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EFFECT OF IRRIGATION INTERVALS AND POTASSIUM FERTILIZER LEVELS ON TWO PEA CULTIVARS UNDER ENVIRONMENTAL CONDITIONS OF UPPER EGYPT

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ABSTRACT: ***The present study was carried out during the two winter seasons of 2006/2007 and 2007/2008 at Shandaweel Agriculture Research Station, Sohag Governorate, to investigate the effect of irrigation intervals and potassium fertilizer levels on two pea cultivars, i.e., Master-B and Brogress under Upper Egypt conditions. Three irrigation regimes were used at 20, 30 and 40 days intervals, while potassium fertilizer rates were added at 0, 24 and 48 kg K_2O/feddan. The results were as follows:***

- ***Increasing both irrigation intervals and potassium rates decreased the time till the first picking especially for Master-B cultivar which picked early more than Brogress cultivar.***
- ***Irrigating pea plants every 30 days combined with applying 48 kg K_2O/fed increased number of branches/plant, plant height (cm), pod length (cm), pod diameter (cm), number of pods/plant, number of seeds/pod and fresh pod yield (ton/fed).***
- ***Irrigating pea plant every 20 days interval led to more water cosumtion. Applying potassium fertilizer decreased water consumtive use (m^3) for the two cultivars during the two seasons under study.***
- ***The highest values of water use efficiency (WUE) for Master-B and Brogress cultivars were obtained under apply 48 kg K_2O/fed when the plants were irrigated every 30 days.***

Generally, it could be concluded that irrigation Brogess pea cultivar at 30 days intervals and ferlilized with 48 kg K_2O/feddan acheived the highest values for vegetative growth and fresh pod yield i.e., 5.76 and 5.75 ton/feddan of 2006/2007 and 2007/2008 seasons, respectively.

Key Words: ***Potassium fertilization, pea cultivars and water regime irrigation.***

INTRODUCTION

Irrigation is one of the important factors for pea production for both an economic and rotational perspective view. Maximizing the production of pea requires suitable cultural practices for increasing soil fertility. It was found that the main factors increasing legumes crop production are the favorable water require irrigation as will as potassium fertilization.

It that regard Shehata, *et al*., (1989) studied the effect of K-fertilization on faba bean under the conditions of the newly reclaimed calcareous soils of Maryut. Seven treatments were involved at different doses ranging from 95 to 285 kg K_2O/ha. They found that significant increases in the yield of faba bean associated with the K-application. The increase ranged between 28-54% for seeds relative to control. Salem *et al*., (1990) studied the effect of soil amendments, irrigation and seeding density on growth of peas and nutrient uptake, they found that the chemical composition and quality of the seeds, did not change by reducing the amount of irrigation. Shehata, *et al*., (1990) study the effect K-fertilization levels on water use efficiency and water economy for different crops, a long term field experiment was started in 1982 with corn as the first crop following by berseem then corn, faba bean, wheat, sorghum, berseem, potatoes, fodder cowpea and finally sugar beet in 1989. Potassium was added in the form of K_2SO_4 at the rates 0, 40, 80 and 120 kg K_2O/feddan in single and split applications. Controlled surface irrigation was applied and water requirements were calculated according to modified Penman method. The results showed that K application had positive affect on the beneficial use of the water for different crops. Also, increases in water use efficiency and water economy ranging between 11.4 and 230% and 10.4 and 217% relative to control. Zayed *et al*., (1999) studied the behavior of some pea cultivars in two locations under upper Egypt condition, they found highly significant differences between these cultivars under all studied traits. Mammoth melting sugar and Toledo sugar cvs. produced the highest pod length and pod width, as well as fresh yield of pods . Sohag location was superior comparison to Kena location in pod length and seed/pod. 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. Three irrigation regimes were used at 12, 24 and 36 days intervals. Four levels of potassium fertilization i.e., 0, 50, 100 and 150kg K_2O/fed were added in the form of K_2SO_4 (48% K_2O). 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. 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. 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. Kakar *et al*., (2002) studied the effect of different rates of NPK on morphological traits of local pea variety. The maximum plant height (46.3 cm), number of branches per plant (5.6), number of pods per plant (33.1), pod length (8.49 cm), seed per pod (6.0) and total marketable green pod yield per plot (6.02 kg) were recorded in treatment 75-120-120 kg NPK ha^{-1}. The greater water use efficiency of the semi-leafless genotype provides a potential explanation for its better yield

performance compared with other plant types. Jackson and Miller (2003) studied the effect of three irrigation water regimes, low, moderate, and high on chickpea and pea cultivars, and 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. El-Dakkak *et al*., (2005) evaluated 17 genotypes of pea under Sohag Governorate conditions, and found that Master-B cv. was characterized with 69.17 day as a maturity date, 70.05 cm stem length, 3.07 No. of branches, 9.77 cm pod length, 6.45 seeds/pod, 203.1 g green pod yield/plant, also Brogress cv. had 92.83 day as a maturity date, 95.68 cm stem length, 5.22 No. of branches, 8.87 cm pod length, 8.87 seeds/pod, 339.4 g green pod yield/plant. For these reasons, this study was conducted to examine the effects of irrigation intervals and potassium fertilization levels during 2006/2007 and 2007/2008 on pea production under sohag condition.

