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EFFECT OF FOLIAR SPRAY WITH AQUEOUS EXTRACT OF DATE PALM POLLEN GRAINS AND LITHOVIT ON COMMON BEAN PLANTS UNDER DIFFERENT IRRIGATION LEVELS

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ABSTRACT: Two field experiments were carried out during two successive seasons of 2017 and 2018 at the Experimental Farm of Kaha Station, Qalubia Governorate, Egypt. The study investigated the effect of three irrigation levels (50%, 75% and 100%) from crop evapotraspiration (ETc) and five foliar spray treatments by aqueous extract of date palm pollen grains at 1, 3 and 5 g/l, lithovit at 1 g/l and tap water (control) on common bean plants c.v. Nebraska. The effect of treatments on growth, seed yield, chemical characters as well as water use efficiency were studied. The recorded results illustrated that the plants sprayed by date palm pollen grains extract at 5 g/l and irrigated by 100% **(**968.72 m^3 water/fad.) or 75% (726.54 m^3 water/fad.) of irrigation water, gave the highest values of all vegetative growth parameters. On the other hand, the plants sprayed with date palm pollen grains extract at 1, 3 or 5 g/l followed by lithovit at 1 g/l, respectively and irrigated by 100% or 75% of irrigation water gave the highest value for each of number of pods/plant, weight of 1000 seeds and total dry seed yield ton/fad., compared to the control, *i.e.* water foliar spray treatment in both growing seasons. Water use efficiency (WUE) decreased when the amount of irrigation water increased to 100% ETc and the highest values were obtained from 50% treatment followed by 75% Etc. Moreover, the plants sprayed with date palm pollen grains extract at 5, 3 or 1 g/l, respectively, followed by lithovit at 1 g/L (nano-fertilizer) showed the highest values of WUE. Generally, it can recommend by spraying common bean plants by date palm pollen grains extract at (5, 3 or 1 g/l) respectively, followed by lithovit at 1 g/l (nano-fertilizer) with irrigation at level of 75% from ETc to obtain the highest seed yield with the best quality and the favorable water use efficiency at the same time saving 25% from water irrigation quantity.

Key words: *Phaseolus vulgaris*, date palm pollen grains, lithovit, seed yield and water use efficiency.

INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) belongs to the legume family (Leguminosae). It is widely cultivated and represents one of the largest food components in Africa which valued for its high content of protein and micronutrients such as iron and folic acid. It is one of the most economically important crops in Egypt and provides an income source for small farmers. It does not consume large amounts of fertilizer, plus it is consider short season crop, as well as, it is one of the crops that cause soil fertility or neither consumes nor depletes soil nutrients. It's also one of the few vegetable crops that can be grown with particularly described it for either local consumption or exportation. It is considered optimum warm-season crop, sensitive to temperature extremes and irrigation (drought or flooding).

Nowadays, there is a critical need to balance water availability, water requirements and water consumption, thus water conserving is becoming a decisive consideration for agriculture, whereas water is the main limiting factor for plant growth. Moreover, plants are prodigal in the water use because only roughly 5% of water

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uptake is used for its growth and development while the remaining 95% is lost through transpiration and leaching (**Prakash and Ramachandran, 2000)**. Agriculture is the largest water consumer worldwide, whereas it using 70% of the total renewable fresh water resources, as reported by **WWAP (2014)**. Climate change has forced scientists and decision makers to think about the future of water resources and their sustainability in a scarcity situation, taking into account less water coming from Ethiopia to Egypt and at the same time a high rate of human population increasing quickly (**Quda, 2016)**. Water resources are a scarce and limiting factor for expanding cultivation and plant production in many arid and semi-arid areas, including Egypt. Environmental stresses and climate change impact agricultural production and the food supply, all that causes of crop losses, reducing average yields for most major crops by more than 50% (**Bisbis *et al*., 2018)**. In addition, improving as well as enhancing water use efficiency (WUE) it is very important, without any reduction in productivity to satisfy present and future requirements of a high population growth rate which it is a very important issue. This may help to minimize water consumption, reduce losses of irrigation water, and increase cultivated area.

In this regard, several investigators reported that values of WUE were. affected by two components, *i.e.,* marketable yield and water applied **(Saleh and El-Tantawy, 2001).**On the other hand, **Byan (2014)** on snap bean showed that there were no differences between 80% ET and 100% ET for most growth parameters. In addition, 80% of ET increased the pod yield and improved the pod parameters, chemical composition, total chlorophyll, Ca, Mg, and protein. Therefore, this irrigation treatment can increase green bean productivity and improve pod quality. Moreover, Reducing water application from 100 to 60% of ET progressively increased WUE. Moreover, **Faloye *et al.* (2016)** on cowpea **and Saleh *et al.* (2018)** on snap bean showed that, the optimum growth, yield, water use efficiency and field water use efficiency for effective water management were obtained at irrigation regime of 60% ET which implies that about 40% of the irrigation can be saved.

Recent studies have focused on the use of plant extracts to improve vegetative growth and increase the production of many plants, because these extracts contain some important nutrients and growth regulators, vitamins and organic acids, which vary in quantity and quality in different parts of the plant as well as easy to be absorbed by the plant and cheaply priced (**Abed Al-Hussain and Ibriham, 2009**). Date palm (*Phoenix dactylifera* L. family Palmaceae) pollen grains consider one of the most effective and commonly used in the Middle East, especially in Egypt, where there are four famous local dates in Egypt; Amhat, Hiani, Sewy and Zaghlol. Date palm pollen grains extract has many compounds which are important in biological processes such as enzymes electrophoresis, sterols, triterpenes, saponins, proteins, vitamins A, C and E, minerals such as B, Zn, Se, Fe, Mo, Cu, Mn, Carbohydrates, glycosides and amino acids (**Hassan, 2011; Basuny *et al*., 2013)** which help in improving plants growth. Moreover, **Abo Al-Mikh (2017) and Abdulkadhim (2019)**, found that the spray of the palm pollen grains extract improved vegetative qualities of plant height, leaf area, number of leaves and dry weight of vegetative and root group, as well as the proportion of NPK for pomegranate seedlings.

