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An Evaluation of Rose (*Rosa* L. *Hybrids* Var. Black Magic) Phosphorus Feeding from Different Sources of Iranian Apatites in Long Periods in Zeoponic Culture

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Abstract: Phosphorus is an essential element in plant growth. Since Iran has huge sources of phosphate rocks, designing systems that can use it, is an efficient way for self-sufficient and reducing money flowing out of the country. In order to phosphorus feeding evaluation Rose plant var. Black magic from Iranian apatites in zeoponic culture over long time, a study was conducted as a factorial experiment on the basis of completely randomized design with three replications, that evaluated the effect of 8 types of media with different percentage of apatite, zeolite, Perlit and soil with 5 types of nutrient solution (3 types of Coïc *et al*. solution and 2 types of solution like a proper soil solution) in different concentrations. The media were provided and used for a similar study one year ago. The results showed, media, nutrient solution and their interaction had significant effect on the leaf phosphorus content. Between nutrient solution, Coïc *et al*. solution (as control), created the highest phosphorus content. All of the media except media including Moondon region apatite (without soil) created highest leaf phosphorus content without significant difference to each other.

Key words: apatite, zeolite, zeoponic, nutrient solution, Black magic.

INTRODUCTION

Phosphorus is an important plant macronutrient, making up about 0.2% of plant's dry weight. It is a component of key molecules such as nucleic acids, phospholipids, and ATP, consequently, palnt cannot grow without a reliable supply of this nutrient (13). Sprouting, fertilization, and ripening depend on suitable amount of this element. In addition, phosphorus causes plant resistance against drought, frost and pests. In natural condition, phosphorus is found in the form of phosphate in mineral structure (apatite) and organic matter (plant and animal residual in soil) compounds (8). Mineral phosphates include more than 200 types of minerals that the most abundant belongs to apatite family. These minerals exist in phosphate rocks and are considered as the only and greatest phosphorus source because after many steps, they can convert to different types of phosphorus fertilizers in industrial factories (1).

Zeoponic is defined as the mixture of zeolite and apatite in hydroponic culture (5). A zeoponic plant growth system is defiend as the cultivation of plants in artificial soils, which have zeolites as a major component (2). An artificial plant growth substrate composed of zeolite and phosphate minerals (i.e. zeoponic substrate) can serve as a controllable and renewable fertilization system to provide plant growth nutrients. Morever, the slow release nature of zeoponic substrate can mitigate the adverse effects of ground- and surface-water contamination due to leaching of highly soluble and concentrated fertilizers (5). zeolites are crystalline, hydrated aluminosilicate minerals that have the ability to exchange constituent cations without major change of the mineral structure (2). This slow release fertilizer (termed zeoponic) is composed of $NH4^+$ and K^+ exchanged clinoptilolite and a nutrient (Fe, Mg, Cu, Zn, Mo, B, S, Cl, Mn) containing synthetic hydroxyapatite (11,12).

Every year, Iran import 1.5 million tones phosphate rocks. Since Iran hasn't any problem to provide phosphorus sources, designing systems that can use phosphate rocks, is an efficient way for self-sufficient and reducing money flowing out of the country (6).

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Rose is one of the most famous flower in the world. In general, Rose is planted as a cut flower, pot plant or in garden. There are a few plants like rose that can express element deficiency rapidly and return to normal growth very late, so for sustainable produce of this flower, having a suitable media is essential for plant growth (14).

Gruener *et al.* (2007) conducted an experiment on plant productivity and characterization of zeoponic substrate after three successive crops of radish (*Raphanus sativus* L.). They reported the increasing trend in radish crop yield after three successive crops (62 total days) and supporting data from other experiments (e.g., zeoponic wheat experiments, 270 total days), also demonstrate the potential for long term nutrient delivery of zeoponic substrates (10) The aim of this study is using Iranian apatites as a replacement of phosphorus fertilizer. Also, in this experiment, the use of zeolite and apatite as a slow release fertilizer was studied in several periods.

MATERIAL AND METHODS

This research was started with the aim of zeoponic culture for utilize of Iranian apatites and continued in 2007-2008 years, in greenhouse of horticulture sciences department of Tehran University. The study was conducted as a factorial experiment on the basis of completely randomized design with three replications. Media was the first factor and the nutrient solution was the second. Because of the gradual element release from zeolite and apatite structure that act as a slow release fertilizer, media that were provided in last trail, were used in this experiment. Eight types of media were provided from different percentage of zeolite, apatite, perlite, and soil including: media AP1) mix of 89% soil+perlite, 10% zeolite and 1% Jeyrood apatite; media AP2) mix of 82% soil+perlite, 15% zeolite and 3% Jeyrood apatite; media A'P'1) mix of 89% soil+perlite, 10% zeolite and 1% Moondoon apatite; media A'P'2) mix of 82% soil+perlite, 15% zeolite and 3% Moondoon apatite; media A"P"1) mix of 89% soil+perlite, 10% zeolite and 1% Delir apatite; media A"P"2) mix of 82% soil+perlite, 15% zeolite and 3% Delir apatite; media APZ) mix of 84% perlite, 13% zeolite and 3% Moondoon apatite without soil; media APO) just soil (as control media). Zeolite was provided form Semnan province (1mm diameter) and apatite from mines of Zagros mountains (Moondon) and Alborz mountains (Delir and Jeyrood). The apatites were cracked to 1mm diameter.