MATERIALS AND METHODS

The present study was carried out during the winter seasons of 2006/2007 and 2007/2008 at Shandaweel Agriculture Research Station, Sohag Governorate, Egypt. The experimental soil was sandy loam and its physical and chemical characteristics were determined before sowing. Ten random sampels from soil at depth of 45 cm were taken for analysis according to Wilde *et al*., (1985). Chemical and physical analysis of the soil are shown in Table (1).

Table (1): Soil characterization for the experimental location.

Texture	$CaCO_3$%	Soil pH	Organic matter (O.M%)	Available nutrients in soil (ppm)		
				N	P	K
Sandy loom	7.50	7.9	0.6	13	18	12

The experimental field were prepared and shaped to ridges 60 cm apart. Each experimental plot was 3x3.5 m and contained six ridges. Seed pea cultivars were sown at the first of october in the two seasons, in hills 10 cm apart on the two sides of ridges and sown two seeds per hill. The normal culture procedures for commerial pea production over than the applied treatments were followed. Three irrigation regimes were used and applied at 20, 30 and 40 days intervals. The irrigation treatments were started after 21 days from sowing.

Three rates of potassium fertilization were added i.e. 0, 24 and 48 kg K_2O/fed. were used in the from of potassium sulfate K_2SO_4 (48% K_2O). Potassium fertilizaer was added at one dose after 21 days from sowing. Brogress and Master-B pea cultivars were used in this study. The experimental design was a split split plot design with three replicates. Irrigation regimes were randomly assigned in the main plots, potassium rates

were rondomly distributed in sub-plot and cultivars were allocated in sub sub-plots.

The following characters were studied:

A- Yield and yield components:

1-Plant height, cm, average of measurements taken from cotyledonary node to the top of the main stem of the randomly sampled plants per plot.

2-Number of branches, average from counts records on the randomly sampled plants per plot.

3-Pod length, cm, average of records on the randomly sampled pods per plot at the marketable green-maturity stage.

4-Pod diameter, cm.

5-The first picking date, recorded as number of days to the marketable green pod maturity.

6-Number of pods/plant, average based on the randomly sampled plants per plot in each harvest.

7-Number of seeds/pods, it was determined for average of records on the randomly sampled pod per plot.

8-Fresh yield (ton/fed.), the sum of weight of green pods in all harvests in each plot.

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

B- Water relation:

1- Actual water consumptive use (CU).

Actual evapotranspiration was estimated by using the soil sampling method and calculated according to the technique used by the Ministry of Agriculture in Egypt,

using the following formula,

$$CU = D \times Bd \times \frac{Q_2 - Q_1}{100}$$

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 next irrigation.

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

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

2- Water use efficiency (WUE).

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

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

RESULTS AND DISCUSSION

A -Yield and yield components

1- Plant height:

Data presented in Table (2) showed clearly that increasing irrigation intervales to 30 days significantly increased this trait in both seasons. Whereas, the tallest plants were found as compared to the other two irrigation intervals in both seasons. This may be due to the fact that water and K nutrient play an active role in bulding new merestematic cells, cell elongation and increasing photosyntheses activity which lead to increasing in number of stem nodes and/or the length of internodes. These results are in agreement with that reported by Salem *et al*., (1990).

Table (2): Effect of irrigation intervals and potassium fertilization with two pea cultivars (Master-B and Brogress) on plant height (cm) during the 2006/2007 and 2007/2008 seasons.

Seasons		2006/2007 season			2007/2008 season		
Irri. (A)	Potassium (B)	Cultivars (C)		Mean	Cultivars (C)		Mean
		Master-B	Brogress		Master-B	Brogress	
20 days	0	42.67	54.00	48.33	43.00	56.00	49.50
	24	46.33	64.00	55.17	45.33	61.67	53.50
	48	48.67	60.33	54.50	45.00	61.00	53.00
Mean		45.89	59.44	52.67	44.44	59.56	52.00
30 days	0	40.67	61.67	51.17	42.33	64.67	53.50
	24	48.00	65.33	56.67	48.67	65.33	57.00
	48	49.00	67.33	58.17	48.00	65.33	56.67
Mean		45.89	64.78	55.33	46.33	65.11	55.72
40 days	0	41.33	53.67	47.50	39.00	54.33	46.67
	24	45.00	58.33	51.67	44.00	58.33	51.17
	48	47.00	57.33	52.17	45.33	58.33	51.83
Mean		44.44	56.44	50.44	42.78	57.00	49.89
B x C	0	41.56	56.44	49.00	41.44	58.33	49.89
	24	46.44	62.56	54.50	46.00	61.78	53.89
	48	48.22	61.67	54.94	46.11	61.56	53.83
Mean		45.41	60.22		44.52	60.56	
LSD	A		2.07			2.26	
	B		1.68			1.73	
	AB		2.92			2.99	
	C		1.52			1.04	
	AC		2.63			1.80	
	BC		2.63			1.80	
	ABC		4.56			3.12	

Concerning potassium fertilization, data revealed that plant height significantly influenced by potassium fertilization in both seasons. Plant height gradually increased from lowest to highest potassium rate. These results are in harmony with those mentioned by Kakar *et al*., (2002).

