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Chemical Fractionation of Phosphorus in the Soil of Some Greenhouses of Hamedan Province

Masumeh Ghanbari*, Shahryar Mahdavi

Department of Agriculture, University of Malayer, Malayer, Iran

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ABSTRACT

The amount of each component depends on the phosphorus chemical soil characteristics and management actions, including the amount and timing of fertilization is. This study was carried out in a number of greenhouses in the province, after sampling the soil inside greenhouses (greenhouse culture history of fertilization) and outside greenhouses (no culture without fertilization) the physical and chemical characteristics of soils were measured by standard methods, then phosphorus categorizing in soils greenhouses and nurseries were carried out. Results were analyzed with the software sauce. Significant at the 5% level for all components of P was significantly different greenhouses outside and inside the greenhouse was higher due to the use of chemical fertilizers and organic. First of all treatments except the lowest amount of soluble and exchangeable. In 32 patients treated with calcium binding but the third had the highest value and the highest value was observed apart from the rest.

KEYWORDS: Chemical fractionation; phosphorus; soil; Hamedan; Iran

INTRODUCTION

Phosphorus was discovered for the first time in 1669 by Brand, German chemist and due to its lighting in the darkness, it was called phosphorus and it is one of the non-metals of fifth group of periodical table and due to its high chemical activity in nature, it is rarely found freely (Halford, 1997). Phosphorus is one of the major food elements of the plant after azoth in arid and semi-arid regions. In most of the countries in the world, phosphorus of soils of cultivation is increased as the phosphorus in soil is more than the chemical fertilizer, organic, waste mud more than the phosphorus yield by the product (Sharili and Smith, 1989; Sims, 1998a). Continual use of phosphorus fertilizers leads to phosphorus accumulation in surface horizon and increasing the wastage potential to surface water and enrichment process (Suyi et al., 1999; Mac Davel et al., 2001). Although total phosphorus in soil is more than the needs of plants, it should be said majority of phosphorus in soil is not used for plant and only a small amount of it exist as phosphorus absorbed by plant in soil (Fotvalice, 1997). Phosphorus distribution in soil is occurred as various forms of geochemical as dissolved phase and soil exchange, organic matter phase, linking with calcium and the phase linking with iron and aluminum (Hedli et al., 1982 a,b). The participation degree of phosphorus in each of geochemical forms depends upon physical chemical features of soils (Tisen et al., 1984). Weather and management (Motavali and Miles, 2002). Fractionation method qualitatively and quantitatively defines these components. The information is potentially used to predict accessibility and transformation of phosphorus among the chemical forms in agricultural and polluted soils (Hedli et al., 1982, a,b suyi eta l., 1992). To define the mobility of phosphorus, besides measuring total phosphorus, its distribution among various components is important. In soils with high phosphorus storage, potential of phosphorus accessibility for plant is high and in these soils majority of phosphorus is exposed to run off and erosion. Phosphorus distribution among various components shows an index of potential stability of phosphorus in soil changing in various applications.

Green house is a site in which environmental conditions as temperature, light and humidity are controlled. The goal of construction is developing the products outside of the season, saving water, using seed and soil with high quality to achieve maximum profitability. Cultivation in green house of Iran is new and in the past 4 decades, phosphorus input (via superphosphates and ammonium phosphates) to agricultural fields of Iran is increased. The majority of soils in Iran during the past 40 years, annually received 100-300 kg superphosphate per hectare. Limited information exists about spatial distribution and accessibility of phosphorus in arid and semi-arid regions. To predict phosphorus fertilizer needs exact fertilizer recommendations, it is required to investigate the available phosphorus remaining in soil. Thus, achieving information about phosphorus and its fractionation in greenhouse soils of Hamedan is the purpose of this study.

Corresponding Author: Masumeh Ghanbari, Department of Agriculture, University of Malayer, Malayer, Iran

MATERIALS AND METHODS

Experiment place

This experiment investigated the condition of phosphorus and its fractionation in some of the greenhouses of Hamedan province. Hamedan is located in the west of Iran in eastern longitude 48°, 20, 49°, 27 and northern latitude 34°, 36 and 35°, 15 with more than 3 thousand years ago. It is semi-arid with annual raining about 300 mm. The rainfall is between Mehr and Ordibehesht and the maximum value is occurred in Aban and Bahman. The average monthly temperature is ranging -4 to 25°C and annual average temperature is 10°C.

