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EFFECT OF IRRIGATION AND POTASSIUM FERTILIZATION ON COMMON BEAN YIELD UNDER SOHAG CONDITIONS

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ABSTRACT

Field experiments were carried out during two summer seasons of 2009 and 2010 at Shandaweel Agriculture Research Station, Sohag Governorate to investigate the effect of irrigation intervals and potassium fertilization on common bean cultivar "Nebraska" under Sohag conditions. Three irrigation intervals were used i.e., (7, 14 and 21 days). Potassium fertilizers were used as five treatments i.e., (unfertilized, Spraying potacin once, twice, three times and the recommended dose of potassium sulphate 50 kg K_2O/feddan as soil dressing).

The obtained results indicated that there are significant differences among different irrigation intervals under study. The best irrigation intervals were each 14 days in most studied charactersitics.

Fertilized common bean plants with recommended dose of potassiun sulphate gave the best results in all studied charactersitcs. There are little differences between recommended dose of potassiun sulphate and spraying potacin three times (30% K_2O), consequently spraying potacin three times appears more economically to get high net return from dry seed yield.

The interaction between the two studied factors significantly affected all studied characteristics. Moreover, the highest values were achieved by the interaction between irrigation intervals each 14 days with recommended dose of potassiun soil dressing in both seasons.

Watering common bean plants every 14 days and spraying with potacin three times recorded the highest values of farmer net return (2812.0 LE) followed by potassium soil dressing as compared to all studied treatments. The farmer net return obtained by irrigation at 14 days and spraying with potacin three times exceeded fertilizing with recommended dose of potassium sulphate by 10.2%. This attractive finding means that it could be replaced spraying with potacin three times instead of the recommended dose of potassium sulphate to achieve the highest farmer net return and best water use efficiency over the two seasons.
Keywords: Potassium fertilization, phaseolus, potacin, irrigation water regime.

INTRODUCTION

Dry bean (*Phaseolus vulgaris* L.) is a human food high in protein, phosphorus, iron, vitamin B_1 and fieber with no clostoyterol. Dry bean is an imported staple food in many areas of the world.

Irrigation water is an important and could be as limiting factor for vegetables production. Nowadays, water will be the most critical resource in the Middle East including Egypt and water deficit will be a very complicated problem. The frequency and amount of irrigation depends on growth stage of the dry beans (which determines the daily crop water use), the water holding capacity of the soil in the effects root zone and the prevailing weather conditions. Water saving became a decisive factor for agriculture production.

Therefore, proper understanding of the optimal water requirements of various crops is very important for judicious use of scarce water resources. Salem *et al*., (1990) studied the effect of soil amendments, irrigation and seeding density on growth of peas and nutrients uptake, they found that the chemical composition and quality of the seeds, did not change by reducing the amount of irrigation. Haqqani and Pandey (1994) stated that mung bean suffering water stress resulted in decreased seed yield, pod number, number of seeds/pod and 1000 seeds weight. Khan *et al*., (2001) found that water use efficiency was significantly higher for Dinkum pea cultivars than for Jupiter and Dundale when it was calculated on the basis of grain yield per unit of cumulative evapotranspiration. Jackson and Miller (2003) studied the effect of three irrigation water regimes, low, moderate, and high on chickpea and pea cultivars, and they found that both pea and chickpea responded to high irrigation levels. Amir *et al*., (2005) found that reduction of the kernel weight value of peanut amounted by 12.4% was happened according to the water stress level. Sheteawi and Tawfik (2007) found that growth of mung bean were suppressed in plants of water regime 10 days drying cycle, while, the greatest yield/plant was obtained in plants of water regime 5 days drying cycle.

Plants receiving an adequate K tended to have slower transpiration rate than K-deficient plants. Moreover, water is vital for K movement from the soil to plant roots. Inadequate soil moisture may result in k-deficient plants, even though adequate K is presented in the soil (Follett *et al*., 1981). Also, large amount of K is consumed by plants and the Egyptian soils are rapidly depleted of their available K by the intensive cropping, especially after the constructed of the high dam. Therefore, the supply of K to plant roots becomes a limiting factor in maximizing yield. Potassium fertilization encourages plant roots development, so that plants could tolerate drought conditions (Mengel, 1984). Many authors studied the effect of K-fertilization on legume crops. Shehata, *et al*., (1989) found that significant increases in the yield of faba bean associated with the K-application. Potassium fertilizer influenced germination of french bean due to role in plant metabolism (Fageira *et al.,* 1991). Tantawy *et al*., (2009) studied the improved growth, production and pod quality of green bean (*Phaseolus vulgaris, L*.) using a foliar fertilizer containing phosphorus (20%), potassium (10%), boron (3%) and natural substance extracted from pollen of cabbage. Pods yield as well as pod quality parameters were also improved as the concentrations of sprayed materials increased.

