Effect of phosphorus and potassium fertilization on green yield, seed production and quality of two okra cultivars in reclaimed soils.

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ABSTRACT

Two field experiments were carried out at the Experimental Farm, Fac. Agric., Sohag, South Valley University, Egypt during 2003 and 2004 seasons to investigate the effect of phosphorus (22.5, 30.0, 37.5 and 45 kg P_2O_5/fed) and potassium (50, 75 and 100 kg K_2O/fed) fertilizers on growth, yield and quality of two okra cultivars (El-Balady and Golden coast). The obtained results could be summarized as follow:

1- Weight of green fruits (ton/fed), weight of seeds/fruit (g), weight of 100-seeds (g) and total seeds yield (kg/fed) of El-Balady cultivar gave significantly increase as compared to Golden coast cultivar in both seasons. However, Golden coast cultivar gave higher values for plant height, protein percentage and lower values for crude fibers percentage.
2- Applying high levels i.e. (37.5 and 45 kg P_2O_5/fed) of phosphorus significantly improved the most studied characters. Also, potassium fertilizer significantly increased all studied characters. The highest values were produced by the highest potassium level i.e. (100 kg K_2O/fed) in both seasons.
3- Interactions between cultivars x phosphorus, cultivars x potassium and phosphorus x potassium were significantly improved most of the studied characters. Moreover, the interaction among El-Balady cultivar x 37.5 kg P_2O_5/fed x 100 kg K_2O/fed recorded the highest number of green fruits/plant, weight of green fruits (ton/fed), weight of 100-seeds and weight of total seed yield (kg/fed) in both seasons. The interaction among Golden coast cultivar x 37.5 kg P_2O_5/fed x 100 kg K_2O/fed gave the best results for quality characters in both seasons.

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is an important fresh vegetable crop in spring and summer for cooking, also used as dry fruits for all year round cooking. In okra it is possible to raise green and seed yield as well as the quality by improving agricultural practices especially with selecting suitable cultivars in reclaimed soil.

Okra cultivars differ significantly in their growth, yield and its components and this was assured by several researches such as **Majanbu *et***

***al* (1986); Arora *et al* (1994); Farag and Damarany (1994); Baruah (1996); Chaudhari *et al* (1997); Singh (2000) and Langaroodi and Kazerani (2000)**.

Phosphorus is an important nutrient for plant growth and economical vegetable production. Deficiency of phosphorus leads to reduce plant growth, green and seed yield. The response of okra to phosphorus fertilizer levels was studied by **Majanbu *et al* (1985); Arora *et al* (1994); and Lenka *et al* (1989).** who reported that plant height, number of fruits, fruit size and total green fruit yield were significantly improved by application of phosphorus from 0-60 kg P_2O_5/ha. **El-Maziny *et al* (1990); Naik and Srinivas (1994); Bhat and Dhar (1999)** found that fruit length, number of fruits/plant, number of seeds/fruit and 1000-seed weight recorded the highest values with the highest phosphorus rate. The same general trend was found by **Naik and Singh (1999); Amjad *et al* (2001); Chattopahyay and Sahana (2001); Patton *et al* (2002) and Singh (2002)**.

Potassium fertilization levels showed progressive and significant effect on okra growth, green and seed yield as reported by **Prabhaker *et al* (1987); Mishra and Pandey (1989); El-Maziny *et al* (1990) and Rao and Subramanian (1991)**. In particular the interactions between phosphorus and potassium have been reported by **El-Maziny *et al* (1990); Farag and Damarany (1994) and Ahmed *et al* (2000)**.

The present work aimed to investigate the response of okra cultivars to phosphorus and potassium levels as reflected on growth, green yield, seed production and quality in newly reclaimed soil under South Valley conditions.

MATERIALS AND METHODS

The present study was carried out during the summer seasons of 2003 and 2004 at the Experimental Farm, Faculty of Agriculture, Sohag, South Valley University, where the soil is newly reclaimed.

Table (1). Soil characterization of the Experimental site.

Sampling depth	E.C (1:5) dsm^{-1}	pH (H_2O) (1:2.5)	O.M %	$CaCO_3$ %	Clay %	Silt %	Sand %
0 – 25	**0.21**	**7.35**	**2.51**	**11.27**	**29.70**	**23.12**	**47.18**
25 – 45	**0.15**	**7.73**	**0.09**	**52.15**	**3.19**	**6.00**	**90.81**
45 – 65	**0.19**	**7.90**	**0.40**	**55.49**	**2.90**	**7.18**	**89.92**
65 – 80	**0.20**	**7.85**	**0.31**	**22.50**	**2.60**	**7.22**	**90.18**

Two cultivars of okra (*Abelmoschus esculentus* L. Moench) were tested i.e., El-Balady and Golden coast (obtained from Vegetable Seed Production Technology Dept., Hort. Res. Inst., Agric. Res. Center, Giza, Egypt).

Phosphorus levels:

Phosphorus fertilizer was added during soil preparation at four levels i.e. (22.5, 30.0, 37.5 and 45 kg P_2O_5/fed) in the form of triple superphosphate (37% P_2O_5).

