J. Plant Production, Mansoura Univ., Vol. 5 (10): 1691 – 1701, 2014

ENHANCING YIELD AND NUTRIENTS UTILIZATION VIA PHOSPHORIN SOIL INOCULATION AND MG FOLIAR APPLICATION TO PUMPKIN (*Cucurbita moschata* Duchesne) PLANTS GROWN IN SANDY CALCAREOUS SOIL

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ABSTRACT

Inoculation with phosphorien-containing phosphate-dissolving bacteria (PDB) and/or foliar application of magnesium (Mg) at the rates of 0, 0.5 and 1 mM on the growth, some chemical constituents and fruit yield and yield quality of pumpkin (*Cucurbita moschata* Duchesne) grown on a sandy calcareous soil were investigated.

Two field experiments (2012 and 2013) were performed in a completely randomized blocks design with six treatments, each with four replicates. The results indicated that PDB and/or Mg significantly increased stem length, canopy dry weight plant^{-1}, number of leaves plant^{-1}, total leaf area plant^{-1}, leaf area leaf^{-1}, leaf contents of pigments, free proline, nitrogen (N), phosphorus (P), potassium (K), magnesium (Mg), and calcium (Ca) and the ratio of Ca/Na, while leaf Na content was reduced. The application of PDB and/or Mg also increased fruit yield and yield quality (fruit length and diameter, flesh thickness, average fruit weight and fruit yield fed^{-1}). It could be concluded that that PDB and Mg have pronounced positive effects on the growth, fruit yield and yield quality of pumpkin plants grown on sandy calcareous soil. PDB and Mg, therefore, have the potential to be used as a soil inoculation and foliar application, respectively for various crops to overcome the adverse effects of the newly-reclaimed sandy calcareous soils.

Keywords: Pumpkin, *Cucurbita moschata* Duchesne, Bio-fertilizer, Magnesium foliar application, growth, yield, leaf chemical constituents

INTRODUCTION

Pumpkin (*Cucurbita moschata* Duchesne) is one of the most popular vegetable crops grown in many of the Middle Eastern countries. It is consumed in different local dishes and used for some food industries such as jams, purees and cakes. It is widely cultivated on the newly-reclaimed sandy calcareous soils, which show a great deficiency in macronutrients especially, magnesium (Mg) and phosphorus (P).

Mg plays a vital role in stepping up the growth and quantitative as well as qualitative features of the plant. Mg deficiency is most prevalent in sandy textured soils because it is subject to oxidation to become in a form un-available for plant and loss by leaching (Doeing, 1986). In reclaimed sandy soils, foliar application of macro- and/or micro-nutrients are widely used and preferable (Amberger, 1982; Fawzi, 1991) and leads to significant increases in vegetative growth and productivity of some crops (Ahmed and Abd El-Hameed, 2003 on red roomy vines; Osman and El-Sawah, 2009 on tomato;

Rady and Osman, 2010on bean). P precipitation and immobilization is the most important problem under calcareous soil having high pH and calcium carbonate. Phosphorien is a bio-fertilizer product-containing PDB which hydrolyzes the insoluble phosphate into soluble one under the previous mentioned adverse conditions. Adding bio-phosphorus-fertilizers lead to significant increments in vegetative growth and productivity of some crops (Hinsinger, 2001; El-Desuki *et al*., 2006 on onion; Shaheen *et al*., 2007on onion; Rady and Osman, 2010 on bean). Therefore, the present work aims to evaluate the influence of soil inoculation with PDB (phosphorien) and/or foliar application of Mg on vegetative features, Fruit yield and yield quality and some chemical constituents of pumpkin (*Cucurbita moschata* Duchesne) grown under sandy calcareous soil conditions.

MATERIALS AND METHODS

Seed of pumpkin (cv. Balady, Fayoum Governorate) was collected from fruits characterized by: skin color; orange, flesh color; orange, fruit size; large (> 4 kg), fruit shape; pyriform-globular and shell; grooved. Phosphorien (*Bacillus megatherium*; phosphate-dissolving bacteria) was provided by the Ministry of Agriculture and mixed with nile water to obtain the concentration of about 0.25×10^7 cfu ml^{-1}, and Mg concentrations used were 0, 0.5 and 1 mM combined with or without phosphorien (6 treatments in total). The rates of Mg (0.5 and 1 mM) were selected based on our preliminary studies, since these rates were generated the best responses. A two-field experiment was undertaken at the Experimental Farm, Faculty of Agriculture, Fayoum University, Egypt in 2012 and 2013 seasons. Preceding the initiation of experiment, soil samples to 25 cm depth were collected and analyzed. Some of the chemical and physical properties according to the standard procedures of Wilde *et al.* (1985) are presented in Table 1.

