J. Agric. Sci. Mansoura Univ., 34 (10): 10233 - 10244, 2009

CONCENTRATION AND TRANSLOCATION OF CD IN RICE PLANT IRRIGATED WITH CONTAMINATED WATER AS AFFECTED BY ORGANIC AND INORGANIC FERTILIZER.

Hammad, S. *; E. Naeem and Howida B. El-habet ****

*** Soil Sci. Dept. of Agric., Mansoura Univ., Egypt.**

**** Rice Research and training Center Sakha, Kafr EL-Sheikh**

ABSTRACT

The variation among different rice plant organs in cadmium (Cd) concentration and translocation were investigated with field experiments. The results showed that Cd concentration in rice straw and grains didn't exceed the critical limits of Cd at all addition levels of composted rice straw (CRS) to the soil whether alone or in combination with urea. Translocation of Cd within rice plant organs at maximum tillering ((TC_{MT}), panicle initiation (TC_{PI}), flowering (TC_F), from roots to straw at harvest (TC_1) and from straw to grains at harvest (TC_2) increased with increasing levels of CRS added to the soil either separately form or combined with urea. Cd translocation percentage within plant organs decreased with time and can be descended in the following order: $TC_{MT} > TC_{PI} > TC_F > TC_1 > TC_2$. Available Cd increased to a peak at 9 tons CRS plus 150 kg urea.fed^{-1} at all stages of growth, but the highest values of available Cd was found at panicle initiation stage compared with the other stages of growth irrespective of treatments. Increasing the total Cd concentration in soil up to the third levels of CRS (9 tons.fed^{-1}) added to the soil either alone or combined with urea compared with the control. The total Cd concentration increased with all treatments with time and the highest values of the total Cd concentration were found at harvest stage.

INTRODUCTION

Reuse of drainage water has been practiced in Egypt since the beginning this century. The drainage water contains amount of Cd which may enhance of Cd in soil. Soil fertility and crop production may be reduce according to accumulation of Cd in soil which increased Cd amount taken up by plant. Cd is considered as being one of the most ecotoxic metals that exhibits adverse effects on all biological processes of plants, animals and humans. This metal reveals its great adverse potential to affects the environmental and the quality of food (Kabata Pendias and Mukhetjee 2007). Composting is defined in general as the practice of employing biological reduction of organic metals to humus. Compost has the unique ability under proper use and application conditions to improve the chemical, physical and biological characteristics of soil. Organic matter plays an important role in the chemical behavior of Cd in soil. Also the amount and type of organic matter in the soil can affect the Cd solubility by complexation and chelation.

Total Cd content of soils ranged from 0.01 to 1.1 ppm with an average value around 0.06 ppm. The higher Cd content in the surface soil is often the result of human activity (Srivastava and Gupta 1996).. The abundance of (Cd) in magmatic and sedimentary rocks does not exceed around 0.3 ppm and shale deposits (Kabata-Pendias and Pendias., 1999). The concentration of Cd accumulated in the different parts of the rice plants as a result of Cd uptake from soils. Accumulations of Cd is the highest in roots, about 20-30 times higher than in stems and leaves and about 100-200 times higher than grains(Le Huy Ba, (2001). Regular consumption of plants containing 3 ppm Cd can poison man and animal, it interferes with other proteins. In livestock, it accumulates in kidneys, spleen and liver (Tuker *et al.*, 2003). The present work was designed to evaluate the combination of composted rice straw plus different rates of nitrogen as urea on :

1) Concentrations of Cd in rice plant organs (root, shoot, straw and grains).
2) Translocation coefficient of Cd through plant organs at different stages of growth.
3) Availability and total concentration of Cd in soil at different stages of rice growth.

MATERIALS AND METHODS

Two field experiments were conducted at the farm of Rice Research & Training Center (RRTC) at Kafr El-Sheikh using rice plant (*Oryza Sativa*), Giza178 cultivar during 2007 and 2008 seasons.

