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FABA BEAN CROP-WATER RELATIONSHIPS,YIELD AND APHID POPULATION UNDER DIFFERENT SOWING DATES AND IRRIGATION SCHEDULING REGIMES

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ABSTRACT

The present research work was conducted at El- Kasmia village, Etsa District, Fayoum Governorate, Egypt, during 2010/2011 and 2011/2012 winter seasons. The trials aiming at investigating the effects of sowing dates as October 15th, November 1st and November 15th and irrigation scheduling regimes, based on 1.1, 0.9 and 0.7 coefficients of Cumulative Pan Evaporation (CPE) records on seed yield, yield components, infestation with Lupine Aphid and some crop - water relations of faba bean (Giza 843 hybrid). The adopted treatments were assessed in split- plot design, with four replicates, where sowing dates occupied the main plots and irrigation scheduling regimes were allocated to the sub- ones. The main results could be as follows:-

- Early sowing date (Oct. 15th) resulted in the highest values of faba bean seed yield and its components, whereas delaying sowing date to Nov.1st or Nov 15th significantly reduced such values. Irrigating faba bean crop at 1.1 (CPE) gave the highest values of seed yield and yield components, comparable with 0.7 and 09 CPE ones. Planting faba bean on Oct. 15th as interacted with irrigating at 1.1 CPE exhibited the highest figures of seed yield and yield components.
- Early sowing date exhibited the highest values of faba bean ETc, whereas moderate or late sowing dates tended to decrease ET_C by 6.80 and 15.39% and by 7.49 and 13.96 % in 1st and 2nd seasons, respectively, compared with early sowing date. Irrigating faba bean at 1.1 CPE resulted in the highest values of ET_C comprised 86.97 and 85.07 cm in the two seasons of study, respectively. Early sowing date, as interacted with irrigating at 1.1 CPE, gave the highest values of ET_C ranged from 94.08 to 90.60 cm. The crop coefficient values (two seasons mean for the highest yielding interaction) were 0.48, 0.64, 0.74, 0.85, 0.98 and 0.66 for October, November, December, January, February and March, respectively. The highest water use efficiency values were obtained from early sowing date e.g. Oct, 1st, and similar trend was found due to irrigating at 1.1 CPE .
- Delaying the sowing date resulted in higher aphid infestation on faba bean crop and higher irrigation level e.g. irrigating at 1.1 CPE exhibited similar trend. Simple correlation of data concerning aphid population and both sowing dates and irrigation scheduling regimes were highly significant (r= 0.797 and 0.712) and (0.712 and 0.544) in 1st and 2nd seasons, respectively. In addition, linear regression of aphid population(Y) and sowing dates(X) and irrigation scheduling regimes (X_1) could be represented as Y= - 6.665+ 12.514 X and Y= - 8.758 + 29.860 X_1 in 1st season and as Y= -8.791+ 12.446 X and Y= 8.791 + 12446 X_1 in 2nd season, respectively. The correlation(r) of seed yield and aphid population data were 0.419 and 0.333 in 1st and 2nd seasons, respectively. Furthermore, linear regression equations for faba bean seed yield (Y) and aphid population(X) were Y = 3244.571 – 14.792 X in 1st season and Y = 2953.487 -11.180 X –11.180 X in 2nd one.

In order to obtain acceptable figure for water use efficiency and to save irrigation water as well, it is advisable to irrigate the early planted faba bean crop according to 0.9 CPE coefficient.

Keywords: Faba bean, yield, yield components, sowing date, irrigation scheduling, faba bean crop water relations , lupine aphid .

INTRODUCTION

Faba bean is considered the most important winter legume crop in Egypt. The high seed protein content (28%) gave the crop great importance (as cheap protein source) in human consumption. Faba bean crop have an important role in improving soil characteristics after harvesting, because it increased soil fertility due to nitrogen fixation by root nodules, leaving about 20-25 units of N/fed, which will be beneficial for the next cultivated crop.

Concerning the effect of sowing date, many investigators have been reported a tendency for increase in seed yield and some yield components such as number of branches plant^{-1}, pods number plant^{-1}, seed weight plant^{-1} and 100- seed weight as faba bean was planted in the proper sowing date (Rabie 1991; Amer *et al.* 1992; Rajender and Singh 1993; Amer *et al.* 1997; Hatam *et el.* 1999 and Sharaan *et al.* 2004). In addition, Husain *et al.* (1988) revealed that water consumption and water use efficiency were positively affected with early sowing date. Regarding aphid infection, EI-Heneidy et al. (1998) and Sucke *et al.* (2009) showed that early sowing dates of faba bean has lowest infection of aphid as compared with late ones.

