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IMPACT OF FARMYARD MANURE ON THE AVAILABILITY OF SOME HEAVY METALS IN FLOODED RICE SOILS IRRIGATED WITH DRAINAGE WATER

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ABSTRACT

A field experiment was conducted in summer season 2007 at the farm of Rice Research and Training Center farm Kafr El-Sheikh to study the impact of FYM and urea and their combination with using drainage water for irrigation on availability of some heavy metals such as Lead(Pb), nickel (Ni), Cadmium (Cd). Results indicated that the highest values of available pb^{+2}, Ni^{+2}, Cd^{+2} were found with the combination of 150 kg urea plus the rate of 9 ton FYM.Fed^{-1}. Data indicated that ,the lowest values of available Cd^{2+},Ni^{2+} and pb^{2+}in soil were found at flowering stage compared with the other stages at all treatments. The results of simple correlation coefficient (r)between organic matter (OM) (y) and each of available Pb^{+2} (X_1), available Ni^{+2} (X_2) and available Cd^{+2} (X_3) at harvest stages showed the character most closely associated with organic matter was the available Pb^{+2} (X_1) (R= 0.9) . Multiple linear regressions showed that the prediction equation for organic matter was formulated as follows:

$Y = -0.8+ 0.224 X_1 + 0.301X_2 + 2.62 X_3$

INTRODUCTION

In arid and semi arid regions where water is most scarce and soil fertility is low, the concept of irrigation with poor quality water is becoming more important. So, Egypt started to look for drainage water reuse for irrigation in order to, cover the shortage of fresh water and meet their demands for more food production such, water may added heavy metals to the soil.

In some areas, this water is polluted by the sewage effluents which are damped into the agriculture drainage system. In north delta region, soils irrigated by drainage water polluted by waste water effluent of some factories were higher in heavy metals content than the normal soil (Zein et al 1998).

Increasing levels of heavy metals in soil irrigated with sewage sludge are considered to cause potentially serious hazards in the soil, plant and animal system (Aboulroos et al 1991).

The mobility of heavy metals in soils differs according to the soil condition, soil pH, type of element and organic matter content are the most important soil components affecting heavy metals movement and accumulation.

Organic materials such as crop residues, FYM and rice straw are available in abundance and reach tremendous amount day after day. Obviously, this means the loss of a great proportion of the organic matter needed to be composed to keep soil productivity. On the other hand, organic matter plays an important factor in the mobility of heavy metals in soil.

Organic matter contains many functional groups which sequestrate and chelate many trace elements such reactions affect the equilibrium of elements in the soil and consequently the plant uptake of these elements by plants.

MATERIALS AND METHODS

A field experiment was conducted at the Rice Research and Training Center Farm using Giza 178 rice variety (*Oryza sativa* L.) to achieve the study objectives. The experiment was conducted in clayey soil , some of its physical and chemical characteristics were determined according to the standard procedures as described by Cottenie et al., (1982) and Page et al., (1982) (Table 1).

Table 1: Some mechanical and chemical analyses of soil used

Tested characteristics	Value
Piratical size distribution	
Sand %	27.3
Silt %	28.64
Clay %	44.06
Texture class	Clayey
PH (1:2.5 soil water suspension)	8.10
EC_e (soil paste extracted at 25c^0 dS.m^{-1})	3.00
OM (organic matter) %	
Total carbonate %	1.65
Soluble cations, meq.l^{-1}(soil paste):	
Ca^{++}	9.5
Mg^{++}	3.94
K^{+}	1.76
Na^{+}	14.8
Soluble anoins,meq.l^{-1}(soil paste):	
CO_3^{--}	-
HCO_3^{--}	6.00
Cl^{-}	8.30
SO_4^{--}	15.7
Available heavy metals:	
Pb ppm	1.60
Ni ppm	1.12
Cd ppm	0.015

The randomized complete block design with four replications was used, involving 12 treatments derived from 3 N- fertilizer (0 , 46 and 69 Kg N. fed^{-1}) combined with Farmyard manure at the rate of 0, 3, 6 and 9 ton FYM .fed $^{-1}$. FYM was added before transplanting. Urea was added in two splits, 2/3 before transplanting and the other 1/3 one month after transplanting.

