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EFFECT OF BIO AND MINERAL PHOSPHATE FERTILIZERS ON GROWTH AND PRODUCTIVITY OF CITRON (*Citrullas colocynthis*).

El-Shabraway, R.A.

Vegetables Res. Dept., Hort. Res. Inst., Agric. Res. Center, Egypt.

ABSTRACT

Two field trails were carried out during two successive summer seasons of 1998 and 1999 at the Farm of El-Gemmeiza Agricultural Research Station to study the response of citron plants to biofertilizer (Phosphorien) at 3 kg/fed and mineral-P fertilizer at 0, 15, 30, 45 and 60 kg P_2O_5 / fed. in addition to their interaction on growth, yield and its components, fruit traits and chemical constituents in plant leaves.

In general, the obtained results can be summarized as follows:-

1. Application of P-biofertilizer (Phosphorien) exerts significant increases in most studied characteristics of plant growth, yield, fruit traits and increased N, P and K concentrations in leaves compared with those of untreated plants.
2. All studied characteristics of plants received mineral-P were generally better than those of unfertilized ones. The highest values were obtained by using 30 kg P_2O_5/fed.
3. The interaction between phosphorien and phosphorus levels had significant effects on all studied characteristics.

In general, treating citron seeds with phosphorien at 3 kg /fed in addition to 30 kg P_2O_5/fed gave the maximum yield.

INTRODUCTION

In Egypt, there has been an increase in the cultivated areas with citron (*Citrullus colocynthis*), it is a good for the new reclaimed desert lands, tolerant to drought and salinity. Moreover, the economic importance of citron has recently increased because its production exceeds the domestic consumption and hence the country became able to export large quantities of citron to the Arab countries. There is no much research has been done on the phosphorus fertilizer application on citron.

Phosphorus is one of the major fertilizer elements required for good production of seeds (seeds are marketable yield of citron).

In Egypt, immobilization of phosphorus is the important problem of phosphate fertilization due to soil alkalinity. Phosphorus of the applied fertilizers could be converted to unavailable form for plant absorption (Abdel-Hafez, 1966, Abdel-Nasser and Makawi, 1979; El-Dahtory *et al*., 1989). Furthermore, from the economical point of view, the high prices of such fertilizers may increase the production costs of the agricultural crops.

Therefore, the use of biofertilizers (untraditional fertilizers) is of a particular interest to avoid the previously mentioned problems. In addition, microorganisms are also involved in the availability of soil immobilized-phosphorus. Sundara Rao *et al*. (1963); El-Dahtory *et al*. (1989) and Abdel-Ati *et al*. (1996) reported that many soil bacteria and actiomycetes were found to have the ability to dissolve soil complex inorganic and organic phosphate.

Several workers indicated that utilization of P-biofertilizer (Phosphorien) with mineral-P markedly increased the available-P concentrations the soil and

plants and improved plant growth and yield (El-Awag *et al*., 1993; Abo El-Nour *et al*., 1986; El-Sheekh, 1997; Ashour, 1998; Abdel-Rahman, 2000 and Ouda, 2000).

On the other hand, many investigators reported that plant growth, yield and chemical constituents in foliage and fruit tissues of different cucurbits were dependent on the applied P-rate to plants (Damarany and Farag, 1994; Ahmed, 1997 and Abd El-Rahman, 2000).

The objective of this work was to study the effects of different mineral-P levels (0, 15, 30, 45 and 60 kg P_2O_5/fed) and P-biofertilizer (Phosphorien), in addition to their interaction on plant growth and productivity of citron plants under conditions of El-Gharbiya Governorate.

MATERIALS AND METHODS

Two field experiments were carried out at Gemmeiza Experimental Station, Gharbiya Governorate during the successive summer season of 1998 and 1999, to investigate the influence of different mineral-P levels either alone or in combination with P-biofertilizer (Phosphorien) on plant growth, yield and its components and chemical composition of citron (*Citrullus colocynthis*) (new strains of citron was obtained from cross pollinated Veget. Crops Dept., Doki, Giza).

The experimental soil was analyzed by using standard method described by Jackson, 1967. The obtained data were tabulated in Table 1.