Irrigation scheduling means keeping the soil moisture within a desired range, usually between field capacity (full point) and a predetermined refill point in order to avoid the problems resulted from either over or under – irrigation. Scheduling involves deciding when and how much water to apply and based on soil-based systems (monitoring soil moisture), climate-based systems or plant-based systems. Concerning climate-based systems, Phene *et al.* (1992) and Phene (1995) showed that frequent measurement of evaporation rates from an automated Class A evaporation pan corrected for water density and pan deformation errors can accurately estimate ET and be used as an irrigation scheduling tool. Regarding the effect of irrigation scheduling, Ibrahim (1986), Ageeb *et al.* (1989), Tawadros *et al.* (1993a&b), and Al-Naeem (2008) showed that faba bean yield and its components were reduced as available soil water depletion% increased. Ashry et al. (2012) stated that the crop coefficient (K_C) values(average of the two seasons) for faba bean were 0.49, 0.62, 0.73, 0.81, 0.90 and 0.59 for Oct., Nov., Dec., Jan., Feb. and March, respectively. Tawadros (1993b), Ainer *et al.* (1994), Khalil (1995) and Ashry *et al.* (2012) reported that water use efficiency was increased due to increasing soil moisture stress. In this sense, Alderfasi and Alghamdi (2010) reported that, for high crop yield, supplying irrigation water for faba beans should not exceed more than 75 % of soil water holding capacity, under Saudi Arabia conditions. Hasan *et al.* (2009) stated that increasing wet conditions around faba bean plants led to increase the aphid infection.

Regarding faba bean yield and aphid population relationship, Saxena and Stewart (1983), Hinz and Daebele (1984); Bakhetia *et al.* (1987); El-Defrawi (1987) ; El-Defrawi *et al.* (1994) and El-Defrawi *et al.* (2000) revealed that the increase of aphid population led to virus transmission causing a range of symptoms including retarded growth, plant stunting, distortion of leaves, stems and abort flowers, drop newly buds and plants may collapse.

The present trial aiming at finding the extent to which faba bean seed yield, yield components, crop – water relationships and aphid infestation were influenced due to different sowing dates and irrigation scheduling regimes under Fayoum area circumstances.

MATERIALS AND METHODS

Two field experiments were carried out at El-Kasmia village, Etsa District, El-Fayoum Governorate, Egypt during 2010/2011 and 2011/2012 winter seasons to study the effect of sowing date and irrigation scheduling regime on faba bean yield, yield components, lupine aphid population and some crop - water relationships. Some soil physical and chemical properties of the experimental site as determined according to Klute (1986) and Page *et al.* (1982) are presented in Table 1. Sowing dates as October. 15^{th}, November. 1^{st}, and November. 15^{th} and irrigation scheduling based on of 1.1, 0.9 and 0.7 pan coefficients for Cumulative Pan Evaporation (CPE) records were assessed in split- plot design, with four replicates, where sowing dates occupied the main plots and irrigation scheduling were allocated to the sub-ones. The sub- plots area was 21 m^2 (6.0 × 3.5 m) and contained 7 ridges 50 cm in width. During seed -bed preparation, Calcium super phosphate (15.5% P_2O_5) and potassium sulphate (48% K_20) fertilizers were applied as recommended. Faba bean seeds (Giza 843 hybrid) were planted in hills 25 cm apart at the rate of 71.5 kg ha^{-1} and prior to planting irrigation, a simulative dose of N (48kgNha^{-1}, ammonium nitrate 33.5% N) was added and seeds were inoculated with rhizobium as recommended. On determining the irrigation time, pan evaporation records was multiplied by the different adopted coefficient, and irrigation was practiced as the two sides of the following formula were the same.

Pan evaporation record(mm) x assessed coefficient = Available soil moisture(mm) in the root zone

It is worthy to mention that the applied irrigation events, for faba bean crop, were 7, 7 and 6 with 1.1 CPE regime and 6, 6 and 5 with 0.9 CPE regime and 5, 5 and 4 with 0.7 CPE regime under 1^{st}, 2^{nd} and 3^{rd} sowing dates, respectively. Harvesting was done on March 24^{th} , April 1^{st} and April 6^{th} for the first, second and third sowing dates, respectively, in both seasons.

The aphid population was weekly monitored and counted during the entire growing season on random intake 10 plants according to Hafez (1964)..

Table 1: Particle size distribution and some chemical analyses of the experimental site in 2010/ 2011 and 2011/2012 seasons (two seasons average).

Particle size distribution				Organic matter (%)	$CaCo_3$ (%)
Sand (%)	Silt (%)	Clay (%)	Textural class		
28.22	23.95	47.73	Clay loam	1.58	7.25

Soluble cations ($meqL^{-1}$)				Soluble anions ($meqL^{-1}$)				EC (dSm^{-1})	P^H(soil paste)	CEC(meq/ 100gm soil)	Exchangeable Cations (meq/100 gm soil)			
Ca^{++}	Mg^{+}	Na^{+}	K^{+}	Cl^{-}	HCO_3^{-}	CO_3^{--}	SO_4^{--}	3.17	8.25	33.06	Ca^{++}	Mg^{++}	K^{+}	Na+
8.42	4.28	18.53	0.50	20.87	2.75	-	8.11				16.88	10.57	1.39	4.22

At harvesting time the following data were recorded for each sub- plots:-

I. Seed yield and yield components:

1- Number of branchesplant^{-1}.
2- Number of podsplant^{-1}
3- Seed weight plant^{-1} (g).
4- 100- seed weight (g).
5- Seed yield (kg ha^{-1}).