Table1: Physical and chemical properties of the experimental soil before planting in 2012 and 2013 seasons

Parameter	2012	2013
Clay [% (w/w)]	22.7	23.8
Silt [% (w/w)]	23.1	22.1
Sand [% (w/w)]	54.2	54.1
Soil texture	sandy	Sandy
pH (1: 2.5)	8.11	7.86
ECe (dS m^{-1})	5.10	4.85
Organic matter [% (w/w)]	1.17	1.24
$CaCO_3$ [% (w/w)]	14.05	14.32
Available N (mg kg^{-1} DW)	43.31	42.00
Available P (mg kg^{-1} DW)	8.11	9.15
Available K (mg kg^{-1} DW)	73.16	74.43
Available Fe (mg kg^{-1} DW)	7.03	8.01
Available Mn (mg kg^{-1} DW)	4.52	5.32
Available Zn (mg kg^{-1} DW)	2.24	2.43
Available Cu (mg kg^{-1} DW)	0.45	0.43

During preparation of the experimental site, farmyard manure at the rate of 15 m^3, 150 kg calcium superphosphate (15.5% P_2O_5) and 100 kg elemental sulphur fed^{-1} were broadcasted and incorporated in the soil. Pumpkin seeds were sown on 11 and 20 March in 2012 and 2013, respectively.

Soil inoculation with phosphorien was performed by injecting 35 ± 5 ml $hole^{-1}$ two times; 20 and 40 days after sowing at the rhizosphere area. The respective source of Mg was Librel 5.5% Mg in chelated form (EDTA, Ciba Specialty chemicals, United Kingdom). Mg solutions were foliar sprayed to run off two times; 25 and 40 days after sowing. Few drops of Tween-20 were added to the spraying solution as a wetting agent. The experimental design was completely randomized blocks with 6 treatments, each with 4 replicates. Each experimental unit measured 80 m^2 and consisted of 5 rows; 8 m long and 2 m width, with row spacing averaged 50 cm apart. Each two adjacent experimental unites were separated by 1 m alley.

After complete earthing, a seasonal total of 66 and 48 kg N and K_2O in the form of ammonium nitrate (33.5% N) and potassium sulphate (48% K_2O), respectively were applied in two equal applications; 30 and 60 days after sowing, respectively. All other agro-management practices for commercial production of pumpkin were followed whenever it was necessary.

Measurements of growth traits

Fifty-five days after sowing, five plants were randomly chosen from the two outer rows of each experimental unit and cut off at ground level to measure the stem length, canopy dry weight $plant^{-1}$, number of leaves $plant^{-1}$ using a digital LI-3000 Portable area meter (LI-COR Lincoln, Nebraska, USA), total leaf area $plant^{-1}$ and leaf area $leaf^{-1}$ was calculated using the following formula:

$$\text{Leaf area leaf}^{-1} = \frac{\text{Leaves area plant}^{-1}}{\text{Number of leaves plant}^{-1}}$$

Measurements of fruit yield and yield quality

In each experimental unit after 115 days from sowing plants of the three middle rows were left to grow till the fruits approach the marketable stage. Then, fruits were picked from 20 plants to determine average fruit weight (kg), fruit length (cm) for the longitudinal axis starting from the peduncle junction to the blossom end, fruit diameter (cm) at the maximum fruit diameter, flesh thickness of fruit (cm), average of four measures, at the beginning of the fruit cavity, at the maximum fruit diameter, and at the blossom end, flesh samples were taken from four different parts of fruit and percent of total soluble solids (TSS%) were measured using a hand heldle refractometer (HRN- 32, Kruss, Germany). The total yield of fruit fed^{-1} was calculated from all plants of the three middle rows.