Potassium levels :

Potassium fertilizer was added at three levels i.e. (50, 75 and 100 kg K_2O/fed) in the form of potassium sulphate (50% K_2O) each added at two doses, the first during the soil preparation and the other one with flowering and start fruit setting.

The experiment was conducted in split-split plots design with four replications. The two cultivars were arranged in the main plots, phosphorus levels were assigned in the sub-plots and potassium levels were arranged in the sub-sub plots.

Each experimental unit was 10.5 m^2 consisted of five ridges 60 cm apart and 3.5 m length (three ridges were used to determine the green yield parameter and the other two ridges for determine the dry seed yield parameter). Sowing was done in 5 and 7 April in the first and second seasons, respectively by sowing three seeds per hill at 30 cm spacing. Growing plants were thinned to one plant just before first irrigation. Normal cultural procedures known for commercial okra production other than the applied treatments were followed. Fruit harvesting was done at every three days.

Ten plants were randomly chosen in each plot to determine the flowing characters:

1- Plant height cm (at the end of harvesting).
2- Number of branches/plant (at the end of harvesting).
3- Number of green fruits /plant.

Also, **the following data were recorded:**

4- Weight of green fruit (ton/fed).
5- Weight of seeds/fruit (g). (Average 50 dry fruit from each plot).
6- Weight of 100 seeds (g).
7- Total seeds yield (kg/fed).
8- Protein percentage (were determined in okra fruit on a dry weight basis according to methods outlined by **Jakson (1967)**.

9- Percentage of crude fibers in fruits (g/100g): Crude fibers were determined in fruit on dry weight basis according to methods outlined by the **A.O.A.C (1960)**.

Statistical analysis :

All obtained data were statistically analyzed and (L.S.D) were estimated according to **Snedecor and Cochran (1980)**.

RESULTS AND DISCUSSIONS

1- Plant height (cm):

Data presented in Table (2) clearly showed that plant height was significantly affected by cultivar in both seasons. However, Golden coast cultivar gave higher plants (257.96 and 256.51 cm) than those produced by El-Balady cultivar in both seasons.

Phosphorus fertilizer significantly affected the plant height in both seasons. The tallest okra plants (231.11 and 230.74 cm) were resulted from P_4 and P_3 in the first and second seasons, respectively. These results are in accordance with those found by **Arora *et al* (1994); Naik and Srinivas (1994) and Patton *et al* (2002)**.

Table (2): Effect of phosphorus (P) and potassium (K) fertilizers on plant height (cm) of okra cultivars (cv.) during 2003 and 2004 seasons.

		Season 2003				Season 2004			
Cultivars	Levels of phosphorus	K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
El-Balady	P_1	172.17	186.20	196.47	**184.94**	172.20	179.47	192.80	**181.49**
	P_2	179.93	191.80	198.90	**190.21**	178.83	185.73	194.60	**186.39**
	P_3	194.10	198.77	207.40	**200.09**	194.77	198.07	203.60	**198.81**
	P_4	195.47	198.60	206.73	**200.27**	194.87	197.57	205.60	**199.34**
Mean		**185.42**	**193.84**	**202.38**	**193.88**	**185.17**	**190.21**	**199.15**	**191.51**
Golden coast	P_1	241.43	252.33	257.83	**250.53**	240.23	248.73	255.43	**248.13**
	P_2	249.87	257.47	265.33	**257.56**	249.73	253.97	260.40	**254.70**
	P_3	256.83	261.57	267.00	**261.80**	257.43	262.43	268.17	**262.68**
	P_4	257.80	262.70	265.33	**261.94**	257.63	259.50	264.50	**260.54**
Mean		**251.48**	**258.52**	**263.88**	**257.96**	**251.26**	**256.16**	**262.13**	**256.51**
Mean PxK	P_1	206.80	219.27	227.15	**217.74**	206.22	214.10	224.12	**214.81**
	P_2	214.90	224.63	232.12	**223.88**	214.28	219.85	227.50	**220.54**
	P_3	225.47	230.17	237.20	**230.94**	226.10	230.25	235.88	**230.74**
	P_4	226.63	230.65	236.03	**231.11**	226.25	228.53	235.05	**229.94**
Mean		**218.45**	**226.18**	**233.13**		**218.21**	**223.18**	**230.64**	

$LSD_{0.05}$		
cv.	**1.39**	**2.52**
P	**0.91**	**1.77**
cv.xP	**1.29**	**2.50**
K	**0.96**	**0.85**
cv.xK	**1.36**	**1.21**
PxK	**1.93**	**1.71**
cv.xPxK	**N.S**	**N.S**

Regarding to the effect potassium fertilization levels, data showed that plant height was significantly increased with increasing potassium levels, the highest values were produced by the highest potassium level i.e. (100 kg K_2O/fed) in both seasons. These results are in line with those found by **Mishra and Pandey (1989).**

Concerning to the effect of the interactions on plant height, data in Table (2) revealed that all possible interactions significantly increased plant height, except for the interaction among cultivars x phosphorus x potassium. These results held good in the two experimental seasons. **Ahmed *et al* (2000)** reported that the interaction between phosphorus x potassium significantly increased growth attributes.

2- Number of branches/plant :

Results presented in Table (3) showed that cultivars significantly affected this trait only in the second season.