According to Sendecor and Cochran (1980) statistical analyses of seed yield and yield components data were done and the means were compared using the LSD test at the level of 5.0% probability. In addition, data of sowing dates, irrigation scheduling regimes, seed yield and aphid population were subjected to simple correlation and linear regression analyses.

II. Reference evapotranspiration (ET_0) and some crop - water relationships:

1- Reference evapotranspiration (ET_0)

Reference evapotranspiration (ET_0) was estimated as (mm/day), using the monthly averages of weather factors for Fayoum Governorate (Table 2) and the procedures of the FAO-Penman Monteith equation (Allen *et al.* 1998).

2- Crop water consumptive use (ETc)

In the present trial, crop evapotranspiration (ET_C) was determined gravimetrically via soil samples taken from each sub-plot, just before and after 48 hours each irrigation, as well as at harvesting time. Some of soil water constants are shown in Table 3. The crop evapotranspiration ET_C between each two successive irrigations was calculated according to Israelson and Hansen, 1962 as follows:-

$$Cu\ (ET_C) = \{(Q_2-Q_1) / 100\} \times Bd \times D$$ where

Cu = Crop water evapotranspiration (cm).
Q_2= Soil moisture percentage(wt/wt) 48 hours after irrigation.

Q_1= Soil moisture percentage(wt/wt) just before irrigation.
Bd = Soil bulk density (g cm^{-3}).
D = Soil layer depth (cm).

Table 2: The monthly averages of weather factors for Fayoum Governorate in 2010/2011 and 2011/2012 seasons

Month	season	Temperature C°			Relative Humidity%	Wind Speed $msec^{-1}$	Class A pan evaporation $mmday^{-1}$
		Max.	Min.	Mean			
October	2010	25.0	11.7	18.35	52	1.48	2.5
	2011	26.3	12.1	19.2	53	1.50	2.6
November	2010	22.4	8.9	15.65	53	1.05	1.9
	2011	21.6	8.6	15.1	53	1.04	1.8
December	2010	21.9	7.6	14.80	53	1.18	1.8
	2011	21.2	7.3	14.3	52	1.16	2.8
January	2011	24.4	8.2	16.30	48	1.65	2.8
	2012	23.6	7.7	15.51	46	1.66	2.6
February	2011	27.5	11.4	19.5	50	2.13	4.3
	2012	27.0	10.8	18.4	51	2.15	4.4
March	2011	31.8	14.3	23.00	46	2.43	5.9
	2012	33	15.4	24.2	48	2.42	5.8
April	2011	33.2	15.6	24.4	50	2.48	4.9
	2012	33.8	14.3	24.0	51	2.49	5.6

Table 3: Average values of some soil moisture constants and bulk density for the experimental field in 2010/2011and 2011/2012 seasons (two seasons average)

Soil depth (cm)	Field capacity (%,w/w)	Wilting point (%,w/w)	Available soil moisture (%,w/w)	Bulk density (gcm^{-3})	Available soil moisture (mm)
00-15	42.56	21.16	21.40	1.41	45.26
15-30	40.76	19.84	20.92	1.43	44.87
30-45	38.32	18.65	19.67	1.31	38.65
45-60	33.69	17.34	16.35	1.39	34.09

3. Crop Coefficient (K_C).

The crop coefficient was calculated as follows:

$$K_C = ET_C / ET_0 \quad \ldots\ldots\ldots$$ Where

ET_C = Actual crop evapotranspiration (mm day^{-1})
ET_0 = Reference evapotranspiration (mm day^{-1}).

4. Water Use Efficiency (WUE).

The water use efficiency as kg seed m^{-3} water consumed was calculated for different treatments as described by Vites (1965) :

$$WUE, kgm^3 = Seed\ yield\ (kg\ ha^{-1}) / Seasonal\ ET_C\ (m^3 ha^{-1})$$

RESULTS AND DISCUSSION

I- Seed yield and yield components:

The results in Table 4 indicate that early sowing date (Oct. 15th) gave the highest averages of faba bean seed yield and its components in 2010/2011 and 2011/2012 seasons. Delaying sowing date from Oct 15th to Nov.1st significantly reduced number of branches plant^{-1}, number of pods plant^{-1}, seed weight plant^{-1}, 100- seed weight and seed yield ha^{-1} by 7.07, 13.89, 7.55, 14.99, 2.61 and 9.41%, respectively, in 2010/2011 season and by 7.04, 14.71, 7.69, 15.63, 2.66 and 11.70%, respectively, in 2011/2012 season. Whereas, the lowest averages of seeds yield and its components were detected from the late sowing date (Nov.15th). These results may be due to that delaying sowing date will reduce the vegetative and reproductive growth periods which in turn reduce dry matter accumulation in plant organs. These results are consistent with those found by Rabie (1991), Amer *et al.* (1992), Rajender and Singh(1993), Amer *et al.* (1997), Hatam *et el.* (1999) and Sharaan *et al.* (2004)

