60.0	78.65	1.52
		26	146.0	4.33	32.50	93.17	66.3	81.5	1.55
		52	147	4.50	35.00	97.00	68.5	82.92	1.57
	60	0.0	144.0	4.33	32.00	93.18	63.2	82.00	1.59
		26	148.0	4.5	35.0	95.41	68.0	83.72	1.61
		52	151.0	4.5	38.25	101.40	70.0	86.51	1.67
L.S.D at 5% level			1.08	0.28	1.90	1.92	0.76	1.98	0.05

Table 9: *Cont.*

Cultivars	Nitrogen rates kg/ feed	Potassium rates kg/ feed	Straw yield Ton/ feed	Bio-yield Ton/ feed	Crop index	Harvest index	RPP $_{seed}$ g/ LAI	RPP $_{bio}$ g/ LAI	RPP $_{veg}$ g/ LAI
Sakha3	15	0.0	1.75	3.27	0.46	0.87	31.93	68.65	36.72
		26	1.8	3.40	0.47	0.89	32.48	69.16	36.68
		52	1.91	3.54	0.46	0.85	32.83	70.16	37.33
	30	0.0	1.94	3.52	0.45	0.81	32.42	70.04	37.62
		26	1.98	3.6	0.45	0.82	33.78	71.22	37.44
		52	2.00	3.64	0.45	0.82	34.59	72.58	37.99
	45	0.0	2.00	3.6	0.44	0.80	33.23	71.07	37.84
		26	2.05	3.88	0.44	0.80	34.72	73.15	38.43
		52	2.11	3.80	0.44	0.80	35.20	75.51	40.31
	60	0.0	2.08	3.72	0.44	0.79	33.04	71.70	38.66
		26	2.14	3.83	0.44	0.79	35.08	74.07	38.99
		52	2.17	3.89	0.44	0.79	35.15	74.45	39.30
Nubaria-1	15	0.0	1.83	3.27	0.44	0.79	29.84	67.40	37.56
		26	1.90	3.40	0.44	0.79	30.03	67.72	37.69
		52	2.0	3.52	0.43	0.76	29.6	66.73	37.53
	30	0.0	2.01	3.59	0.42	0.71	30.26	67.98	37.72
		26	2.15	3.69	0.42	0.72	30.81	68.00	37.52
		52	2.17	3.72	0.42	0.71	31.92	70.27	38.35
	45	0.0	2.20	3.72	0.41	0.69	31.58	72.97	41.39
		26	2.25	3.8	0.41	0.69	33.32	74.27	40.95
		52	2.28	3.85	0.41	0.69	33.25	73.50	40.25
	60	0.0	2.30	3.89	0.41	0.69	32.75	75.23	42.48
		26	2.32	3.93	0.41	0.60	33.33	74.37	41.04
		52	2.39	4.06	0.41	0.70	32.56	72.80	40.24
L.S.D at 5% level			0.06	0.03	n.s	n.s	0.17	0.19	0.08

References

A.O.A.C., 1984.Official Methods of Analysis Chemists, 12th ed. A.O.A.C., Washington D.C.,U.S.A.

Abdallah, A.M., 2014. Response of faba bean (*Vicia faba* L.)to different planting densities and bio-mineral fertilization systems. American-Eurasian J.Agric. Environ.Sci.14(6):541-545.

Abdel-Gawad, A.A., K.A.El-Shouny, S.A. Saleh and M.A.Ahmed, 1987. Partition and migration of dry matter in newly cultivated wheat varieties. Egypt J. of Agronomy,12 (1-2):1-16.

Abo El-kheir, M.S.A., A.A.Abo Ellil and H.A.El-Zeiny, 2000.Effect of water stress at different growth stages on three faba bean cultivars. J. Agric. Sci. Mansoura Univ.,25(3):1485-1493.

Ahmed, A.G.,M.H.Mohmed, M.S. Hassanein, N.M. Zaki, S.F.El-Habbasha, M.M. Tawfic and M.F.Mohamed, 2015.Effect of water regime and potassium fertilization on productivity of two chickpea (*Cicer arietium* L.) cultivars. Inter.J. of Chem. Tech. Res.,894):1509-15019.

Ahmed, M.A. and H.M.El-Abagy, 2007. Effect of bio and mineral phosphorus fertilizer on the growth, productivity and nutritional value of some faba bean (*vicia faba* L.) cultivars in newly cultivated land. J. of Appl.Sci.Res.,3(6):408-420.

Ahmed, M.A., N.Y. Naguib and N.M.Zaki, 1994.Increasing lupine (*Lupinus termis* L.) productivity by improving the effect of nitrogen using potassium application. Egypt J. Appl. Sci. 9(3):471-488.

Ahmed, M.A.,M.A. Hassanein and N.M.Zaki, 1997. Yield capacity of some faba bean varieties (*Vicia faba* L.).Egypt. J.Appl.Sci.,12:134-154.