Application of phosphorus levels to okra plants significantly increased number of branches in both seasons. The highest phosphorus level (45 kg P_2O_5/fed) exceeded the lowest one (22.5 P_2O_5/fed) by 12.6 and 16.2 % in the first and second seasons, respectively. These results are in agreement with those found by **Naik and Srinivas (1994) and Patton *et al* (2002)**.

Table (3): Effect of phosphorus (P) and potassium (K) fertilizers on number of branches per plant of okra cultivars (cv.) during 2003 and 2004 seasons.

		Season 2003				Season 2004			
Cultivars	Levels of phosphorus	K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
El-Balady	P_1	5.10	5.27	5.67	**5.34**	5.00	5.33	5.70	**5.34**
	P_2	5.33	5.63	5.90	**5.62**	5.23	5.63	5.90	**5.59**
	P_3	5.57	5.70	6.10	**5.78**	5.80	5.83	6.07	**5.90**
	P_4	5.73	6.00	6.53	**6.09**	6.17	6.37	6.60	**6.38**
Mean		**5.43**	**5.65**	**6.05**	**5.71**	**5.55**	**5.79**	**6.07**	**5.80**
Golden coast	P_1	4.67	5.47	5.83	**5.32**	4.90	5.03	5.33	**5.09**
	P_2	5.20	5.50	5.80	**5.50**	5.23	5.70	5.93	**5.62**
	P_3	5.73	6.20	6.63	**6.19**	5.80	5.97	6.07	**5.94**
	P_4	5.77	6.03	6.53	**6.11**	5.93	6.03	6.27	**6.08**
Mean		**5.34**	**5.80**	**6.20**	**5.78**	**5.47**	**5.68**	**5.90**	**5.68**
Mean PxK	P_1	4.88	5.37	5.75	**5.33**	4.95	5.18	5.52	**5.22**
	P_2	5.27	5.57	5.85	**5.56**	5.23	5.67	5.92	**5.61**
	P_3	5.65	5.95	6.37	**5.99**	5.80	5.90	6.07	**5.92**
	P_4	5.75	6.02	6.53	**6.10**	6.05	6.20	6.43	**6.23**
Mean		**5.39**	**5.73**	**6.13**		**5.51**	**5.74**	**5.98**	

$LSD_{0.05}$		
cv.	**N.S**	**0.07**
P	**0.09**	**0.11**
cv.xP	**0.13**	**0.15**
K	**0.06**	**0.05**
cv.xK	**0.09**	**N.S**
PxK	**N.S**	**0.10**
cv.xPxK	**N.S**	**N.S**

Potassium fertilization levels significantly improved this trait in both seasons. However, the highest numbers of branches were obtained when okra plants received the highest potassium level (100 kg K_2O/fed) in both seasons. This result is in harmony with those mentioned by **Mishra and Pandey (1989).**

The interaction between cultivars x phosphorus affected this trait in both seasons. Whereas, the interaction between cultivars x potassium increased the number of branches. in the first season, but the interaction between phosphorus x potassium increased the same trait in the second season. On the other hand, the interaction among the three studied factors failed to be a significant from the statistical point of view in both seasons. **Ahmed *et al* (2000)**.

3- Number of green fruits/plant:

Data presented in Table (4) indicated that the two studied cultivars did not differ significantly in number of green fruits/plant in the two experimental seasons.

Application of phosphorus fertilizer rates to okra plants increased significantly this character up to the third phosphorus rate i.e. 37.5 kg P_2O_5/feddan. While, the third and fourth phosphorus rates did not differ significantly in affecting the number of fruits/ plant in both seasons. These results may be due to the beneficial effect of phosphorus on cell division and the formation of carbohydrates as well as reducing abscission of flowers. The importance of phosphorus on number of fruits/plant in okra cultivars had been found by many investigators such as **Naik and Srinivas (1994); Naik and Singh (1999) and Chattopahyay and Sahana (2001)**.

The increase in potassium fertilizer rate up to 100 kg K_2O/fed significantly increased the number of green fruits/plant in both seasons. This result is in harmony with those mentioned by **Mishra and Pandey (1989).**

The interaction between all studied factors significantly increased green fruit/plant. However, the highest number of fruits/plant resulted from El-Balady cultivar received 37.5 kg P_2O_5/fed and 100 kg K_2O/fed in both seasons. **Ahmed *et al* (2000)**.

Table (4): Effect of phosphorus (P) and potassium (K) fertilizers on number of green fruits per plant of okra cultivars (cv.) during 2003 and 2004 seasons.