Moreover, it was found that, application of bio stimulants, *i.e.* amino acids extract was found to extent positive effect of plant growth which overcomes the harmful effect of some environmental stress such as drought. Amino acids have traditionally been considered as precursors and constituents of proteins, and play an important role in plant metabolism as well as development. Many studies reported that the foliar application of amino acids caused an enhancement in plant growth, fruit yield and its components (**El-Shabasi *et al*., 2005** on cucumber**; Neeraja *et al*., 2005** on tomato**; Awad *et al.*, 2007** on garlic**; Hayat *et al*. 2012**).

In addition, several investigators found that, Nano-fertilizers are used recently as an alternative to conventional fertilizers for slow release and efficient use by plants. Nano-fertilizers could enhance nutrient use efficiency and decrease the costs of environmental protection, (**Naderi and Shahraki, 2013**). One example of that lithovit, it is a natural intensified

CO_2 foliar fertilizer for indoor/outdoor use it, is a top-quality natural technological product created by tribodynamic activation and micronization to levels of 10-20 microns. lithovit can considerably increase the photosynthesis rate, since one of the essential factors limiting photosynthesis outdoors is the lower natural CO_2 content of the air, this leads to yield increases (up to 50% and more), accompanied by a reduced water requirement (by up to 75%), and since with using lithovit, plants are able to keep the stomata closed longer time in case of water stress (balancing of nutrients). In addition, the micro-nutrients also contained in the product and the trace elements that influence plant physiology and increase the resistance against unfavorable weather condition and diseases, growth, vitality and general quality of the crop. The additional supply of micronutrients from the lithovit complex provides a source of key plant available elements required to aid photosynthetic activity, **(Thorn and Rogan, 2015)**.Moreover, **Abd El-Aal and Rania (2018)** reported that foliar application with growth stimulators as lithovit at 500 mg/l and amino acids at 4 ml/l induced favorable results on soybean cultivation which improved its growth, productivity and quality.

The objective of this experiment was to study the influence of foliar spraying with aqueous extract of date palm pollen grains as a natural bio- stimulant on common bean plants to improve the vegetative growth, yield and its chemical composition as well as water use efficiency under different irrigation levels.

MATERIALS AND METHODS

The present work was carried out during two successive seasons of 2017 and 2018 at the Experimental Farm, Kaha Station, Qalubia Governorate to study the effect of different irrigation levels and foliar spray with some safety materials (date palm pollen grains extract and lithovit) on growth, seed yield and seed quality as well as water use efficiency of common bean plants grown in clay soil using drip irrigation system. Soil of the experiment was clay in texture with 7.2 pH, 3.5 EC 1.15% organic matters, 115 ppm N, 41 ppm P and 99 ppm K. Seeds of common bean cv. Nebraska were obtained from Hort. Res. Inst., Agric. Res. Center, Egypt and sown on February 23rd and 22nd in 2017 and 2018 seasons, respectively. Seeds were sown in hills on one side of ridge (two dripper lines) at 35 cm spaces between the hills. The area of each experimental plot was 2.8m^2 (4 m long with 0.7 m width).

The experiment was arranged in a split plot design with three replicates. It was included fifteen treatments, *i.e.,* the combination between 3 irrigation levels, namely 50%, 75% and 100% from crop evapotraspiration (ETc) which calculated according to historical class A pan evaporation data (2016 and 2017) for Qalubia region, expressed as mm/ day were distributed at random in main plots and five safety materials were used, *i.e.* (water, date palm pollen grains extract at 1, 3 and 5 g/L and lithovit at1 g/L) occupied in the sub plots. Irrigation water quantities (as average of two seasons) were about 484.36 m^3/fad., for 50% ETc,726.54 m^3/fad., for 75% ETc and 968.72 m^3/fad., for 100% ETc. Initial irrigation treatments was at 19 days up to 109 days from sowing. Plants were sprayed three times with aqueous solution of the used materials; the first spray was conducted at the three true leaves stage, whereas the second and third sprays were preformed later every12 days intervals.

The other cultural practices for growing common bean plants were carried out as recommended by Egyptian Ministry of Agriculture.

Preparation of Date Palm Pollen Grains Extracts

Pollen grains of Egyptian date palm (*Phoenix dactylifera* L.) were collected at the end of March from Shabramant, Giza, Egypt during the agricultural season at the beginning of the opening the covers of the male species. The extract was prepared from pollen grains of date palm using the procedure reported by **Nagai *et al.* (2002)** with some modifications as follows: To prepare three concentrations of water pollen grains extract (1, 3 and 5 g) of pollen grains whereas every one soaked in 1 litter of distilled water for 24 hours and turning with electric mixer and filter the extract with filter paper.

Components of date palm pollen grains taken as shown in Table 1.

Names and contains of the safety materials as shown in Table 2.

Table 1. Components of date palm pollen grains according to Hassan (2011)

Subject	Ingredient
Moisture	28.80 (%)
Vitamins	Vitamin A, H, E, D, K and group vitamins B (B1, B2, B6, B12, Niyasine, Butine, Anysitole, Rothine
Hormones	Astron hormone
Food Ingredients	Carbohydrates 13%, Protein 35%, Fat 5%
Mineral salts	Ti, Mo, B, Si, Zn, I, Cu, Mn, Mg, Fe, Cl, Na, S , P, K, Ca
Amino acids	Alanine (Ala) 2.61 Arginine (Arg) 1.61 Aspartic acid (Asp) 3.55 Glutamic acid (Glu) 1.74 Glycine (Gly) 2.24 Serine (Ser) 1.89 Cysteine (Cys) 0.42 Tyrosine (Tyr) 1.55 Proline (Pro) 0.28 Ammonia 0.45
Other compounds	phenolic acids, , clycerides, mono acids, bilateral acids and triple acids auxin (IBA) and tryptophan (auxin precursor)

Table 2. Names and contains of the safety materials used in this study

Compound name	Composition	Concentration
Control	Tap water	-
Date palm pollen grains	As shown in Table 1	1 - 3 -5 g/ liter
Lithovit	80.2% Ca Co_3, 4.6 % Mg Co_3, 0.2% K_2O, 0.75% Fe	1 g/ liter

Water Management Measurements

The water requirement for common bean plants was calculated based on the following formulas, according to **Allen *et al.* (1998)**.

