

Original Research Article

<https://doi.org/10.20546/ijcmas.2017.608.088>

Phosphorus Uptake by Fodder Maize (*Zea mays* L.) Influenced by Different Levels of Lead and Farm Yard Manure Grown in Texturally Different Soils

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ABSTRACT

Keywords

Lead, Farm Yard Manure, Pb (NO₃)₂, Phosphorus uptake.

Article Info

Accepted:

04 June 2017

Available Online:

10 August 2017

A pot experiment was laid out to investigate the impact of different levels of Lead and FYM on phosphorus uptake by plant components and total phosphorus uptake by the crop in texturally different soil. Treatments were comprised of five level of Pb (0, 5, 10 20 and 40 ppm) applied as Pb (NO₃)₂ and two levels of FYM (0 and 10 t ha⁻¹) applied on two texturally different soils (Loamy sand and Clayey soils). The Result revealed that phosphorus uptake by plant components and total P uptake was significantly decreased with increased Pb levels (0 to 40 ppm). This might be due to with increasing dose of Pb reducing the uptake of phosphorus through raising the level of toxicity. When organic matter with reactive groups such as hydroxyl, phenoxy and carboxyl effectively controls the adsorption and complexation of Pb and the activity of Pb in the soil, the application of FYM @ 10 t ha⁻¹ gave significantly higher uptake of phosphorus as compared to no FYM explicated plot. In addition, applied FYM has not increased the removal of P by plant along with increasing doses of Pb but its reduced the toxicity of this metal meanwhile reducing trend of P uptake with increasing doses of Pb was same as no FYM treated plot.

Introduction

Lead is non essential element for plants from the view point of plant nutrition. It is one of the major chemical pollutant of the environment and is highly toxic to human beings and animals because it mimics many aspects of the metabolic behavior of the nutrient and inhibits much enzyme system. However, it sets added in the agricultural soil mainly through irrigation with sewage water and industrial effluents from battery, smelter, paint and pigment, fertilizer, pesticides and petroleum. Lead compounds are major pollutants emitted by automobiles. Sewage sludge containing large quantities of Pb and

other metals is regularly discharged on to field and garden soils due to increase trends in urbanization (Paivoke, 2002). The nutrient concentration in plant is also affected by lead. Lead can be accumulated in plant organs and agricultural products (Burzynski, 1987; Mahmoud and El-Beltagy, 1998) and consequently enter human food chain (Wagner, 1993).

FYM is the source of primary, secondary and micronutrient to the plant growth. Farm yard manure (FYM) improves the crop production (Kaihura *et al.*, 1999) and can be used to

reduce heavy metals hazards in plants (Yassen *et al.*, 2007). Organic matter with reactive groups such as hydroxyl, phenoxy and carboxyl effectively controls the adsorption and complexation of heavy metal and the activity of metal in the soil (Lee *et al.*, 2004; Mahmood, 2010). Maize (*Zea mays* L.) is grown for both grain and fodder. It is the ideal forage crop having quick growing habit, high yielding ability, palatability, nutritive value and acceptable to the cattle at any stage of growth. Maize is the indicator crop so it has been selected as a test crop for studying the behaviour of lead in presence of FYM in two different soils.

Materials and Methods

A pot experiment was conducted to study the effect of varying levels of Pb (0, 5, 10 20 and 40 ppm) applied as Pb (NO₃)₂ and two levels of FYM (F0 and F1 *i.e.* 0 and 10 t ha⁻¹) on phosphorus uptake by fodder maize cv. AFRICAN TALL on two types of soil Loamy sand (S₁) of Agronomy farm of Anand and Clayey soil (S₂) of Karvan village Gujarat. The physico-chemical properties of the soil are given in the table 1. The experiment was conducted in Factorial CRD with three replications. The pots were brought to FC and 10 seeds of maize were sown in each pot. After germination, maize plants were thinned to 5 plants per pot.

Pots were regularly watered and weed free condition was maintained till 60 DAS required for maize crop. Irrigation at maturity, the plants were uprooted carefully and after oven drying at 65°C, the dry matter yield of plant components was recorded.

The total phosphorus uptake in plant samples was analyzed following vanadomolybdo-phosphoric acid yellow colour method (Jackson, 1973). The data on uptake was subject to statistical analysis as per methods

suggested by Steel and Torrie (1982). Farm Yard Manure (FYM) was analyzed for its OC, N, P, K, Ca, Mg, micronutrient and heavy metal contents, whereas di ammonium phosphate (DAP) was analysed only for Pb content before incorporation in to the soil. The results obtained are given below (Table 2).

Results and Discussion

The results gained from the present experiment and relevant discussion has been summarized under the following head.

Effect of Pb levels

A significant decreased in uptake by shoot and roots and total P were noted with increasing Pb application (Table 4).

The P uptake decreased with increasing levels of Pb from 0 to 40 ppm in shoot (102.21 to 59.75 mg pot⁻¹), root 48.61 to 27.62 mg pot⁻¹ and total P 150.82 to 87.36 mg pot⁻¹. Kansal *et al.*, (1992) was observed that phosphorus content was found to be negatively correlated with soil Pb in maize crop. This is in agreement with Walker *et al.*, (1997) who reported that Pb decreased the uptake of phosphorus in maize.

Effect of FYM

Result (Table 4) revealed that P uptake by plant parts were significantly higher in FYM treated soil (F₁) as compared to no FYM application (F₀).