		Season 2003				Season 2004			
Cultivars	Levels of phosphorus	K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
El-Balady	P_1	18.23	22.50	24.70	**21.08**	18.40	20.40	22.90	**20.60**
	P_2	21.90	25.70	25.70	**24.40**	23.40	24.70	25.60	**24.60**
	P_3	28.80	29.90	31.03	**29.90**	28.30	28.50	30.80	**29.20**
	P_4	27.20	29.60	29.60	**28.80**	28.30	29.30	29.70	**29.10**
Mean		**24.00**	**26.90**	**27.70**	**26.30**	**24.60**	**25.70**	**27.30**	**25.90**
Golden coast	P_1	21.03	23.10	24.30	**22.80**	20.10	22.30	24.30	**22.30**
	P_2	23.70	24.90	28.30	**25.60**	22.70	25.00	27.70	**25.20**
	P_3	25.80	27.40	26.60	**26.60**	27.10	28.10	29.10	**28.10**
	P_4	27.90	28.00	28.90	**28.30**	26.90	28.20	29.10	**28.10**
Mean		**24.60**	**25.80**	**27.10**	**25.90**	**24.20**	**25.90**	**27.50**	**25.80**
Mean PxK	P_1	19.60	22.60	24.50	**22.30**	19.20	21.40	23.60	**21.40**
	P_2	22.80	25.30	27.00	**25.10**	23.10	24.90	26.70	**24.80**
	P_3	27.30	28.70	28.80	**28.20**	27.70	28.30	29.90	**28.60**
	P_4	27.60	28.80	29.20	**28.50**	27.60	28.70	29.40	**28.60**
Mean		**24.30**	**26.40**	**27.40**		**24.40**	**25.80**	**27.40**	

$LSD_{0.05}$		
cv.	**N.S**	**N.S**
P	**0.78**	**0.40**
cv.xP	**1.11**	**0.56**
K	**0.68**	**0.34**
cv.xK	**0.96**	**0.49**
PxK	**1.36**	**0.69**
cv.xPxK	**1.92**	**0.98**

4- Weight of green fruits yield (ton/fed):

Data presented in Table (5) clearly revealed that the two cultivars differed significantly regarding this character in both seasons. However, the highest weights of green fruit (6.982 and 6.968 ton/fed) were recorded by El-Balady cultivar in the first and second seasons, respectively. These results are in line with those found by **Arora *et al* (1994) and Chaudhari *et al* (1997)**.

Applied phosphorus levels to okra plants significantly increased this character in the both seasons. The highest values were produced by P_3 (37.5 kg P_2O_5/fed) and P_4 (45 kg P_2O_5/fed) in the first and second seasons, respectively. The positive effect of phosphorus on vegetative growth and number of fruits/plant previously discussed surely reflected on this character. Same general trend were found by **Naik and Srinivas (1994) and Bhat and Dhar (1999)**.

Table (5): Effect of phosphorus (P) and potassium (K) fertilizers on weight of green fruits (ton/fed) of okra cultivars (cv.) during 2003 and 2004 seasons.

		Season 2003				Season 2004			
Cultivars	Levels of phosphorus	K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
El-Balady	P_1	5.435	5.818	6.179	**5.810**	5.350	5.860	6.247	**5.819**
	P_2	5.743	6.468	6.785	**6.399**	5.867	6.460	6.867	**6.398**
	P_3	6.915	7.774	8.786	**7.825**	6.873	7.787	8.843	**7.834**
	P_4	7.259	7.688	8.730	**7.892**	7.232	7.600	8.630	**7.821**
Mean		**6.388**	**6.937**	**7.620**	**6.982**	**6.330**	**6.927**	**7.647**	**6.968**
Golden coast	P_1	5.183	5.732	5.933	**5.616**	5.160	5.667	5.953	**5.593**
	P_2	5.881	6.219	6.538	**6.213**	5.880	6.242	6.567	**6.229**
	P_3	6.231	6.483	7.466	**6.726**	6.248	6.580	7.487	**6.772**
	P_4	6.386	6.620	7.137	**6.714**	6.393	6.543	7.103	**6.680**
Mean		**5.920**	**6.263**	**6.769**	**6.317**	**5.920**	**6.258**	**6.777**	**6.319**
Mean PxK	P_1	5.309	5.775	6.056	**5.713**	5.255	5.763	6.100	**5.706**
	P_2	5.912	6.343	6.662	**6.306**	5.873	6.351	6.717	**6.314**
	P_3	6.573	7.128	8.126	**7.276**	6.561	7.183	8.165	**7.303**
	P_4	6.822	7.154	7.933	**7.303**	6.813	7.072	7.867	**7.250**
Mean		**6.154**	**6.600**	**7.194**		**6.125**	**6.592**	**7.212**	

$LSD_{0.05}$

cv.	**0.012**	**0.046**
P	**0.051**	**0.042**
cv.xP	**0.072**	**0.060**
K	**0.043**	**0.034**
cv.xK	**0.060**	**0.048**
PxK	**0.085**	**0.069**
cv.xPxK	**0.121**	**0.097**

Concerning to the effect of potassium fertilization levels, on the weight of green fruits/plant data in abovementioned Table showed that levels of potassium significantly increased this character in both seasons. Meanwhile, the highest potassium level i.e. 100 kg K_2O/fed exceeded the lowest level i.e. 50 kg K_2O/fed by 14.5 and 15.1% in the first and second seasons, respectively. These results may be due to the positive effect of potassium in improving the biosynthesis of okra plants and translocation of the photosynthetic assimilates carbohydrates from vegetative parts to fruits. **Mishra and Pandey (1989)** came to the same results.

Regarding to the effect of different studied interactions, the results indicated that most possible interactions significantly affected this character in the two experimental seasons. The obtained results could be explained in the light of the increments induced in number of green fruits per plant previously mentioned. These results are in agreement with those reported by **Ahmed *et al* (2000)**.