The obtained date of the organic matter, available pb^{+2}, available Ni^{+2} and available Cd^{+2} were subjected to simple correlation and regression. The same data were also subjected to multiple linear regressions and stepwise according to this formula:

$Y = a + b_1x_1 + b_2x_2 + b_3x_3$ according to Hammad, (1995).

RESULTS AND DISCUSSION

Heavy metals availability in soil

1- lead (Pb) availability:

Table 2 Show the available Pb in soil treated with farm yard manure (FYM) and urea treatment and their combination at different stages of rice growth. Data illustrated that available Pb increased with increasing levels of FYM added to the soil either, alone or in combinations with urea at all stages compared with the control. These results are in accordance with those obtained by Kandil Hala (2005). Results also, indicated that the highest values of available Pb (4.31, 5.85, 5.09 and 5.35 ppm) were recorded with combinations with urea at 150 kg. fed^{-1} plus the rate of 9 tons $FYM.fed^{-1}$ treatment at maximum tillering, panicle initiation, flowering and at harvest, respectively. These results are in harmony with those obtained by Huang et al.,(1995)

Data in the same table showed that the available Pb increased at all treatments with time till panicle initiation then tended to decrease at later stages of rice growth (flowering and at harvest). This finding and conclusion are in agreement with the results obtained by (Yanni ,1979) who observed the large amount of CO_2 formed under anaerobic conditions due to the decomposition of starch might have converted some insoluble heavy metals to more soluble. Data indicated also, that lowest values of available Pb in soil were found at flowering stage compared with the other stages at all treatments. This could be attributed to Pb organic complexes which are rather stable (Kabata- Pendias and Pendias, 2000).

Table 2: Effect of farmyard manure (FYM) and different rates of urea and their combination on available lead (Pb) at different stages of rice growth (ppm).

Treatments	Urea kg. fed^{-1}	FYM t. fed^{-1}	Maximum tillering	Panicle initiation	Flowering	Harvest
N0F0	0	0	3.57	4.79	4.08	4.31
N0F1	0	3	3.72	4.93	4.38	4.52
N0F2	0	6	3.88	5.17	4.62	4.85
N0F3	0	9	3.97	5.32	4.83	5.02
N1F0	100	0	3.53	4.76	4.33	4.57
N1F1	100	3	3.82	5.16	4.59	4.75
N1F2	100	6	3.92	5.42	4.77	4.91
N1F3	100	9	4.03	5.74	4.92	5.20
N2F0	150	0	3.68	4.83	4.42	4.65
N2F1	150	3	3.94	5.38	4.73	4.86
N2F2	150	6	4.15	5.56	4.88	5.01
N2F3	150	9	4.31	5.85	5.09	5.35

2-Nickel (Ni) availability:

Table 3 shows the available Ni in soil treated with FYM and urea treatment and their combinations at different stages of rice growth.

Data revealed that at all stages of rice growth (maximum tillering, panicle initiation, flowering and at harvest) available Ni in soil increased with increasing the levels of FYM, whether, added to the soil alone or in combinations with urea compared to the control. These results are in accordance with those obtained by Kabata – Pendias and Pendias (2000) who found that reaction between organic matter and Ni which led to the solubility of humic acid complexes with Ni at high pH (7 to 9.3) and precipitation at low pH.

Data also, indicated that the highest values of available Ni (4.62, 3.23, 3.01 and 3.90) were attained with combinations of urea at 150 kg urea plus the rate of 9 tons FYM.fed^{-1} treatment at maximum tillering, panicle initiation, flowering and at harvest respectively. These results are in harmony with those obtained by Stevenson (1995) who observed that organic complexes agents act as carriers of trace elements in the soil solution, thereby enhancing the availability of trace elements to plant, as well as to soil micro organisms.