(1) $ET_0 = Kp \times Epan$ mm/day

Where:

ET_0 = Potential evapotranspiration

Kp = Pan Coefficient = 0.85

Epan = Pan evaporation in mm/day

(2) $ETc = ET_0 \times Kc$ mm/day

Where:

ET_0 = the rate of evapotranspiration from an excessive surface of green cover of uniform height (8 to 15 cm) actively growing, completely shading the ground and did not face shortage in water.

Kc = Crop coefficient

ETcrop = the water requirement of a given crop in mm per unit of time mm/day, mm/month or mm/season.

Crop evapotranspiration and total water consumption of common bean plants during seasons of 2017 and 2018 are presented in Table 3.

Water Use Efficiency (WUE)

Water use efficiency was calculated for different treatments using the following equation **(Monteith, 1986**).

WUE = Total seed yield (kg/fad.)/ Total water consumption (m^3/fad.)

The monthly temperature and relative humidity during growing seasons of 2017 and 2018 are presented in Table 4.

Table 3. Crop evapotranspiration and total water consumption of common bean plant at different levels of irrigation during 2017 and 2018 seasons

Growth stage	Days	Class A pan mm	Potential evapotranspiration (ET_0)	FAO Kc	Crop evapotranspiration mm			Total water consumption (m^3/fad.)		
					50%	75%	100%	50%	75 %	100%
First season										
Initial	**20** (19-39)	2.82	2.40	0.5	12.00	18.00	24.00	30.00	45.00	60.00
Crop development	**30** (39-69)	3.64	3.10	0.8	37.20	55.80	74.40	130.20	195.30	260.40
Mid- season	**30** (69-99)	4.35	3.70	1.1	61.05	91.57	122.10	244.20	366.30	488.40
Late season	**10** (99-09)	5.05	4.30	0.9	19.35	29.02	38.70	87.07	130.61	174.15
Seasonal	**90**	**3.96**	**3.37**	**0.8**	**129.60**	**194.40**	**259.20**	**491.47**	**737.21**	**982.95**
Second season										
Initial	**20** (19-39)	2.70	2.30	0.5	11.50	17.25	23.00	28.75	43.12	57.50
Crop development	**30** (39-69)	3.41	2.90	0.8	34.80	52.20	69.60	121.80	182.70	243.60
Mid- season	**30** (69-99)	4.23	3.60	1.1	59.40	89.10	118.8	237.60	356.40	475.20
Late season	**10** (99-09)	5.17	4.40	0.9	19.80	29.70	39.60	89.10	133.65	178.20
Seasonal	**90**	**3.87**	**3.30**	**0.8**	**125.50**	**188.25**	**251.00**	**477.25**	**715.87**	**954.50**

Table 4. The monthly temperature (˚C) and relative humidity (%) during 2017 and 2018 seasons

Month	2017			2018		
	Temperature (°C)		RH (%)	Temperature (°C)		RH (%)
	Max.	Min.		Max.	Min.	
March	38.2	9.3	100	32.8	12.5	93
April	38.8	12.6	100	40.1	16	100
May	45.4	16.8	92.3	42.0	19.1	89.9
June	43.6	20.4	87.1	41.9	23.3	92.3

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Sampling and collecting data

Vegetative growth characteristics

Three plants from each experiment unit were randomly taken at flowering stage (55 days after sowing) to measure plant growth characteristics *i.e.,* plant length (the length of main stem, cm), stem diameter (cm), No. of leaves/plant, No. of branches/plant and dry weights of shoots (Leaves and stems)/ plant. The samples of the vegetative parts were dried in the oven at 75°C till constant weight and then the dry weight per plant was calculated using the standard methods as illustrated by **AOAC (1990)**.

The leaf area was calculated at flowering stage (55 days after sowing) from the fourth upper leaves according to the following formula of **Wallace and Munger (1965):**

Leaf area (cm^2) = Leaves dry weight (g) x disk area/disk dry weight (g)

Yield and its components

At harvest, (120 days after sowing) samples of dry seed yield were taken from each experiment unit to estimate yield characters, *i.e.,* number of dry pods/plant, number of dry seeds/ pod, weight of 1000 dry seeds (g), dry seed yield ton/fad.

Chemical properties

Total leaf chlorophyll was measured at flowering stage (55days after sowing) from the fourth upper leaves using Minolta chlorophyll Meter SPAD- 501 as SPAD units

Total nitrogen, phosphorus and potassium were determined in the dry seeds on the basis of dry weight according to the methods described by **Bremner and Mulvaney (1982), Olsen and Sommers (1982) and Jackson (1967)**, respectively.

Total protein (%)

It was determined as nitrogen of seed content and converted to its equivalent protein content by multiplying total nitrogen x 6.25 **(AOAC, 1990)**

Statistical Analysis

All data were subjected to statistical analysis according to the procedures reported by **Snedecor and Cochran (1980)** using M. stat program and means were compared by LSD multiple range tests at the 5% level of probability in the two seasons of experimentation.

RESULTS AND DISCUSSION

Vegetative Growth Characteristics

Effect of irrigation levels

The vegetative growth parameters of common bean plants, *i.e.,* plant length, number of leaves/plant, stem diameter, number of branches/plant, leaf area as well as dry weight of plant as affected by irrigation levels are shown in Table 5. The results revealed that irrigation regime did not exert significant effect on stem diameter or number of branches/plant in both growing season in spite of the 100% and 75% of crop evapotraspiration (ETc) showed obvious increment in plant length, number of leaves, leaf area as well as dry weight of plant compared to 50% of ETc. The abundance of water under 100% and 75 of ETc encouraged the meristematic activity and hence the length of plants. The greatest number of leaves was found on the tallest plants where the abundance of water under 100% and 75% of ETc promoted the meristematic activity then led to increasing the length of the plant and hence, number of leaves. Moreover, the highest values of leaf area founded under the levels of 100% or 75% of ETc might enable to plants intercept and synthesize more metabolites than plants irrigated by 50% treatment which might be reflected on the fresh and dry weight of the plants. These results are in the same line with those obtained by **Byan (2014) and Saleh *et al.* (2018)** on snap bean.

