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Valuation of some *Vicia faba* L. cultivars depended on physiological and biochemical traits under different water requirements

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ABSTRACT

Drought stress is the main environmental factor that negatively influences Faba bean (*Vicia faba* L.,) yield throughout the world. The five faba bean cultivars; Sakha 1, Sakha 2, Sakha 3, Masr 1 and Nobaria 1, were evaluated under three irrigation treatments i.e., 100% ETc (1254 m^3/faddan), 80 % ETc (1009 m^3/faddan) and 60 % ETc (760 m^3/faddan) during the growing seasons 2015/2016 and 2016/2017. The results revealed high significant difference among varieties for all the studied agro-Physiological and biochemical under water treatments. Although all studied traits in all varieties were significantly affected by drought but some varieties such as Sakha 1 and Nubaria 1showed drought tolerance by maintaining the highest values of RWC, stomatal conductance, leaf temperature, transpiration efficiency, total chlorophyll, and lowest values of osmotic potential, EL%, MDA and proline content under drought stress, while variety Masr 1 and Sakha 3 showed drought susceptible, the growth, yield and its components were associated with each of the agro-Physiological and biochemical under normal and drought conditions. So, it could be concluded that the agro-Physiological and biochemical could be used as selection criteria for improving drought tolerance and high yield under water deficit.

***Keywords*: Water Requirements, Growth, Yield and Yield components**

Introduction

Faba bean (*Vicia faba* L.,) is viewed as a standout amongst the most critical legumes in Egypt. It has turned out to be one of the key yields. Likewise, it's essential for soil richness, human sustenance as a decent wellspring of vegetarian protein and creature sustaining (Sharaan et al., 2004). It is a major part of the nutrition for Egyptian people (Zeidan, 2002). Increasing production of faba bean and enhancement yield quality under stress conditions is the major aim to meet the demand of the expanding Egyptian population. Four-tenths of the world's agricultural land located in arid or semi-arid regions (Ceccarelli 2010 and Farooq *et al.,* 2017), and, more that half of the normal yield of most real harvests is lost because of dry spell pressure (Zlatev, and Lidon, 2012). Today, it has turned into a testing errand to battle drought stress around the world. Drought stress causes a progression of, physiological, biochemical and sub-atomic changes in plants and entire plant digestion is contrarily influenced by the over-creation of receptive oxygen species that are in charge of oxidation of multicellular segments like proteins, lipids, DNA and RNA, bringing about death of cells (De Carvalho, 2008). Subsequently, Drought restrains the development and efficiency of most harvest species including faba bean. Faba bean plants are delicate to drought (Khan *et al*., 2007 and 2010 and Ammar *et al.,* 2014), dry spell fundamentally influenced development and yield and its attributes, the decrease in faba bean seed yield was emphatically identified with the measure of water decrease and reach up to half of seed yield (Musallam *et al.,* 2004; Ouda *et al.,* 2010; and Ammar *et al.,* 2014). Understanding the agro-physiological and biochemical instruments in faba bean under the drought stress is generous to distinguish characters related with drought stress resilience that can be chosen in breeding programs. Water shortage in plants causes hindrance of photosynthesis by adjusting pathway guideline by stomatal conclusion and diminishing stream of CO_2 into mesophyll tissues and furthermore by impeding the movement of ribulose-1,5-bisphosphate carboxylase/oxygenase (Cornic, 2000 and Bota *et al*., 2004) Also, breath, translocation, particle take-up, sugars, supplement absorption and development advertisers are aggravated under drought (Farooq *et al*., 2008 and Jaleel *et al.,* 2008). Under drought stress, plants

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build up a protective instrument and cell homeostasis by the amassing of osmolytes (i.e., proline, glycinebetaine) and proteins along these lines expanding resistance of plants to drought stress (Shinozaki, 2007 and Siddiqui *et al*., 2008). In any case, plant resilience to abiotic stresses is a complex trait, involving, including a scope of atomic, biochemical and physiological components (Razmjoo *et al*., 2008). The reaction of plants to stresses relies upon species and genotypes, the length and seriousness of water shortfall, and age and improvement organize (Barnabás *et al*., 2008). Faba bean development especially in bone-dry and semi-bone-dry districts is inadmissible on the grounds that this yield isn't adequately dry spell and warmth tolerant as it is defenseless to dampness and high temperature stresses (Loss, and Siddique, 1997) Keeping in view the significance of this crop for people and animals. The present experiment was planned to study the effect of drought stress on different genotypes of faba bean plants. The principle goal of this test was to decide drought stress tolerant and delicate cultivars relying upon agro-physiological instruments, yield parts, seed yield and nature of faba bean to uncover the best mix between water system level and cultivars that can be prescribed to increment faba bean yield.