Pea cultivars showed significant effect on plant height in the two seasons. Brogress cultivar plants seemed to be taller than Master-B cultivar and exceeded than it by (30.5 and 24.69%) in the first and second seasons, respectively. Those results are in harmony with those mentioned by El-Dakkak *et al*., (2005).

The all possiple interactions had significant effect on plant height during both seasons. The highest plants were obtained by irrigation every 30 days interval and adding 48 kg K_2O/fed (67.33 and 65.33 cm) in 2006/2007 and 2007/2008 seasons, respectively by using Brogress cultivar.

2 Number of branches/plant :

Data illustrated in Table (3) obviously showed that irrigation intervales significantly effected the number of branches/plant in both seasons. In the first season, the differences in number of branches/plant were significant between 20 days intervals and the other two intervals, while there was no significant defference was found between 30 and 40 days intervals. In the second seasons, the significant difference was found between 20 days intervals and either of 30 and 40 days intervals. Th highest number of branches/plant was found at the second intervals during the two seasons. But, the differences were more announced and statistically approved in the second season. These results are in line with those found by Salem *et al*., (1990).

Regarding potassium fertilization, results in Table (3) indicated that potassium fertilization increased number of branches/plant in both seasons and the highest values were recorded by the highest potassium rates, but the differences failed to be significant in both seasons. This results are in line with those reported by Kakar *et al*., (2002). Pea cultivars had a significant effect on the number of branches/plant during both seasons. Brogress cultivar had more branches/plant than Master-B cultivar. The same general trend were reported by El-Dakkak *et al*., (2005).

Interactions between irrigation intervals and cultivars, also the interaction among the three studied factors affected significantly on the number of branches/plant in both seasons, however, the interacton between irrigation and potassium fertilization significantly effect this trait only in the first season. All possible combination between the three factors under study were significant. The highest values were obtained with irrigation at 30 days intervals, 48 kg K_2O/fed for Brogress cultivar in the first and second seasons.

Table (3): Effect of irrigation intervals and potassium fertilization with two pea cultivars (Master-B and Brogress) on number of branches/plant during the 2006/2007 and 2007/2008 seasons.

Seasons		2006/2007 season			2007/2008 season		
Irri. (A)	Potassium (B)	Cultivars (C)		Mean	Cultivars (C)		Mean
		Master-B	Brogress		Master-B	Brogress	
20 days	0	1.30	2.67	1.98	1.30	2.70	2.00
	24	1.20	2.53	1.87	1.30	2.50	1.90
	48	1.27	2.43	1.85	1.43	2.40	1.92
Mean		1.26	2.54	1.90	1.34	2.53	1.94
30 days	0	1.33	2.77	2.05	1.40	2.90	2.15
	24	1.33	2.80	2.07	1.40	3.00	2.20
	48	1.30	3.60	2.45	1.30	3.13	2.22
Mean		1.32	3.06	2.19	1.37	3.01	2.19
40 days	0	1.40	2.70	2.05	1.27	2.60	1.93
	24	1.43	3.17	2.30	1.30	3.03	2.17
	48	1.40	2.70	2.05	1.50	2.97	2.23
Mean		1.41	2.86	2.13	1.36	2.87	2.00
B x C	0	1.34	2.71	2.03	1.32	2.73	2.03
	24	1.32	2.83	2.08	1.33	2.84	2.09
	48	1.32	2.91	2.12	1.41	2.83	2.12
Mean		1.33	2.82		1.36	2.80	
LSD	A		0.11			0.13	
	B		NS			NS	
	AB		0.27			0.21	
	C		0.12			0.08	
	AC		0.21			0.14	
	BC		0.21			0.14	
	ABC		0.37			0.24	

3- Pod length:

Data illustrated in Table (4) revealed that irrigation at 30 days intervales significantly increased pod length as compared to other two irrigation intervales in the two experimental seasons. Salem *et al*., (1990) came to the same conclusion.

Increasing potassium rates significantly increased pod length during both seasons. Increasing in pod length (cm) by adding potassium 48 kg K_2O/fed under 30 days intervals may be due to the sutable water amount at this stage and K presention which increase the phisological and enzimatic prosses activity to produce more of pod component and increase elongation of cells. These results are at same line with those reported by Kakar *et al*., (2002).

Table (4): Effect of irrigation intervals and potassium fertilization with two pea cultivars (Master-B and Brogress) on pod length (cm) during the 2006/2007 and 2007/2008 seasons.

Seasons		2006/2007 season			2007/2008 season		
Irri. (A)	Potassium (B)	Cultivars (C)		Mean	Cultivars (C)		Mean
		Master-B	Brogress		Master-B	Brogress	
20 days	0	8.90	9.80	9.35	8.77	9.67	9.22
	24	9.17	10.00	9.58	9.10	9.87	9.48
	48	9.07	10.17	9.62	9.07	10.23	9.65
Mean		9.04	9.99	9.52	8.98	9.92	9.45
30 days	0	8.93	9.80	9.37	9.53	9.67	9.60
	24	9.97	10.40	10.18	9.97	9.90	9.93
	48	10.40	10.40	10.40	10.40	10.43	10.42
Mean		9.77	10.20	9.98	9.97	10.00	9.98
40 days	0	8.60	9.23	8.92	8.80	8.40	8.60
	24	8.73	9.53	9.13	9.50	9.23	9.37
	48	9.80	9.97	9.88	9.70	9.60	9.65
Mean		9.04	9.58	9.31	9.33	9.08	9.21
B x C	0	8.81	9.61	9.21	9.03	9.24	9.14
	24	9.29	9.98	9.63	9.52	9.67	9.59
	48	9.75	10.18	9.97	9.72	10.09	9.91
Mean		9.28	9.92		9.43	9.67	
LSD	A		0.34			0.14	
	B		0.25			0.18	
	AB		0.42			0.30	
	C		0.11			0.10	
	AC		0.20			0.18	
	BC		0.19			0.18	
	ABC		0.34			0.30	