Sampling and soil analysis

Based on the number and cultivation area of greenhouse in Hamedan province, randomly 35 green houses in the province (based on the total number of greenhouses in province and variety of fertilization and soil) and surrounding soil from the depth 0-30 cm with focus on greenhouses of Amzagerd township in Hamedan city and 2 combined samples were acquired of each greenhouse. For fractionation phosphorus, these two samples were mixed and a soil sample was collected from outside greenhouses, then the samples were dried in the air and were passing sieve 2mm. The soil tissue was determined based on Stox law and Hydrometry method (Baikas, 1962). Ph of soil in extract 1:5 water to soil was measured by ph meter (Thomas, 1962). Electric conductivity in extract 1:5 water to soil was determined by electric conductivity meter (Redus, 1962). The carbonate calcium was determined by back titration with NaOH (Sims, 1996). The soil organic matter was measured by Walkley –Black method (Ravel 1994). Solution cations including Ca, Mg, Na and K in extract 1:5 water to soil were measured. Exchange cation including Ca, Na, K were extracted by acetate ammonium 1 molar (Ravel 1994) and then Ca and Mg were measured by titrometer and Na and K were measured by Flame Photo Meter. The sum of exchange cations was considered as cation exchange capacity (CEC). It is worth to mention that each of exchange cations was obtained of the required cation in extracting with distilled water (solution) of reading value in extracting method with acetate ammonium. The concentration of the absorbed phosphorus by Olsen method and bicarbonate sodium 0.5 molar in Ph 8.5 as 1 to 20 by Colorimetric method (Morphi and Rayli, 1962) and spectrophotometer were measured. Phosphorus fractionation is done by An et al. (2000) method. To one gram soil inside centrifuge pipes, 40mL chloride potassium 2 molar is added and it is shaken for 2 hours, the required suspension is centrifuged and it is passed through filter paper (dissolved phosphorus+ exchange) on the same soil, 40 cc hydroxide sodium 0.1 molar is added and 17 hours is waited to achieve balance (1 hour shaking, 15 hours silent, 1 hour shaking). Then, the required suspension is centrifuged and filtered (phosphorus in combination with oxide and hydroxides of iron and aluminum). Next, on the same soil sample, 40mL acid hydrochloric 0.5 molar is added, after 24 hours it achieved balance (1 hour shaving, 22 hours silent and 1 hour shaking) and then it is centrifuged and then it is extracted after being filtered (phosphorus in combination with carbonate calcium). On the same soil, 12cc strong nitric acid and 2cc strong Perchloric acid is added and then is put in bath at temperature 80°C (we can keep it for 2 to 6 hours periodically), centrifuge it and then filter it and increase it in flask 50 (by distilled water) and the residual is separated. Finally, one gram soil is put in centrifuge tube and the previous stage is repeated to achieve the total component (the sum of phosphorus concentration in the previous stages is equal to phosphorus concentration in the final stage). The concentration of the phosphorus of the extracts of various stages is read by spectrophotometer and the exchange, with iron oxide and aluminum and the componets with carbonate calcium is separated.

DISCUSSION AND RESULTS

Soil features

Physical-chemical features of studies oil as statistical parameters are shown in Table 1:

Table 1- Maximum, Minimum, range, median and mean of the green house soil characteristics

Exchange calcium (cmolc/kg)	Dissolved sodium (meq/l)	Dissolved potassium (meq/l)	Dissolved magnesium (meq/l)	Dissolved calcium (meq/l)	Organic matter percent	Lime percent	Electric conductivity (ds/m)	PH	Statistical parameter
21.2	10.1	6.5	11.6	27.4	5.2	12.5	4.6	8.9	**Max**
0.8	0.1	0.1	0	0.8	0.6	5.4	0.2	6.7	**Min**
0.8-21.2	0.1-10.1	60.5-0.1	0-11.6	0.8-27.4	0.6-5.2	5.4-12.5	0.2-4.6	6.7-8.9	**Range**
10.7	1.8	1.1	2.2	3	1.9	12.4	0.7	7.3	**Median**
11.1	2.5	1.5	2.8	4.7	2.0	11.9	1.1	7.3	**Mean**