Materials and Methods

Plant materials and experimental site: Five faba bean cultivars were used in this investigation to study the effect of drought stress on Physiology and biochemistry and yield and its components. The five faba bean cultivars were; Sakha 1, Sakha 2, Sakha 3, Masr 1 and Nobaria 1. The seed of these cultivars were supplied by Legume department, Field Crops Research Institute, Agriculture Research Center at Giza, Egypt. The Studied cultivars were cultivated in November 2015/2016 and 2016/2017 growing seasons. The two experiments were carried out at Snores, Fayoum Governorate.

Water treatments: three separate experiments were carried out for each water treatment. The first water treatment was irrigation at 100% ETc, 1254 m^3/ faddan which represent normal water treatment, the second was irrigation at 80% ETc, 1009 m^3/ faddan, and the third was irrigation at 60% ETc, 760 m^3/ faddan. The aggregate sum of water system water was determined according to Penman-Montieth method (Allen *et al*., 1996), Penman-Monteith method gives more consistently accurate ETo estimates than other ETo methods. Data in Table 1 show the measured climatic factor during the experimental period (1st of October till 1st of April during 2015/2016 and 2016/2017 seasons). These data collected from automated weather station of CLAC allocated at the experimental site. Drip irrigation system was installed; the drip lateral had emitters spaced 30 cm apart with a nominal discharge of 4 liters/h. Blocks were irrigated using an electric timer with appropriate run times to give the desired application of water.

Table1: Average monthly climatic data of El fayoum location during the two studied seasons 2015/2016 and 2016/2017.

	Max. temp.	Min. temp.	Humidity	Rainfed	Soil temp.	ETo
			2015/2016			
Nov-15	31.6	9.9	62	3.4	24.7	2.5
Dec-15	30.5	5.8	69	0.6	20.9	2.7
Jan-16	27.2	3.6	62	0.4	17.5	2.8
Feb-16	30.6	5.4	62	2.6	17.6	3.6
Mar-16	36.8	8.4	56	0	21.1	4.5
Apr-16	38.8	9.8	46	0	24.2	5.7
			2016/2017			
Nov-16	25.25	13.79	60.25	0	24	2.7
Dec-16	32.5	9.4	67	0	24	2.6
Jan-17	27.4	4.1	77	0.4	19.7	4.3
Feb-17	27.2	0.1	73	0	17.1	4.4
Mar-17	37.2	2.8	64	0.2	18.4	4.3
Apr-17	35.3	2.9	51	0	21.4	4.5

Chemical and mechanical properties of the experiment: soil was analyzed before cultivation according to Chapman and Pratt (1961), the results are tabulated in Table 2. The permanent wilting point (PWP) and field capacity (FC) of the trial soil were determined according to Israelsen and Hansen (1962).

Experimental design:

The experimental design was arranged in split plot design with three replications. The irrigation requirements were arranged in the main plot and five faba bean cultivars were allocated in the sub plots. Sub-Plot area was 15 m length and 3 m width, occupying an area of 45 m2. Plant distances were 0.30 m apart; the distances between rows were 0.60 m. A distance of 2 m was left between each two irrigation treatments as a border among the treatments. All other agriculture practices of faba bean cultivation were done in accordance with standard recommendations for commercial growers by the Ministry of Agriculture.