Effect of foliar spray by date palm pollen grains extract and lithovit

The recorded results in Table 5 illustrate that foliar application by date palm pollen grains extract at 5, 3 or 1 g/L respectively, followed by foliar application by lithovit 1 g/L caused stimulatory effects on all vegetative growth parameters compared with the control treatment in both seasons, this may be due to the fact that date palm pollen grains extract contains many mineral elements, including K, Ca, Mg, P, in addition to proteins, vitamins and organic acids as shown in Table 1, which increase the process of photosynthesis, respiration and metabolism thus encouraging cell division and elongation, in addition to the presence of micro elements Fe, Mn, Zn, the Zn component which plays an important role in activating many of the enzymes necessary to formation the auxins that cause cell division and elongation, thus increasing plant height, stem diameter, leaves number and its area (**Hassan, 2011; Basuny *et al.*, 2013)** came to the same results**.** Concerning to lithovit, it is a natural intensified CO_2 foliar fertilizer can considerably increase the photosynthesis rate. In addition, the micro-nutrients also contained in the product and the trace elements that influence plant physiological process and increase growth **(Thorn and Rogan, 2015; Abd El-Aal and Rania, 2018)**.

Table 5. Effect of irrigation levels and foliar spray with date palm pollen grain extract and lithovit on vegetative growth of common bean plants during 2017 and 2018 seasons.

Treatment		Plant length (cm)		Stem diameter (cm)		No. of. leaves / plant		No. of. branches/ plant		Leaf area (cm²)		Dry weight g / plant	
		2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Irrigation levels (ETc)													
100% (cont)		46.76	46.40	0.78	0.79	21.52	21.78	15.34	14.56	298.42	306.74	19.16	19.40
75%		45.24	45.10	0.73	0.75	20.56	21.00	14.86	14.40	290.10	291.04	17.38	18.04
50%		45.42	45.56	0.73	0.76	16.82	17.20	14.22	14.00	270.68	269.60	11.20	12.47
LSD at 5%		**0.26**	**0.26**	**NS**	**NS**	**0.26**	**0.90**	**NS**	**NS**	**5.78**	**2.50**	**0.45**	**1.05**
Foliar spray													
Without (cont)		38.00	39.00	0.65	0.67	14.00	13.83	10.53	10.80	151.77	158.30	10.66	11.10
Lithovit 1 g/l		43.46	42.00	0.69	0.72	17.93	18.66	12.70	11.76	202.03	197.87	12.36	12.30
Date palm pollen grains extract 1 g/l		47.40	48.10	0.79	0.80	20.20	20.56	16.06	15.33	346.03	334.07	18.13	19.43
Date palm pollen grains extract 3 g/l		49.17	49.00	0.83	0.83	22.83	23.00	16.30	16.43	350.63	354.17	18.63	19.78
Date palm pollen grains extract 5 g/l		51.00	50.33	0.81	0.82	23.20	23.90	18.43	17.26	381.53	401.23	19.76	20.56
LSD at 5%		**0.53**	**0.50**	**0.05**	**0.06**	**0.53**	**0.61**	**0.43**	**0.64**	**3.08**	**2.68**	**0.96**	**0.66**
Irrigation levels (ETc) X Foliar spray													
	Without (cont)	40.00	41.00	0.70	0.70	17.50	16.50	12.60	12.00	176.30	174.90	12.30	12.90
	Lithovit 1 g/l	44.50	43.00	0.66	0.70	18.00	20.00	13.00	12.00	206.80	202.00	14.00	13.00
100% Etc	**Date palm pollen grains extract 1 g/l**	47.00	47.50	0.85	0.85	23.00	23.70	16.80	16.00	357.60	344.60	21.50	23.10
	Date palm pollen grains extract 3 g/l	49.33	48.20	0.85	0.85	24.50	24.00	16.60	16.00	360.80	379.50	22.90	23.00
	Date palm pollen grains extract 5 g/l	53.00	52.30	0.85	0.86	24.60	24.70	17.70	16.80	390.60	432.70	25.10	25.00
	Without	38.00	39.00	0.65	0.68	13.70	14.00	10.00	11.00	150.00	166.00	10.40	10.40
	Lithovit 1 g/l	42.50	42.00	0.66	0.70	18.80	18.00	12.60	11.00	202.00	190.60	12.80	12.30
75% Etc	**Date palm pollen grains extract 1 g/l**	46.00	46.80	0.70	0.77	19.00	20.00	15.80	15.00	350.00	350.60	21.00	21.80
	Date palm pollen grains extract 3 g/l	49.20	48.00	0.85	0.84	25.30	26.00	16.30	17.00	358.20	353.00	21.10	22.90
	Date palm pollen grains extract 5 g/l	50.50	49.70	0.80	0.80	26.00	27.00	19.60	18.00	390.30	395.00	21.60	22.80
	Without	36.00	37.00	0.60	0.65	10.80	11.00	9.00	9.40	129.00	134.00	9.30	10.00
	Lithovit 1 g/l	43.40	41.00	0.77	0.76	17.00	18.00	12.50	12.30	197.30	201.00	10.30	11.60
50% ETc	**Date palm pollen grains extract 1 g/l**	49.20	50.00	0.82	0.80	18.60	18.00	15.60	15.00	330.50	307.00	11.90	13.40
	Date palm pollen grains extract 3 g/l	49.00	50.80	0.80	0.80	18.71	19.00	16.00	16.30	332.90	330.00	11.90	13.45
	Date palm pollen grains extract 5 g/l	49.50	49.00	0.80	0.82	19.00	20.00	18.00	17.00	363.70	376.00	12.60	13.90
LSD at 5%		**0.31**	**0.29**	**NS**	**NS**	**0.31**	**0.36**	**0.25**	**0.38**	**1.83**	**1.59**	**0.57**	**0.39**

Irrigation water quantity (as average of two seasons) were about 484.36 m³water/fad., for 50% Etc, 726.54 m³water/fad., for 75% Etc and 968.72 m³water/fad., for 100% Etc.