5- Weight of seeds/fruit (g):

Results listed in Table (6) showed that the tested okra cultivars influenced significantly the weight of seeds/fruit in the two seasons. However, cultivar El-Balady gave higher values than Golden coast cultivar in both seasons. Similar trends were found by **Baruah (1996) and Singh (2000)**.

Table (6): Effect of phosphorus (P) and potassium (K) fertilizers on weight of seeds per fruit of okra cultivars (cv.) during 2003 and 2004 seasons.

		Season 2003				Season 2004			
Cultivars	Levels of phosphorus	K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
El-Balady	P_1	4.73	5.90	6.36	**5.66**	4.80	5.10	6.20	**5.35**
	P_2	5.26	5.60	5.80	**5.56**	5.43	5.50	5.76	**5.56**
	P_3	5.73	5.53	6.66	**5.97**	5.66	5.90	6.60	**6.05**
	P_4	6.23	6.16	6.70	**6.36**	6.00	6.56	6.86	**6.46**
Mean		**5.49**	**5.80**	**6.38**	**5.90**	**5.47**	**5.75**	**6.35**	**5.90**
Golden coast	P_1	4.83	5.90	6.20	**5.66**	4.60	4.90	5.33	**4.94**
	P_2	4.80	5.33	5.73	**5.28**	4.90	5.16	5.80	**5.28**
	P_3	5.00	5.10	5.80	**5.31**	5.26	6.06	6.46	**5.93**
	P_4	5.73	5.33	5.63	**5.56**	5.26	5.66	6.23	**5.72**
Mean		**5.09**	**5.43**	**5.85**	**5.50**	**5.00**	**5.45**	**5.95**	**5.50**
Mean PxK	P_1	4.78	5.91	6.30	**5.66**	4.70	4.48	5.76	**5.15**
	P_2	5.03	5.48	5.76	**5.42**	5.16	5.33	5.78	**5.42**
	P_3	5.36	5.33	6.23	**5.64**	5.46	5.89	6.53	**5.99**
	P_4	5.98	5.75	6.16	**5.96**	5.63	6.11	6.55	**6.10**
Mean		**5.29**	**5.62**	**6.11**		**5.24**	**5.60**	**6.15**	

$LSD_{0.05}$		
cv.	**0.21**	**0.44**
P	**0.292**	**0.139**
cv.xP	**0.413**	**0.196**
K	**0.253**	**0.120**
cv.xK	**0.358**	**0.170**
PxK	**0.56**	**0.240**
cv.xPxK	**0.716**	**0.340**

Application different phosphorus levels to okra plants increased significantly weight of seeds/plant in the two experimental seasons. The highest values were recorded by the highest phosphorus level i.e. (45 kg P_2O_5/fed) in both seasons. These results are in agreement with those reported by **Naik and Srinivas (1994); Bhat and Dhar (1999) and Amjad *et al* (2001)**.

With regard to the effect of potassium fertilization rates on weight of seeds/fruit, data in Table (6) clearly revealed that this character was increased significantly with increasing potassium fertilizer rates up to the highest rate i.e. (100 kg K_2O/fed) in both seasons. These results are in agreement with those obtained by **Mishra and Pandey (1989).**

Results shown in the same Table indicated that all possible interactions between all studied factors increased this character significantly in both seasons. However, the highest values were (6.70 and 6.86 g) produced by El-Balady cultivar, when fertilized with (45 kg/P_2O_5/fed and 100 kg/K_2O) in both seasons. These results are in line with those obtained by **Ahmed *et al* (2000)**.

6- Weight of 100-seeds (g):

Weight of 100-seeds is an important component of seed yield of okra. The data presented in Table (7) clearly revealed that cultivars significantly affected this character in both seasons. However, El-Balady cultivar

produced the highest values in both seasons. These results are in confirmed by **Arora *et al* (1994) and Baruah (1996)**.

Application of phosphorus levels to okra plants significantly increased weight of 100-seeds in the both seasons. However, the highest values (7.85 and 7.89 g) were achieved by P_4 (45 kg P_2O_5/fed) in the first and second seasons, respectively. These results are in line with those obtained by **Naik and Srinivas (1994) and Bhat and Dhar (1999)**.

Data presented in Table (7) cleared that increasing potassium levels significantly increased weight of 100-seeds. The highest values were recorded by the highest potassium level i.e. 100 kg K_2O/fed in both seasons. The improving effect of potassium may be attributed to its effect on enhancing the uptake of nutrients and the nutritional status of the plants. These results are in accordance with those found by **Mishra and Pandey (1989) and Rao and Subramanian (1991)**.

All studied interactions significantly increased this character in both seasons. While, the highest values (9.34 and 9.42 g) were resulted from combination among El-Balady cultivar x 37.5 P_2O_5/fed x 100 kg K_2O/fed in the first and second seasons, respectively.

Table (7): Effect of phosphorus (P) and potassium (K) fertilizers on weight of 100-seeds (g) of okra cultivars (cv.) during 2003 and 2004 seasons.