The application of organic manure has increasing the phosphorus uptake as compared to no manure application. Similar effects of organic manures were also recorded by Prasad *et al.*, (2010) in maize grown in Alfisols of Jharkhand. Sidhu and Narwal (2003) reported that application of FYM in Pb treated soil increased the P content in maize.

Effect of soil

The clayey soil (S₂) registered higher P uptake by shoot, root and total as compared to that in loamy sand soil (S₁) (Table 4).

It might be ascribed that the low availability of Pb in clayey soil than loamy sand soil and less toxic effect on P uptake.

Interaction effect

Effect of F X S interaction

It is indicated from the result (Table 3) that the shoots of maize grown in FYM treated clayey (F₁S₂) soil accumulated significantly more P over all other treatments. The lowest P uptake was found in (F₀S₁) treatments combination.

Table.1 Initial physico-chemical properties of the experimental soil

Sr.No	Characteristics			Reference
A	Characteristics			
	Mechanical Analysis	Anand	Karvan	
1	Coarse sand (%)	4.47	7.80	Piper (1966)
2	Fine sand (%)	77.94	22.71	
3	Silt (%)	10.95	21.73	
4	Clay (%)	6.12	47.26	
5	Texture	Loamy sand	Clayey	
6	WHC (%)	33.00	51.00	
7	CEC [cmol (p+) kg ⁻¹]	17.00	32.50	Jackson (1973)
B	Chemical Analysis			
1	pH (1:2.5)	7.4	8.02	Jackson (1973)
2	EC (1:2.5) dS m ⁻¹	0.13	0.62	
3	Organic carbon (%)	0.386	0.451	Walkley and Black (1934)
4	Available P ₂ O ₅ (kg ha ⁻¹)	26.34	34.28	Olsen <i>et al.</i> , (1954)
5	Available K ₂ O (kg ha ⁻¹)	213.17	323.49	Jackson (1973)
6	Available S (ppm)	4.72	4.51	Chesnin and Yien (1950)
7	DTPA- Pb (ppm)	0.20	0.34	Lindsay and Norvell (1978)

Table.2 Chemical composition of FYM and fertilizer used in experiment

Elements	OC	N	P	K	Ca	Mg	Zn	Fe	Cu	Mn	Pb
	(%)						(ppm)				
FYM	27.7	0.61	0.34	0.30	0.53	0.61	136	545	193	57	0.42
DAP	-	18	46	-	-	-	-	-	-	-	-

Table.3 Interaction effect of FYM and soil on P uptake by maize

Types of soil	FYM levels	
	F ₀	F ₁
	P uptake by Shoot	
S ₁	60.46	81.79
S ₂	83.68	94.67
F X S	SEm ±	2.11
	CD @ 5%	6.04

Table.4 Effect of lead and FYM on P uptake by maize grown in different soils

Treatment	P uptake (mg pot ⁻¹)		
	Shoot	Root	Total
Levels of Pb (Pb)			
Pb ₀ : 0 ppm	102.21	48.61	150.82
Pb ₁ : 5 ppm	90.62	43.57	134.19
Pb ₂ : 10 ppm	79.70	39.71	119.42
Pb ₃ : 20 ppm	68.46	34.72	103.19
Pb ₄ : 40 ppm	59.75	27.62	87.36
SEm ±	2.36	0.64	2.74
CD @ 5 %	6.75	1.82	7.82
Levels of FYM (F)			
F ₀ : 0 t ha ⁻¹	72.07	36.38	108.45
F ₁ : 10 t ha ⁻¹	88.23	41.31	129.55
SEm ±	1.49	0.40	1.73
CD @ 5 %	4.27	1.15	4.95
Types of soil (S)			
S ₁ : Loamy sand	71.13	35.27	106.40
S ₂ : Clayey	89.18	42.42	131.60
SEm ±	1.49	0.40	1.73
CD @ 5 %	4.27	1.15	4.95
CV %	10.22	5.69	7.97

Table.5 Interaction effect of lead and soil on P uptake (mg pot⁻¹) by of maize

Types of soil	Pb levels				
	Pb ₀	Pb ₁	Pb ₂	Pb ₃	Pb ₄
	P uptake by root				
S ₁	42.30	39.08	35.34	32.51	27.12
S ₂	54.93	48.05	44.08	36.94	28.12
Pb X S	SEm ± 0.90 CD @ 5% 2.58				
	Total P uptake				
S ₁	130.38	119.70	107.06	94.73	80.10
S ₂	171.27	148.68	131.77	111.64	94.62
Pb X S	SEm ± 3.87 CD @ 5% 11.07				

Effect of Pb X S interaction

The P uptake by roots and the total P were significantly higher when they grown in clayey soil (S₂) as compared to loamy sand soil (S₁) under different Pb levels (Table 5).

The lowest P uptake was noticed under 40 ppm Pb application to the soil in all the cases.

In conclusion, the result of pot experiment revealed that phosphorus uptake in plant components significantly decreased when 40

ppm Pb was added. The total phosphorus uptake by maize significantly decreased at each level of Pb application. Among the soil, plant depleted more phosphorus when grown in clayey soil than loamy sand soil. The phosphorus removal was significantly higher in FYM treated soil as compare to no FYM treated soil.

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How to cite this article:

Patel, V.J., J.C. Patel, S.V. Rathod and Mori, B.J. 2017. Phosphorus uptake by Fodder Maize (*Zea mays* L.) Influenced by Different Levels of Lead and Farm Yard Manure Grown in Texturally Different Soils. *Int.J.Curr.Microbiol.App.Sci*. 6(8): 697-701.
doi: <https://doi.org/10.20546/ijcmas.2017.608.088>