Continuance of Table 1: Maximum, Minimum, range, median and mean of the characteristics of green house soil

Nitrate (mg/kg)	Potassium (extracting: calcium chloride) (mg/kg)	Potassium (Nitric acid extracting) (mg/kg)	Phosphorus (Elsen method) (mg/kg)	Cation exchange capacity (cmolc/kg)	Exchange sodium (cmolc/kg)	Exchange potassium (cmolc/kg)	Exchange magnesium (cmolc/kg)	Statistical parameter
1484.7	1673.9	7291.4	321.2	25.6	1.4	6.5	13.4	**Max**
174.8	38.3	1205.8	8.5	10.0	0	0.1	0.4	**Min**
174.8-1484.7	38.3-1673.9	1205.8-7291.4	8.5-321.2	10.0-25.6	0-1.4	0.1-6.5	0.4-13.4	**Range**
291.4	321.4	2957.9	83.5	16.2	0.3	1.4	3.3	**Median**
197.0	617.5	3600.4	95.3	16.8	0.3	1.6	3.7	**Mean**

Table 2- Max, Min and mean of phosphorous fractions in green house soils as general (mg per kg)

Fraction 4	Fraction 3	Fraction 2	Fraction 1	Statistical parameter
1034.4	724.0	94.8	21.9	**Max**
95.8	30.7	9.7	1.5	**Min**
210.8	253.9	31.4	8.2	**Mean**

Table 3- Max, Min and mean of phosphorous fractions in green house soils (mg per kg)

Fraction 4	Fraction 3	Fraction 2	Fraction 1	Statistical parameter
1009.9	718.4	94.8	21.9	**Max**
115.3	68.5	10.6	1.5	**Min**
200.1	279.3	39.1	8.7	**Mean**

Table 4- Max, Min and mean of phosphorous fractions in soils outside of green house (mg per kg)

Fraction 4	Fraction 3	Fraction 2	Fraction 1	Statistical parameter
1034.4	724.0	45.2	11.4	**Max**
95.8	30.7	9.7	5.3	**Min**
227.0	215.3	19.6	7.5	**Mean**

Table 5- The comparison of the mean of various fractions of phosphorous inside and outside greenhouse (in mg per kg)

		The mean of phosphorus fractions of soil		
Residual fraction	**Carbonate fraction**	**Organic fraction**	**Dissolved fraction**	**Treatment**
a 190.3	a 278.5	A39.1	A8.7	**Inside greenhouses**
b 176.5	b 215.3	^{b}19.6	b 7.5	**Outside greenhouses**

In each column, the simialr alphabets show the lack of significant difference at level 5% based on Duncan test.

Charts

The charts of phosphorus fractions are shown in Figures 1-5. The first step is dedicated to dissolved phosphorus and exchange with blue, second step is dedicated to organic phosphorus with brown, third step is phosphorus carbonate with green and fourth step is phosphorus residual with purple. The charts were considered as inside and outside of greenhouse and Hamedan and suburb cities of Hamedan are plotted separately.