Brogress cultivar significantly had the tollar pod length as compared with Master-B in both seasons. These results are in agreement with those reported by Zayed *et al*., (1999) and El-Dakkak *et al*., (2005).

All possible combinations had significant effect on this character in both seasons. The highest value was obtained at 30 days interval, 48 kg K_2O/fed for Brogress cultivar in the second season (10.43 cm).

4- Pod diameter:

Data illustrated in Table (5) indicated that irrigation regimes significantly increased pod diameter during the two experimental seasons. The highest values were obtained with irrigation at 30 days intervals in the first and second seasons. These results are in line with those found by Salem *et al*., (1990).

Table (5): Effect of irrigation intervals and potassium fertilization with two pea cultivars (Master-B and Brogress) on pod diameter (cm) during the 2006/2007 and 2007/2008 seasons.

Seasons		2006/2007 season			2007/2008 season		
Irri. (A)	Potassium (B)	Cultivars (C)		Mean	Cultivars (C)		Mean
		Master-B	Brogress		Master-B	Brogress	
20 days	0	1.17	1.90	1.53	1.20	1.77	1.48
	24	1.27	1.87	1.57	1.20	1.87	1.53
	48	1.27	1.83	1.55	1.30	2.00	1.65
Mean		1.23	1.87	1.55	1.23	1.88	1.56
30 days	0	1.20	1.90	1.55	1.30	1.83	1.57
	24	1.40	2.03	1.72	1.40	1.93	1.67
	48	1.57	2.17	1.87	1.60	2.20	1.90
Mean		1.39	2.03	1.71	1.43	1.99	1.71
40 days	0	1.27	1.77	1.52	1.27	1.70	1.48
	24	1.27	2.03	1.65	1.40	1.90	1.65
	48	1.43	2.10	1.77	1.40	2.07	1.73
Mean		1.32	1.97	1.64	1.36	1.89	1.62
B x C	0	1.21	1.86	1.53	1.26	1.77	1.51
	24	1.31	1.98	1.64	1.33	1.90	1.62
	48	1.42	2.03	1.73	1.43	2.09	1.76
Mean		1.32	1.96		1.34	1.92	
LSD	A		0.05			0.07	
	B		0.08			0.07	
	AB		0.13			0.11	
	C		0.05			0.05	
	AC		0.08			0.09	
	BC		0.08			0.09	
	ABC		0.14			0.16	

Pod diameter significantly increased with increasing potassium rates up to the highest rate (48 kg K_2O/fed.) in both seasons.

The studied pea cultivars showed a significant effect on pod diameter. Brogress cultivar gave the highest values in the two experimental seasons. Same trends were reported by Zayed *et al*., (1999).

Regarding interactions, data in the same Table showed that all possible had significant effect on pod diameter in the two studied seasons. The highest value was obtained at 30 days interval, 48 kg K_2O/fed for Brogress cultivar in the second season (2.20 cm).

5- The first picking date :

Data presented in Table (6) showed that increasing the irrigation intervales encurage plants to reach the first picking early. Also, increasing the rate of K fertilization had the same result under all irrigation intervals during the two seasons of planting and the differences were significant. The lowest number of days till the first picking was found under 40 days irrigation intervals combined with adding 48 kg K_2O/fed. This may be due to the fact

that under this content of water in cells and sutable or enough K, pea plants are completed to increase bulding rate of new merestematic cells, increasing photosyntheses activity and synthises of protien. These results are in agreement with that reported by Salem *et al*., (1990).

Table (6): Effect of irrigation intervals and potassium fertilization with two pea cultivars (Master-B and Brogress) on the first picking date during the 2006/2007 and 2007/2008 seasons.

Seasons		2006/2007 season			2007/2008 season		
Irri. (A)	Potassium (B)	Cultivars (C)		Mean	Cultivars (C)		Mean
		Master-B	Brogress		Master-B	Brogress	
20 days	0	71.33	90.67	81.00	70.67	89.00	79.83
	24	69.67	88.00	78.86	69.67	87.33	78.50
	48	68.67	88.33	78.50	68.33	86.33	77.33
Mean		69.89	89.00	79.44	69.56	87.56	78.56
30 days	0	70.67	89.00	79.83	67.00	86.00	76.50
	24	67.00	86.33	76.67	66.00	85.00	75.50
	48	66.67	85.33	76.00	64.67	86.67	75.67
Mean		68.11	86.89	77.50	65.89	85.89	75.89
40 days	0	65.33	84.33	74.83	65.00	83.00	74.00
	24	64.00	83.33	73.67	64.33	82.67	73.50
	48	63.67	82.00	72.83	83.67	82.67	73.17
Mean		64.33	83.22	73.78	64.33	82.78	73.56
B x C	0	69.11	88.00	78.56	67.56	86.00	76.78
	24	66.89	85.89	76.39	66.67	85.00	75.83
	48	66.33	85.22	75.78	65.56	85.22	75.39
Mean		67.44	86.37		66.59	85.41	
LSD	A		0.76			0.69	
	B		0.80			1.25	
	AB		1.39			2.16	
	C		0.64			0.91	
	AC		1.11			1.58	
	BC		1.11			1.58	
	ABC		1.92			2.73	