Effect of the interaction between irrigation levels and foliar spray with date palm pollen grains extract and lithovit

The results of the interaction effect between irrigation levels and safety materials on vegetative growth, *i.e.,* plant length, number of leaves, number of branches, stem diameter and leaf area as well as dry weight of common bean plant are shown in Table 5. The recorded results illustrate that the plants sprayed by date palm pollen grains extract at 5 g/l and irrigated by 100% or 75% of irrigation water gave the highest values of all vegetative growth parameters except stem diameter which showed non-significant differences between irrigation water quantity and safety materials in both growing seasons. The enhancing effect of the interaction treatments may be due to the fact that date palm pollen grains extract contains several compounds from vitamins, micro elements and hormones as well as amino acids which it having traditionally been considered as precursors to and constituents of proteins, which plays an important role in plant metabolism and development. Many investigators reported that the foliar application of amino acids caused an enhancement in plant growth (**El-Shabasi *et al*., 2005** on cucumber; **Neeraja *et al*., 2005** on tomato; **Awad *et al.*, 2007** on garlic; **Hayat *et al*., 2012).**

Yield and Its Components

Effect of irrigation levels

Results in Table 6 obviously indicate the effect of different water regime levels on yield and its components of common bean. In this respect, the results reveal that, the means of pod number/plant, weight of 1000 dry seeds and seed yield were the highest in irrigation regime at 100% ETc followed by 75% ETc and the lowest was obtained in irrigation regime of 50% ETc in both growing seasons. Moreover, the results revealed that irrigation regime did not exert significant effect on number of seeds/pod in both growing season, this stimulation of seed yield production is considered as a direct result of the vigorous growth (Table 5). These results are in agreement with those of **Byan (2014)** on snap bean, **Faloye *et al*. (2016)** on cowpea and **Saleh *et al*. (2018)** on snap bean.

Effect of foliar spray with date palm pollen grains extract and lithovit

Results in Table 6 reveal that foliar spraying common bean plants by date palm pollen grains extract at 5, 3 or 1 g/L respectively, then lithovit 1 g/L induced significant increases on all yield and its components *i.e.,* number of pods/plant, number of dry seeds/pod, weight of 100 dry seeds and seed yield ton/fad., compared with the control treatment in both growing seasons. This may be due to the fact that date palm pollen grains extract contains many mineral elements, including K, Ca, Mg, P, in addition to proteins, vitamins and organic acids as shown in Table 1. In other words, date palm pollen grains extract and lithovit as foliar applications increased number of dry seeds/pod as well as causing significant increment on the dry seed weight and this reflect on the total dry seed yield, this results are in harmony with those reported by **Hassan (2011)** on tomato **and Basuny *et al*. (2013)**. Moreover, **Abd El-Aal and Rania (2018)** on soybean reported that foliar application with growth stimulators as lithovit at 500 mg/l improving its growth, productivity and quality.

Effect of the interaction between irrigation levels and foliar spray by date palm pollen grains extract and lithovit

The recorded results in Table 6 illustrate that the plants which sprayed with date palm pollen grains extract at 1, 3 or 5 g/l followed by lithovit at 1 g/l and irrigated by 100% or 75% of irrigation water gave the highest values of the total seed yield and its components *i.e.,* number of pods/plant, weight of 1000 seeds and dry seed yield ton/fad., compared to the control, *i.e.* water foliar spray treatment in both growing seasons. Moreover, the results revealed that, the interaction between irrigation levels and foliar spray by date palm pollen grains extract and lithovit did not exert significant effect on number of seeds/pod in both growing season. This may be due to the fact that date palm pollen grains extract contains amino acids which play an important role in plant metabolism and development. Many studies reported that the foliar application of amino acids caused an enhancement in fruit yield and its components (**El-Shabasi *et al*., 2005** on cucumber; **Neeraja *et al*., 2005** on tomato; **Awad *et al.*, 2007** on garlic; **Hayat *et al*., 2012)**.

Table 6. Effect of irrigation levels and foliar spray with date palm pollen grain extract and lithovit on dry seed yield and its components of common bean plants during 2017 and 2018 seasons

Treatment		No.of pods/plant		No.of seeds/pod		Weight of 1000 dry seeds (g)		Total seed yield ton/fad.	
		2017	2018	2017	2018	2017	2018	2017	2018
Irrigation levels (ETc)									
100% (cont)		21.87	21.58	4.30	4.25	418.92	425.60	1.58	1.56
75%		21.86	22.16	4.16	4.20	415.88	414.60	1.45	1.50
50%		21.21	21.23	4.14	4.25	401.00	401.52	1.29	1.40
LSD at 5%		**0.52**	**0.52**	**NS**	**NS**	**1.36**	**0.84**	**0.02**	**0.03**
Foliar spray									
Without (cont)		18.18	17.93	3.13	3.40	280.17	293.83	0.59	0.67
Lithovit 1 g/l		20.76	20.94	4.16	4.06	362.67	362.93	1.02	1.06
Date palm pollen grains extract 1 g/l		22.72	22.46	4.36	4.49	455.97	452.17	1.61	1.77
Date palm pollen grains extract 3 g/l		23.04	23.16	4.60	4.49	483.37	480.83	1.91	1.92
Date palm pollen grains extract 5 g/l		23.53	23.80	4.73	4.72	477.50	479.77	2.07	2.01
LSD at 5%		**0.61**	**0.58**	**0.30**	**0.64**	**0.56**	**0.51**	**0.03**	**0.05**
Irrigation levels (ETc) X Foliar spray									
100% ETc	**Without (cont)**	19.50	18.80	3.40	3.52	257.50	305.20	0.64	0.75
	Lithovit 1 g/l	20.10	19.33	4.30	4.00	395.00	397.00	1.28	1.16
	Date palm pollen grains extract 1 g/l	22.66	22.50	4.20	4.40	453.50	508.30	1.65	1.79
	Date palm pollen grains extract 3 g/l	23.50	23.40	4.80	4.60	518.10	474.10	2.16	2.05
	Date palm pollen grains extract 5 g/l	23.60	23.90	4.80	4.75	470.50	443.40	2.21	2.06
75% ETc	**Without**	18.61	18.33	3.00	3.20	299.00	300.50	0.60	0.67
	Lithovit 1 g/l	20.50	22.00	4.00	4.00	357.00	354.50	1.09	1.09
	Date palm pollen grains extract 1 g/l	23.20	23.20	4.50	4.60	474.40	469.00	1.67	1.88
	Date palm pollen grains extract 3 g/l	23.43	23.43	4.50	4.40	467.00	484.00	1.83	1.89
	Date palm pollen grains extract 5 g/l	23.56	23.85	4.80	4.80	482.00	465.00	2.06	2.00
50% ETc	**Without**	16.43	16.66	3.00	3.50	284.00	275.80	0.53	0.61
	Lithovit 1 g/l	21.70	21.50	4.20	4.18	336.00	337.30	0.71	0.93
	Date palm pollen grains extract 1 g/l	22.30	21.70	4.40	4.48	440.00	448.10	1.52	1.64
	Date palm pollen grains extract 3 g/l	22.21	22.66	4.50	4.48	465.00	465.20	1.74	1.84
	Date palm pollen grains extract 5 g/l	23.43	23.66	4.60	4.62	480.00	481.20	1.96	1.99
LSD at 5%		**0.36**	**0.34**	**NS**	**NS**	**0.33**	**0.31**	**0.01**	**0.02**