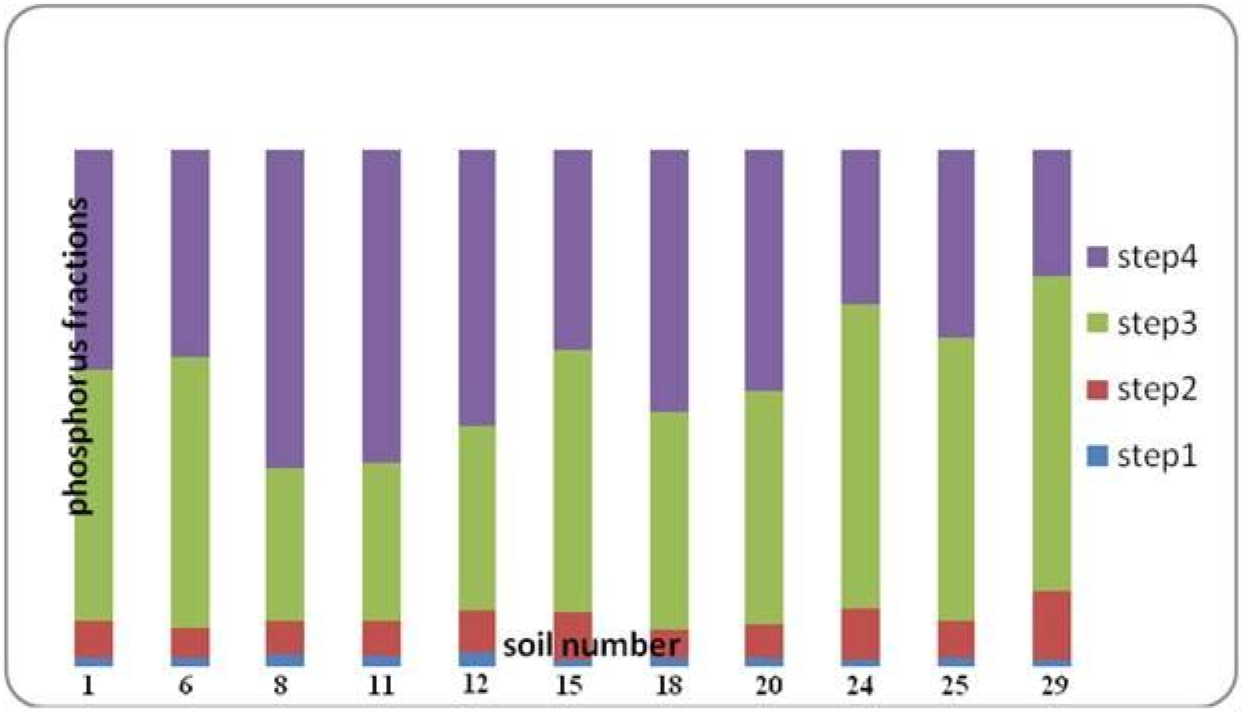

Chart 1- Phosphorus fractions inside greenhouses of Hamedan

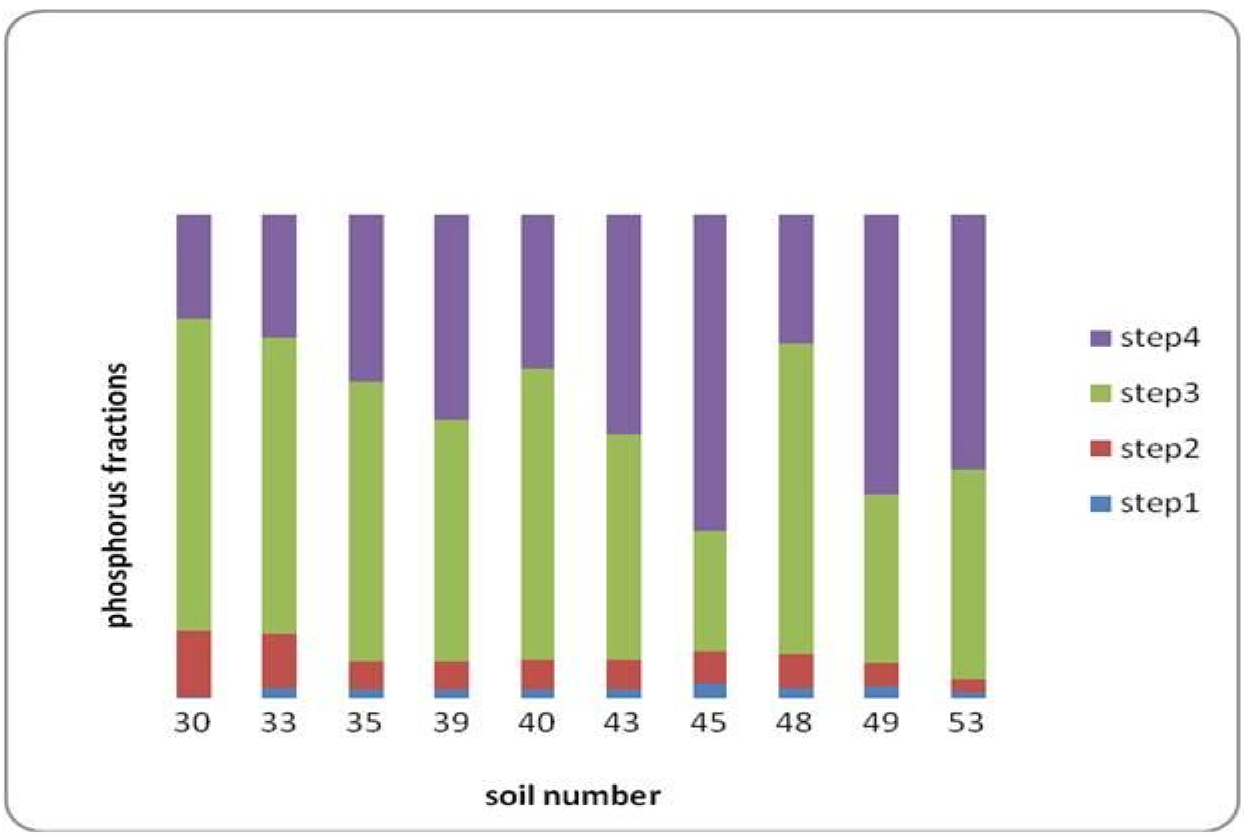