Data in the same Table showed that available Ni decreased with progress stages of rice growth. This could be attributed to 1) The absorption of Ni by plant. 2) Sulphate ions which reduced to sulphides under flooded conditions and this can lead to the precipitation of metal sulphides such as PbS, NiS and CdS. 3) Metal ion concentrations levels in the soil solutions may be reduced to nontoxic through complex with organic matter. This is particularly true when the metal organic complexes has low solubility such as in the case of complexes with humic acids and other high molecular weight components of organic matter (Abou Seeda *etal*,1997). Data clearly show that the highest values of available Ni were found at maximum tillering stage at all treatments and then decreased with other stages (panicle initiation, flowering and at harvest).

Table (3): Effect of farm yard manure (FYM) and different rates and their combination of urea on available nickel (Ni) at different stages of rice growth (ppm).

Treatments	Urea Kg. fed^{-1}	FYM t. fed^{-1}	Maximum tillering	Panicle initiation	Flowering	Harvest
N0F0	0	0	3.52	2.01	1.91	2.84
N0F1	0	3	3.79	2.21	2.28	3.02
N0F2	0	6	3.95	2.52	2.39	3.29
N0F3	0	9	4.13	2.86	2.65	3.40
N1F0	100	0	3.84	2.09	1.94	2.83
N1F1	100	3	4.04	2.49	2.39	3.20
N1F2	100	6	4.25	2.89	2.69	3.50
N1F3	100	9	4.53	3.08	2.91	3.70
N2F0	150	0	4.02	2.14	2.09	3.16
N2F1	150	3	4.27	2.81	2.67	3.36
N2F2	150	6	4.45	2.23	2.91	3.72
N2F3	150	9	4.62	2.23	3.01	3.90

2- Cadmium (Cd) availability:

Available cadmium (Cd) in soil (ppm) as affected by the applications of farm yard manure (FYM) and urea treatments and their integration at different stages are presented in Table (4). Data revealed that at all stages of rice growth, available Cd in soil increased with increasing levels of FYM added to the soil either separated or in combinations with urea compared with the control. These might be first, due to as alkalinity increases Cd adsorbtion decreases. Probably due to the competition from Ca^{+2} and Mg^{+2} ions. Second, complexing and chelation of Cd with organic ligands led to solubilities of humic acid complexes with Cd. Third, the soil pH values under flooded soil tend to neutrality. Fourth, in alkaline soil, monovalent hydroxy ion species are likely to occur ($CdOH^{+}$), which not easily occupy the sites on cationic exchange capacity. These results are in quite agreement with those reported by Kabata- pendias and pendias (2000).

Concerning to changes of available Cd in soil through different stages of rice growth. Data in the same Table illustrated that the available Cd^{2+} increased at all treatments with lapse of time at maximum tillering and panicle initiation but their trended to decrease at later stages of rice growth (flowering and at harvest). This increase of available Cd^{2+} during maximum tillering and panicle Initiation may be due to organic acids release as a result of organic matter fermentation caused decrease of soil pH. These results are in harmony with those obtained by (Yanni 1979).

It is clear from the data the lowest values of available Cd^{2+} in soil were attained at flowering stage compared with the other stages at all treatments. It may be attributed to 1) Increase head of water over surface soil, with progress height of rice plant, which increases anaerobic conditions that caused a reduction of sulphate ions to sulphides which form a complex with Cd^{2+} and Ni and immobilize them as sulphide salts 2) Humic materials in anaerobic system are usually characterized by large molecular weight and greater structural complexity, caused increase metal retention capacity (Chen and Avnimelech 2002).

Table (4): Effect of farmyard manure (FYM) and different rates of urea and their combination on available cadmium (ppm) at different stages of rice growth.