Irrigation water quantity (as average of two seasons) were about 484.36 m³water/fad., for 50% Etc, 726.54 m³water/fad., for 75% Etc and 968.72 m³water/fad., for 100% Etc.

Chemical Properties

Effect of irrigation levels

Results in Table 7 show the influence of irrigation levels on chemical properties of common bean seeds, *i.e.,* protein percentage, P%, K% as well as total chlorophyll of the leaves. It was found that the plants irrigated by 100% of the calculated amount of water treatments, showed higher concentration of P% in its seeds than those irrigated by other irrigation treatments. While, the plants irrigated by 75% of the calculated amount of water treatments produced seeds containing the highest value for each of K%, protein percentage and total chlorophyll in the leaves. These results may be due to abundance of water quantities encouraged the absorption of minerals and its translocation to leaves**.** These results are in agreement with those obtained by **Byan (2014)** on snap bean, **Faloye *et al.* (2016)** on cowpea **and Saleh *et al.* (2018)** on snap bean. Generally, drought reduces both nutrient uptakes by the roots and transport from the roots to the shoots, because of restricted transpiration rates and impaired active transport and membrane permeability.

Effect of foliar spray with date palm pollen grains extract and lithovit

The recorded results in Table 7 illustrate that the plants sprayed by date palm pollen grains extract or lithovit gave dry seeds contains the highest value for each of protein percentage in the dry seeds, P% as well as total chlorophyll in the leaves while results revealed that foliar spray by date palm pollen grains extract and lithovit did not exert significant effect on k% in the dry seeds during both growing seasons. This results may be due to the fact that date palm pollen grains extract contains many mineral elements, including K, Ca, Mg, P, in addition to proteins, vitamins and organic acids as shown in Table 1, Moreover, **Abo Al-Mikh (2017) and Abdulkadhim (2019)**, found that the spray of the palm pollen grains extract improved proportion of NPK for pomegranate seedlings.

Effect of the interaction between irrigation levels and foliar spray with date palm pollen grains extract and lithovit

The recorded results in Table 7 illustrate that the plants sprayed by date palm pollen grains extract at 5 g/l and irrigated by 75% of irrigation water gave the highest value for each of protein percentage, P% as well as k% in spite it did not reach to significance level in the case of k% compared with the control (without) in both growing seasons. Moreover, the results revealed that foliar spray by date palm pollen grains extract at 3 g/l and irrigated by 75% of irrigation water gave the highest values of total chlorophyll in the leaves at the first season but did not reach to significance level in the second season as well as irrigated by 50% of irrigation water treatment in both growing seasons.

Water Use Efficiency (WUE)

Water use efficiency of common bean plants at different levels of irrigation and foliar spray by date palm pollen grains extract and lithovit is shown in Figs. 1 and 2. Results illustrated that water use efficiency decreased as the amount of irrigation water increased to 100% level of Etc and the highest values were obtained from 50% treatment followed by 75% of ETc. This was true in both growing seasons as shown in Fig. 1. The reduction in WUE by increasing the amount of irrigation might be due to the increasing in common bean water consumption use (WCU) as shown in Fig. 1. In this regard **Byan (2014)** on snap bean, **Faloye *et al.* (2016)** on cowpea and **Saleh *et al.* (2018)** on snap bean found that water use efficiency was decreased at the high level of irrigation levels.

Regarding water use efficiency (WUE) for common bean plants sprayed by the materials used in this study, results in Fig. 2 show that plants sprayed by date palm pollen grains extract at 5, 3 or 1 g/l, respectively, followed by lithovit 1 g/l elucidated the highest values of WUE in the first season as well as in the second season. The increasing in WUE might be due to the increasing in total seed yield of common bean plants which produced as result of the favorable role of the foliar spray treatments as shown in Table 6. In this regard, several investigators reported that values of WUE were affected by two components, *i.e.,* marketable yield and water applied **(Saleh and El-Tantawy, 2001)**.

As shown in Table 8, results illustrate that, the plants sprayed by date palm pollen grains extract at 5, 3 or 1 g/l, respectively, followed by lithovit 1 g/l and irrigated by 50% or by 75% of

Table 7. Effect of irrigation levels and foliar spray with date palm pollen grain extract and lithovit on chemicals properties of common bean seeds and leaf chlorophyll during 2017 and 2018 seasons