Regarding the effect of irrigation scheduling treatments, data in Table 4 reveal that seed yield and its components were significantly affected in both seasons. Irrigating faba bean plant at 1.1 (CPE) gave the highest averages of yield and its components, whereas irrigation at 0.7 (CPE) gave the lowest ones in both seasons. Increasing irrigation scheduling coefficient from 0.7 to 1.1 CPE significantly increased number of branches plant^{-1}, number of pods plant^{-1}, seed weight plant^{-1}, 100- seed weight and seed yield by 21.47, 33.33, 35.06, 44.10, 16.01 and 17.36%, respectively, in 2010/2011 and by 21.60, 36.11, 35.47, 44.57, 16.92 and 16.77%, in 2011/2012 season, respectively. In connection, Alderfasi and Alghamdi (2010) reported that, for high crop yield, supplying irrigation water for faba beans should not exceed more than 75 % of soil water holding capacity, under Saudi Arabia conditions. The present results may be referred to the effect of soil moisture stress (under 0.7 CPE treatment) which may be responsible for reducing photosynthesis, cell division, stem elongation, leaf area, leaf duration and dry matter accumulation in plant organs. The obtained results could be enhanced with those reported by Ibrahim (1986), Ageeb *et al.* (1989), Tawadros *et al.* (1993a &b), and Al-Naeem (2008).

Table 4: Effect of sowing date , irrigation scheduling regime and interaction on faba bean seed yield and some yield components, 2010/2011 and 2011/2012 seasons.

Sowing date	Irrigation scheduling coefficient	Seed yield (kgha^{-1})	Branches N^{o} plant^{-1}	Pods N^{o} plant^{-1}	Seed Weight plant^{-1} (g)	100-seed Weight (g)
2010/2011 season						
October, 15th	1.1	3713.51	4.3	19.3	49.1	62.5
	0.9	3331.52	3.5	16.6	39.3	57.3
	0.7	3078.05	2.9	11.7	27.8	52.3
Mean		**3374.36**	**3.6**	**15.9**	**38.7**	**57.4**
November, 1st	1.1	3352.71	3.8	17.2	42.1	61.2
	0.9	3043.31	3.1	15.5	32.8	55.8
	0.7	2774.6	2.5	11.4	23.7	50.7
Mean		**3056.87**	**3.1**	**14.7**	**32.9**	**55.9**
November, 15th	1.1	2921.93	3.5	15.8	40.9	58.2
	0.9	2613.72	2.9	14.9	31.0	53.4
	0.7	2401.29	2.3	10.7	22.3	49.6
Mean		**2645.65**	**2.9**	**13.8**	**31.4**	**53.7**
Irrigation scheduling mean						
1.1		**3329.38**	**3.9**	**17.4**	**44.0**	**60.6**
0.9		**2996.18**	**3.2**	**15.7**	**34.4**	**55.5**
0.7		**2751.31**	**2.6**	**11.3**	**24.6**	**50.9**
LSD,05						
Sowing date		37.60	0.17	0.19	1.88	0.40
Irrigation Scheduling		32.33	0.27	0.32	1.20	0.32
Interaction		55.98	0.31	0.54	2.10	0.51
2011/2012 season						
October, 15th	1.1	3447.47	4.1	19.0	48.7	61.9
	0.9	3115.66	3.5	16.3	39.2	57.0
	0.7	2821.73	2.6	11.5	27.3	50.1
Mean		**3128.29**	**3.4**	**15.6**	**38.4**	**56.3**
November, 1st	1.1	3097.24	3.6	17.0	41.8	59.4
	0.9	2759.30	2.8	15.1	32.3	55.1
	0.7	2430.69	2.3	11.2	23.1	49.9
Mean		**2762.41**	**2.9**	**14.4**	**32.4**	**54.8**
November, 15th	1.1	2730.61	3.1	15.7	39.5	57.8
	0.9	2521.65	2.7	14.4	29.8	52.9
	0.7	2358.37	2.0	10.5	21.5	48.8
Mean		**2536.88**	**2.6**	**13.5**	**30.3**	**53.2**
Irrigation scheduling mean						
1.1		**3024.11**	**3.6**	**17.2**	**43.3**	**59.7**
0.9		**2768.87**	**3.0**	**15.3**	**33.8**	**55.0**
0.7		**2516.93**	**2.3**	**11.1**	**24.0**	**49.6**
LSD,05						
Sowing date		37.21	0.42	0.63	1.62	1.15
Irrigation Scheduling		47.34	0.21	0.40	0.65	0.53
Interaction		82.02	0.22	0.65	1.15	0.92

Data in Tables 4 indicate that the seeds yield and its components were significantly affected by interaction of sowing dates and irrigation scheduling regimes. The highest averages of number of branches plant^{-1}, number of pods plant^{-1}, seed weight plant^{-1}, 100- seed weight and seed yield resulted from planting faba bean on Oct. 15th and irrigating at 1.1 CPE in both seasons. On the other hand, the lowest averages of yield and its components were resulted from planting faba bean in Nov.15th as interacted with irrigation at 0.7 CPE in both seasons of study.