After providing the final mixture, it was translocated to the pots with 30cm diameter, and 30cm height. Five types of different nutrient solutions were made, including: (a1) Coïc *et al*. solution (1975) (7) (as control); (a2) half strength of Coïc *et al*. Solution (7); (a3) half strength of Coïc *et al*. solution without phosphorus (7); (a4) solution like a proper soil solution (7); (a5) solution like a proper soil solution without phosphorus (7) (Tables 1,2,3,4,5,6).

Table 1: Coic *et al*. solution (1975) (7)

	NO_3	PO_4	SO_4	Cl	Total
K	3.8	0.8,0.6			5.2
Na				0.2	0.2
Ca	6.2				6.2
Ng			1.5		1.5
NH_4	2				2
H		1.6,0.3			2
Total	12	3.3	1.5	0.2	17

Table 2: half strength of Coic *et al*. Solution (1975) (7)

	NO_3	PO_4	SO_4	Cl	Total
K	1.9	0.4,0.3			2.6
Na				0.1	0.1
Ca	3.1				3.1
Ng			0.75		0.75
NH_4	1				1
H		0.15,0.8			0.95
Total	6	1.65	0.75	0.1	8.5

Table 3: half strength of Coic *et al*. Solution without phosphorus (1975) (7)

	NO_3	PO_4	SO_4	Cl	Total
K	2.6				2.6
Na				0.1	0.1
Ca	3.8				3.8
Ng			1		1
NH_4	1				1
H					
Total	7.4		1	0.1	8.5

Table 4: solution like a proper soil solution (15)

	NO_3	PO_4	SO_4	Cl	Total
K	1	0.3,0.2	0.25		1.75
Na				0.1	0.1
Ca	1.5				1.5
Ng			0.75		0.75
NH_4					
H		0.6,0.1			0.7
Total	2.5	1.2	1	0.1	4.8

Table 5: solution like a proper soil solution without phosphorus (15)

	NO_3	PO_4	SO_4	Cl	Total
K	1.5		0.25		1.75
Na				0.1	0.1
Ca	2.2				2.2
Ng			0.75		0.75
NH_4					
H					
Total	3.7		1	0.1	4.8

Table 6: micro elements value in final soil solution

Micro Elements	mg/lit
H_3BO_3	1.5
$CuSO_4,5H_2O$	0.25
$ZnSO_4,7H^2O$	1
Mn SO_4	2
$(NH_4)_6Mo_7O_{24},4\ H_2O$	0.05
EDTA-Fe	10

Rose var. Black magic rooted cuttings were disinfected and pruned a little root and shoot. They were planted in autumn 2007 and the study was finished at spring 2008. Plants were irrigated about 15 days only with water until establishing and adapting to environmental conditions. Then the hand fertigation was started.

Leaf samples were collected at the end of experiment and dried at oven (72ºC for 48h), and were grinded for phosphorus measurement (3). Phosphorus content was measured by the colorimetry method with spectrophotometer (9).

The data were analysed using SAS program and mean comparison was done by Duncan (DNMRT) test.

RESULTS AND DISCUSSION

According to analysis variance table 1, the effect of media treatment on leaf phosphorus content was significant on level 1%, but the effect of nutrient solution on this factor was not significant. Also the interaction between media treatment and nutrient solution was significant on level 1%.

Table 1: The analysis of variance for leaf phosphorus content in Rose var. Black magic

Source of variation	d.f.	Mean square -------------------------------------- Leaf phosphorus content
meida	7	0.82**
nutrient solution	4	0.31^{ns}
media*nutrient solution	28	0.43**
error	80	0.15
C.V		9.07

ns : nonsignificant

** : significant at 0.01 probability levels

Mean comparison showed that media AP1, AP2, A'P'1, A'P'2, A"P"1, A"P"2, and APO had created the highest leaf phosphorus content and the APZ media had created the lowest (Figure 1).

A1 nutrient solution (as control) created the highest leaf phosphorus content and a5 nutrient solution created the lowest. The other nutrient solutions didn’t have significant difference with a1 and a5, but they are in next level after a1 (Figure 2).

The interaction showed that media A"P"2 and nutrient solution a5 created the highest leaf phosphorus content while there wasn’t any significant difference with the most of the media feeded with other nutrient solution except media APZ. APZ media with a3 nutrient solution had the lowest phosphorus content although there wasn’t any significant difference with the other solutions that feeded this media (Figure 3).