Akhtar, N.,M. A. Amijad, and M.A. Anjium, 2003. Growth and yield response of pea (*Pisum sativum* L.)crop to phosphorus and potassium application. Pakistan J. of Agric. Sci. 40:217-222.

Alghamdi, S., 2007.Genetic behavior of some selected faba bean genotypes. Pages 709-714. Proce. of the 8th African Crop Sci. Conf. October,27-31,2007African Crop Sci. Conf. October,27-31,2007,El-Minia-Egypt.

Alghamdi, S.S.and K.A.Ali, 2004.Performance of several newly bred faba bean lines. Egypt J. Plant Breed, 8:189-200.

Amjad M., M.A. Anjium, and N. Akhtar, 2004. Influence of phosphorus and potassium supply to mother plant on seed yield, quality and vigour in pea (*Pisum sativum* L.). Asian J. of Plant Sci., 3:108-113.

Asghar, A., M. Ather Nadeen, A.Tanveer, M.Tahir and M.Hussain, 2007. Effect of different potash levels on growth,yield and protein contents of chickpea(*Cicer arietinum* L.). Pakistan J.of Botany,39 (2):523-527).

Ashoori, J.M.M.,2014.Effect of biological fertilization, mineral phosphorus and nitrogen on faba bean yield and yield components in northern iron. Indian J.4 (3):84-92.

Awad,G.O., I.F.AbdEl-Aziz and A.E.Gadalla, 2010. Effects of biological and mineral fertilization on yield,chemical composition and physical characteristics of faba bean (*vicia faba* L.) cultivar selim. Pakistan J.of Nutrition, 9(7):703-708.

Bansal, S.K., A.K. Dixit, P. Imas and H. Magen, 2001. The effect of potassium application on yield and quality of soybean and wheat in Madhya Pradesh. Fertilizer Nius 46:45-52.

Black,C. A., 1983. Methods of soil Analysis parts and .Amer. Soc. Agron. Inc. Publ., Madison, Wise., USA.

Bonzorgi, A.R., E. Azarpour, and M.Morad, 2011.The effect of bio, mineral nitrogen fertilization and foliar zinc spraying on yield and components of faba bean. World Appl. Sci. J.,13(6): 1409-1414.

Boulbaba,L., Z. A. Sifibouaziz, L.Z. Mocinassara, and L.Mokhtar, 2005. Response of chickpea (*Cicer arietinum* L.) to potassium fertilization. J.Agric. Soc. Sci.,1(1):7-9.

Bremner P.M. and M.A. Taha, 1966. Studies in potato agronomy 1-The effect of variety, seed size and spacing on growth, development and yield. J.Agric.Sci.,66:241-242.

Bucheyeki, T. Lugende and T.E Mmbuga, 2013.On-Farm Evaluation of beans varieties for adaptation and adoption in Kigoma Region in Tanzania. ISRN Agron.2013.

Dubois, M.,K.A. Gilles, R.Hamilton, J.Robers and I.Smith, 1956. Colormetric methods for determination of sugar and related substances. Anal. Chem.,28:350-356.

El-fouly, M., Z.M. Moubarak and Z.A. Salama, 2010.Improving tolerance of faba bean during early growth stages to salinity through micronutrients foliar spray. NRC, Egypt Not. Sci. Biol.2(2):98-102.

El-Gizawy, N. Kh .B. and S.A.S. Mehasen, 2009. Response of faba bean to bio mineral phosphorus fertilizer and foliar application with zinc. World Appl. Sci. J., 6(10):1359-1365.

El-Habbasha, S.F.,M. Hozayn and M.A. Khalafallah, 2007.Integration effect between phosphate levels and bio-fertilizers on quality of faba bean in newly cultivated sandy soils. Res. J. of Agric. and Biol.Sci.,3(6):966-971.

El-Murshedy, W.A.,M.A. El-Metwally and O.G.Mahmoud, 2002. Performance of two faba bean varieties under different plant densities and nitrogen fertilization. Egypt J. Appl. Sci. 17(7):527-545.

Fivawo,N.C. and S.N. Msolla, 2012.The diversity of common bean landraces in Tanzania. Ja JONAS: Tanzania J. of Nut. and Appl.Sci.2:337-351.

Ihsanullah, D., S. Hasan, B.M. Khan,H. Gul and A.K.H. Ijaz, 2008. Effect of different levels of nitrogen on dry matter and grain yield of faba bean (*vicia faba* L.) Pakistan J.Botany,40 (6):2453-2459.

Jin, S.H, J.Q.Huang, X.Q. Li, B.S.Zheng, J.S.Wu, Z.J.Wang, G.H.Liu and M.Chen, 2011. Effect of potassium supply on limitations of photosynthesis by mesophyll diffusion conductance in Carya eathaynsis. Tree Physiol. 31:1142-1151.