2. Water relations

Seasonal evapotranspiration (ET_C) :

Results in Table 5 indicate that seasonal evapotranspiration (ET_C) of faba bean crop, as a function of sowing dates and irrigation scheduling treatments were, 81.49 and 80.09 cm in 2010 /2011 and 2011/2012 seasons, respectively. Early sowing date exhibited the highest values of faba bean ETc comprised 88.00 and 86.26 cm in the two successive seasons. Nov 1st or Nov 15th sowing dates seemed to decrease ET_C in 2010/2011 season by 6.80 and by 15.39% and by 7.49 and 13.96 % in 2011/2012 season, respectively, compared with early sowing date. The present results may be referred to the shorter crop duration under both Nov 1st and Nov 15th sowing dates, comparable with early sowing. These results are in agreement with those reported by Husain *et al.* (1988).

Regarding the effect of irrigation scheduling regimes, data in Table 5 show that irrigating faba bean at 1.1 CPE regime produced the highest values of ET_C reached 86.97 and 85.07 cm in 2010/2011 and 2011/2012 seasons, respectively. The lowest ET_C values e.g. 76.67 and 76.43 cm resulted from irrigation at 0.7 CPE in two successive seasons. Moreover, irrigation at 0.9 CPE decreased ET_C by 7.04 and 6.22 % in 2010/2011 and 2011/2012 seasons, respectively, comparable with that irrigated at 1.1 CPE. This could be attributed to increasing the available soil moisture in the root zone of faba bean plants, under irrigating at 1.1 CPE, resulted in higher ET_C values which are resulted from both higher transpiration rate from plants canopy and evaporative demands from soil surface. Under water stress i.e. irrigating at 0.9 or 0.7 CPE, the transpiration from plants may decreased as a result of poor vegetative growth and less evaporation from dry soil surface. These results are in accordance with those reported by Tawadros *et al.* (1993a), Tawadros *et al.* (1993b), Ainer *et al.* (1994), Khalil (1995) and Ashry *et al.* (2012).

Data in Table 5 indicate that early sowing date, as interacted with irrigating at 1.1 CPE, gave the highest values of ET_C which comprised 94.08 and 90.60 cm in 2010/2011 and 2011/2012 seasons, respectively. Nevertheless, the lowest ET_C values (70.54 and 70.84 cm) in the two successive seasons were obtained from the interaction between late sowing date and irrigating at 0.7 CPE.

Table 5: Effect of sowing date and scheduling irrigation regime and interaction on seasonal consumptive use of faba bean crop (ET_C, cm)

Sowing date	2010/2011			Mean	2011/2012			Mean
	Cumulated pan evaporation coefficient				Cumulated pan evaporation coefficient			
	1.1	0.9	0.7		1.1	0.9	0.7	
Oct 15th	94.08	87.30	82.61	88.00	90.60	86.70	81.48	86.26
Nov 1st	87.04	82.18	76.85	82.02	86.30	79.13	73.96	79.80
Nov 15th	79.78	73.07	70.54	74.46	78.32	73.51	70.84	74.22
Mean	86.97	80.85	76.67	81.49	85.07	79.78	75.43	80.09

Reference evapotranspiration (ET_0)

The reference ET or ET_0 (mm/day) during faba bean growing season extended from October to April in both seasons were estimated using the FAO Penman-Monteith equation and the meteorological data of Fayoum area and are recorded in Table 6. The obtained results show that the daily ET_0 rate values were high during Oct., then decreased during Nov. and Dec. months. Thereafter, the daily ET_0 values started to increase from Jan. up to March and April. These results are mainly attributed to the changes in weather factors from month to the other.

Crop coefficient (K_C)

The crop coefficient (K_C**)** reflects the crop cover percentage on ET_C and estimated by dividing ET_C over the ET_0. Data in Table 6 show the K_C values of faba bean crop under first sowing date and irrigation at 1.1 CPE, as the interaction gave the highest seeds yield . Results in Table 6 reveal that in both seasons, the K_C values were low at the initial growth stage (Oct.), then increased at Nov. as the plant cover percentage increased to reach the maximum values during Feb. (maximum plant growth, flowering and seed setting periods). The K_C values decreased again during March as plants reaching maturity and harvesting. These results are due to that at the initial growth period, the low K_C values are mainly due to high diffusive resistance of bare soil which tended to decrease as the plants become dry and transpiration decreased to lower rates. These results are in agreement with those reported by Tawadros *et al.* (1993b)