Treatments	Urea Kg. fed^{-1}	FYM t. fed^{-1}	Maximum tillering	Panicle initiation	Flowering	Harvest
N0F0	0	0	0.192	0.194	0.178	0.180
N0F1	0	3	0.259	0.274	0.201	0.185
N0F2	0	6	0.275	0.293	0.208	0.213
N0F3	0	9	0.287	0.296	0.224	0.268
N1F0	100	0	0.225	0.239	0.185	0.164
N1F1	100	3	0.271	0.282	0.212	0.213
N1F2	100	6	0.283	0.293	0.222	0.238
N1F3	100	9	0.295	0.306	0.239	0.274
N2F0	150	0	0.225	0.234	0.189	0.174
N2F1	150	3	0.281	0.276	0.218	0.213
N2F2	150	6	0.297	0.308	0.233	0.249
N2F3	150	9	0.313	0.314	0.248	0.280

Simple correlation coefficient (r) between organic matter (OM) (y) and each of available Pb^{2+} (X_1), available Ni^{2+} (X_2) and available Cd^{2+} (X_3) at harvest stages indicated that the character most closely associated with organic matter was the available Pb^{2+} (X_1).The simple correlation coefficient between y and x was 0.9. The simple regression equation for predicting organic matter was computed from the following equation

Y = -6.43223 + 2.60501X - 0.181143X2 with**
R-Sq = 82.8% (fig.1)

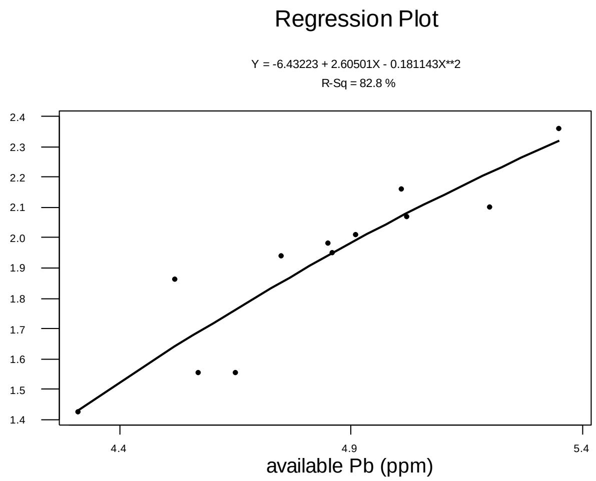

Fig.1 Simple regression coefficient between organic matter and available Pb as affected by different treatments in 2007 season.

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تأثير استخدام السماد البلدي علي تيسر بعض العناصر الثقيلة في اراضي الارز المروية بمياه الصرف.

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****مركز البحوث والتدريب فى الأرز- سخا- كفرالشيخ**

أجريت تجربة حقلية في موسم ٢٠٠٧ في مزرعة مركز البحوث والتدريب في الأرز –كفر الشيخ مستخدماً صنف الأرز جيزة ١٧٨ وذلك بهدف دراسة تأثير بعض الأسمدة العضوية (السماد البلدي) والأسمدة الكيماوية (اليوريا) على تيسر بعض العناصر الثقيلة مثل الكادميوم والنيكل والرصاص في اراضي الأرز المروية بماء الصرف. أوضحت النتائج أن أعلى قيمة ميسرة للكادميوم والنيكل والرصاص ظهرت عند استخدام ٩طن سماد بلدي +١٥٠ كجم نيتروجين . فدان $^{-1}$.
أظهرت النتائج ايضا ان اقل القيم للعناصر الميسرة وجدت عند مرحلة التزهير مقارنة بباقي المراحل.
وجد من النتائج ايضا من المعادلات الخطية أن اكثر العناصر ارتباطا بالمادة العضوية هو عنصر الرصاص ويتضح ذلك من المعادلة الأتيه:

$Y = -6.43223 + 2.60501X - 0.181143X^{2}$ with R-Sq = 82.8%

Y= organic matter X= available lead