The interaction between irrigation intervals and potassium fertilizers was studied by many authors. Shehata, *et al*., (1990) studied the effect of K-fertilization levels on water use efficiency and water economy for different crops. The results showed that K application had positive effect on the beneficial use of the water for different crops. Also, increases in water use efficiency and water economy was ranging between 11.4 and 230% and 10.4 and 217% relative to control. Abd El-Ati, *et al*., (2000) studied the effect of irrigation regime and potassium fertilizer on the yield and quality of cowpea under Sohag conditions. Irrigation at 24 days interval combined with 150 kg K_2O/feddan produced the highest values for most of the studied vegetative growth characters and fresh pod yield characters. Water consumptive use measurement 1266.5 and 1346.3 m^3 produced the highest cowpea yield with a maximum water use efficiency (WUE) 0.87 and 0.78 kg/m^3. Also, the highest potassium rate of 150 kg/fed. gave the highest WUE. Sheteawi and Tawfik (2007) studied the interaction effect of biogin and nitrobin biofertilizers and compost on growth, yield and metabolic products of mung bean (*Vigna radiata* L.) under different irrigation water regimes. Plants treated with biogin under water regime 10 days drying cycle yielded 145% of unfertilized control.

The present investigation was designed as an attempt to use an important physiological role of potassium fertilizer to reduce water consumptive use and enhancing water use efficiency in common bean crop under Sohag conditions.

MATERIALS AND METHODS

Two field experiments were conducted at Shandaweel Agriculture Research Station, Sohag Governorate, during the summer 2009 and 2010 seasons to study the effect of irrigation intervals and potassium fertilizer levels on common bean cultivar “Nebraska” grains used in this study.

A split plot design with three replications was used, where irrigation intervals (7, 14 and 21 days) were randomly assigned in the main plots, the five potassium fertilizers i.e., (unfertilized ‘without potassium application’, spraying potacin once, twice, three times and the recommended dose of potassium sulphate 50 kg K_2O/feddan as soil dressing) were randomly distributed in sub-plot. The experimental field was prepared and shaped to ridges 60 cm apart. Each experimental plot was 3 x 3.5 m and contained five ridges. Seed common bean cultivar were sown at the first of March in the two seasons, in hills 10 cm apart on both sides of ridges and sown one seed per hill. The irrigation treatments were started after 10 days from sowing. However, the numbers of irrigations were 12, 7 and 4 for the irrigation intervals at 7, 14 and 21 days, respectively. Potacin is a product by Ministry of Agriculture, which contains 30% K_2O. Spraying once (after 30 days from sowing), twice (after 30 and 45 days from sowing) and three times (after 30, 45 and 60 days from sowing), the recommended dose of potassium sulphate 50 kg K_2O/fed. was applied at two equal batches, the frist dose was with the frist irrigation and the second dose at the flowering stage.

The normal culture processes for commerial common bean production over than the applied treatments were practiced. The experimental soil was sandy loam and its physical and chemical characteristics were determined before sowing.

Table (1): Some soil physical and chemical properties for the experimental sites.

Seasons	Texture	$CaCO_3$%	Soil pH	Organic matter (O.M%)	Available nutrients in soil (ppm)		
					N	P	K
2009	Sandy loam	7.50	7.9	0.60	13	18	12
2010	Sandy loam	7.55	7.7	0.80	14	17	13

Table (2): Air temperature (C^o) and relative humidity% during the experimental period of 2009 and 2010 seasons at Shandaweel site.

Seasons		2009 season			2010 season		
Sampling date		Maximum Temprature, C^o	Minimum Temprature, C^o	Relative humidity%	Maximum Temprature, C^o	Minimum Temprature, C^o	Relative humidity%
March	**1**	25.14	9.09	65.29	31.14	15.43	34.71
	8	24.14	8.29	60.14	36.36	17.14	32.86
	15	23.86	8.43	63.71	23.43	10.86	23.43
	22	26.00	8.00	57.71	23.86	9.57	24.79
	29	29.57	9.29	56.14	32.86	14.86	34.86
April	**6**	31.29	11.14	51.57	33.14	14.00	35.43
	13	35.74	10.57	55.57	34.86	19.43	37.71
	20	36.14	13.71	57.86	34.29	22.14	31.43
	27	33.57	14.43	52.43	38.57	22.43	32.29
May	**5**	32.00	15.64	60.86	36.71	19.14	36.29
	12	32.79	17.93	58.86	43.71	31.14	61.29
	19	38.57	21.36	54.29	38.29	24.57	50.00
	26	34.43	20.64	61.43	32.86	18.43	37.64
June	**3**	42.00	22.50	48.00	34.00	21.43	46.29
	10	39.14	22.00	57.71	35.00	15.86	42.00
	17	37.29	23.29	54.71	36.57	18.71	46.93
	24	43.14	26.43	55.43	41.00	23.57	45.71