Treatment		P (%)		K (%)		Protein (%)		Leaf chlorophyll SPAD unite	
		2017	2018	2017	2018	2017	2018	2017	2018
Irrigation levels (ETc)									
100% (cont)		0.34	0.35	1.47	1.49	17.67	17.65	40.78	40.18
75%		0.30	0.30	1.61	1.61	19.03	19.59	41.40	41.68
50%		0.29	0.34	1.42	1.43	18.55	18.66	41.06	40.92
LSD at 5%		NS	NS	NS	NS	NS	NS	NS	NS
Foliar spray									
Without (cont)		0.25	0.26	1.25	1.25	16.53	17.33	36.06	36.26
Lithovit 1 g/l		0.29	0.27	1.50	1.48	16.60	17.07	41.76	41.20
Date palm pollen grains extract 1 g/l		0.29	0.33	1.55	1.55	18.98	19.57	42.83	42.63
Date palm pollen grains extract 3 g/l		0.34	0.35	1.54	1.59	19.23	19.62	43.00	43.20
Date palm pollen grains extract 5 g/l		0.38	0.43	1.64	1.68	20.75	19.59	41.73	41.33
LSD at 5%		0.03	0.05	NS	NS	0.64	0.65	0.65	0.68
Irrigation levels (ETc)X Foliar spray									
	Without (cont)	0.27	0.29	1.26	1.29	17.90	15.00	34.20	33.00
100% ETc	**Lithovit 1 g/l**	0.26	0.24	1.36	1.33	17.96	15.20	42.60	41.00
	Date palm pollen grains extract 1 g/l	0.35	0.36	1.60	1.62	17.96	19.40	43.10	42.40
	Date palm pollen grains extract 3 g/l	0.41	0.41	1.65	1.65	16.58	20.70	42.70	42.90
	Date palm pollen grains extract 5 g/l	0.42	0.44	1.45	1.57	17.96	17.96	41.30	41.60
	Without	0.23	0.22	1.22	1.24	15.24	19.30	39.00	39.80
75% ETc	**Lithovit 1 g/l**	0.28	0.27	1.66	1.67	15.26	19.40	40.10	40.20
	Date palm pollen grains extract 1 g/l	0.28	0.27	1.72	1.69	19.58	19.90	42.80	43.00
	Date palm pollen grains extract 3 g/l	0.27	0.28	1.61	1.61	20.21	17.96	43.50	44.00
	Date palm pollen grains extract 5 g/l	0.45	0.46	1.82	1.85	24.88	21.40	41.60	41.40
	Without	0.25	0.26	1.25	1.23	16.46	17.70	35.00	36.00
50% ETc	**Lithovit 1 g/l**	0.33	0.31	1.49	1.44	16.58	16.60	42.60	42.40
	Date palm pollen grains extract 1 g/l	0.25	0.36	1.34	1.35	19.40	19.40	42.60	42.50
	Date palm pollen grains extract 3 g/l	0.35	0.37	1.37	1.52	20.91	20.21	42.80	42.70
	Date palm pollen grains extract 5 g/l	0.27	0.39	1.66	1.61	19.40	19.40	42.30	41.00
LSD at 5%		0.02	0.03	NS	NS	0.38	0.38	0.36	NS

Irrigation water quantity (as average of two seasons) were about 484.36 m³water/fad., for 50% Etc, 726.54 m³water/fad., for 75% Etc and 968.72 m³water/fad., for 100% Etc.

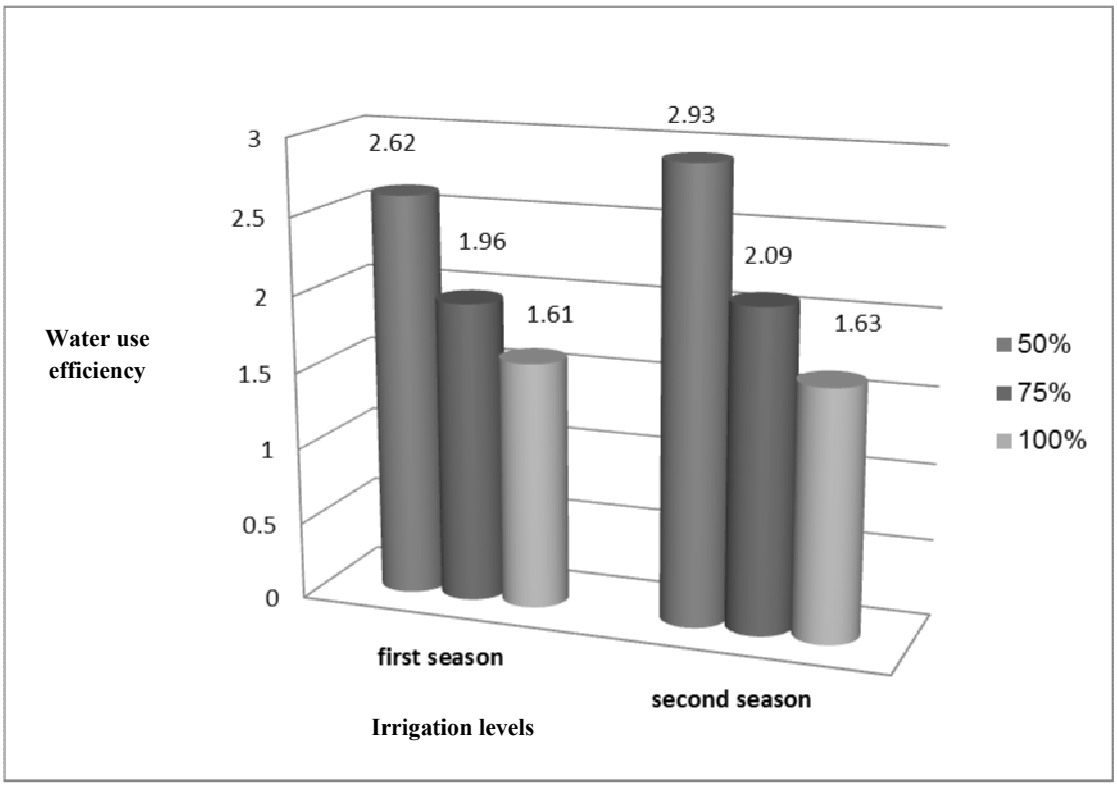

Fig. 1. Water use efficiency (WUE) of common bean plant at different levels of irrigation during 2017 and 2018 seasons