		Season 2003				Season 2004			
Cultivars	**Levels of phosphorus**	**K_1**	**K_2**	**K_3**	**Mean**	**K_1**	**K_2**	**K_3**	**Mean**
El-Balady	**P_1**	5.65	6.81	7.32	**6.59**	5.70	6.88	7.40	**6.66**
	P_2	6.37	6.79	7.51	**6.89**	6.46	6.89	7.48	**6.94**
	P_3	7.64	8.79	9.34	**8.59**	7.76	8.82	9.42	**8.66**
	P_4	7.80	8.20	8.47	**8.15**	7.93	8.30	8.50	**8.24**
Mean		**6.86**	**7.65**	**8.16**	**7.56**	**6.96**	**7.72**	**8.20**	**7.63**
Golden coast	**P_1**	5.59	6.15	6.96	**6.24**	5.55	6.19	6.88	**6.21**
	P_2	5.96	6.73	9.97	**6.55**	6.00	6.70	6.98	**6.56**
	P_3	6.55	6.95	7.53	**7.01**	6.53	6.97	7.50	**7.00**
	P_4	7.15	7.57	7.91	**7.55**	7.15	7.53	7.90	**7.53**
Mean		**6.31**	**6.85**	**7.34**	**6.84**	**6.31**	**6.85**	**7.32**	**6.82**
Mean PxK	**P_1**	5.62	6.48	7.14	**6.41**	5.63	6.54	7.14	**6.44**
	P_2	6.17	6.76	7.24	**6.72**	6.23	6.79	7.23	**6.75**
	P_3	7.09	7.87	8.44	**7.80**	7.14	7.90	8.46	**7.83**
	P_4	7.46	7.89	8.19	**7.85**	7.54	7.92	8.20	**7.89**
Mean		**6.59**	**7.25**	**7.75**		**6.64**	**7.29**	**7.76**	

$LSD_{0.05}$

cv.	**0.120**	**0.090**
P	**0.059**	**0.053**
cv.xP	**0.083**	**0.074**
K	**0.055**	**0.039**
cv.xK	**0.078**	**0.055**
PxK	**0.110**	**0.079**
cv.xPxK	**0.156**	**0.111**

7- Total seed yield (kg/fed):

Data presented in Table (8) showed that the type of okra cultivars significantly affected total seed yield kg/fed. However, the highest values (705.64 and 702.68 kg/fed were produced by El-Balady cultivar as

compared to Golden coast cultivar in the first and second seasons, respectively. Similar trends was found by **Singh (2000)**.

Results in Table (8) indicated that increasing phosphorus fertilizer up to 37.5 kg P_2O_5/fed significantly increased total seed yield in both seasons. These results may be due to the beneficial effect of phosphorus on encouraging cell division, cell enlargement, the formation and movement of carbohydrates **Marschner (1995).** Also, the increments induced in weight of seeds per fruit and weight of 100-seeds previously mentioned surely reflected on total seed yield. **Majanbu *et al* (1985); Lenka *et al* (1989) and Naik and Singh (1999)** came to the same general conclusion.

Levels of Potassium fertilization significantly increased total seed yield in the two experimental seasons. However, the highest potassium level 100 kg K_2O/fed surpassed the lowest level 50 kg K_2O/fed by 15.2 and 14.8 % in the first and second seasons, respectively. These results are in agreement with those obtained by **Mishra and Pandey (1989).**

Considerable influences were detected owing to all studied combinations treatments among the three studied factors during the two experimental seasons on total seed yield (kg/fed). The highest values were produced when okra plants of El-Balady cultivar were fertilized with 37.5 kg P_2O_5/fed and 100 kg K_2O/fed in both seasons. Similar general trend was found by **Ahmed *et al* (2000)**.

Table (8): Effect of phosphorus (P) and potassium (K) fertilizers on weight of total seed yield (kg/fed) of okra cultivars (cv.) during 2003 and 2004 seasons.

		Season 2003				Season 2004			
Cultivars	Levels of phosphorus	K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
El-Balady	P_1	548.93	610.87	670.17	**609.99**	550.07	603.60	649.47	**601.04**
	P_2	594.73	688.97	731.23	**671.64**	592.70	684.93	729.83	**669.16**
	P_3	692.50	761.10	894.60	**782.73**	695.97	762.63	895.93	**784.84**
	P_4	720.97	759.17	794.50	**758.21**	716.73	757.80	792.47	**755.67**
Mean		**639.28**	**705.03**	**772.63**	**705.14**	**638.87**	**702.24**	**766.93**	**702.68**
Golden coast	P_1	510.47	550.30	597.53	**552.77**	517.80	561.43	596.10	**558.44**
	P_2	584.57	627.67	673.07	**628.43**	575.93	625.03	677.93	**626.30**
	P_3	647.30	690.37	751.63	**696.43**	653.10	690.00	750.90	**698.00**
	P_4	671.17	708.53	746.40	**708.70**	671.83	697.30	748.87	**706.00**
Mean		**603.38**	**644.22**	**692.16**	**646.58**	**604.67**	**643.44**	**693.45**	**647.19**
Mean PxK	P_1	529.70	580.58	633.85	**581.38**	533.93	582.52	622.78	**577.74**
	P_2	589.65	658.32	702.15	**650.04**	584.32	654.98	703.88	**647.73**
	P_3	669.90	725.73	823.12	**739.58**	674.53	726.32	823.42	**741.42**
	P_4	696.07	733.85	770.45	**733.46**	694.28	727.55	770.67	**730.83**
Mean		**621.33**	**674.62**	**732.39**		**621.77**	**672.84**	**730.18**	

$LSD_{0.05}$

cv.	**16.55**	**3.79**
P	**7.72**	**5.11**
cv.xP	**10.92**	**7.23**
K	**5.29**	**4.82**
cv.xK	**7.48**	**6.81**
PxK	**10.57**	**9.64**
cv.xPxK	**14.95**	**13.63**

8- Protein percentage:

Data listed in Table (9) showed that protein percentage was significantly affected by type of cultivars in the two seasons. Cultivar Golden coast surpassed cultivar El-Balady by 17.6 and 21.9 % in the first and second seasons, respectively. The same general conclusion were reported by **Farag and Damarany (1994)**.