Table 1. Data of physical and chemical analysis of experimental soil during 1998 and 1999 seasons.

Measurements	1998	1999
Physical properties:		
Silt	24.73	24.88
Sand	23.5	23.1
Clay	50.5	50.13
Soil type	Clay	Clay
Chemical properties:		
pH	8.3	8.5
EC / 25° (mmhos/cm)	1.4	1.6
Organic matter (%)	1.8	1.5
Available nitrogen (ppm)	32	30
Available phosphorus (ppm)	8.8	8.0
Available potassium (ppm)	420	360

A split plot design with ten treatments and three replications was used. The treatment consisted of fine mineral-P levels, i.e., 0, 15, 30, 45 and 60 kg P_2O_5 / fed. in the form calcium superphosphate (15.5 P_2O_5) either alone or with P-biofertilizer (Phosphorien at 3 kg/fed, Phosphorien is a commercial locally produced by the Ministry of Agric., Egypt. It contains active bacteria, which is capable to convert tri-calcium phosphate to mono-calcium phosphate). Phosphorien inoculum were randomly distributed to treated and untreated treatments, which mixed with seeds directly, while sub-plots were assigned to phosphorus levels. The sub-plot area was 30 m^2 (4 ridges, each 5 m long and 1.5 m width).

The planting date was during the first week of April in both seasons of this study. The seeds were sown on one side of ridge at 50 cm between hills. Only one plant was left in each hill. All plants were fertilized with 60 kg N + 48 kg K_2O/fed at two equal doses after 30 and 50 days from planting. Normal

cultural practices for citron commercial production were used as recommended by Ministry of Agric.

Studied characteristics:

1. Vegetative growth parameters: At 60 days after planting, a random samples (3 plants) were taken from each treatment to determine plant length (m), fresh and dry weight / plant (gm) and number of both
2. Yield components and fruit quality: Weight of 100 seeds, weight of fruit seeds, weight of seeds / fed (kg), number of fruits / plant and length and diameter of fruits (cm) were studied.
3. Chemical constituents: N, P and K (%) in plant leaves were determined according to the method described by Black (1965), John (1970) and Brown and Lilleland (1946), respectively.

The obtained data from this study were statistically analyzed and treatment means were compared by using least significant differences (LSD) as reported by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

a. Vegetative growth:

Results in Table (2) show a significant increase in all vegetative growth characteristics, i.e. plant fresh and dry weight, main stem length and number of leaves and branches in the two seasons of study as a result of treating seeds of citron with phosphorien compared with those untreated. The increase in vegetative growth may be due to active bacteria in phosphorien, which is capable to convert tri-calcium phosphate to mono-calcium phosphate (Hauka *et al*., 1990 and Sherief *et al*., 1997),

Concerning the effect of phosphorus fertilization levels, data in Table (2) reveal that all vegetative growth parameters were significantly increased by phosphorus fertilizers compared with unfertilized one. The highest values were obtained in plants which received 30 kg P_2O_5/fed. The pronounced superior of P at 30 kg P_2O_5/fed than P at other higher rates may be lead to suggestion that 30 kg P_2O_5/fed alone with the soil P content (Table 1) might be sufficient for growth requirement, added to that raising P level up to 60 kg P_2O_5/fed could not significantly increased P content of plant tissues (Table 5). Meanwhile, such promotional effect of 30 kg P_2O_5/fed could be due to that the same treatment significantly increased the uptake and content of N and K (Table 5). These elements known to be in tight relation with growth and development of plants.

The positive effect of phosphorus may be due to the role of phosphorus in photosynthesis and respiration in addition to its role in cell division and development of merestematic tissues (Mengel and Kirkby, 1982). Similar results were obtained by Ahmed (1997).