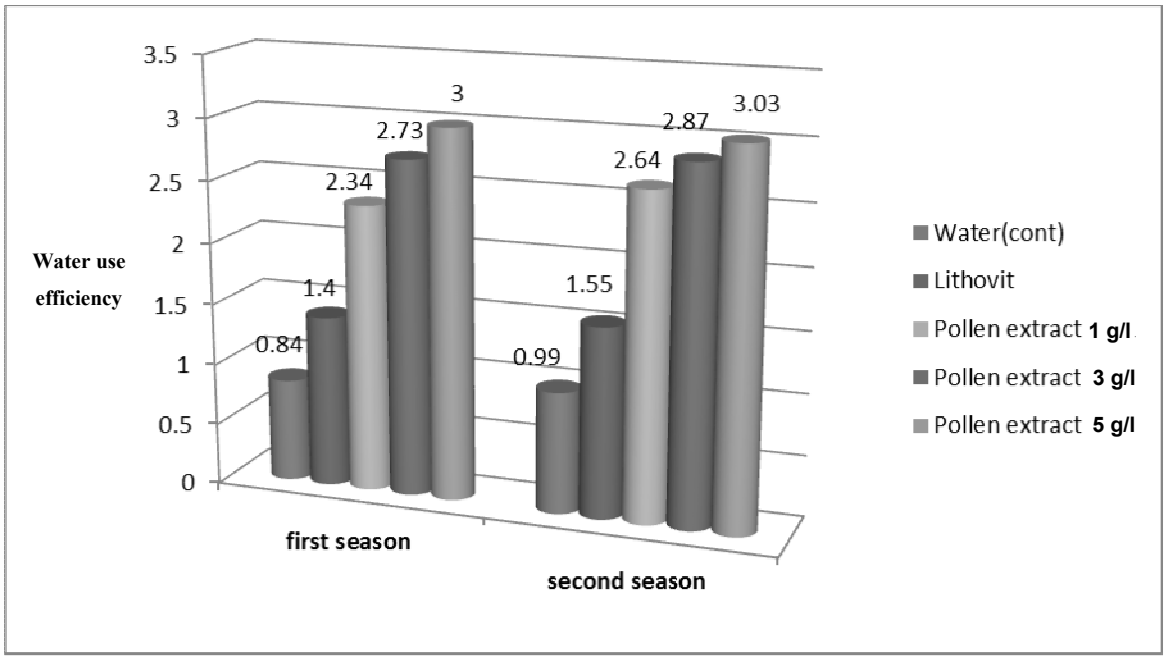

Fig. 2. Water use efficiency (WUE) of common bean plant at different foliar spray by date palm pollen grains extract and lithovit during 2017 and 2018 seasons

Table 8. Effect of the interaction between irrigation levels and foliar spray with date palm pollen grains extract and lithovit on water use efficiency of common bean plants during 2017 and 2018 seasons

Foliar spray	Tap water (cont)	Lithovit1 g/l	Date palm pollen grains extract 1 g/l	Date palm pollen grains extract 3 g/l	Date palm pollen grains extract 5 g/l
First season					
100% ETc	0.65	1.30	1.67	2.19	2.24
75% ETc	0.81	1.47	2.26	2.48	2.79
50% ETc	1.07	1.44	3.09	3.54	3.98
Second season					
100% ETc	0.78	1.21	1.87	2.14	2.15
75% ETc	0.93	1.52	2.62	2.64	2.79
50% ETc	1.27	1.94	3.43	3.85	4.16

Etc gave the highest values of water use efficiency this was true in both growing seasons. The increasing in WUE might be due to the increasing in total seed yield of common bean plants which produced as result of the favorable role of the foliar spray treatments as shown in Table 6 and decreasing in common bean water consumption use.

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تأثير الرش الورقى بالمستخلص المائى لحبوب لقاح نخيل البلح والليثوفيت على جودة محصول الفاصوليا الجافة تحت مستويات رى مختلفة

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أجريت تجربتان حقليتان خلال موسمى الزراعة ٢٠١٧و٢٠١٨ فى محطة التجارب الزراعية بقها محافظة القليوبية لدراسة تأثير استخدام ثلاث مستويات من معدلات مياه الرى وهى ٥٠%، ٧٥% و١٠٠% المحسوبة من قراءة البخر بالإضافة إلى استخدام مستخلص حبوب لقاح نخيل البلح (الطلع) بثلاثة تركيزات (١ ، ٣ أو ٥ جم/لتر)، ليثوفيت (سماد ثانى أكسيد الكربون) بتركيز ١ جم/لتر والماء (كنترول) كرش ورقى على نباتات الفاصوليا صنف نبراسكا وأثر ذلك على النمو الخضرى ومحصول البذور الجافة ومواصفاتها الكيميائية وكفاءة استخدام المياه، وقد أوضحت النتائج أن رش النباتات بمستخلص حبوب لقاح نخيل البلح بتركيز (٥ جرام للتر) مع الرى بمستوى ١٠٠ % أو ٧٥% من مياه الرى اظهر أعلى القيم بالنسبة للنمو الخضري، من ناحية أخرى ، ادى رش النباتات بواسطة مستخلص حبوب لقاح نخيل البلح بتركيز (٣،٥ أو ١ جم/لتر) تليها معاملة الرش بالليثوفيت مع الرى بمستوى ١٠٠% أو ٧٥ % من مياه الرى الى زيادة المحصول ومكوناته (عدد القرون/نبات، وزن ١٠٠٠ بذرة و المحصول البذرى طن/فدان مقارنة بمعاملة (بدون رش) في كلا الموسمين، بالنسبة لكفاءة استخدام المياه، أوضحت البيانات أن كفاءة استخدام المياه انخفضت مع زيادة الري إلى ١٠٠% من مياه الرى وتم الحصول على أعلى القيم من معاملة٥٠ % تليها ٧٥% من مياه الرى علاوة على ذلك ، أظهرت البيانات أن النباتات التي تم رشها بمستخلص حبوب لقاح نخيل البلح (٥ ، ٣ أو ١ جرام/لتر) على التوالي، تليها معاملة الرش بالليثوفيت اعطت أعلى قيم كفاءة استخدام المياه WUE في كلا موسمى الزراعة وهذا يرجع لأثر هذه المعاملات على زيادة المحصول البذرى، بوجه عام ، يمكن التوصية باستخدام الرش الورقي بمستخلص حبوب لقاح نخيل البلح (٥ ، ٣ أو ١ جرام / لتر) على التوالي ، يليه مركب الليثوفيت مع مستوى الري ٧٥ % من ماء الرى المحسوب باستخدام طريقة حلة البخر طراز -أ وذلك لتوفير ٢٥%من مياه الرى مع الحصول على أفضل محصول بذري من الفاصوليا الجافة وأفضل كفاءة لاستخدام مياه الرى.

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