Application of phosphorus levels significantly increased this trait in both seasons. However, the highest protein percentage values (20.22 and 20.25%) were recorded by P_3 i.e. 37.5 kg P_2O_5/fed in the first and second seasons, respectively. **El-Maziny *et al* (1990) and Farag and Damarany (1994)** came to the same result.

Protein percentage was gradually increased due to increasing the rate of potassium fertilizer. The highest potassium rate K_3 i.e. 100 kg K_2O/fed exceeded this trait by (9.1 and 8.4 %) as compared by the lowest potassium rate K_1 i.e 50 kg/K_2O/fed in the first and second seasons, respectively. These findings confirmed with those found by **El-Maziny *et al* (1990)** and **Farag and damarany (1994)**.

Table (9): Effect of phosphorus (P) and potassium (K) fertilizers on protein percentage of okra cultivars (cv.) during 2003 and 2004 seasons.

		Season 2003				Season 2004			
Cultivars	Levels of phosphorus	K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
El-Balady	P_1	14.97	15.47	15.83	**15.42**	15.00	15.50	15.87	**15.46**
	P_2	15.57	15.93	16.77	**16.09**	15.67	16.03	16.83	**16.18**
	P_3	16.73	17.53	18.80	**17.69**	16.67	17.80	18.57	**17.68**
	P_4	16.77	17.57	18.73	**17.69**	16.70	17.70	18.50	**17.63**
Mean		**16.01**	**16.63**	**17.53**	**16.72**	**16.01**	**16.76**	**17.44**	**16.79**
Golden coast	P_1	16.30	16.87	17.83	**17.00**	17.00	17.07	18.03	**17.37**
	P_2	17.67	18.83	19.87	**18.79**	17.70	18.73	20.00	**18.81**
	P_3	21.43	22.83	23.97	**22.74**	21.80	22.80	23.87	**22.82**
	P_4	21.77	22.50	23.47	**22.58**	21.73	22.63	23.53	**22.63**
Mean		**19.29**	**20.26**	**21.28**	**20.28**	**19.56**	**20.31**	**21.36**	**20.41**
Mean PxK	P_1	15.63	16.17	16.83	**16.21**	16.00	16.28	16.95	**16.41**
	P_2	16.62	17.38	18.32	**17.44**	16.68	17.38	18.42	**17.49**
	P_3	19.08	20.18	21.38	**20.22**	19.23	20.30	21.22	**20.25**
	P_4	19.27	20.03	21.10	**20.13**	19.22	20.17	21.02	**20.13**
Mean		**17.65**	**18.44**	**19.41**		**17.78**	**18.53**	**19.40**	

$LSD_{0.05}$		
cv.	**0.580**	**0.180**
P	**0.124**	**0.145**
cv.xP	**0.105**	**0.098**
K	**0.175**	**0.205**
cv.xK	**0.149**	**0.139**
PxK	**0.210**	**0.197**
cv.xPxK	**0.297**	**0.278**

Regarding to effect of interactions, data in Table (9) revealed that the studied interactions i.e. (cv.×P, cv.× K, P×K and cv.× P×K) increased protein percentage significantly in both seasons. Moreover, the

combination between cultivar Golden coast and phosphorus or potassium recorded higher values as compared with El-Balady cultivar combined with the two studied factors in both seasons. The highest protein percentage (23.97 and 23.87%) were achieved by the combination among the cultivar Golden coast x 37.5 kg P_2O_5/fed x 100 kg K_2O/fed in the first and second seasons, respectively.

9- Percentage of crude fibers:

Data collected in Table (10) clearly revealed that the tested two cultivars significantly differed regarding this trait in both seasons. However, Golden coast cultivar achieved values lower than El-Balady cultivar by (31.8 and 47.8%) in the first and second seasons, respectively. These results are in accordance with those found by **Farag and Damarany (1994)**.

Regarding to phosphorus fertilizer, data in Table (10) revealed that phosphorus levels significantly reduced percentage of crude fibers in the two experimental seasons. The lowest values (10.22 and 10.28%) were recorded by P_3 treatment (37.5 kg P_2O_5/fed). While, P_3 did not differ significantly with P_4 in both seasons. These results are in harmony with those reported by **Farag and Damarany (1994)** who found that percentage of crude fiber significantly decreased as NPK level increased and the higher NPK level gave the lowest percentage of crude fiber, while the control gave the highest record.

Table (10): Effect of phosphorus (P) and potassium (K) fertilizers on percentage of crude fibers of okra cultivars (cv.) during 2003 and 2004 seasons.