With respect to the effect of the interaction treatments, data in Table (2) reveal also that mean values of all studied characteristics of plant vegetative growth were generally significant increased by using phosphorien with mineral-P fertilizer than mineral-P alone. The highest values were obtained by 30 kg P_2O_5/fed with phosphorien application, The values were higher than those attained by 45 and 60 kg P_2O_5/fed. These results propose that phosphorien application may be increased number and activity of soil microorganisms and P-solubilizing bacteria in particular consequently exert

increases in the available P and hence plant growth (El-Awag *et al*., 1993). Similar results were obtained by Abo El-Nour *et al*. (1996), who reported that inoculation of faba bean seeds with phosphorien enhanced plant growth when combined with 50% of recommended mineral-P dose as compared with treatments without phosphorien.

b. Yield and its components:

Data presented in Table (3) revealed that treated citron seeds with phosphorien resulted in significant increase in number of fruits / plant, weight of 100 seeds (gm), weight of seeds in fruit (gm) and yield (kg seed/fed) in the two seasons of study compared with untreated seeds. These results are in agreement with those of Abd El-Rahman (2000) and Abdel-Ati *et al*. (1998), who indicated that the increase in yield may be due to the role of phosphate biofertilizer in availability of phosphorus soil immobilization.

With respect to the effect of phosphorus levels, data in the same table show that number of fruits / plant, weight of 100 seeds (gm), weight of seeds in fruit (gm) and yield (kg seed/fed) were significantly increased by increasing phosphorus level up to 30 kg P_2O_5/fed. The lowest values were obtained from plants were untreated (0 level) in both seasons. Meanwhile, the level of 30 kg P_2O_5/fed gave significantly highest yield and yield components compared with other levels (0, 15, 45 and 60 kg P_2O_5/fed). Similar results were obtained by Ahmed (1997) on squash and Abd El-Rahman (2000) on cantaloupe.

The pronounced superior effect of 30 kg P_2O_5/fed on yield of citron plants could be expected herein, since the same applied P level significantly improved growth and dry accumulation (Table 2) and N, P and K content (Tables). All these constituents and traits would be directly or indirectly involved in such yield superiority.

In addition, as numerous metabolic processes directly or indirectly depend on energy supply (ATP), inadequate P nutrition may be affect various processes including protein synthesis and the synthesis of nucleic acid.The interaction between phosphorien and phosphorus levels had significant effect on yield and its components in both seasons. The maximum yield was noticed when citron seeds were treated with phosphorien under the rate of 30 kg P_2O_5/fed. Whereas, the lowest values were obtained as a result of untreated seeds and without phosphorus application. Similar results were obtained by Abo El-Nour *et al*. (1996) on faba bean, Sherif *et al*., (1997) on lentil, Ashour (1998) on potato and Abd El-Rahman (2000) on cantaloupe.

c. Fruit traits:

From Table (4), it is evident that all traits, i.e, fruit weight (gm), fruit diameter (cm) and fruit length (cm) were generally significantly increased with phosphorien inoculum application comparing with those of untreated ones. Apparently, it is known that P-solubilizing bacteria might enhance improved fruit traits. The obtained results are in accordance with those of Abdel-Rahman (2000), who mentioned that phosphorien application increased fruit weight of cantaloupe.

Table 4. Fruit traits of citron as affected by P-biofertilizer (Phosphorien), different P-mineral levels and their interaction during 1998 and 1999 seasons.

Characters	Fruit weight (gm)		Fruit diameter (cm)		Fruit length (cm)	
Treatments	**1998**	**1999**	**1998**	**1999**	**1998**	**1999**
Phosphorien (a):						
Witout	622.0	617.5	10.10	9.27	12.20	11.53
With	712.0	702.6	11.77	10.93	12.93	12.33
LSD at 5%	11.5	9.2	0.52	0.38	NS	NS
P_2O_5 levels (b): kg/fed.						
0	573.7	565.7	9.67	9.00	11.67	10.92
15	680.8	672.5	10.75	10.83	13.17	12.58
30	725.7	719.7	12.17	11.33	14.00	13.17
45	683.3	676.3	11.08	10.00	12.50	12.00
60	673.0	666.2	11.00	10.08	11.50	11.00
LSD at 5%	14.7	17.1	0.88	0.82	9,56	1.09
Interaction (axb):						
Without Phosphorien						
P_2O_5 kg/fed.						
0	536.7	531.3	8.83	8.17	11.33	10.33
15	636.7	628.3	10.00	9.500	13.00	12.17
30	679.7	676.0	11.00	10.00	14.00	13.00
45	635.0	630.3	10.17	9.33	12.00	11.83
60	625.0	621.7	10.50	9.33	10.67	10.33
With Phosphorein						
0	610.7	600.0	10.50	9.83	12.00	11.50
15	725.0	716.7	11.50	10.67	13.33	13.00
30	771.7	763.3	19.30	12.67	14.00	13.33
45	731.7	722.3	12.00	10.67	13.00	12.17
60	721.0	710.7	11.50	10.83	12.33	11.67
LSD at 5%	20.7	24.1	1.24	1.15	0.79	1.54