The following characters studied:

Vegetative characters:

1- Plant height, cm, average of measurements were taken from cotyledonary node to the top of the main stem of the randomly sampled plants per plot before harvesting.
2- Number of branches, average from counts was recorded on the randomly sampled plants per plot before harvesting.

Dry yield characteristics:

1- Pod length, cm, average of records on the randomly sampled dry pods per plot.
2- Pod diameter, cm, average pod diameter of 10 dry pods per plant.
3- Number of seeds/pod, it was determined for average of records on the randomly sampled pod per plot.
4- Pod filling% was determined according to Remison (1978) according to the following formula: Pod filling % = (No. seeds per pod / pod length, cm) x100
5- Number of pods/plant, average of 10 randomly sampled plants per plot at harvesting.

6- 100-seeds weight (g), it was calculated as an average weight (g) of 100 dry seeds/plot.
7- Dry seed yield (kg/fed.).
8- Seeds germination percentage, (number of germinating seeds / number of total seeds) x 100.
9- Economic evaluation, were calculated according to Buckett (1981).

All obtained data were subjected to the statistical analysis and treatments means were compared using the LSD test according to Snedecor and Cochran (1981).

Some water relations:

Actual water consumptive use (CU).

Actual evapotranspiration was estimated by using the soil mositure samples method and calculated according to the (Iserelsen and Hansen, 1962) using the following formula CU= D x Bd x Q2-Q1/100

Where:

CU = Actual evapotranspiration (mm).

D = Irrigation soil depth.

Bd = Bulk density of soil (g/cm^3).

Q_2 = The percentage of soil moisture two days after irrigation.

Q_1 = The percentage of soil moisture before the next irrigation.

CU (m^3/fed) = CU (mm) x 4.2

For soil moisture determination, soil samples were taken each 15 cm depth (0-15, 15-30 and 30-45) from the ground surface by a regular auger. The samples were weighed immediately and oven dried to a constant weight at 105 °C. Percentage of soil moisture at the three soil depths was calculated on oven dry weight basis.

Water use efficiency (WUE).

Water use efficiency was calculated for the different treatments according to the following formula of Vites (1965).

$$WUE = \frac{\text{Dry seeds yield (kg/fed.)}}{\text{Water consumtive use (m}^3\text{/fed.)}} = \text{kg seeds/m}^3$$

RESULTS AND DISCUSSION

Vegetative characteristics:

Data presented in Table (3) clearly show that irrigation intervals affect significantly vegetative growth characteristics expressed as plant height and number of branches/plant in both seasons. Adding irrigation water to common bean at 14 days achieved the highest values of plant height and number of branches/plant in both seasons. Meanwhile, there are no significant differences between 7 and 14 days intervals in number of branches/plant in both seasons. These results are in line with those reported by Salem *et al.,* (1990).

The results in Table (3) showed that potassium fertilizer significantly affected plant height (cm) in both seasons. The talllest plants were resulted from the application the recommended dose of potassium as soil dressing as compared to the other treatments in bothe seasons. Also, potassium fertilization significantly increased number of branches/plant as compared to unfertilized one, but, there are no significant differences among different potassium treatments in both seasons. These results may be due to the role of potassium in cell division, in addition to its role in activating protein synthesis and enzymes of carbohydrate building-up. These results are in agreement with that reported by Tantawy *et al*., (2009).

The results showed that the interaction between irrigation intervals and potassium fertilizer has a significant effect on the plant height (cm) and number of branches/plant in both season. Supplying common bean with irrigation intervals at 14 days and fertilization at potassium recommended dose gave the highest values without significant differences between irrigation every 7 days in both seasons. These results are in line with those reported by Abd El-Ati, *et al*., (2000) and Sheteawi and Tawfik (2007).

Table (3): Effect of irrigation intervals and potassium fertilization on plant height (cm) and number of branches/plant during the 2009 and 2010 seasons.