Chart 2- Phosphorus fractions inside soil of Hamedan

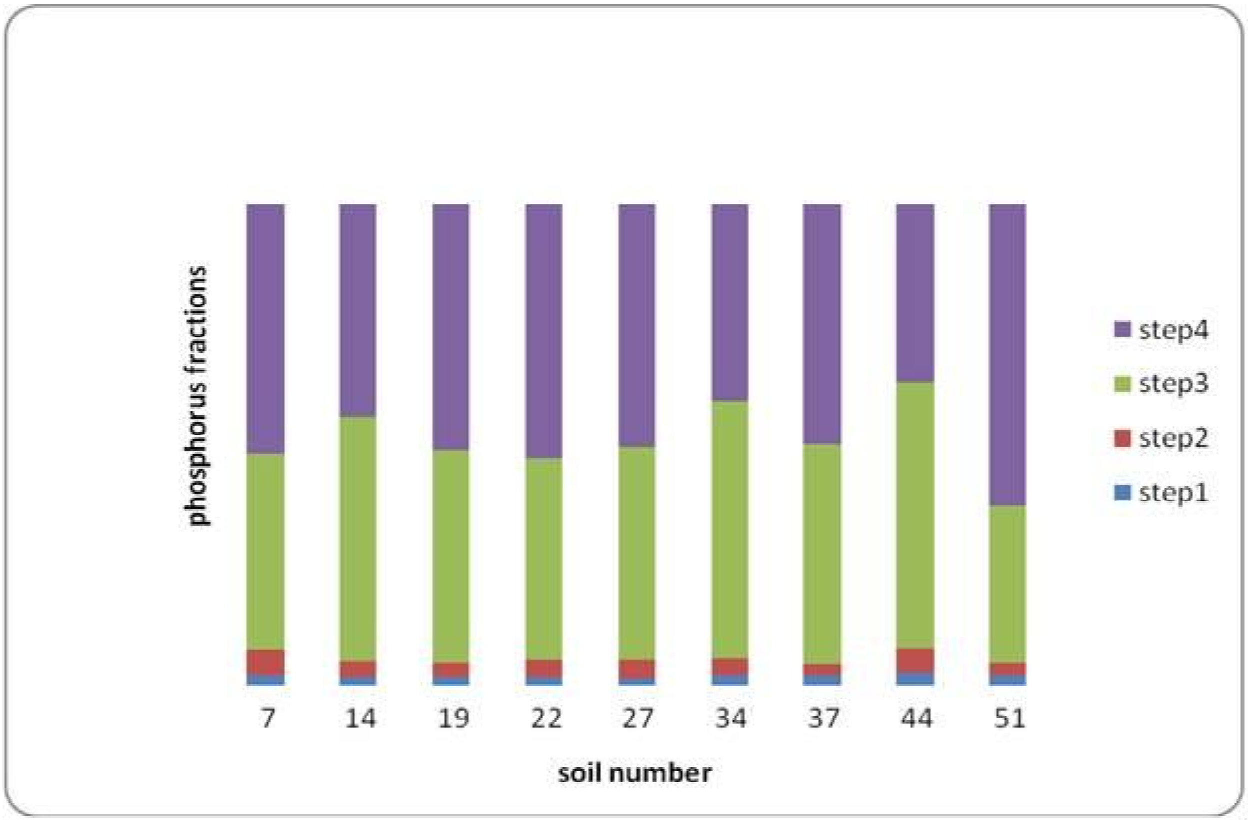

Chart 3- Phosphorus fractions outside of greenhouses in Hamedan