With respect to the effect of phosphorus levels, data in Table (4) showed that all traits of citron fruits were generally greater with than without mineral P application. The highest values were obtained from plants fertilized with 30 kg P_2O_5/fed. Similar results were obtained by Ahmed (1997) on squash, who reported that fruit trait (average fruit weight and fruit dimensions) of squash were increased by using 15 kg P/fed.

As regard to the interaction effect of P-biofertilizer (phosphorien) with mineral-P on fruit traits, data presented in Table (4) revealed that fruit weight (gm) and fruit diameter and length were significantly increased in both seasons by application of phosphorien with 30 kg P_2O_5/fed. The positive effect of interaction treatments on fruit traits might be due to the double effect of phosphorien and mineral-P together on photosynthesis and translocation rate of photosynthates from plant foliage to fruits. The obtained results are in agreement with those of Ashour (1998) and Abd El-Rahman (2000).

d. N, P and K percentage:

Data in Table (5) revealed that application of phosphorien caused a significant increase in percentage of N, P and K in both seasons of study. Similar results were obtained by Abdel-Ati *et al*. (1996).

Table 5. Chemical constituents in plant leaves of citron as affected by P-biofertilizer (Phosphorien), different P-mineral levels and their interaction during 1998 and 1999 seasons.

Characters	N (%)		P (%)		K (%)	
Treatments	**1998**	**1999**	**1998**	**1999**	**1998**	**1999**
Phosphorien (a):						
Witout	2.73	2.87	0.539	0.519	5.33	5.81
With	3.66	4.08	0.594	0.555	6.45	6.45
LSD at 5%	0.07	0.08	0.036	0.016	0.39	0.06
P_2O_5 levels (b): kg/fed.						
0	2.84	3.03	0.393	0.358	5.86	5.99
15	2.98	3.19	0.533	0.467	6.26	6.27
30	3.68	4.36	0.668	0.582	6.303	6.29
45	3.35	3.57	0.605	0.650	5.54	6.05
60	3.13	3.20	0.633	0.630	5.48	6.05
LSD at 5%	0.06	0.06	0.010	0.026	0.267	0.132
Interaction (axb):						
Without Phosphorien						
P_2O_5 kg/fed.						
0	2.40	2.57	0.337	0.303	5.49	5.85
15	2.48	2.70	0.523	0.483	5.88	5.92
30	3.16	3.467	0.657	0.600	5.88	5.89
45	2.80	2.87	0.557	0623	4.79	5.60
60	2.82	2.70	0.623	0.587	4.60	5.79
With Phosphorein						
0	2.28	3.49	0.450	0.413	6.23	6.13
15	3.47	3.68	0.543	0.450	6.65	6.62
30	4.21	5.25	0.680	0.563	6.72	6.70
45	3.90	4.27	0.653	0.677	6.28	6.50
60	3.45	3.70	0.643	0.673	6.37	6.30
LSD at 5%	0.84	0.09	0.014	0.037	0.38	0.19

With respect to the effect of phosphorus levels, data in the same table show that N, P and K in leaves of citron increased by mineral-P application compared with untreated treatment. The highest values were obtained by using 30 kg P_2O_5/fed in both seasons. Similar results were obtained by Ahmed (1997) on squash. These results may be due to the effect of phosphorus on plant growth and consequently to the efficiency of the root absorbing various nutrients.