Master-B cultivar picked early more than Brogress cultivar, i.e, after 67.44 vs 86.37 days from sowing, respectively during the fist season and 66.59 vs 85.41 days for Master-B and Brogress cultivars, respectively during the second season. Those results are in harmony with those mentioned by El-Dakkak *et al*., (2005).

The interaction between irrigation intervals, K rates and pea cultivars were significant. The latest date from sowig till the first picking (90.67 days) was obtained wh pea plants irrigated at 20 day interval, with zero potassium and

brogress cultivar. The earliness date of piking (63.67 day) was obtained at 40 days interval, 48 kg K_2O/fed for Master-B cultivar allover the two growing seasons.

6- Number of pods/plant :

Data presented in Table (7) showed clearly that irrigation intervales significantly affected on number of pods/plant in both seasons. Whereas, the highest number of pods/plant i.e. 32.57 and 32.84 pods were obtained at 30 days irrigation intervals and the lowest values i.e. 26.76 and 26.73 pods were produced by 40 days interval in the first and second seasons, respectively. These results are in accordance with those mentioned by Salem *et al*., (1990).

Table (7): Effect of irrigation intervals and potassium fertilization with two pea cultivars (Master-B and Brogress) on number of pods/plant during the 2006/2007 and 2007/2008 seasons.

Seasons		2006/2007 season			2007/2008 season		
Irri. (A)	Potassium (B)	Cultivars (C)		Mean	Cultivars (C)		Mean
		Master-B	Brogress		Master-B	Brogress	
20 days	0	20.30	32.13	26.22	14.09	31.83	22.96
	24	25.47	35.90	30.68	23.40	34.27	28.83
	48	23.97	37.63	30.80	26.07	36.67	31.37
Mean		23.24	35.22	29.23	21.18	34.26	27.72
30 days	0	21.90	35.40	28.65	22.53	34.73	28.63
	24	28.77	40.83	34.80	29.27	39.13	34.20
	48	30.47	38.07	34.27	31.17	40.23	35.70
Mean		27.04	38.10	32.57	27.66	38.03	32.84
40 days	0	16.20	26.57	21.38	15.80	27.37	21.58
	24	23.10	33.73	28.42	23.03	33.43	28.23
	48	25.63	35.33	30.48	25.30	35.47	30.38
Mean		21.64	31.88	26.76	21.38	32.09	26.73
B x C	0	19.47	31.37	25.42	17.47	31.31	24.39
	24	25.78	36.82	31.30	25.23	35.61	30.42
	48	26.69	37.01	31.85	27.51	37.46	32.48
Mean		23.98	35.07		23.41	34.79	
LSD	A		1.89			1.65	
	B		1.11			2.04	
	AB		1.92			3.54	
	C		0.71			1.72	
	AC		1.22			2.98	
	BC		1.22			2.98	
	ABC		2.12			5.16	

Potassium fertilization significantly affected on this character in both seasons. The highest number of pods/plant i.e. 31.85 and 32.48 pod were obtained from the highest potassium rate (48 kg K_2O/fed.) in 2006/2007 and

2007/2008 seasons, respectively. Without significant differences between 48 kg K_2O/fed. and 24 kg K_2O/fed. in the two experimental seasons. These findings are in harmony with those obtained by Kakar *et al*., (2002).

Regarding pea cultivars it showed significant effect in number of pods/plant in both seasons. Brogress cultivar exceeded than Master-B cultivar by 31.6 and 32.7% during the first and second seasons, respectively. Same trend were reported by El-Dakkak *et al*., (2005).

All possible interactions had a significant effect on this character in the two studied seasons. Increasing number of pods/plant is the net result of increasing plant height and number of branches which were effected significantly by adding the same treatment (30 days intervals combined with adding 48 kg K_2O/fed).

7- Number of seeds/pod :

Data presented in Table (8) showed that irrigation intervales had a significant effect on number of seeds/pod in the first season only. The highest values of seeds/ pod were obtained when pea plants irrigated at 30 days interval as compared with the two other irrigation intervals (7.5 and 7.39 seed) in the firest and second seasons, respectively. These results are in line with those found by Salem *et al*., (1990).

Number of seeds/pod was improved significantly with increasing potassium rates in the two seasons. The improving effect of potassium fertilization on this character may be due to the role of potassium in plants as exzyme activation for water relations, energy relations, translocations of assimilates N uptake and protein and syntheses starch which led to form more seeds and consequently high seed setting percentage. Shehata, *et al*., (1989) and Kakar *et al*., (2002) came to the same conclusion.

Number of seeds/pod for Master-B cultivar were more higher than those obtained by Brogress cultivar in both seasons. The increases were amounted by 30.5 and 24.7% in the first and second seasons, respectively. These results are in accordance with those found by El-Dakkak *et al*., (2005).