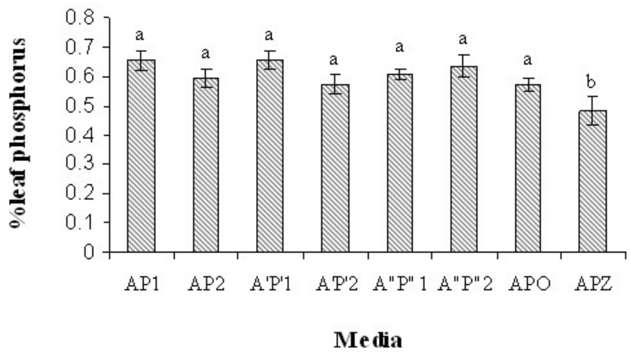

Fig. 1: The effect of media on leaf phosphorus content

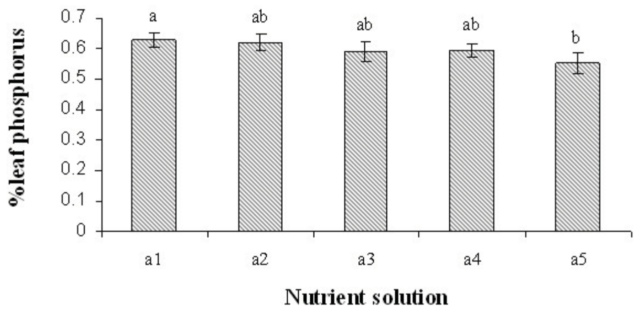

Fig. 2: The effect of nutrient solution on leaf phosphorus content

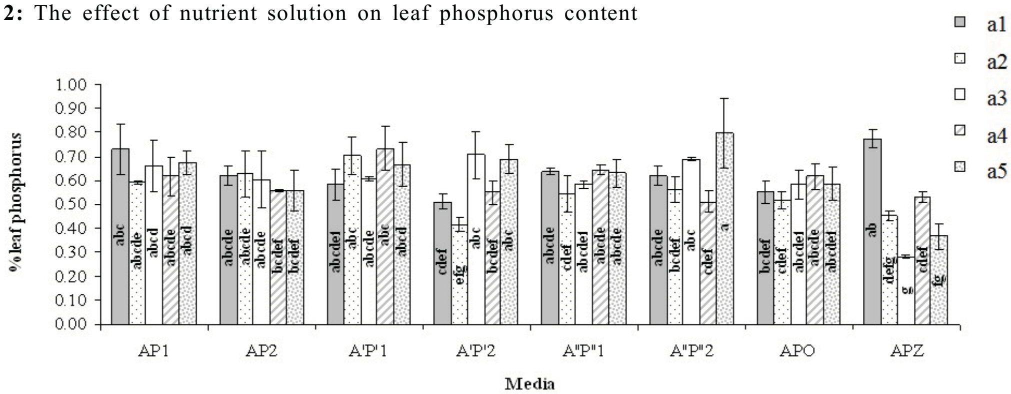

Fig. 3: Interaction of media and nutrient solution on leaf phosphorus content

Discussion:

Leaf element analysis showed, media including apatite except APZ media had the highest phosphorus content and could provide plant phosphorus requirement in long term periods and act like APO media (that was the best media in last trail) or even better than it.

Media APZ created the lowest leaf phosphorus content comparing to the other media. The reasons are:

1) The composition of this media: because the most volume of this media was composed of perlite and there wasn't any soil in it. Consequently its cation exchange capacity (CEC) was low; also zeolite, apatite, and nutrient solution exited from this media(Because of its high porosity). For example A'P'2 media with the same kind of apatite (in amount and type) was better than APZ media in most cases.
2) Because the amount of apatite was 1% in A'P'1, this media that its apatite belonged to Moondon region, caused higher phosphorus content than APZ. So the amount of apatite in APZ media wasn't suitable too.
3) Although the apatite percentage in A"P"2, and AP2 was similar to APZ and A'P'2 (3%), and they were different only in type of apatite, they created the best results especially about A"P"2 media, so the Zagros apatite (Moondon region) comparing to Alborz apatite especially Delir region was not so suitable.

The results showed that almost all of the media included apatite and all of nutrient solutions even solution without phosphorus could supply phosphorus requirement and had a sufficient phosphorus content. So this is noticeable that phosphorus rocks can replace phosphorus fertilizers, because according to this trail, they could provide phosphorus reqirement of plants in long term. This is in agreement with the results of Barbarick *et al*. (1990) researches that reported some successes with the use of zeolite/phosphate rock as an exchange medium in the fertilizer system in slowing the release of P in soil growing sorghum-sudangrass(4).

A1 nutrient solution (as control) because of its concentration and complement of the elements was the most suitable nutrient solution that influenced the leaf phosphorus content and was more normal than the other solution. A5 nutrient solution created the lowest phosphorus content in leaves. So, lack of phosphorus element and low element concentration in this solution, comparing to the other solutions, caused the decrease of phosphorus in plants that were feeded with this solution.

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