Measurements: after 75 days from sowing ten plants were randomly selected from each replicate and the following parameters were determined; number of days to first flower /(day), number of leaves/ plant, leaf area index (LAI), number of branches per plant and total plant dry weight (g/plant),. Physiological traits i.e. relative water content (RWC %) (Weatherley, 1950), electrolyte leakage (EL %), (Arora *et al*. 1992), leaf temperature taken with a non-contact infrared thermometer (Raynger ST60 ProPlus, Raytek, Santa Cruz, CA, USA), held at a fitting edge around 10 cm over the leaf, centering the laser point in the focal point of the leaflet. To measure osmotic potential (wp), a handout from a similar leaf utilized for RWC was extracted specifically into a plastic microcentrifuge tube and promptly solidified in fluid nitrogen. The cylinders were later exchanged to – 30C and kept solidified until estimations. The solidified leaf material was permitted to defrost at room temperature for 30 min and sap was extricated utilizing a 2.5-mL syringe. A channel paper plate was set in the testing council of a vapor weight osmometer (demonstrate 5100C; Wescor, Logan, UT, USA) and 8 lL sap was connected to immerse the circle to gauge osmotic potential. Toward the finish of 10-day drying cycle, the most youthful extended leaf (generally the one after the leaf picked for osmotic potential examination) was gathered from water pushed and all around watered plants and dried in a broiler at 80C for 24 h for carbon isotope assurance. Transpiration proficiency was determined as unit weight of dry issue created per unit weight of water unfolded. The information recorded over the span of the examinations were exposed to investigation of fluctuation and sets of methods were thought about utilizing least huge contrasts (LSD) at 5% dimension of likelihood ($P < 0.05$) lipid peroxidation (nmol g^{-1}fw) (Heath and Packer, 1968), proline accumulation (µg/ f wt.) (Petters *et al*., 1997) and total *Chl* content (mg g^{-1} f wt) (Hiscox and Israelstam, 1979),. At harvest ten plants of each experimental plot were taken to determine plant height (cm), number of pods per plant, number of seeds per plant, weight of pods per plant(g), weight of 100 seeds (g) and weight of seeds per plant.(g). While grain yield (ton/fed) and biological yield (ton/fed) were resolved from each plot. Water use efficiency and seasonal water consumption were resolved after harvesting. Harvesting was done following 120 days from sowing.

Statistical analysis:

The obtained data were exposed to the proper statistical analysis according to Gomez and Gomez (1984), Data of 2015/2016 and 2016/2017 growing seasons were subjected to homogeneity variance test for running the combined analysis of the data using the least significant difference (L.S.D.) done by Costat computer program V 6.303, test shown by Waller and Duncan (1969) at the 5% level of probability.

Results and Discussion

1. Agro-Physiological and biochemical traits.

Data in table 3 indicate that RWC, electrolyte leakage, osmotic potential, stomatal conductance, leaf temperature, transpiration efficiency, MDA Content, proline accumulation and total Chl content for all studied cultivars were significantly affected by water treatments i.e.100%, 80% and 60% ETc t. Significant reduction was observed in leaf relative water content % (RWC) stomatal conductance, transpiration efficiency and total Chl content by decreeing water treatment from 100% to 60% ETc, similar results were observed by Malik *et al*. (1999); Rahman *et al*. (2000); Siddique *et al*. (2000) and Parida *et al*. (2007). While, electrolyte leakage (EL%), osmotic potential, leaf temperature, MDA Content and proline accumulation were increased. Significant differences among faba bean varieties were presented in tables ??. The differences in RWC, EL%, osmotic potential, stomatal conductance, leaf temperature, transpiration efficiency, MDA Content, proline accumulation and total Chl content,

Table 3: Effect of irrigation levels and cultivars on faba bean physiological traits (average data of 2015/2016 and 2016/2017 growing seasons).