Seasons		Plant height (cm)							
		2009 season				2010 season			
Potassium fertilizer (B)		Irrigation intervals (A)			Mean	Irrigation intervals (A)			Mean
		7 days	14 days	21 days		7 days	14 days	21 days	
Unfertilized		16.87	17.03	14.73	**16.21**	16.23	16.57	14.43	**15.74**
Spraying potacin once		19.00	23.87	15.70	**19.52**	18.67	23.67	15.23	**19.19**
Spraying potacin twice		23.07	28.27	17.73	**23.02**	22.90	27.67	17.33	**22.63**
Spraying potacin three times		27.83	32.70	19.17	**26.57**	27.63	31.80	18.63	**26.02**
Potassium sulfate		34.20	35.17	25.03	**31.47**	34.50	34.87	24.10	**31.16**
Mean		**24.19**	**27.41**	**18.47**		**23.99**	**26.92**	**17.94**	
LSD 0.05	**A**		**0.91**				**1.16**		
	B		**0.63**				**0.75**		
	AB		**1.09**				**1.30**		
		Number of branches/plant							
		2009 season				**2010 season**			
Unfertilized		5.32	5.33	3.87	**4.84**	5.50	5.70	3.77	**4.99**
Spraying potacin once		5.56	5.80	5.40	**5.59**	5.63	5.78	5.30	**5.57**
Spraying potacin twice		5.77	5.80	5.73	**5.77**	5.67	5.83	5.60	**5.70**
Spraying potacin three times		5.67	5.80	5.23	**5.57**	5.60	5.90	5.10	**5.53**
Potassium sulphate		5.87	5.93	5.37	**5.72**	5.87	5.97	5.23	**5.69**
Mean		**5.64**	**5.73**	**5.12**		**5.65**	**5.84**	**5.00**	
LSD 0.05	**A**		**0.63**				**0.89**		
	B		**0.24**				**0.29**		
	AB		**0.42**				**0.50**		

Dry seed yield characteristics:

Results in Table (4) show that the differences among different studied irrigation intervals were significantly in dry pods characteristics in both seasons. 14 days irrigation intervals caused an increase in pod length, pod diametr, number of seeds/pod and pod filling%. These results are in line with those reported by Haqqani and Pandey (1994) and Amir, *et al*., (2005).

Table (4): Effect of irrigation intervals and potassium fertilization on pod length (cm), pod diameter (cm), number of seeds/pod and pod filling% during the 2009 and 2010 seasons.

Seasons	Pod length (cm)							
	2009 season				2010 season			
Potassium fertilizer (B)	Irrigation intervals (A)			Mean	Irrigation intervals (A)			Mean
	7 days	14 days	21 days		7 days	14 days	21 days	
Unfertilized	8.73	9.20	6.67	**8.20**	8.63	9.00	6.53	**8.05**
Spraying potacin once	8.90	9.50	6.73	**8.38**	8.80	9.27	6.67	**8.25**
Spraying potacin twice	9.33	9.63	7.37	**8.78**	9.27	9.40	7.20	**8.62**
Spraying potacin three times	9.75	10.20	8.53	**9.49**	9.67	10.03	8.40	**9.37**
Potassium sulfate	9.84	10.53	8.97	**9.78**	9.74	10.43	8.77	**9.65**
Mean	**9.31**	**9.81**	**7.65**		**9.22**	**9.63**	**7.51**	
LSD $_{0.05}$ A		**0.20**				**0.18**		
B		**0.18**				**0.23**		
AB		**0.34**				**0.41**		
	Pod diameter (cm)							
	2009 season				**2010 season**			
Unfertilized	1.14	1.16	0.90	**1.07**	1.09	1.25	0.88	**1.07**
Spraying potacin once	1.22	1.25	0.93	**1.13**	1.21	1.22	0.91	**1.11**
Spraying potacin twice	1.24	1.30	0.95	**1.16**	1.23	1.26	0.93	**1.14**
Spraying potacin three times	1.27	1.34	1.03	**1.21**	1.26	1.30	1.00	**1.19**
Potassium sulphate	1.32	1.37	1.07	**1.25**	1.30	1.35	1.04	**1.23**
Mean	**1.24**	**1.28**	**0.98**		**1.22**	**1.28**	**0.95**	
LSD $_{0.05}$ A		**0.04**				**0.11**		
B		**0.04**				**0.06**		
AB		**0.07**				**0.11**		
	Number of seeds/pod							
	2009 season				**2010 season**			
Unfertilized	3.24	3.34	1.67	**2.75**	3.27	3.27	1.10	**2.55**
Spraying potacin once	3.50	3.70	1.77	**2.99**	3.43	3.67	1.70	**2.93**
Spraying potacin twice	3.60	4.10	2.33	**3.34**	3.50	3.67	2.10	**3.09**
Spraying potacin three times	4.07	4.22	2.70	**3.66**	3.93	4.00	2.30	**3.41**
Potassium sulphate	4.20	4.23	3.87	**4.10**	4.10	4..26	2.63	**3.66**
Mean	**3.72**	**3.92**	**2.47**		**3.65**	**3.77**	**1.97**	
LSD $_{0.05}$ A		**0.16**				**0.35**		
B		**0.22**				**0.23**		
AB		**0.37**				**0.40**		
	Pod filling %							
	2009 season				**2010 season**			
Unfertilized	35.19	36.24	25.08	**32.17**	35.94	37.15	16.84	**29.98**
Spraying potacin once	39.35	39.96	26.27	**35.19**	39.04	40.46	25.53	**35.01**
Spraying potacin twice	38.57	40.13	31.71	**36.80**	37.80	41.13	29.17	**36.03**
Spraying potacin three times	41.24	40.20	31.67	**37.70**	40.28	40.20	27.39	**35.96**
Potassium sulphate	42.18	40.21	31.99	**38.13**	41.59	36.68	30.02	**36.10**
Mean	**39.31**	**39.35**	**29.34**		**38.93**	**39.13**	**25.79**	
LSD $_{0.05}$ A		**1.95**				**1.61**		
B		**1.67**				**2.78**		
AB		**2.89**				**1.61**		