The interaction between phosphorien and phosphorus levels had significant effect on the percentage of N, P and K in plant leaves of citron in the two seasons of study. The highest values were obtained by using phosphorien and 30 kg P_2O_5/fed. Similar results were obtained by Ashour (1998) and Abd El-Rahman (2000).

The results in this investigation indicated that treating citron seeds pre-sowing with phosphorien at 3 kg/fed with using 30 kg P_2O_5/fed is recommended for improving plant growth and yield. Therefore, phosphorien application reduced production cost and environmental pollution.

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تأثير التسميد الفوسفاتى الحيوى (الفوسفورين) والمعدنى إلى نمو وإنتاجية بطيخ اللب (الجورمة)٠

رضا عبد الخالق الشبراوى

قسم بحوث الخضر - معهد بحوث البساتين - مركز البحوث الزراعية - الجيزة - مصر

أجريت تجربتان حقليتان فى محطة البحوث الزراعية بالجميزة - محافظة الغربية على محصول البطيخ الجورمة (سلالة جديدة تم الحصول عليها من قسم بحوث الخضر خلطية التلفيح - الدقى - جيزه) أثناء موسمى الزراعة الصيفى ١٩٩٨ ، ١٩٩٩ لدراسة تأثير السماد الحيوى (فوسفورين) وخمس مستويات مختلفة من الفوسفور (صفر ، ١٥ ، ٣٠ ، ٤٥ ، ٦٠ كجم فو٢أ٥ ، بالإضافة للتفاعل بينهما على نمو ومحصول بطيخ الجورمة وأيضا على تركيز عناصر النيتروجين والفسفور والبوتاسيوم فى الأوراق٠

ويمكن تلخيص النتائج المتحصل عليها كالآتى:-

- أدى تلقيح بذور البطيخ بالسماد الحيوى (الفوسفورين) إلى حدوث زيادة معنوية فى كل الصفات المختبرة وذلك بالمقارنة مع تلك المتحصل عليها من النباتات غير الملقحة بالفوسفورين فى كلا موسمى الدراسة٠
- أدى التسميد بالفوسفور المعدنى إلى حدوث زيادة معنوية فى معظم قياسات نمو النباتات ومحصول البذور وصفات الثمار والمحتوى الكيماوى وذلك بالمقارنة مع تلك المتحصل عليها من النباتات غير المسمدة وكان أعلى قيم تم الحصول عليها بإستخدام التسميد الفوسفاتى بمعدل ٣٠ كجم فو٢أ٥ (٢٠٠ كجم سوبر فوسفات الكالسيوم ١٥,٥% فو٢أ٥)٠
- كما أدى التفاعل بين الفوسفورين والتسميد الفوسفورى إلى حدوث تأثيرمعنوى على الصفات المدروسة٠

وبصفة عامة توصى الدراسة بمعاملة بذور البطيخ الجورمة بالفوسفورين بمعدل ٣ كجم مع إضافة الفوسفور بمعدل ٣٠ كجم فو٢أ٥ للفدان للحصول على أعلى محصول٠

Table 2. Vegetative growth characteristics of citron as affected by P-biofertilizer (Phosphorien), different P-mineral levels and their interaction during 1998 and 1999 seasons.

Characters	Plant fresh weight (gm)		Plant dry weight (gm)		Mean stem length (cm)		No. of leaves / plant		No. of branches / plant	
Treatments	**1998**	**1999**	**1998**	**1999**	**1998**	**1999**	**1998**	**1999**	**1998**	**1999**
Phosphorien (a):										
Witout	628.5	603.3	102.3	97.1	184.9	179.1	61.47	58.13	3.50	3.27
With	734.6	713.2	119.7	117.7	205.5	214.1	72.27	68.87	4.36	3.93
LSD at 5%	33.54	24.04	13.49	12.32	3.87	5.92	3.48	2.45	0.17	0.05
P_2O_5 levels (b): kg/fed.										
0	601.6	558.3	98.83	91.75	175.7	172.0	55.00	51.67	2.95	2.57
15	667.3	645.8	105.8	105.0	189.2	183.8	64.50	62.33	3.80	3.15
30	758.0	741.7	124.0	120.1	218.7	211.7	77.83	76.00	4.93	4.10
45	717.8	699.7	117.5	114.0	218.0	211.0	69.33	65.17	4.12	4.57
60	662.8	645.8	108.7	106.1	218.0	204.3	67.67	62.33	3.85	3.60
LSD at 5%	25.13	47.11	4.02	6.79	5.49	5.24	4.03	4.59	0.29	0.28
Interaction (axb):										
Without Phosphorien										