Leaf photosynthetic pigment, proline and nutrient determinations

Leaf samples were collected from the fourth upper leaf of five randomly selected plants from each experimental unit, after 60 days from planting, to determine the concentrations of some nutrients. Leaf chlorophyll and carotenoid contents in the 4th leaf were colorimetrically determined as outlined by Arnon (1949). Leaf samples were dried in a forced air oven at 70 °C till a constant weight and then ground. For leaf mineral determinations, samples of fine dry ground material each of 0.1 g was digested with a mixture of sulphuric and perchloric acids as mentioned by Piper (1947). Free proline (µg g^{-1} leaf dry matter) was extracted by 5-sulphosalicylic acid (3%) then, determined colorimetrically using acid ninhydrin reagent as outlined by Bates *et al.* (1973). Leaf N content was colorimetrically determined using Orange G dye as suggested by Hafez and Mikkelsen (1981). Leaf P content was colorimetrically estimated using the method of chloro-stannus molybdo-phosphoric blue color in sulphuric acid system according to the procedure of Jackson (1967). Leaf K and Na contents were determined using a Flame-photometer as documented by Page *et al.* (1982). Leaf Ca and Mg contents were measured using a Perkin-Elmer, Model 3300, Atomic Absorption Spectrophotometer as mentioned by Chapman and Pratt (1961).

Statistical analysis

Data of the two seasons were subjected to the statistical analysis according to the design used (Snedecor and Cochran, 1980). All data were statistically analyzed based on ANOVA and Duncan Multiple Range Test of means by using Co-stat statistical software (V. 6.311).

RESULTS AND DISCUSSION

Vegetative Growth Traits

Data in Table 2 show that stem length, canopy dry weight $plant^{-1}$, number of leaves $plant^{-1}$, total leaf area $plant^{-1}$ and leaf area $leaf^{-1}$ significantly increased in plants that foliar sprayed with Mg at the 2 rates (0.5 and 1 mM) compared to plants that not treated with Mg. Plants received Mg at the rate of 1 mM gave higher growth traits than plants received Mg at 0.5 mM Mg. Soil inoculation with phosphorien further increased growth traits. The best results were obtained from the combined treatment of soil inoculation with bio-phosphorus fertilizer and foliar application with 1 mM Mg. The same trend was observed over both the 2012 and 2013 growing seasons.

These results can be explained on the basis that, phosphate-solublizing bacteria produces organic and inorganic acids and/or CO_2 which dissolve the precipitated form of phosphate to an available one. Thereby, offered adequate quantity of phosphorus in root media, promotes roots growth to go forward and keep roots healthy (Zayed, 1998; Rady and Osman, 2010). Phosphate-solubilizing bacteria also produses many growth-promoting substances such as auxins, gibberellins and cytokinins (Sabik *et al.*, 2001), these substances improve plant growth and stimulate beneficial microbial development in the rhizosphere zone (Abdel-Rasoul *et al.*, 2002). Many investigators reported similar findings on broad bean (Hinsinger, 2001), on onion (Shafeek *et al.,* 2004; Shaheen *et al.*, 2007), on garlic (Badawy *et al.,* 2008) and on bean (Rady and Osman, 2010).

Addition of Mg as foliar application is ready to be absorbed through leaves and not to be lost through fixation, decomposition or leaching under unfavorable soil conditions. Mg is essential component of chlorophyll molecule and plays a vital role in carbohydrate synthesis due to activation of many enzymes (Marschner, 1995). He also stated that Mg acts as an osmotic material in the cells against adverse conditions and consequently the metabolic activities are completely achieved due to the cell turgor. Hao and Papadoulos (2004) on tomato, Rady and Osman (2010) on bean, stated that plant dry matter production increased as Mg concentration increased to a certain level. These results are in accordance with those obtained by Ahmed and Abd El-Hameed (2003) and Osman and El-Sawah (2009).

Table 2: Effect of soil inoculation with phosphorien (Bio-P) and foliar application with magnesium (Mg; mM) on vegetative growth traits of pumpkin plants (at 55 days from sowing) grown in 2012 and 2013 seasons

Treatment		Stem length (cm)	Canopy DW (g plant^{-1})	No. of leaves (plant^{-1})	Leaf area leaf^{-1} (dm^2 leaf^{-1})	Leaf area plant^{-1} (dm^2 plant^{-1})
Bio-P	Mg (mM)					
				2012 season		
	0	174d*	96d	36d	2.34d	84.4c
without	0.5	193c	119c	43c	2.56c	110.2c
	1	220b	131b	51b	2.84b	144.6b
	0	185cd	113c	41cd	2.64c	108.1c
With	0.5	225b	134b	53ab	2.90b	153.4b
	1	268a	153a	58a	3.19a	185.1a
				2013 season		
	0	183d	104d	41d	2.42d	99.3c
without	0.5	203c	122c	48c	2.69c	129.2c
	1	231b	139b	54b	2.90b	156.4b
	0	196c	121c	44cd	2.72c	119.5c
With	0.5	240b	145b	57ab	2.96b	168.3ab
	1	276a	169a	62a	3.23a	199.8a