All possible interactions were significant in the two studied seasons. The highest value on number of seeds/pod were obtained by Master-B cultivar as irrigated every 30 days interval and fertilized with 48 kg K2O/fed (9.67 and 8.67) for the first and second seasons, respectively.

8- Fresh pod yield (ton/fed.) :

Table (8): Effect of irrigation intervals and potassium fertilization with two pea cultivars (Master-B and Brogress) on number of seeds/pod during the 2006/2007 and 2007/2008 seasons.

Seasons		2006/2007 season			2007/2008 season		
Irri. (A)	Potassium (B)	Cultivars (C)		Mean	Cultivars (C)		Mean
		Master-B	Brogress		Master-B	Brogress	
20 days	0	7.00	4.33	5.67	7.67	5.00	6.33
	24	8.67	5.33	7.00	8.33	6.00	7.17
	48	8.33	6.33	7.33	8.63	6.67	7.65
Mean		8.00	5.33	6.67	8.21	5.89	7.05
30 days	0	7.33	5.00	6.17	7.67	5.33	6.50
	24	8.67	7.33	8.00	8.33	7.00	7.67
	48	9.67	7.00	8.33	8.67	7.33	8.00
Mean		8.56	6.44	7.50	8.22	6.56	7.39
40 days	0	7.33	4.67	6.00	7.33	5.33	6.33
	24	8.33	5.67	7.00	8.67	6.33	7.50
	48	9.00	6.00	7.50	8.67	6.67	7.67
Mean		8.22	5.44	6.83	8.22	6.11	7.17
B x C	0	7.22	4.67	5.94	7.56	5.22	6.39
	24	8.55	6.11	7.33	8.44	6.44	7.44
	48	9.00	6.44	7.72	8.67	6.89	7.77
Mean		8.26	5.74		8.22	6.19	
LSD	A		0.60			NS	
	B		0.38			0.42	
	AB		0.66			0.73	
	C		0.49			0.38	
	AC		0.85			0.66	
	BC		0.85			0.66	
	ABC		1.47			1.14	

Data in Table (9) showed that irrigation treatments significantly affected this character in both seasons. The highest values of fresh pod yield (4.72 and 4.68 ton/fed.) were obtained with irrigation at 30 days interval in the first and second seasons, respectively. The increase in fresh yield could be explained in the light of increaments in yield parameters i.e., number of pods/plant, number of seeds/pod and pod length in both seasons. These results are in line with those found by Salem *et al*., (1990) .

Fresh pod yield significantly increased with increasing potassium rates in both seasons. These results may be attributed to the importance of potassium in lowering the sensitivety to the drought stress in terms of biomass production. Potassium improved the rates of photosynthesis, the biosynthses of pea plants and translocation of carbohydrates from sorce to sink. These results are in accordance with those obtained by Kakar *et al*., (2002).

Brogress cultivar significantly produced more fresh pod yield as compared with Master-B cultivar during the two experimental seasons. Brogress cultivar surpassed Master-B cultivar by (36.1 and 36.5%) in the first and second seasons, respectively. These results may be attributed to the positive effect happend in number of pods/plant, pod length and pod diameter previously disscused. The same trends were reported by Shehata, *et al*., (1989), Zayed *et al*., (1999) and El-Dakkak *et al*., (2005).

All possible interations between irrigation intervals, potassium and cultivars had significant effect on fresh pod yield during the two seasons. The highest fresh pod yield values (5.76 and 5.75 ton/fed) were obtained by irrigating Brogress cultivar every 30 days and adding 48 kg K_2O/fed in 2006/2007 and 2007/2008 seasons, respectively.

Table (9): Effect of irrigation intervals and potassium fertilization with two pea cultivars (Master-B and Brogress) on fresh pod yield (ton/fed) during the 2006/2007 and 2007/2008 seasons.

Seasons		2006/2007 season			2007/2008 season		
Irri. (A)	Potassium (B)	Cultivars (C)		Mean	Cultivars (C)		Mean
		Master-B	Brogress		Master-B	Brogress	
20 days	0	3.06	5.22	4.14	3.27	5.23	4.25
	24	3.36	5.39	4.37	3.40	5.46	4.43
	48	3.61	5.70	4.65	3.58	5.72	4.65
Mean		3.34	5.44	4.39	3.42	5.46	4.44
30 days	0	3.40	5.44	4.42	3.43	5.37	4.40
	24	3.94	5.67	4.80	3.76	5.69	4.72
	48	4.14	5.76	4.95	4.07	5.75	4.91
Mean		3.83	5.62	4.72	3.75	5.60	4.68
40 days	0	2.39	3.94	3.17	2.67	4.48	3.58
	24	3.19	5.19	4.19	3.09	5.23	4.16
	48	3.34	5.31	4.33	3.40	5.38	4.39
Mean		2.97	4.81	3.89	3.05	5.03	4.04
B x C	0	2.95	4.87	3.91	3.12	5.03	4.07
	24	3.49	5.42	4.45	3.42	5.46	4.44
	48	3.70	5.59	4.64	3.68	5.62	4.65
Mean		3.38	5.29		3.41	5.37	
LSD	A		0.19			0.14	
	B		0.14			0.07	
	AB		0.24			0.13	
	C		0.11			0.06	
	AC		0.20			0.11	
	BC		0.20			0.11	
	ABC		0.34			0.19	

Effect of irrigation intervals, potassium fertilizer levels and pea cultivars on water relations:

1. Water consumptive use (CU):

Data presented in Table (10) showed the consumed amounts of water by the studied pea cultivars as affected by irrigation intervals regimes and potassium levels in 2006/2007 and 2007/2008 seasons.