Table 6: Crop coefficient values under first sowing date and irrigation at 1.1 CPE, as the interaction resulted in the highest faba bean yield, in 2010 /2011 and 2011/2012 seasons

Month	2010/2011 season			2011/2012 season		
	ET_0 (mm)	ET_C (mm)	K_C	ET_0 (mm)	ET_C (mm)	K_C
October	3.30	1.58	0.48	3.50	1.65	0.47
November	2.30	1.50	0.65	2.20	1.39	0.63
December	2.10	1.58	0.75	2.00	1.46	0.73
January	2.80	2.41	0.86	2.90	2.44	0.84
February	4.00	3.96	0.99	4.00	3.88	0.97
March	5.70	3.76	0.66	5.70	3.71	0.65

Water Use Efficiency (WUE)

Results in Table 7 show that WUE average values, as affected by the adopted sowing date and scheduling irrigation treatments were 0.881 and 0.833 kg seeds m^{-3} water consumed in 2010/2011 and 2011/2012 seasons, respectively. The highest water use efficiency values of 0.912 and 0.862 kg seeds m^{-3} water consumed in 2010/2011 and 2011/2012 seasons, respectively, were obtained from early sowing date, whereas, the lowest ones, i.e. 0.845 and 0.813 kg seeds m^{-3} water consumed in the two successive seasons were obtained from the late sowing date e.g. Nov. 15th . These results are in the same trend with those obtained by Husain *et al.* (1988)

Regarding scheduling irrigation regimes, data in Table 7 reveal that the highest WUE values, i.e. 0.910 and 0.864 kg seeds m^{-3} water consumed in 2010/2011 and 2011/2012 seasons, respectively, were detected from irrigating faba bean plants at 1.1 CPE. On the contrary, irrigation at 0.7 CPE gave the lowest WUE values which comprised 0.853 and 0.800 kg seeds m^{-3} water consumed in the two successive seasons, respectively. These results are in agreement with those reported by Tawadros (1993b), Ainer *et al.* (1994) and Khalil (1995).

Table 7: Effect of sowing date, irrigation scheduling regime and interaction on water use efficiency for faba bean (kg seeds m^{-3} water consumed) in 2010/2011 and 2011/2012 seasons

Sowing date	2010/2011				2011/2012			
	Cumulated pan evaporation coefficient			Mean	Cumulated pan evaporation coefficient			Mean
	1.1	0.9	0.7		1.1	0.9	0.7	
Oct 15th	0.940	0.909	0.887	0.912	0.906	0.856	0.825	0.862
Nov 1st	0.917	0.882	0.860	0.886	0.855	0.830	0.782	0.822
Nov 15th	0.872	0.852	0.811	0.845	0.830	0.817	0.793	0.813
Mean	0.910	0.881	0.853	0.881	0.864	0.834	0.800	0.833

The interaction data reveal that the highest WUE figures for faba bean(0.940 and 0.906 kg seeds m^{-3} water consumed) were obtained due to early planting and irrigating at 1.1 CPE in the two seasons of study. However, on managing the limited irrigation water resources efficiently, it is advisable to irrigate the early planted faba bean crop (15th Oct.) according to 0.9 CPE coefficient to obtain reasonable figure for water use efficiency and to save irrigation water as well.

3. Aphid population:

Data in Table 8 reveal that, regardless sowing date and irrigation scheduling regime, aphid population on faba bean plants in 1st season were higher than those reported in 2nd season and such findings could be attributed to the prevailing weather elements, in 1st season, which encouraging aphid infestation. It is clear from data in Table 8 that delaying the sowing date resulted in higher aphid infestation on faba bean crop, where aphid population under 3rd sowing date were 209.7 and 292.1% higher than those under 2nd and 1st ones, respectively, in 1st season. Similar trend was

observed in 2nd season where the increases in aphid population under 3rd sowing date comprised 226.16 and 343.79% higher than those reported under 2nd and 1st ones, respectively. These results are in agreement with those obtained by Hinz and Daebele (1984), Bakhetia *et al.* (1987), El-Defrawi *et al.* (1994 and 2000) and Sucke *et al.* (2009). It is worthy to mention that the aphid infestation peak was noticed at February in the two seasons of study regardless the sowing date.

The results in Table 8 indicate that higher irrigation level resulted in higher aphid infestation rate, where aphid population with irrigating at 1.1 CPE (higher irrigation rate) were higher by 39.99 and 101.04% in 1st season and by 39.39 and 105.88% in 2nd season than those found under irrigating at 0.9 and 0.7 CPE, respectively. These results are in agreement with those obtained by Hasan *et al.* (2009) who stated that increasing wet conditions around faba bean plants led to increase the aphid infection.

3.1. Relationship of aphid population and both sowing date and irrigation scheduling regime:

Results in Table 9 show that statistical analysis proved that aphid population and the sowing dates were highly correlated in 2010/2011 and 2011/2012 seasons (r= 0.797 and 0.717, respectively). In addition, the linear regression of aphid population (Y)and sowing dates (X) relationship were $Y = -6.665 + 12.514 X$ and $Y = -8.791 + 12.446 X$ in 2010/2011 and 2011/2012 seasons, respectively.