Treatments		RWC%	Electrolyte Leakage (%)	Osmotic potential (-MPa)	Stomatal conductance (mmol ms^{-1})	Leaf temperature (c)	Transpiration efficiency (g L^{-1})	MDA Content (nmol·g^{-1}·FW)	proline (µg^{-1}·FW)	Total Chl (mg·g^{-1}·FW)
60%		39.89	69.72	0.80	50.2	24.56	2.47	59.94	2.16	28.64
80%		60.35	47.78	0.64	84.5	20.49	2.81	38.48	1.42	37.43
100%		75.39	33.69	0.55	155.7	15.38	3.15	25.83	0.89	41.68
LSD 5%		0.97	0.71	0.02	4.32	0.99	0.2	4.1	0.07	1.97
Sakha 1		62.07	47.24	0.62	99.00	20.33	2.57	38.69	1.14	37.93
Sakha 2		58.49	50.17	0.66	91.83	19.07	2.62	40.49	1.45	37.44
Sakha 3		55.02	53.75	0.71	100.50	19.69	2.96	45.27	1.75	34.04
Masr 1		58.32	50.67	0.69	92.67	20.54	3.05	40.8	1.81	34.91
Nobaria 1		58.82	50.18	0.65	100.00	21.09	2.85	41.83	1.30	35.25
LSD 5%		1.13	1.85	0.02	1.84	0.6	0.1	1	0.13	1.9
60%	**Sakha 1**	42.24	65.96	0.71	54	24.49	2.53	59.49	1.69	31.1
	Sakha 2	41.09	68.99	0.77	35	22.98	2.65	60.7	2.21	29.75
	Sakha 3	34.66	76.56	0.87	61	23.9	2.36	64.36	2.27	25.62
	Masr 1	36.82	71.29	0.9	57.5	26.49	2.39	61.15	3.27	24.68
	Nobaria 1	44.64	65.82	0.74	43.5	24.94	2.39	54	1.38	32.04
80%	**Sakha 1**	65.13	44.76	0.6	79.5	21.6	2.44	33.04	1.11	40.26
	Sakha 2	61.08	48.08	0.64	84	20.28	2.61	34.19	1.34	40.93
	Sakha 3	58.18	49.92	0.65	91.5	18.55	3.16	43.24	1.78	35.69
	Masr 1	61.27	46.4	0.64	80	19.55	2.94	36.13	1.27	38.24
	Nobaria1	56.11	49.76	0.67	87.5	22.46	2.88	45.81	1.61	32.01
100%	**Sakha 1**	78.83	30.98	0.54	163.5	14.89	2.73	23.55	0.61	42.42
	Sakha 2	73.29	33.44	0.58	156.5	13.93	2.6	26.58	0.82	41.64
	Sakha 3	72.21	34.78	0.6	149	16.62	3.35	28.2	1.21	40.81
	Masr 1	76.86	34.31	0.52	140.5	15.59	3.81	25.13	0.9	41.81
	Nobaria 1	75.72	34.95	0.54	169	15.87	3.26	25.66	0.91	41.7
LSD 5%		1.95	3.2	0.03	3.19	1.05	0.17	1.73	0.22	3.29