The results showed that applying irrigation at closest irrigation intervals, every 20 days, recorded the highest seasonal water consumptive use by pea cultivars (1942.37 and 1962.56 m^3/fed) in the first and second seasons, respectively, The increases which found was by applying water every 20 days were amounted by 43.61% and 52.63% from those obtained by 30 days irrigation regime and 40 days irrigation regime, respectively in 2006/2007 season, also amounted by 44.28% and 52.09% with applying the 30 days irrigation regime and 40 days irrigation regime, respectively, in the 2007/2008 season. This result coincides with that found by Shehata, *et al*., (1990), Mohamed *et al*., (1999) and Abd El-Ati *et al*., (2000).

Table (10): Seasonal water consumptive use (m^3) as affected by irrigation intervals and potassium fertilization with two pea cultivars (Master-B and Brogress) during the 2006/2007 and 2007/2008 seasons.

Seasons		2006/2007 season			2007/2008 season		
Irri. (A)	Potassium (B)	Cultivars (C)		Mean	Cultivars (C)		Mean
		Master-B	Brogress		Master-B	Brogress	
20 days	0	1989.36	1902.07	1945.72	1994.85	1645.35	1970.10
	24	1973.18	1888.81	1930.99	1985.58	1635.65	1960.62
	48	1957.93	1942.85	1950.39	1960.30	1653.62	1656.96
Mean		1973.49	1911.24	1942.37	1980.24	1944.87	1962.56
30 days	0	1396.26	1374.39	1385.33	1410.65	1395.30	1402.98
	24	1366.65	1361.48	1364.07	1377.85	1355.65	1366.75
	48	1299.51	1316.96	1308.24	1315.20	1306.85	1311.03
Mean		1354.14	1350.94	1352.54	1367.90	1352.60	1360.25
40 days	0	1294.11	1296.91	1295.51	1310.25	1320.30	1315.28
	24	1271.10	1281.34	1276.22	1285.30	1295.36	1290.33
	48	1261.43	1230.48	1245.96	1275.55	1255.36	1365.46
Mean		1275.55	1369.58	1272.58	1290.37	1290.34	1290.36
Mean of cultivars		1534.39	1543.92		1546.17	1529.27	

Regarding the effect of the applied potassium fertilizer levels on water consumptive use by pea cultivars plants, the obtained results indicated that a gradual decrease in CU as K-level increased up to 48 kg K_2O/fed was happened in both seasons. At 40 days irrigation intervals, the highest value of CU (1295.51 m^3/fed) was obtained at the control treatment (zero K_2O level)

in the first season, being 1315.28 m^3/fed in the second season. The results pointed out that increasing the applied level from 0 to 48 kg K_2O/fed. decreased CU by 1.51% and 3.98% for 24 and 48 kg K_2O, respectively, as compared to those obtained by zero potassium level in the 1st season, corresponding to 1.93% and 3.940% for 24 and 48 kg K_2O, respectively, as compared those obtained by zero potassium level in the 2nd season. These results were in line with that found by Shehata, *et al*., (1990), and Abd El-Ati *et al*., (2000).

Concerning the differences among the tested pea cultivars in their water consumptive use, it was found that Master-B cv. recorded the highest CU (1534.39 and 1546.17 m^3/fed.) as compared with Brogress cv. which recorded the lowest CU amounted to (1543..92 and 1529.27 m^3/fed), in the first and second season, respectively. It could be suggested that the amount of water consumed by the examined varieties is probably affected by their gene make-up.

The results showed that the maximum CU (1989.36 and 1994.85 m^3/fed) were recorded by Master-B cv., without K_2O fertilization and irrigated at 20 days intervals, in the 1st and 2nd seasons, respectively.

2. Water Use Efficiency (WUE) on fresh pod yield (kg pod/m^3) :

Data presented in Table (11) showed the values of water use efficiency calculated on fresh pods yield (kg pod/m^3 water consumed) as affected by the studied irrigation regimes, potassium levels and pea cultivars during 2006/2007 and 2007/2008 seasons.

Table (11): Water use efficiency on fresh pod yield (kg pod/m^3) as affected by irrigation intervals and potassium fertilization with two pea cultivars (Master-B and Brogress) during the 2006/2007 and 2007/2008 seasons.