Results in Table (4) reveal that potassium fertilizer significantly affected pod length, pod diameter, number of seeds/pod and pod filling% in both seasons. Increasing the applied K doses from once up to three times sprays gave higher values of pod length, pod diameter and number of seeds/pod than unfertilized.

Moreover, the highest values were achieved by potassium as soil dressing in both seasons. These results may be due to the role of potassium in cell division, in addition to its role in activating protein synthesis and enzymes of carbohydrate building-up. These results are in agreement with that reported by Tantawy *et al*., (2009).

Results showed that the interaction between irrigation intervals and potassium fertilizer revealed a significant effect in the pod length, pod diameter, number of seeds/pod and pod filling% in both season. Common bean plants irrigated every 14 days intervals and fertilized with potassium soil dressing gave the highest values for dry pods characteristics, except pod filling% which produced the highest values, when irrigated at 7 days intervals and fertilized with potassium soil dressing in both seasons. These results are in line with those reported by Abd El-Ati, *et al*., (2000) and Sheteawi and Tawfik (2007).

Data listed in Table (5) clearly show that prolenged irrigation intervals from 7 days up to 21 days significantly reduced the two studied charactersitcis expressed as number of pods/plant and 100-seeds weight in both seasons. The highest values were recorded by the medium irrigation intervals (14 dsys) as compared to the two other irrigation intervals in both seasons. These results are in line with those reported by Khan *et al*., (2001), Jackson and Miller (2003) and Sheteawi and Tawfik (2007).

Table (5): Effect of irrigation intervals and potassium fertilization on number of pods/plant and 100-seeds weight (g) during the 2009 and 2010 seasons.

Seasons	Number of pods/plant							
	2009 season				2010 season			
Potassium fertilizer (B)	Irrigation intervals (A) 7 days	14 days	21 days	Mean	Irrigation intervals (A) 7 days	14 days	21 days	Mean
Unfertilized	10.50	10.87	4.33	**8.57**	10.26	10.53	3.6	**8.13**
Spraying potacin once	11.93	11.93	6.03	**9.96**	11.70	11.63	5.50	**9.61**
Spraying potacin twice	14.27	14.60	6.80	**11.89**	14.07	14.27	6.47	**11.60**
Spraying potacin three times	15.73	16.50	7.80	**13.34**	15.57	16.70	7.50	**13.26**
Potassium sulphate	16.93	17.70	9.67	**14.77**	16.70	17.60	9.17	**14.49**
Mean	**13.87**	**14.32**	**6.93**		**13.66**	**14.15**	**6.45**	
LSD $_{0.05}$ A		**0.53**				**0.65**		
B		**0.38**				**0.47**		
AB		**0.65**				**0.82**		
Seasons	100-seeds weight (g)							
	2009 season				2010 season			
Unfertilized	22.93	24.70	11.17	**19.60**	23.50	24.33	10.93	**19.59**
Spraying potacin once	25.40	28.43	13.77	**22.53**	25.10	28.37	13.47	**22.31**
Spraying potacin twice	31.00	32.53	16.43	**26.65**	30.67	32.50	16.07	**26.41**
Spraying potacin three times	35.77	37.97	22.80	**32.18**	35.37	37.27	21.77	**31.47**
Potassium sulphate	45.20	47.63	29.23	**40.69**	44.77	46.80	28.67	**40.08**
Mean	**32.06**	**34.25**	**18.68**		**31.88**	**33.85**	**18.18**	
LSD $_{0.05}$ A		**0.92**				**2.21**		
B		**0.62**				**0.80**		
AB		**1.07**				**1.39**		