in all cultivars could be associated with their ability of tolerate drought stress. Thus, we conclude that sakha 1, Nobaria 1 and Sakha 3 could have better ability to tolerate drought stress. By analysis Interaction between irrigation level i.e.100%, 80% and 60% ETc and cultivars, data reveal that the highest value of RWC% obtained by cultivar Nobaria 1 under 60% ETc and sakha 1 under both 80% and 100% ETc, and lowest value of RWC% obtained by cultivar sakha 3 under 60% and 100% ETc and Nobaria1 under 80% ETc treatments. Highest value of EL% documented by Sakha 3 under both 60% and 80% ETc and Nobaria 1under 100% ETc, on another hand; the lowest values obtained by Sakha1under the three irrigation treatments. Highest value of stomatal conductance gotten by sakha 3 under 60% and 80% ETc and Nobaria 1 under 100% ETc, while the lowest values recorded by sakha 2 under 60%, Sakha 1 under 80% and Masr 1 under 100% ETc. Highest value of osmotic potential recorded by Masr 1 under 60%, Nubaria 1 under 80% and Sakha 3 under 100% ETc, while the lowest value obtained by Sakha1under the three irrigation treatments. Highest value of leaf temperature found by Masr 1 under 60%, Nobaria 1 under 80% ETc and Sakha 3 under 100% ETc, the lowest value gained by Sakha 2 under 60%, Sakha 3 under 80% ETc and Sakha 2 under 100% ETc. Cultivars Sakha 1 under 60%, Sakha 3 under 80% and Masr 1 under 100% ETc recorded the highest value of transpiration efficiency, and the cultivar Sakha 3 under 60%, Sakha 1 under 80% and Sakha 2 under 80% ETc recorded the lowest values. Highest value of lipid peroxidation (MDA) found by Sakha 3 under 60%, Nobaria 1 under 80% ETc and Sakha 3 under 100% ETc, the lowest value gained by Nobaria 1 under 60%, Sakha 1under 80% ETc and 100% ETc. Highest value of proline accumulation recorded by Masr 1 under 60%, Sakha 3 under 80% and 100% ETc, while the lowest value obtained by Nobaria 1under 60% and Sakha 1 under 80% and 100% ETc. No significant difference found in total chlorophyll, highest value of total chl. Recorded by Nobaria 1 under 60%, Sakha 2 under 80% and Sakha 1 under 100% ETc, the lowest value obtained by Masr1 under 60%, Nobaria 1under 80% and Sakha 3 under 100% ETc. Under drought stress, RWC plays an important role in tolerance of plants to stress by inducing osmotic adjustment due to the accumulation of osmoprotectants (Ritchie *et al*. 1990; Barnabas *et al*. 2008 and Zhang *et al*. 2012). Low of leaf water potential causes stomata closure (Nardini *et al*. 2001), lower stomatal conductance was associated with warmer leaves. Among various mechanisms, osmotic adjustment provided by the synthesis of osmoprotectants like proline may confer tolerance to drought injuries by maintaining high tissue water potential (Mohammadkhani & Heidari, 2008). Drought stress resulted in a significant accumulation of free proline in shoots of faba bean varieties, and the magnitude of increase in free proline accumulation was higher in the tolerant cultivars than in the sensitive ones (Khalafallah *et al*. 2008). The maintenance of a high plant water status during stress is an important defensive mechanism to retain enough water by minimizing water loss (e.g., caused by stomatal closure, trichomes, reduced leaf area, senescence of older leaves, etc.) and maximizing water uptake (Barnabas *et al*. 2008). Under stress, plants develop a defensive mechanism and cellular homeostasis by the accumulation of osmolytes (i.e., proline, glycinebetaine) and proteins thereby increasing tolerance of plants to stress (Shinozaki, 2007 and Siddiqui *et al*., 2008). The decrement of chlorophyll content during drought stress could be related to photo-oxidation resulting from oxidative stress which reduces photosynthetic process (Abd El-hady *et al*., 2018). Oxidative injury at the cellular level under water stress has high lipid peroxidation and electrolytic leakage which decreased stability of cell membrane and led to lose more water from cells (Sanchez-Blanco *et al*., 2006 and Abdalla and Khoshiban, 2007). The drought stress lead to increase in electrolyte leakage in plant leaves (Sairam and Saxena 2000 and Sibet and Birol 2007).

2. Growth traits.

Our finding reveal that different irrigation levels significantly affected number of days to first flower /(day), number of leaves / plant, leaf area index (LAI), number of branches per plant and total plant dry weight (g/plant), whereas the early flowers (45.43 day from sowing) was recorded when faba bean plant was irrigated with 60% (IR) followed by 80% and 100% (IR) Table 4. Results commendable uncover that the best treatment was water system up to 100% (IR), it gives the most astounding estimations of number of leaves / plant, leaf area index (LAI), number of branches per plant and total plant dry weight (g/plant), whereas the lowest value of such traits was more pronounced when (IR) reached up to 60% The decrement estimated by 31.7% and 14.3% on number of leaves; 38.1% and 18.2% on LAI; 24.7% and 15.2% on number of branches per plant and 31.4% and 15.1% on total plant dry weight with water supplies up to 60% and 80% compared with the level of 100%, respectively..

Comparable outcomes were recorded. Al-Suhaibani (2009) announced that plants under higher water supply recorded higher number of leaves per plant and subsequently higher leaf area per plant. Then again, plants developed submerged deficiency conditions had less leaves area per plant. Decreased leaf development for plants under pressure is helpful which created lessleaf zone and brought about diminished transpiration. Comparative outcomes on the pernicious effects of water weight on development criteria of faba bean plants were accounted for by Abdel-Mottaleb *et al*. (2000), Ahmed *et al*. (2008), Alderfasi and Alghamdi (2010) and Hegab *et al*. (2014).