Likewise, the comparisons within soil inoculation with and without phosphorien reflect the valuable effect of soil inoculation with phosphorien and spraying Mg, particularly at 1 mM, on all various studied vegetative parameters compared to the untreated control. Therefore, the best valuable combination was soil inoculation with phosphrien and foliar application of Mg at 1 mM. The superiority of the combined treatment having the highest results might have come from improving the nutritional status of plants of this treatment (Table 4), the abundant values of leaf pigments (Table 3), the obvious shortage in Na^+ (Table 4) saving more osmotic solutes which enable plant cells to maintain more water against the adverse conditions of the soil under study.

Leaf photosynthetic pigment, free praline and nutrient contents

Data in Tables 3 and 4 reveal that the contents of total chlorophyll, total carotenoids, free proline, N, P, K, Mg and Ca, and the ratio of Ca/Na significantly increased in plants, which received 0.5 or 1 mM Mg as foliar application compared to those untreated ones. Plants supplied with Mg at the rate of 1 mM had higher total chlorophyll, total carotenoids, free proline and nutrient contents and Ca/Na ratio than plants applied with Mg at 0.5 mM Mg.

Further increased contents of these attributes were observed with soil inoculation with phosphorien. The content of Na showed the reverse trend to other measurements. The best results were obtained from the combined treatment of soil inoculation with phosphorien and foliar application with 1 mM Mg. Similar trends were observed in both the 2012 and 2013 growing seasons.

The enhancing effects of phosphorien on the contents of leaf nutrients and photosynthetic pigments can be owe to the efficiency of phosphorien in dissolving immobilized P and producing appropriate amounts of phytohormones, which increased surface area per unit area of root with an eventual increase in the uptake of nutrients from the soil. Therefore, more storage of energy in the form of ADP and ATP which grant transportation of nutrient across the cell wall and the synthesis of nucleic acid and proteins as well as other photosynthates. These results are in accordance with those of Al-kaff *et al.* (2002), Badawy *et al.* (2008), Rady and Osman (2010) and Naeem et al. (2010).

The positive linear relationship between foliar application of Mg and leaf Mg content and interrelationship between leaf Mg and P contents due to Mg acts as a carrier of P in plants were documented by Osman and El-Sawah (2009) and Rady and Osman (2010). Marschner (1995) stated that Mg is essential element involving in the biosynthesis of chlorophyll and consequently the higher leaf Mg content, and consequently the higher leaf chlorophyll content. The combined treatment of soil inoculation with phosphorien plus foliar application of Mg at 1 mM significantly attained the highest leaf chlorophyll, carotenoid, N, P, K, Mg and Ca contents.

Table 3: Effect of soil inoculation with phosphorien (Bio-P) and foliar application with magnesium (Mg; mM) on the leaf contents of photosynthetic pigments and free proline (µg g^{-1} DW) of pumpkin plants (at 60 days from sowing) grown in 2012 and 2013 seasons

Treatment		Total chlorophyll	Total carotenoids	Free proline
Bio-P	Mg (mM)	(mg g^{-1} FW)	(mg g^{-1} FW)	(µg g^{-1} DW)
			2012	
	0	0.89d*	0.33d	24.3c
without	0.5	1.09c	0.39c	26.7b
	1	1.26b	0.50b	28.1b
	0	1.00c	0.43c	27.7b
with	0.5	1.29b	0.52b	31.2a
	1	1.38a	0.58a	32.3a
			2013	
	0	0.93d	0.36d	26.5c
without	0.5	1.12c	0.45c	28.4bc
	1	1.29b	0.53b	30.1b
	0	1.05c	0.46c	29.1b
with	0.5	1.32b	0.55b	32.8a
	1	1.44a	0.63a	33.7a

Table 4: Effect of soil inoculation with phosphorien (Bio-P) and foliar application with magnesium (Mg; mM) on leaf mineral content and the ratio of Ca/Na of pumpkin plants (at 60 days from sowing) grown in 2012 and 2013 seasons