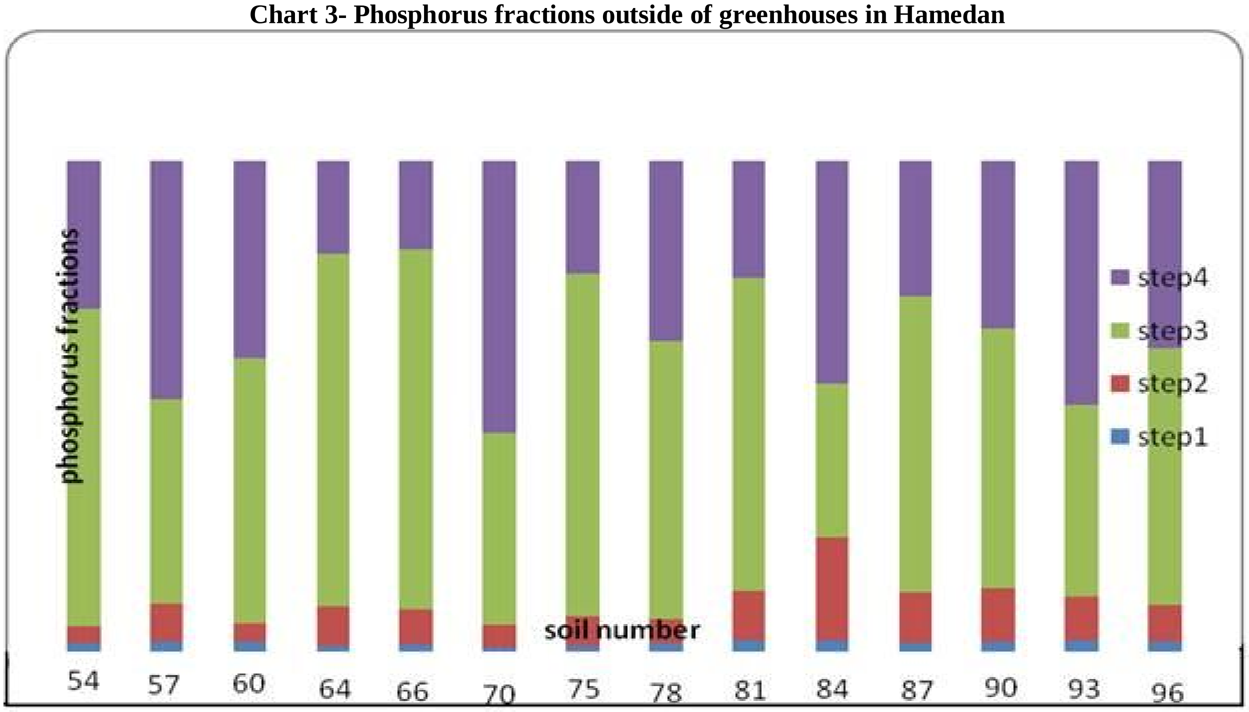

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Chart 4- Phosphorus fraction inside of greenhouses in the cities around Hamedan