		Season 2003				Season 2004			
Cultivars	Levels of phosphorus	K_1	K_2	K_3	Mean	K_1	K_2	K_3	Mean
El-Balady	P_1	17.90	17.17	15.47	**16.84**	18.10	16.23	15.53	**16.86**
	P_2	16.33	15.27	13.20	**14.93**	15.90	15.13	13.40	**14.81**
	P_3	13.50	12.20	11.20	**12.30**	13.60	12.53	11.40	**12.51**
	P_4	13.47	12.33	11.20	**12.33**	13.53	12.53	11.27	**12.44**
Mean		**15.30**	**14.24**	**12.77**	**14.10**	**15.28**	**14.28**	**12.90**	**14.16**
Golden coast	P_1	13.23	12.07	11.00	**12.10**	13.07	12.10	11.17	**12.11**
	P_2	10.77	10.00	9.27	**10.01**	10.77	9.97	9.30	**10.01**
	P_3	9.33	8.13	6.97	**8.14**	9.17	7.97	7.00	**8.04**
	P_4	9.33	8.13	7.13	**8.20**	9.20	8.20	7.10	**8.17**
Mean		**10.67**	**9.58**	**8.59**	**9.61**	**10.55**	**9.56**	**8.64**	**9.58**
Mean PxK	P_1	15.57	14.62	13.23	**14.47**	15.58	14.52	13.35	**14.48**
	P_2	13.55	12.63	11.23	**12.47**	13.33	12.55	11.35	**12.41**
	P_3	11.42	10.17	9.08	**10.22**	11.38	10.25	9.20	**10.28**
	P_4	11.40	10.23	9.17	**10.27**	11.37	10.37	9.18	**10.31**
Mean		**12.98**	**11.91**	**10.68**		**12.92**	**11.92**	**10.77**	

$LSD_{0.05}$		
cv.	**0.640**	**0.350**
P	**0.201**	**0.223**
cv.xP	**0.109**	**0.125**
K	**0.285**	**N.S**
cv.xK	**0.155**	**0.176**
PxK	**N.S**	**N.S**
cv.xPxK	**0.310**	**N.S**

Potassium fertilizer levels significantly reduced % of protein in both seasons. Whereas, The lowest values were produced by the highest level of potassium i.e. 100 kg K_2O/fed in both seasons. Similar trend was found by **Farag and damarany (1994)**.

The interaction between cultivars and phosphorus significantly affected percentage of crude fibers only in the first season. However, the lowest percentage of crude fibers resulted from the Golden coast cultivar received 100 kg K_2O/fed in both seasons. The combination between phosphorus x potassium reduced this trait in both seasons. But, the differences were not significant. The combination between the three studied factors did not significantly affect this trait in the second season.

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الملخص العربي

تأثير التسميد بالفوسفور والبوتاسيوم على المحصول الأخضر وإنتاج البذور والجودة لصنفين من الباميا فى الأراضى المستصلحة

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أجريت تجربتان حقليتان فى المزرعة التجريبية لكلية الزراعة بسوهاج ـ جامعة جنوب الوادى خلال موسمى 2003 ، 2004م وذلك لدراسة تأثير التسميد بالفوسفور بمعدل (22.5 ، 30 ، 37.5 و 45 كجم P_2O_5) والتسميد بالبوتاسيوم بمعدل (50 ، 75 و100 كجم K_2O /فدان) على النمو والمحصول الأخضر والبذرى وصفات الجودة فى صنفين من الباميا (البلدى وجولدن كوست) . ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى :

1- أعطى الصنف البلدى زيادة معنوية لصفات وزن القرون الخضراء (طن/فدان) ووزن بذور القرن (جم) ووزن 100 بذرة (جم) والوزن الكلى للبذور (كجم/فدان) وذلك مقارنة بالصنف جولدن كوست خلال موسمى الدراسة . فى حين أن الصنف جولدن كوست أعطى أعلى القيم بالنسبة لصفتى إرتفاع النبات ونسبة البروتين وأقل القيم لصفة نسبة الألياف الخام .

2- إضافة المستويات العالية من الفوسفور (37.5 و45 كجم P_2O_5) حسنت معظم الصفات تحت الدراسة معنوياً. وأيضاً السماد البوتاسى أعطى زيادة معنوية لكل الصفات تحت الدراسة . أعلى القيم تم الحصول عليها من أعلى مستوى للبوتاسيوم فى خلال موسمى الدراسة .

3- التفاعل بين الأصناف × الفوسفور ، الأصناف × البوتاسيوم و الفوسفور × البوتاسيوم حسنت معنوياً معظم الصفات تحت الدراسة . علاوة على ذلك سجل التفاعل بين الصنف البلدى × 37.5 كجم P_2O_5 × 100 كجم K_2O أعلى القيم لصفات عدد القرون الخضراء للنبات ، وزن القرون الخضراء بالطن/فدان ، وزن 100 بذرة والوزن الكلى للبذور فى خلال موسمى الدراسة . فى حين أن التفاعل بين صنف الباميا جولدن كوست × 37.5 كجم P_2O_5 × 100 كجم K_2O أعطت أعلى نسبة بروتين وأقل نسبة ألياف خلال موسمى الدراسة .