Simple correlation of aphid population and irrigation scheduling regimes exhibited highly significant correlation in 2010/2011 and 2011/2012 seasons (r = 0.712 and 0.544). Furthermore, the linear function of aphid population (Y)and scheduling irrigation regimes (X) relationship *were* $Y = -8.758 + 29.860 X$ and $Y = -8.791 + 12.446 X$ in 2010/2011 and 2011/2012 seasons, respectively.

3.2. Aphid and yield relationship:

Data in Table 10 show the correlation coefficient of data concerning faba bean seed yield and aphid population, in 2010/2011 and 2011/2012 seasons were (r = 0.419 and 0.333, respectively). Results reveal that the increase of aphid population led to decrease in seed yield in 1st season (r^2) by 17.5 and by 11.1% in 2nd one. These results may be due to virus transmission which caused a range of symptoms, including retarded growth, stunting, distortion of leaves, stems and abort flowers, drop newly buds and plants may collapse. These results are in agreement with those obtained by Saxena and Stewart (1983), Hinz and Daebele (1984) and El-Defrawi *et al.* (1987)

The linear regression equation describes faba bean seed yield ,kg ha^{-1} (Y) and aphid population (X) were $Y = 3244.571 - 14.792 X$ and $Y = 2953.487 - 11.180 X$, in the 1st and 2nd seasons, respectively:

Table 9: Correlation coefficient (r) and linear regression parameters (Y = a + bx) for the relationships of aphid population and both sowing dates and irrigation scheduling regimes in 2010/2011 and 2011/2012 seasons

	Linear regression parameters	2010/2011	2011/2012
Sowing dates	r	0.797**	0.717**
	a	- 6.865	- 8.791
	b	12.514	12.446
irrigation Scheduling regimes	r	0.712**	0.544**
	a	- 8.758	- 9.392
	b	29.860	28.325

**** Significant at level of 0.01**

Table 10: Correlation coefficient (r) and linear regression parameters (Y = a + bx) for the relationship of faba bean seed yield (kg ha^{-1}) and aphid population in 2010/2011 and 2011/2012 seasons

	Linear Regression parameters	2010/2011	2011/2012
Aphid population	**r***	- 0.419	- 0.333
	a	3244.571	2953.487
	b	- 14.792	- 11.180

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العلاقات المائية و المحصول وتعداد المن في محصول الفول البلدي تحت مواعيد الزراعة وجدولة الري

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أقيمت تجربتان حقليتان بقرية القاسمية – مركز إطسا – محافظة الفيوم – مصر خلال موسمي الزراعة 2010 /2011 ، 2012/2011 لدراسة تأثير مواعيد الزراعة (15 أكتوبر ، الأول من نوفمبر ، 15 نوفمبر) والري عند (1,1 ، 0,9 ، 0,7 من البخر التراكمي لوعاء البخر القياسي) علي محصول الفول البلدي (هجين جيزة 843) ومكوناته وتعداد حشرة من اللوبيا وبعض العلاقات المائية للمحصول. اختبرت المعاملات في تصميم القطع المنشقة مرة واحدة في أربعة مكررات . وفيما يلي أهم النتائج المتحصل عليها:-

1- أوضحت الدراسة تفوق الزراعة في 15 أكتوبر والري عند 1,1 من بخر الوعاء التراكمي في زيادة محصول الفول البلدي (3713.51 ، 3347.47 كجم /هكتار) ومكوناته (عدد القرون بالنبات ، عدد الفروع بالنبات ، وزن بذور النبات ، وزن ال100 بذرة) في كلا الموسمين علي الترتيب بالمقارنة بجميع المعاملات الاخري تحت الدراسة.

2- وصل المتوسط العام للاستهلاك المائي الموسمي إلي (81,49 ، 80,09 سم) في موسمي الزراعة المتتابعين علي الترتيب ، وكانت أعلي قيم للاستهلاك المائي الموسمي (94,08، 90,60 سم) مع الزراعة في 15 أكتوبر والري عند 1,1 من بخر الوعاء القياسي في موسمي الزراعة المتعاقبين علي الترتيب ، وكانت أقل القيم للاستهلاك المائي الموسمي (70,54، 70,84 سم) مع الزراعة في 15 نوفمبر والري عند 0,7 من البخر التراكمي لوعاء البخر القياسي في كلا الموسمين علي الترتيب.

3- كان معامل المحصول للمعاملة التي أعطت أعلي محصول هي (0,48، 0,64، 0,74، 0,85، 0,98، 0,66) لشهور أكتوبر ، نوفمبر، ديسمبر، يناير، فبراير ، مارس علي التوالي (كمتوسط للموسمين).