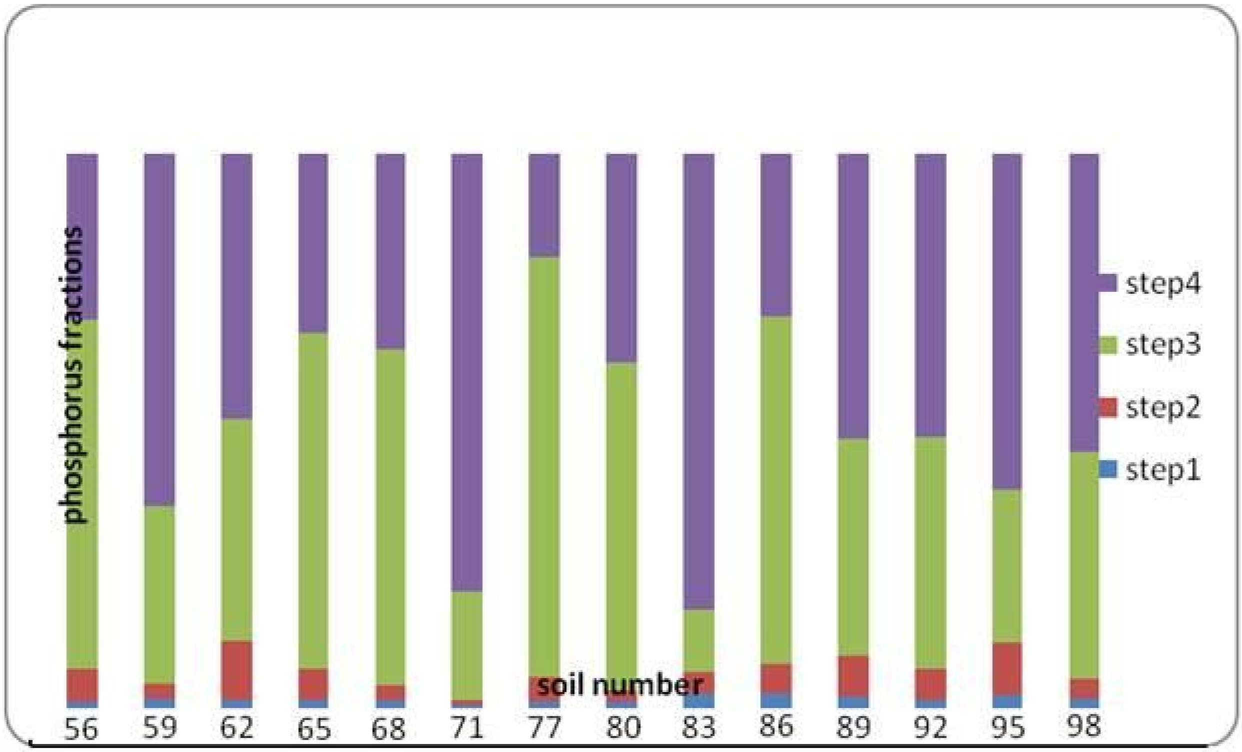

Chart 5- Phosphorus fractions outside the greenhouses around Hamedan city

Combined phosphorus (dissolved and exchange)

Determining the features of soil phosphorus by chemical fraction methods is possible but the general order of the bond difficulty is as exchange-dissolved phosphorus, phosphorus bond with iron and aluminum, phosphorus bond with calcium and residual phosphorus (Radi eta l., 1998, Terner et al., 2005). Phosphorus extracted by chloride potassium indicates soil dissolved phosphorus that is turned into sustainable fractions gradually (2, 3). Combined phosphorous is the most available biological form of phosphorus. In the soil with high combined phosphor storage, the potential of the accessibility of phosphorus for plant is high and in these soils, more phosphorus is exposed to runoff and washing. The majority of phosphorus in soils under various managements due to being exposed to bond phases with calcium or phosphorus residual is available less. According to tables 3, 4 the exchange phosphorus changes and dissolved (fraction 1) in the soils inside greenhouse is 1.53 to 66.6. Outside greenhouses, the changes of dissolved phosphorus and exchange are ranging 5.28 to 11.40. According to Table 5, the mean phosphorus of fraction 1 inside the greenhouses has significant difference with the same fraction outside greenhouses. The dissolved and exchange phosphorus inside the green houses is more than the same place outside greenhouses and the reason of this increase is using organic and non-organic fertilizers of phosphorus inside greenhouses. According to figures 1-5 in experiment soil, the dissolved and exchange fraction had the lowest amount. Jimens-Carslez and Alvarz-Rugel (2008) studied phosphorus storage in lime soils of Spain. They showed that extracted phosphorus with potassium chloride is low and ignorable to total phosphorus.