Application potassium fertilizer to common bean plants significantly affected number of pods/plant and 100-seeds weight charactersitcs as compared to unfertilized one in the two experimental seasons. The highest values were recorded with application as potassium soil dressing when compared to foliar spray with potacin in both seasons. These results are in agreement with those reported by Follett *et al*., 1981 and Tantawy *et al*., (2009).

The interaction between the two studied factors significantly affected number of pods/plant and 100-seeds weight charactersitcis in both seasons. However, watering common bean plants each 14 days irrigation intervals combined with potassium soil dressing produced the highest number of pods/plant and 100-seeds weight in both seasons. These results are in agreement with those reported by Abd El-Ati, *et al*., (2000) and Sheteawi and Tawfik (2007).

Data listed in Table (6) clearly show that prolenged irrigation intervals from 7 days up to 21 days significantly reduced studied dry seed yield expressed as dry seed yield (kg/fed.) and germenataion percentages in both seasons. The highest values were recorded with the medium irrigation intervals (14 days) as compared to the two other irrigation intervals in both seasons. These results are in line with those reported by Haqqani and Pandey (1994), Khan *et al*., (2001), Jackson and Miller (2003) and Sheteawi and Tawfik (2007).

Table (6): Effect of irrigation intervals and potassium fertilization on dry seed yield (kg/fed.) and seed germination% during the 2009 and 2010 seasons.

Seasons		Dry seeds yield (kg/fed.)							
		2009 season				2010 season			
Potassium fertilizer (B)		Irrigation intervals (A)			Mean	Irrigation intervals (A)			Mean
		7 days	14 days	21 days		7 days	14 days	21 days	
Unfertilized		589.3	690.7	258.7	**512.90**	546.7	683	221.3	**483.67**
Spraying potacin once		639.3	704.3	285.3	**542.97**	610.7	697.3	274.7	**527.57**
Spraying potacin twice		749.3	800.3	394.7	**648.10**	725.3	815.7	370.7	**637.23**
Spraying potacin three times		965.3	983.3	578.7	**842.43**	932.3	975.5	541.3	**816.37**
Potassium sulphate		1010.7	1024.7	718.7	**918.03**	1002.0	1015.3	706.7	**908.00**
Mean		**790.78**	**840.66**	**447.22**		**763.40**	**837.36**	**422.94**	
LSD 0.05	**A**		**59.50**				**82.03**		
	B		**36.34**				**41.56**		
	AB		**60.42**				**77.73**		
		Seed germination %							
		2009 season				**2010 season**			
Unfertilized		72.50	79.00	72.00	**74.50**	82.00	82.00	79.00	**81.00**
Spraying potacin once		77.63	82.17	72.00	**77.27**	82.00	84.00	79.17	**81.72**
Spraying potacin twice		82.17	84.81	72.00	**79.66**	84.50	86.83	80.00	**83.78**
Spraying potacin three times		85.67	87.17	72.67	**81.84**	88.83	90.67	82.50	**87.33**
Potassium sulphate		85.00	88.00	81.00	**84.67**	89.67	92.00	84.00	**88.56**
Mean		**80.59**	**84.23**	**73.93**		**85.40**	**87.10**	**80.93**	
LSD 0.05	**A**		**2.65**				**1.07**		
	B		**1.58**				**1.42**		
	AB		**2.74**				**2.46**		

Application of potassium fertilizer to common bean plants significantly affected dry seed yield as compared to unfertilized one in the two seasons. The highest values were recorded by potassium soil dressing as compared to foliar spray with potacin in both seasons. These results are in agreement with those reported by Follett *et al*., 1981 and Tantawy *et al*., (2009).