Treatment		N	P	K	Mg	Na	Ca	Ca/Na ratio
Bio-P	Mg (mM)	(mg g^{-1} DW)	(mg g^{-1} DW)	(mg g^{-1} DW)	(mg g^{-1} DW)	(mg g^{-1} DW)	(mg g^{-1} DW)	
					2012			
without	0	18.2d*	2.67d	24.2d	1.48e	6.23a	2.30c	0.37c
	0.5	20.9c	3.15c	26.8cd	1.80d	5.89ab	2.64b	0.45bc
	1	24.4b	3.41c	28.4bc	2.09c	5.50bc	2.85b	0.52b
with	0	21.2c	3.27c	28.6bc	2.01c	5.26cd	2.72b	0.52b
	0.5	25.2b	4.03b	30.2ab	2.51b	4.82de	3.21a	0.67a
	1	28.3a	4.65a	31.3a	2.97a	4.58e	3.38a	0.74a
					2013			
without	0	18.8d	2.82d	24.8d	1.53e	6.07a	2.46c	0.41c
	0.5	21.6c	3.26c	27.5c	1.86d	5.73ab	2.86b	0.50bc
	1	25.1b	3.73c	29.1b	2.15c	5.35bc	3.01b	0.56b
with	0	21.7c	3.46c	29.3b	2.08c	5.13c	2.91b	0.57b
	0.5	26.2b	4.22b	32.5a	2.59b	4.62d	3.30a	0.71a
	1	29.4a	4.78a	33.6a	3.05a	4.48d	3.41a	0.76a

Fruit yield and yield quality

Data in Table 5 show that, except TSS in the first season, the fruit yield and yield quality (fruit length and diameter, flesh thickness, average fruit weight and fruit yield fed^{-1}) significantly increased with plants which sprayed with Mg at the 2 rates (0.5 and 1 mM) compared to plants that not supplied with Mg. Plants received Mg at the rate of 1 mM gave higher fruit yield than plants received Mg at 0.5 mM Mg. Soil inoculation with phosphorien further increased fruit yield. The best results were obtained when the combined treatment of soil inoculation with bio-phosphorus fertilizer and foliar application with 1 mM Mg was applied. The same trends were seen in both the 2012 and 2013 growing seasons.

The enhancing effects of soil inoculation with phosphorien on fruit length and diameter, flesh thickness, average fruit weight and fruit yield fed^{-1} can be attributed to the positive effects of phosphorien on plant growth traits (Table 2) and leaf photosynthetic pigment contents (Table 3), which may coubled togther to enhance photosynthesis to go forward. Also, phosphorien-treated soil improved plant nutritional status (Table 4) and probably reflected better partitioning of photosynthates to reproductive organs with an eventual result increasing fruit yield and yield quality. Many investigators reported similar trends on onion (El-Desuki *et al*., 2006; Shaheen *et al*., 2007), on garlic (Badawy *et al.*, 2008) and on bean (Rady and Osman, 2010).

Table 5: Effect of soil inoculation with phosphorien (Bio-P) and foliar application with magnesium (Mg; mM) on yield and fruit quality of pumpkin plants grown in 2012 and 2013 seasons

Treatment		Fruit length (cm)	Fruit diameter (cm)	Flesh thickness (cm)	TSS (%)	Average fruit weight (kg)	Fruit yield fed^{-1} (ton fed^{-1})
Bio-P	Mg (mM)						
				2012			
	0	17.6d*	12.2d	3.0d	5.98a	3.11d	15.0d
without	0.5	19.7c	14.3c	3.3cd	5.93a	3.42c	16.9c
	1	22.5b	16.1b	3.7b	5.89a	3.66b	18.4b
	0	19.5c	14.6c	3.3cd	6.02a	3.52c	17.5c
with	0.5	23.1b	16.7ab	4.0ab	6.01a	3.76b	18.8b
	1	25.5a	17.2a	4.3a	5.93a	3.93a	20.7a
				2013			
	0	18.4d	12.7e	2.9d	6.03a	3.40d	16.7d
without	0.5	20.4c	14.9d	3.3cd	6.01a	3.74c	18.6c
	1	23.1b	16.5bc	3.5bc	5.98b	4.00b	20.2b
	0	20.6c	15.0c	3.3cd	6.03a	3.81c	18.9c
with	0.5	23.8b	17.1ab	3.9ab	6.04a	4.11b	20.7b
	1	26.1a	17.9a	4.2a	6.01a	4.34a	22.7a