Phosphorus linked with iron and aluminum

The link fraction with iron and aluminum including phosphorus of) Amorphous (oxy) hydroxides and iron and aluminum crystal oxides.

Phosphorus concentration in this fraction in all treatments was after combined in terms of low amount and this result was similar to the results of Ranjbar (2010) study. Based on table 3, 4 changes range of phosphorus linked with iron and aluminum (fraction 2) in the soil inside greenhouse is 10.62 to 94.83. Outside greenhouse, the changes of phosphorus link with iron and aluminum is ranging 9.74 to 45.18. According to Table 5, the mean phosphorus fraction 2 inside greenhouse was significantly different with this fraction outside greenhouse. The share of phosphorus bound with iron and aluminum of total phosphorus is lower than residual phosphorus and bond with calcium. The existing phosphorus in this section is unstable with the fluctuation of oxidation and reduction conditions in soil (Mor and Redi, 1994). Thus, transferring phosphorus to inside and outside this section can be considered based on environmental conditions. As combined and bond with iron and aluminum are the most available phosphorus storage, it shows the recent entrance of phosphorus to soil via fertilizer.

Phosphorus bond with calcium

Phosphorus concentration in bond with calcium is shown in Figures 1-5. Phosphorus in bond fraction with calcium inside the greenhouse soil is ranging 68.51 to 718.39 mg/kg and in the soil outside greenhouse is 30.70 to 724.03 mg/kg.

Mahmood Soltani and Samadi (2003) in a study of various fractions of phosphorus in lime soils of Fars province reported the changes of calcium phosphate in these soils 126-778 mg/kg.

Of total 58 soils in which phosphorus fractions are used, in 32 treatments, the highest value was dedicated to bounded fraction with calcium, of which 22 treatments were dedicated to the soil inside greenhouse and 10 cases about the soil outside greenhouses. Phosphorus absorption and its sedimentation by calcium indicate more stability of this fraction to the combined and bond with iron and aluminum (Diaz et al., 2006). Thus, the phosphorus in bond with calcium is less exposed to enrichment risk. The major difference between various applications in phosphorus distribution is dedicated to this fraction. Indeed, the extra chemical fertilizers in located in non-organic sections. The application of hen fertilizer and organic residuals in mentioned treatments and lime soil can be the reasons of high phosphorous in this fraction. Hen fertilizer is full of calcium and phosphorous. In addition, organic residuals in soil produce organic and mineral acids affecting the calcium carbonate and lime and release calcium of these compounds in soil (Magoer et al., 2009) and it is combined in the presence of phosphate ion and produces phosphate calcium in soil. Also, the application of phosphate soil in phosphate fertilizer increases phosphate ion concentration in soil and helps the formation of this fraction in soil. Also, calcium entrance to soil via irrigation water can have effect on increasing phosphorus in this fraction. According to Table 5, carbonate fraction in greenhouse soil had significant difference with treatments outside greenhouse. There was a positive correlation between phosphorus bond with calcium and ph., calcium, magnesium and electric conductivity of soil.

Residual phosphorus

The residual phosphorus is associated with Lignin and organic complexes with metals and is recognized as a stable chemical fraction with high bond stability (Terner et al., 2005).

Of total 58 fractioned soils for phosphorus, in 26 cases of treatment soil, the major fraction is dedicated to residual fraction.

Mother materials, microbial activities, soil particles and climate are effective in phosphorus fraction.

According to Table 5, based on statistical comparison at level 5%, there is a significant difference between all fractions of phosphorus in terms of value inside and outside greenhouses.

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