The interaction effect between the two studied factors on dry seed yield were significant in both seasons. However, irrigating common bean plants with the medium irrigation intervals 14 days combined with potassium soil dressing gave the highest values of dry seed yield in both seasons. These results are in agreement with those obtained by Abd El-Ati, *et al*., (2000) and Sheteawi and Tawfik (2007).

Some water relations:

Actual water consumptive use (CU).

Data in Table (7) pointed out that water consumptive use by common bean was increased by 423.0 and 678.9 m^3/fed. of water in case of applying irrigation at 7 days compared with that irrigated at 14 and/or 21 days, in the 1^{st} season, to corresponding to 552.8 and 612.9 m^3/fed. water, in the 2^{nd} season, respectively.

Increasing the applied K doses from once up to three times as sprays decreased water consumptive use of common bean as compared to unfertilized one in both seasons. Moreover, the lowest values of water consumptive use were achieved with application of potassium as soil dressing in both seasons. These results may be due to the fact that high concentrations of K element occur in meristematic tissues and stomatal guard cells. Potassium is also involved in turgor control in specialized cells in leaves (Anderson and Bowen 1990), which may led to a reduction in the amount of water lost to the air by transplanting from plant foliage surface. These results are in agreement with those reported by Shehata, *et al*., (1990), Abd El-Ati, *et al*., (2000) and Sheteawi and Tawfik (2007).

Water use efficiency:

Data in Table (7) indicated that water use efficiency (WUE) calculated on dry seeds yield (kg seeds/m^3) reached its maximum value when irrigation was given to common bean at 14 days, followed by that applied at 7 days. Increasing the applied K doses from once up to three times as sprays increased (WUE) of common bean as compared to unfertilized one in both seasons. Moreover, the highest values of (WUE) were achieved by application potassium as soil dressing in both seasons. These results are in line with those reported by Shehata, *et al*., (1990), Abd El-Ati, *et al*., (2000) and Sheteawi and Tawfik (2007).

Economic evaluation:

Data presented in Table (8) show that average data over the two seasons indicated that spraying potacin or fertilizing with Potassium sulphate markedly increased farmer net return as compared to unfertilized.

Watering common bean plants every 14 days and spraying with potacin three times recorded the highest values of farmer net return (2812.0 LE) followed by potassium soil dressing as compared to all studied treatments. The farmer net return obtained by irrigation at 14 days and spraying with potacin three times exceeded fertilizing with recommended dose of potassium sulphate by 10.2%. This attractive finding means that it could be replaced by spraying with potacin three times instead of the recommended dose of potassium sulphate to achieve the highest farmer net return and best water use efficiency over the two seasons. The obtained results are in line with those of Besheit *et al* (2002) and El-Shaikh et al., (2009).

Table (7): Seasonal water consumptive use (m^3/fed.) and water use efficiency on dry seed yield (kg/m^3) as affected by irrigation intervals and potassium fertilization during the 2009 and 2010 seasons.

Seasons	Water consumptive use (m^3/fed.)							
	2009 season				2010 season			
Potassium fertilizer (B)	Irrigation intervals (A) 7 days	14 days	21 days	Mean	Irrigation intervals (A) 7 days	14 days	21 days	Mean
Unfertilized	1975.2	1412.5	1275.4	**1554.4**	1994.3	1435.2	1301.5	**1577.0**
Spraying potacin once	1952.6	1405.3	1262.5	**1540.1**	1972.7	1429.2	1288.2	**1563.4**
Spraying potacin twice	1932.1	1398.2	1256.8	**1529.0**	1964.2	1412.5	1275.4	**1550.7**
Spraying potacin three times	1912.8	1385.4	1251.2	**1516.5**	1953.6	1402.1	1653.2	**1669.6**
Potassium sulphate	1910.7	1367.3	1243.2	**1507.1**	1949.2	1391.2	1251.2	**1530.5**
Mean	**1936.7**	**1393.7**	**1257.8**		**1966.8**	**1414.0**	**1353.9**	
	Water use efficiency							
	2009 season				2010 season			
Unfertilized	0.298	0.489	0.203	**0.330**	0.274	0.476	0.170	**0.307**
Spraying potacin once	0.327	0.501	0.226	**0.353**	0.310	0.488	0.213	**0.337**
Spraying potacin twice	0.388	0.572	0.314	**0.424**	0.369	0.577	0.291	**0.411**
Spraying potacin three times	0.505	0.710	0.463	**0.556**	0.477	0.696	0.327	**0.485**
Potassium sulphate	0.529	0.521	0.578	**0.538**	0.514	0.730	0.565	**0.593**
Mean	**0.408**	**0.555**	**0.356**		**0.388**	**0.592**	**0.312**	

Table (8): Economic evaluation of irrigation intervals and potassium fertilization (average of 2009 and 2010 seasons).