The improving effects of Mg on studied yield and yield quality was mainly attributed to its positive action on enhancing vegetative growth traits (Table 2), leaf photosynthetic pigments (Table 3) and plant nutritional status (Table 4) for sustenance of cells turgor leading to maintenance of metabolic activities in plants at their highest levels. In this respect, on different crops, Ahmed and Abd El-Hameed (2003), Hao and Papadoulos (2004), Osman and El-Sawah (2009) and Rady and Osman (2010) found a positive relationship between yield and Mg level which may attributed to the important role of Mg in increasing the activity of plant metabolism, which in turn reflected on the yield under study. At any concentration of Mg, soil application of phophorien was pioneer and recorded higher mean values of all studied parameters of fruit yield and yield quality than the un-inoculated ones. Likely, soil inoculation with phosphorien reflects the desirable effect of Mg on all studied parameters of fruit yield and yield quality, particularly at 1 mM. The superiority of the best combined treatment on fruit yield and yield quality may be arised as a result of positive combined effects of soil inoculation with phosphate-solubilizing bacteria and foliar application with 1 mM Mg on growth traits (Table 2), leaf photosynthetic pigments (Table 3) and nutritional status of plants (Tables 4).

We concluded that, under the conditions of sandy calcareous soils, phosphorien (phosphate-solubilizing bacteria) was capable to hydrolyze the insoluble phosphate into soluble one, which reflected an increase of Mg foliar application efficiency in overcoming the great deficiency of Mg in such soils. Therefore, the positive reflection of these applications on growth, fruit yield and chemical composition of pumpkin (cv. Balady, Fayoum Governorate) was expected.

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تحسين الإنتاجية والمحتوى الغذائى لنباتات القرع العسلى النامية تحت ظروف الأراضى الرملية الجيرية بتلقيح التربة بالفوسفورين والرش الورقى بالماغنسيوم

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أجرى هذا البحث بمزرعة دمو- كلية الزراعة- جامعة الفيوم خلال موسمين متتاليين (٢٠١٢ و ٢٠١٣) لدراسة تأثير تلقيح التربة بالفوسفورين المحتوى على بكتريا مذيبة للفوسفور، والرش الورقى للماغنسيوم بتركيزات صفر ، ٠.٥ ، ١.٠ ملى مول، على النمو والمحصول والتركيب الكيميائى لنباتات القرع العسلى النامية تحت ظروف الأراضى الرملية الجيرية بمحافظة الفيوم.

أوضحت النتائج المتحصل عليها أن تلقيح التربة بالفوسفورين عكس تأثرات معنوية ايجابية على صفات النمو الخضرى (طول الساق، الوزن الجاف للمجموع الخضرى/ نبات، عدد الأوراق/ نبات، مساحة الأوراق الكلية / نبات، متوسط مساحة الورقة)، كما زاد معنويا محتوى الأوراق من الصبغات التمثيلية (الكلوروفيل والكاروتينات) والبرولين ومحتوى الأوراق من العناصر (النتروجين، الفوسفور، البوتاسيوم، الماغنسيوم، الكالسيوم، والعلاقة بين نسبة الكالسيوم إلى الصوديوم، بينما حدث نقص لمحتوى الأوراق من عنصر الصوديوم)، بالإضافة إلى زيادة معنوية للمحصول ومكونات الجودة للثمار (طول وقطر الثمرة ، سمك لحم الثمار، متوسط وزن الثمرة، محصول الثمار الكلى / فدان) مقارنة بالتربة غير الملقحة. أظهرت النتائج أيضا أن رش المجموع الخضرى لنباتات القرع العسلى بالماغسيوم بتركيز ١.٠ ملى مول كان رائدا في تأثيره الإيجابى على كل الصفات المدروسة والمذكورة سابقا.

وفى ضوء النتائج السابقة يمكن الاستنتاج أن كفاءة الرش الورقى للماغنسيوم قد ازدادت بتلقيح التربة بالفوسفورين مما أنعكس على زيادة النمو والمحتوى الكيميائى ومحصول الثمار للقرع العسلى. وكانت المعاملة المختلطة (التلقيح بالفوسفورين + ١.٠ ملى مول ماغنسيوم) الأفضل في كل الصفات المدروسة والتى ربما استطاعت أن تتصدى للتأثيرات المعاكسة لظروف التربة الرملية الجيرية.