Table 4: Effect of irrigation levels and cultivars on faba bean growth traits (average data of 2015/2016 and 2016/2017 growing seasons).

Treatments		Number of days to first flower /(day)	Number of leaves / plant	Leaf area index (LAI)	Number of branches per plant	Total plant dry weight (g/plant)
60%		45.43	34.78	3.37	3.91	49.30
80%		49.70	43.62	4.45	4.39	61.05
100%		54.42	50.89	5.44	5.19	71.89
LSD 5%		0.75	0.86	0.17	0.27	0.63
Sakha 1		50.38	48.53	5.81	5.14	75.94
Sakha 2		48.13	40.60	3.98	4.07	54.43
Sakha 3		45.69	38.47	3.16	4.14	46.98
Masr 1		53.57	42.89	4.41	4.27	60.40
Nobaria 1		51.48	44.99	4.74	4.87	65.99
LSD 5%		1.14	1.13	0.03	0.31	1.13
60%	**Sakha 1**	46.69	38.11	4.83	4.33	55.97
	Sakha 2	43.79	32.10	2.75	3.79	44.99
	Sakha 3	40.61	30.49	2.25	3.54	40.90
	Masr 1	48.63	35.24	2.91	3.76	48.78
	Nobaria 1	47.46	37.97	4.14	4.14	55.89
80%	**Sakha 1**	49.63	47.47	6.02	5.21	79.09
	Sakha 2	48.13	42.27	4.08	3.72	54.76
	Sakha 3	46.31	39.82	3.05	4.25	44.83
	Masr 1	53.23	43.78	4.64	3.91	60.53
	Nobaria 1	51.22	44.74	4.46	4.88	66.04
100%	**Sakha 1**	54.82	60.02	6.57	5.89	92.78
	Sakha 2	52.49	47.43	5.13	4.70	63.54
	Sakha 3	50.15	45.10	4.17	4.64	55.21
	Masr 1	58.86	49.65	5.70	5.13	71.89
	Nobaria 1	55.77	52.27	5.64	5.59	76.05
LSD 5%		ns	1.96	0.53	0.54	1.96

Data in Table (4) obviously exhibited significant differences in number of days to first flower /(day), number of leaves / plant, leaf area index (LAI), number of branches per plant and total plant dry weight (g/plant), due to cultivars. In this regard, sakha 3 was characterized by the early flowers (45.69 day from sowing), while, masr 1 gave the late flowers (53.57 day from sowing). sakha 1 exhibited the highest values for number of leaves / plant (48.51), LAI (5.14), number of branches per plant (5.15) and total plant dry weight (75.94 g/plant), as compared to the other cultivars. sakha 3 showed the lowest values for number of leaves / plant (38.47), LAI (3.16) and total plant dry weight (46.98g/plant), while, sakha 2 gave the lowest value for number of branches per plant (4.07). A decrease in growth parameters may be due to the impairment of cell division, cell enlargement caused by loss of turgor, and inhibition of various growth metabolisms (Farooq *et al*. 2012 and Yordanov *et al*. 2003).

As to the interaction impact between various irrigation levels and cultivars, data in table 4 showed that the early flowers no significantly effect. The highest vegetative growth traits were obtained from sakha 1 with 100% (IR), whereas, the lowest values were obtained by using the sakha 3 combined with 60% (IR). These results strengthen the findings of Ouzounidou *et al.* (2014), Ali *et al.* (2013) who reported that drought stress reduced plant growth characteristics. Among the cultivars, "sakha 1" was found to be more tolerant by giving highest values for all growth characteristics in comparison to four cultivars.