Irrigation intervals (A)	Potassium fertilizer (B)	Economic criteria: Yield (kg/fed)	TR	TC	NR
7 days	**Unfertilized**	568.0	2840.00	2335.0	505.0
	Spraying potacin once	625.0	3125.00	2385.0	740.0
	Spraying potacin twice	737.3	3686.50	2435.0	1251.5
	Spraying potacin three times	971.5	4857.50	2485.0	2372.5
	Potassium sulphate	1056.4	5281.75	2975.0	2306.8
14 days	**Unfertilized**	686.9	3434.25	1935.0	1499.3
	Spraying potacin once	700.8	3504.00	1985.0	1519.0
	Spraying potacin twice	808.0	4040.00	2035.0	2005.0
	Spraying potacin three times	979.4	4897.00	2085.0	2812.0
	Potassium sulphate	1020.0	5100.00	2575.0	2525.0
21 days	**Unfertilized**	240.0	1200.00	1695.0	-495.0
	Spraying potacin once	280.0	1400.00	1745.0	-345.0
	Spraying potacin twice	382.7	1913.50	1795.0	118.5
	Spraying potacin three times	560.0	2800.00	1845.0	955.0
	Potassium sulphate	712.7	3563.50	2335.0	1228.5

(TR) Total return = total yield x price.
(TC) Total Costs (LE).
(NR) Net Return = Total Return - Total Costs.

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تأثير الرى والتسميد البوتاسى على محصول الفاصوليا تحت ظروف سوهاج

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أجريت تجربتان حقليتان خلال موسمى صيف 2009 و 2010م بمحطة البحوث الزراعية بجزيرة شندويل – محافظة سوهاج لدراسة تأثير فترات الرى والتسميد البوتاسى على صنف الفاصوليا (نبراسكا) تحت ظروف محافظة سوهاج . استخدمت ثلاثة فترات رى هى (7 ، 14 ، 21 يوم) . استخدمت الأسمدة البوتاسية فى صورة خمسة معاملات هى (بدون تسميد ، الرش بالبوتاسين مرة واحدة ، مرتان ، ثلاثة مرات ، وأضيفت سلفات البوتاسيوم بالمعدل الموصى به 50 كجم (K_2O) للفدان).

النتائج المتحصل عليها :

أظهرت الدراسة أن هناك فروق معنوية بين فترات الرى المختلفة تحت الدراسة . كانت أفضل فترات الرى هى كل 14 يوم فى كل الصفات تحت الدراسة فى كلا الموسمين .

أعطى التسميد الأرضى بسلفات البوتاسيوم بالجرعة الموصى بها أعلى النتائج فى كل الصفات موضع الدراسة . توجد فروق قليلة بين التسميد الأرضى بسلفات البوتاسيوم بالجرعة الموصى بها والرش ثلاث مرات بسماد البوتاسين 30% (K_2O) وبناء عليه يمكن إستخدام معاملة الرش ثلاث مرات بسماد البوتاسين 30% (K_2O) للحصول على أكبر عائد إقتصادى من محصول البذور الجاف للفاصوليا .

يتضح من التفاعل بين الرى كل 14 يوم والتسميد البوتاسى الأرضى بالجرعة الموصى بها أنها كانت أفضل المعاملات للحصول على أكبر محصول بذور جاف من الفاصوليا فى كلا الموسمين .

رى نباتات الفاصوليا كل 14 يوم مع الرش ثلاث مرات بسماد البوتاسين 30% (K_2O) حقق أعلى صافى عائد لمزارعى الفاصوليا (2812.0 جنيه) يليه التسميد بالجرعة الموصى بها من التسميد البوتاسى الأرضى مقارنة بباقى المعاملات المدروسة. وقد تجاوز صافى العائد من الرى كل 14 يوم والرش ثلاث مرات بسماد البوتاسين 30% (K_2O) صافى العائد الناتج من الجرعة الموصى بها من سماد البوتاسيوم الأرضى بنسبة 10.2% . وهذه النتائج تعنى أنه يمكن إستبدال التسميد بالجرعة الموصى بها من التسميد البوتاسى الأرضى بالرش ثلاث مرات بسماد البوتاسين 30% (K_2O) لإحراز أعلى صافى عائد لمزارعى الفاصوليا وأفضل كفاءة إستخدام لمياه الرى فى كلا الموسمين.

قام بتحكيم البحث

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