Kalavat P. and H.A.Modi, 2012.The importance of potassium in plant growth. A. Review; Indian J. of Sci.,1:177-186.

Khalil, N.A., W.A.El-Murshidy and F.El-Tokhy, 2012. Studies on fertilizer requirements of faba bean. J. plant Production, Mansoura Univ.,3(6):1027-1038.

Krouma, A., J.J. Drevon and C.Abdelly, 2006.Genotype variation of fixing common bean *phaseolus vulgaris* in response to iron deficiency. J. of plant Physiol., 163:1094-1100.

Kurdali, F., F. Al-Ain and M. Al-Shamma, 2002. Nodulation, dry matter, production and N_2 fixation by faba bean and chickpea as affected by soil moisture and potassium fertilizer. J. of Plant Nutrition, 25:355-368.

Mam Rasul, G.A., 2017. Effect of different level of nitrogen and phosphorus on yield and yield components of faba bean (*Vicia faba* L.) in calcareous soil from kurdistan Region of Iraq. J. of Agric.Res., 2(1):000126

Marschner, H., 1995. Mineral nutrition of higher plants Academic Press, London.

Mfiling, A.,K.Mtei and P.A.Nolakidemi, 2014. Effect of rhizobium inoculation and supplementation with P and K on growth, leaf chlorophyll content and nitrogen fixation of bush bean varieties. Amer.J.of Res.Comm. 2(16):49-87.

Mohmoud, M.S.,F.A. El-Sayed, A.El-Nour, E.A.M. and A. K. El-Mohamed, 2006. Boron nitrogen interaction effect on growth and yield of faba bean plants grown under sandy soil conditions. Int. J. of Agric. Res., 1(4):322-330.

Radi, A.F., A.M.Ismail and M.M.Azooz, 2001. Interactive effect of some vitamins and salinity on the rate of transpiration and growth of some broad bean lines. Ind. J. Plant Physiol.,6:24-29.

Raza, S., M.F.Saleem, G.M.Shah, M.Jamil and I.H.Khan, 2013. Potassium applied under drought improves physiological and nutrient uptake performances of wheat (*Triticum aestivum* L.) J. of Soil Sci and plant Nut. 13:175-185.

Shaaban, M.M., F.E. Abdallah, E.A.A. Abou El-Nour, A.M. El-Saady, 2006. Boron/nitrogen interaction effect on growth and yield of faba bean plants grown under sandy soil conditions. Intern. J. of Agric. Res., 1(4):322-330.

Shalaby, M.A.F., 2000.Influence of cycocel (2-chloroethyl trimethyl ammonium chloride) on the vegetative growth, photosynthetic pigments, flowering, abscission and yield of faba bean. Ann. of Agric. Sci. Moshtohor, 38(3):1485-1502.

Sharma, K.D., N.Singh and M. S. Kuhad, 2008. Possible role of potassium in drought tolerance in Brassica. J. of Potassium Res.,8:320-327.

Singh, N. and M.S. Kuhad, 2005. Role of potassium in alleviating the effect of water stress on yield and seed quality in chickpea (*Cicer arietinum* L.) Bull Nat. Inst.Ecol.,15:219-225.

Singh, S.P., N.P. Singh and R.K. Pondey, 1992. Effect of variety and plant density on the pattern of dry matter accumulation in faba bean Fabis Neewsletter, 31:21-24.

Snedecor, G.W. and G.W.Cochran, 1990.Statistical Methods,8th,Ed.Iowa State Univ., Press., Ames Iowa, U.A.S.

Tawfic, M.M., M. A. Azzazy and M.A.Mohamed, 1991. Discrepany response of some soy bean cultivars to rhizobial inoculation under newly reclaimed soils. Egypt J. Aron., 16(1-2):95-105.

Van Wettstein, D., 1957.Chlorophyll-lethal und der submink roskopiscpe formivechsel der plastide. Explt. Cell. Res.,12: 427-433.

Vidovic,J. and V.Pokorny, 1973.The effect of different sowing densities and nutrient levels in LAI,production and distribution of dry matter in maize, Glologia planta, 15:374-382.

Watson, D.J.,1952. The physiological basis of variation in yield.Advance.Agron.,4:101-145.

Zaho,D., D.M.Oosteruis and C.W.Bednarz, 2001. Influence of potassium deficiency on photosynthesis, chlorophyll content and chloroplast ultra structure of cotton plants .. Photosynthesis.39:103-109.

Zaki, N.M., A.G. Ahmed, M.H. Mohamed and M.M. Tawfic and M.S.Hassanein, 2013.Effect of skipping one irrigation and potassium fertilization on growth and yield of chickpea plants. World Appl. Sci.J., 27(5):557-561.