3. Yield components.

Analysis of variance indicated clearly that yield components of faba bean were significantly affected by irrigation requirement (Table 5). Generally, plant height (cm) at harvest, number of pods per plant, number of seeds per plant, weight of pods per plant(g), weight of 100 seeds (g) and weight of seeds per plant.(g) of faba bean were increased with increasing irrigation requirement. In this regard, 100% (IR) gave the highest values of plant height (cm) at harvest, number of pods per plant, number of seeds per plant, weight of pods per plant (g), weight of 100 seeds (g) and weight of seeds per plant.(g), whereas the lowest value of such traits was more pronounced when (IR) reached up to 60%. The decrement estimated by 28.2% and 9.5% on number of pods per plant, 17.6% and 8.4% on number of seeds per plant; 17.3% and 9.3% on weight of pods per plant; 6.6% and 3.0% on weight of 100 seeds and 23.5% and 10.7% on weight of seeds per plant with irrigation water supplies up to 60% and 80% compared with the level of 100%, respectively. These results are in agreement with these obtained by Khalafallah *et al*. (2008), Ouzounidou *et al.* (2014), Ammar *et al.* (2014) and Alghamdi *et al.* (2014) found that drought stress significantly influenced all faba bean characters. At harvest, the faba bean cultivars showed significant discrepancy in their yield components including plant height (cm), number of pods per plant, number of seeds per plant, weight of pods per plant(g), weight of 100 seeds (g) and weight of seeds per plant.(g).

Table 5: Effect of irrigation levels and cultivars on faba bean yield components. (average data of 2016/2017 and 2017/2018 growing seasons).

Treatments		Plant height (cm) at harvest	Number of pods per plant.	Number of seeds per plant.	Weight of pods per plant(g)	Weight of 100 seeds (g)	Weight of seeds per plant.(g)
60%		129.45	22.23	72.79	84.04	90.15	59.44
80%		131.23	26.23	82.76	92.69	93.31	68.91
100%		133.81	30.96	88.30	101.66	96.48	91.41
LSD 5%		1.05	1.20	1.51	0.82	1.09	0.97
Sakha 1		148.02	29.15	86.74	101.01	95.98	78.52
Sakha 2		121.55	25.29	79.01	88.66	92.10	72.31
Sakha 3		105.94	23.83	77.02	85.95	89.83	67.47
Masr 1		139.31	26.48	80.28	92.52	93.67	72.80
Nobaria 1		142.66	27.61	83.36	95.84	94.99	75.17
LSD 5%		1.12	0.91	0.96	0.84	0.87	1.08
60%	**Sakha 1**	146.32	24.92	79.20	91.07	93.30	64.41
	Sakha 2	121.12	20.97	69.40	80.46	87.63	57.50
	Sakha 3	105.96	18.49	67.56	77.17	85.29	54.18
	Masr 1	134.13	22.09	70.53	83.42	91.36	59.22
	Nobaria 1	139.74	24.70	77.25	88.09	93.16	61.90
80%	**Sakha 1**	147.19	27.59	86.60	98.16	95.79	70.38
	Sakha 2	120.42	25.87	80.83	88.98	92.91	72.90
	Sakha 3	105.29	24.38	80.00	88.27	90.12	65.56
	Masr 1	141.23	26.64	82.08	93.65	92.92	68.02
	Nobaria 1	142.02	26.68	84.31	94.40	94.84	67.71
100%	**Sakha 1**	150.55	34.96	94.42	113.81	98.84	100.77
	Sakha 2	123.12	29.03	86.81	96.53	95.77	86.54
	Sakha 3	106.58	28.63	83.51	92.40	94.07	82.68
	Masr 1	142.57	30.72	88.22	100.51	96.75	91.16
	Nobaria 1	146.22	31.46	88.53	105.04	96.97	95.92
LSD 5%		1.94	1.57	1.66	1.46	1.5	1.87

Data in table 5 reveal that the studied faba bean cultivars significantly differed in yield components. sakha 1 exhibited the maximum values for plant height (148.02cm), number of pods per plant (32.12), number of seeds per plant (83.66), weight of pods per plant(100.23g), weight of 100 seeds (96.36g) and weight of seeds per plant (87.32g) as compared to the other cultivars. sakha 3 showed the lowest values for plant height (105.94cm), number of pods per plant (23.83), number of seeds per plant (77.02), weight of pods per plant(85.95g), weight of 100 seeds (89.83g) and weight of seeds per plant (74.52g). Differences in yield components among cultivars may be mainly attributed to their genetic diversity and genetic make-up.