4- بلغت أعلي كفاءة لاستخدام ماء الري (0,940، 0,906 كجم بذور/ م ^{3} ماء مستهلك) في موسمي 2011/2010، 2012/2011 علي الترتيب عند الزراعة في 15 أكتوبر والري عند 1,1 من البخر التراكمي لوعاء البخر القياسي.

5- معدل تعداد المن بدأ بقيم منخفضة خلال أكتوبر ثم ازداد خلال نوفمبر وديسمبر ثم عاود الانخفاض مرة أخري خلال يناير ومن ثم عاود الارتفاع مجددا خلال فبراير ليصل إلي أقصي تعداد ثم انخفض التعداد مرة أخري حتى الحصاد في خلال (مارس ، ابريل) في موسمي الزراعة المتعاقبين . وكان أعلي تعداد تم ملاحظته هو عند زراعة الفول البلدي في 15 نوفمبر والري عند 1,1 (وعاء بخر قياسي) في موسمي الزراعة المتعاقبين. كان الارتباط بين تعداد المن وموعد الزراعة عالي المعنوية في كلا الموسمين(r = 0,797 ، 0,717) في 2011/2010 ، 2012/2011 علي الترتيب وكان معادلة انحدار الخط هي Y = - 6,165 + 12,514 X موسم أول ، Y = - 8,791 + 12,446 X ، حيث Y تعداد المن ، X هو موعد الزراعة – وكان الارتباط بين تعداد المن ومعاملات جدولة الري عالية المعنوية أيضا (r = 0,712 ، 0ز544) وانحدار الخط هو Y= -8,758 + 29,86 X موسم أول ، وكان في الموسم الثاني Y = -9,382 + 28,325 X ، حيث Y هو تعداد المن ، X هو معاملات جدولة الري. كان الارتباط بين المحصول وتعداد المن معنويا (r = 0,419، 0,333).

تشير النتائج المتحصل عليها إلي أن الزراعة في منتصف أكتوبر والري عند 0,9 من وعاء البخر القياسي تؤدي إلي الحصول علي كفاءة مقبولة لاستخدام ماء الري ولتوفير مياه الري كذلك.

قام بتحكيم البحث

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J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 4 (3): 109 - 124, 2013

Table 8: Effect of sowing date and irrigation scheduling regime on monthly survey for lupine aphid in faba bean during 2010/2011 And 2011/2012 seasons.

Sowing date*	CPE Coefficient	2010/2011 season							2011/2012 season						
		October	November	December	January	February	March	April	October	November	December	January	February	March	April
S_1	1.1.	7.53	10.98	11.95	11.25	13.94	8.56	-	7.97	7.97	11.27	7.24	12.20	5.35	-
	0.9	5.87	8.75	9.50	8.33	10.66	6.21	-	6.25	6.25	7.85	4.39	8.89	3.14	-
	0.7	3.19	5.99	7.20	6.49	9.04	5.67	-	4.82	4.82	6.94	3.90	7.47	2.85	-
Mean		5.53	8.57	9.55	8.69	11.21	6.81	-	6.35	6.35	8.69	5.18	9.52	3.78	-
S_2	1.1	-	11.28	17.00	14.35	19.60	12.28	8.28	-	9.42	18.30	10.90	19.51	7.70	5.75
	0.9	-	10.27	12.60	10.20	13.20	9.33	6.61	-	7.43	12.32	8.10	12.91	6.10	4.60
	0.7	-	5.86	9.20	8.11	10.33	7.10	3.42	-	5.10	9.80	6.22	10.70	5.55	2.35
Mean		-	9.14	12.93	11.63	14.38	9.57	6.10	-	7.32	13.47	8.41	14.37	6.45	4.23
S_3	1.1	-	50.88	59.87	35.83	66.53	22.50	38.68	-	38.11	66.58	29.44	71.62	15.43	25.72
	0.9	-	32.90	39.80	26.70	44.50	17.72	26.15	-	25.90	46.66	20.10	50.51	11.89	20.30
	0.7	-	21.44	25.76	19.98	31.31	14.20	17.58	-	16.45	27.68	15.25	29.70	8.61	10.85
Mean		-	35.07	41.81	27.50	47.45	18.14	27.47	-	26.82	46.97	21.60	50.61	11.98	18.96
Irrigation scheduling regime mean															
1.1 CPE		7.53	24.38	29.61	20.48	33.36	14.45	23.48	7.97	18.50	32.05	15.86	34.44	9.49	15.74
0.9 CPE		5.87	17.31	20.63	15.08	22.79	11.09	16.38	6.25	13.19	22.28	10.86	24.10	7.04	12.45
0.7 CPE		3.19	11.10	14.05	11.53	16.89	8.99	10.5	4.82	8.79	14.81	8.46	15.96	5.67	6.60
Over all mean		5.53	17.60	21.43	15.60	24.35	11.51	16.79	6.35	13.49	23.05	11.73	24.83	7.40	11.60

*** S_1 , S_2 and S_3 are referred to Oct.15th , Nov.1st and Nov. 15th sowing dates, respectively**

J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 4 (3): 109 - 124, 2013