Seasons		2006/2007 season			2007/2008 season		
Irri. (A)	Potassium (B)	Cultivars (C)		Mean	Cultivars (C)		Mean
		Master-B	Brogress		Master-B	Brogress	
20 days	0	1.54	2.74	2.12	1.64	2.69	2.16
	24	1.70	2.86	2.26	1.71	2.82	2.26
	48	1.84	3.02	2.43	1.83	2.94	2.36
Mean		1.69	2.87	2.27	1.73	2.82	2.27
30 days	0	2.43	3.96	3.19	2.43	3.85	3.14
	24	2.88	4.33	3.61	2.73	4.37	3.55
	48	3.18	4.83	4.01	3.09	4.73	3.90
Mean		2.83	4.37	3.59	2.74	4.31	3.52
40 days	0	1.84	3.04	2.45	2.04	3.39	2.72
	24	2.51	4.05	3.28	2.40	4.04	3.22
	48	2.65	4.31	3.47	2.66	4.32	3.48
Mean		2.33	3.79	3.06	2.36	3.91	3.14
Mean of cultivars		2.28	3.68		2.27	3.68	

The results showed that the highest value of WUE (3.59 kg fresh pod yield/m^3 water) was obtained when irrigation was applied at 30 days followed by the values of 3.06 and 2.27 kg fresh pods yield /m^3 water which was recorded as irrigation was given at 40 and 20 days, respectively, in the 1st season. Similar results were obtained in the 2nd season, where, it was found that WUE values decreased gradually from 3.52 to 3.14 and 2.27 kg fresh pods yield /m^3 water when pea cultivars were watered at 30, 40 and 20 days, respectively. The reduction in WUE in the values of 20 and 40 days could be attributed to the increase in water consumptive use recorded by applying the 1st and 2nd irrigation regimes, respectively (Table 10). These results were in agreement with that obtained by Shehata, *et al*., (1990), and Abd El-Ati *et al*., (2000).

Regarding potassium effect on WUE, it was found that increasing potassium rate to pea cultivars from 0 to 48 kg K_2O/fed caused in a gradual increase in the values of WUE in the 1st and 2nd seasons. These results were in agreement with that obtained by Shehata, *et al*., (1990) and Abd El-Ati *et al*., (2000).

As for the cultivars effect, the highest value of WUE was recorded by Brogress cv. (3.68 kg fresh pod yield/m^3 water consumed) in the two seasons, In comparison to Master-B cv. which attained the lowest value of WUE (2.28 and 2.27 kg fresh pod yield/m^3 water consumed) in the 1st and 2nd season, respectively. The obtained results showed that the higher values in water consumptive use lowered the WUE and vice versa (Tables 10 and 11).

The results in Table (11) pointed out that the maximum value of WUE (4.83 and 4.73) was obtained by planting Brogress cv., irrigated at 30 days and fertilized with 48 kg K2O/fed. in the 1st season and 2nd season, respectively.

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تأثير الرى والتسميد بالبوتاسيوم على صنفين من البسلة تحت ظروف مصر العليا

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الملخص العربي

أجريت هذه الدراسة بمحطة بحوث جزيرة شندويل – محافظة سوهاج خلال موسمى شتوى ٢٠٠٦/٢٠٠٧ و ٢٠٠٧/٢٠٠٨م لدراسة تأثير الرى والتسميد البوتاسى على صنفين من البسلة (ماستر ب و بروجرس) . وقد استعملت فترات رى هى كل ٢٠ ، ٣٠ ، ٤٠ يوم وقد تمت معاملات الرى بعد رية المحاياة (٢١ يوم من الزراعة) . وكانت معاملات التسميد البوتاسى هى بدون معاملة (صفر) ، ٢٤ ، ٤٨ كجم (K_2O) للفدان من سماد سلفات البوتاسوم ٤٨% .

وقد زرعت التجربة بتصميم القطع المنشقة مرتين فى ثلاث مكررات بحيث كان الرى فى القطع الرئيسية والتسميد البوتاسى فى القطع الشقية والأصناف فى القطع الشقية مرتين .

وقد كانت أهم النتائج كالتالى :

- **زيادة فترات الرى ومعدلات التسميد البوتاسى لصنفى البسلة موضع الدراسة أدت إلى تبكير جمع محصول قرون البسلة الأخضر (الجمعة الأولى) وخاصة للصنف ماستر ب.**
- **رى نباتات البسلة كل ٣٠ يوم مع إضافة ٤٨ وحدة بوتاسيوم (K_2O) للفدان أعطت زيادة فى الصفات التالية وهى عدد فروع النبات ، طول النبات ، طول القرن ، عرض القرن ، عدد قرون النبات ، عدد بذور القرن وكذلك محصول القرون الخضراء للفدان.**
- **الرى المتقارب لنباتات البسلة (كل ٢٠ يوم) أدى إلى زيادة الإستهلاك المائى لصنفى البسلة موضع الدراسة ، بينما أدت إضافة البوتاسيوم إلى تقليل الإستهلاك المائى لهذين الصنفين .**
- **وجد أن أعلى معدل إستفادة من مياه الرى (WUE) لصنفى البسلة ماستر ب وبروجرس يتحقق مع إضافة ٤٨ كيلوجرام وحدة بوتاسيوم (K_2O) والرى كل ٣٠ يوم.**

ويمكن التوصية انه برى البسلة صنف بروجرس كل ٣٠ يوم والتسميد البوتاسى بـ ٤٨ وحدة بوتاسيوم (K_2O) من سماد سلفات البوتاسوم ٤٨% أدى للحصول على أعلى القيم للنمو ومحصول القرون الخضراء ٥.٧٦ – ٥.٧٥ طن للفدان خلال موسمى ٢٠٠٦/٢٠٠٧ – ٢٠٠٧/٢٠٠٨ .