P_2O_5 kg/fed.										
0	523.3	465.0	85.67	75.00	161.0	160.0	49.33	46.33	2.27	2.100
15	601.7	576.7	93.67	92.87	171.0	165.7	58.33	57.00	3.33	3.07
30	717.3	706.7	118.7	112.2	195.7	188.3	71.00	68.33	4.33	4.10
45	652.7	673.3	114.3	108.3	206.0	196.7	64.33	61.33	3.97	3.77
60	607.3	595.0	99.00	96.10	190.7	185.0	64.33	57.67	3.60	3.30
With Phosphorein										
0	680.0	651.7	112.0	107.7	190.1	184.0	60.67	57.00	3.63	3.03
15	733.0	715.0	118.0	117.2	207.3	202.3	70.67	67.67	4.27	3.23
30	798.7	776.7	129.3	128.0	240.3	235.0	84.67	83.67	5.53	4.10
45	743.0	726.0	120.7	119.7	231.3	225.3	74.00	69.00	4.27	5.37
60	718.0	696.7	118.3	116.0	228.7	223.7	71.00	67.00	4.10	3.90
LSD at 5%	35.53	66.63	5.68	9.50	7.76	7.42	5.69	6.50q	0.42	0.39

Table 3. Yield and its components of citron as affected by P-biofertilizer (Phosphorien), different P-mineral levels and their interaction during 1998 and 1999 seasons.

Characters	No. of fruits / plant		Weight of 100 seed (gm)		Weight of seeds in fruit (gm)		Yield (kg/seed/fed)	
Treatments	**1998**	**1999**	**1998**	**1999**	**1998**	**1999**	**1998**	**1999**
Phosphorien (a):								
Witout	2.99	2.84	13.81	13.00	24.13	21.87	4o4.9	398.5
With	3.29	3.08	15.90	14.93	29.67	27.47	493.7	487.1
LSD at 5%	0.12	0.19	1.99	1.74	4.13	4.33	4.45	29.84
P_2O_5 levels (b): kg/fed.								
0	2.82	2.63	12.17	11.17	22.33	20.33	358.5	351.8
15	3.13	2.95	15.03	14.25	25.17	23.50	398.7	383.3
30	2.58	3.42	16.58	15.75	30.83	28.33	510.7	488.5
45	3.18	2.98	15.67	14.67	29.00	26.33	490.3	484.5
60	2.98	2.82	14.83	14.00	27.17	24.83	488.3	480.8
LSD at 5%	0.21	0.23	0.66	0.74	1.38	1.25	5.24	23.06
Interaction (axb):								
Without Phosphorien								
P_2O_5 kg/fed.								
0	2.63	2.50	11.50	10.33	20.00	18.33	326.0	321.0
15	2.87	2.63	13.57	13.17	22.00	20.00	350.7	335.0
30	3.37	3.20	15.17	14.50	27.67	25/.33	466.0	418.3
45	3.13	2.97	14.83	13.67	26.33	22.67	444.0	437.3
60	2.93	2.90	14.00	13.33	24.67	23.00	437.7	431.0
With Phosphorein								
0	3.00	2.77	12.83	12.00	24.67	22.33	391.0	382.7
15	3.40	3.27	16.50	15.33	28.33	27.00	446.7	441.7
30	3.80	3.63	18.00	17.00	34.00	31.33	555.3	548.7
45	3.23	3.00	16.50	15.67	31.67	30.00	536.7	531.7
60	3.03	2.73	15.67	14.67	29.67	26.67	539/0	530.7
LSD at 5%	0.30	0.32	0.94	1.05	1.96	1.76	7.41	32.61