The data reveal that growth performance of faba bean cultivars were affected significantly, depending on the level of water requirement (Table 5). In general, water requirement affected all yield components (plant height, number of pods per plant, number of seeds per plant, weight of pods per plant, weight of 100 seeds and weight of seeds per plant) of plants of all cultivars. sakha 1 with 100% (IR), exhibited maximum tallest plants, number of seeds per plant, weight of pods per plant, weight of 100 seeds and weight of seeds per plant, whereas the highest number of pods per plant was obtained when sakha 1 irrigated with 80% (IR).

4. Yields.

Faba bean plants treated with higher rates of irrigation requirement not only produced higher yield attributes (Table 5) but also increase biological and seed yields (Table 6). Thus, plots received 60% and 80% irrigation requirement exhibited decreases 18.8% and 10.8%; 36.6% and 26.1% in biological and seed yields, respectively, compared to the 100% irrigation requirement. Application of 60% (IR) gave maximum water use efficiency (1.33 kg/m^3). Elucidation of such discoveries was accounted for by (Erdem *et al*., 2006) who expressed that satisfactory dampness accessibility in soil prompts increment different physiological procedures, better of supplements take-up, higher rates of photosynthesis which may thought about increasingly number and area of leaves and higher yields.

Table 6: Effect of irrigation levels and cultivars on faba bean seed yield, biological yield and water use efficiency. (average data of 2016/2017 and 2017/2018 growing seasons).

Treatments		Biological yield (ton/fed)	Seed yield (ton/fed)	Water use efficiency (kg/m3)
60%		1.51	1.02	1.33
80%		1.66	1.19	1.17
100%		1.86	1.61	1.26
LSD 5%		0.07	0.02	0.02
Sakha 1		1.84	1.37	1.34
Sakha 2		1.63	1.26	1.24
Sakha 3		1.46	1.16	1.16
Masr 1		1.67	1.27	1.24
Nobaria 1		1.79	1.31	1.29
LSD 5%		0.08	0.02	0.02
60%	**Sakha 1**	1.59	1.06	1.37
	Sakha 2	1.49	1.01	1.32
	Sakha 3	1.33	0.98	1.28
	Masr 1	1.51	0.97	1.26
	Nobaria 1	1.65	1.09	1.42
80%	**Sakha 1**	1.84	1.28	1.25
	Sakha 2	1.64	1.19	1.17
	Sakha 3	1.42	1.15	1.13
	Masr 1	1.68	1.24	1.21
	Nobaria 1	1.74	1.11	1.08
100%	**Sakha 1**	2.09	1.77	1.39
	Sakha 2	1.76	1.58	1.24
	Sakha 3	1.65	1.35	1.06
	Masr 1	1.84	1.60	1.26
	Nobaria 1	1.99	1.74	1.37
LSD 5%		ns	0.04	0.04

Regarding the biological, seed yields and water use efficiency, results presented in Table (6) showed significant differences among studied faba bean cultivars in final biological and seed yields, which cleared that sakha 1 had the highest biological, seed yields and water use efficiency, reaching 1.84, 1.37 ton/fed and 1.34 kg/m^3, respectively, whereas, Sakha 3 was the lowest one being recorded 1.46, 1.16 ton/fed and 1.16 kg/m^3 respectively.

The data reveal that growth performance of faba bean cultivars were affected significantly, depending on the level of water requirement (Table 6). In general, water requirement affected all yield components of plants of all cultivars which were reflected on biological and seed yields. Sakha 1 with 100% (IR), exhibited maximum biological and seed yields 2.09 and 1.77ton/fed, respectively, while, Nobaria 1 with 60% (IR), gave the highest value of water use efficiency (1.42 kg/m^3). Overall, drought stress has considerable impact on faba bean growth and seed yield, although the ranges of reductions are highly variable due to differences in cultivars used (Emam 1985; Shenkut and Brick 2003; Frahm *et al*. 2004). Bean seed yield reduction due to drought stress is attributed to the adverse effects of stress on individual yield components (plant height, number of pods per plant, number of seeds per plant, weight of pods per plant, weight of 100 seeds and weight of seeds per plant). The relative importance of individual components as determinants of seed yield varies from experiment to experiment (Emam 1985; Boutraa and Sanders 2001; Shenkut and Brick 2003).

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