The experiment aimed to study the effect of different rates of organic fertilizer (CRS), inorganic fertilizer (urea) and their integrations in flooded rice soil irrigated with drainage water (waste water + agricultural drainage water) on: 1) Concentrations of Cd in plant parts and its translocation coefficient through different rice plant organs 2) Availability and total Cd concentration in rice soil at different stages of growth (maximum tillering, panicle initiation, flowering and at harvest). The experimental design system of layout was randomized complete block with four replications. The treatments of experiments were as shown in Table 1. Composted rice straw was incorporated with soil before transplanting and urea was added in two splits, 2/3 before flooding and 1/3 one month after transplanting. Plots were fertilized with super phosphate (7 % P) at the rate of 100 $kg.fed^{-1}$ (0.286 kg super phosphate /12 m^2) before flooding. Plants in each plot (12 m^2) were harvested for grain yield. Plants were left for drying about three days, and then threshed. The weight of grains was recorded and moisture content was measured then grains weight was calibrated to 14 percent moisture basis. Mechanical and chemical analysis of soil was determined according to Cottenie *et al.* (1979) and Page *et al.* (1982). The results are presented in Table 2. Soil was sampled at the four times (maximum tillering, panicle initiation, flowering and at harvest) then stored in the refrigerator for analysis to monitor Cd behavior in the soil.

Plants were sampled four stages and separated into roots and shoots at tillering, panicle initiation and flowering while, at harvest stage roots, straw and grains were taken. All plant samples were oven dried at 70 c for 48 hours then ground and kept in plastic bags for chemical analysis.

Water was sampled at the four times (maximum tillering, panicle initiation, flowering and at harvest) for analysis and the values were 0.030, 0.033, 0.031 and 0,035 ppm respectively.

Translocation coefficient(TC) of heavy metals through rice plant organs were computed according to Zein *et al.* (2002).

I-The translocation coefficients % (TC) of metal from roots to shoots was calculated as the following equations:

$$TC = \frac{\text{Concentration of heavy metal in shoots (mg.kg}^{-1})}{\text{Concentration of the same heavy metal in roots (mg.kg}^{-1})} \times 100$$

The translocation of metal from roots to shoots denoted as (TC_{MT}) at maximum tillering, (TC_{PI}) at panicle initiation and (TC_F) at flowering stage.

II-The translocation of metal from roots to straw (TC) was calculated as following:

$$TC_1 = \frac{\text{Concentration of heavy metal in straw (mg.kg}^{-1})}{\text{Concentration of the same heavy metal in roots (mg.kg}^{-1})} \times 100$$

III-The translocation of metal from straw to grains (TC) was calculated as following:

$$TC_2 = \frac{\text{Concentration of heavy metal in grains (mg.kg}^{-1})}{\text{Concentration of the same heavy metal in straw (mg.kg}^{-1})} \times 100$$

Table 1: Experiment treatments.

Treat. No.	Composted rice straw (CRS)	Abbreviation	Treat. No.	Composted rice straw (CRS)	Abbreviation
1	Control	N_0C_0	7	6 tons CRS + 46 kg N. fed^{-1}	N_1C_2
2	3 tons CRS. fed^{-1}	N_0C_1	8	9 tons CRS + 46 kg N. fed^{-1}	N_1C_3
3	6 tons CRS. fed^{-1}	N_0C_2	9	69 kg N. fed^{-1}	N_2C_0
4	9 tons CRS.fed^{-1}	N_0C_3	10	3 tons CRS + 69 kg N. fed^{-1}	N_2C_1
5	46 kg N. fed^{-1}	N_1C_0	11	6 tons CRS + 69 kg N. fed^{-1}	N_2C_2
6	3 tons CRS + 46 kg N. fed^{-1}	N_1C_1	12	9 tons CRS + 69 kg N. fed^{-1}	N_2C_3

N= inorganic fertilizer **C=composted rice straw**

Table2: Some mechanical and chemical characteristics of the used soil.

Tested characteristics	Value(2007)	Value(2008)
Particle size distribution		
Sand %	27.3	13.2
Silt %	28.64	32
Clay %	44.06	55.8
Texture class	Clay	clay
pH (1:2.5 soil water suspension)	8.10	8.19
Ec_e (soil paste extracted at 25 C° dS.m^{-1})	3.00	3.1
OM (organic matter) %	1.65	1.6
Soluble cations, meq.l^{-1}(soil paste):		
Ca^{++}	9.5	10
Mg^{++}	3.94	3.98
K^+	1.76	1.8
Na^+	14.8	15.2
Soluble anions, meq.l^{-1}(soil paste):		
CO_3^{-}	-	-
HCO_3^-	6.00	6.75
Cl^-	8.30	8.44
SO_4^{--}	15.7	15.79
Available Cd mg/Kg soil	0.015	0.017
Aqua- Regia extracted elements (Total)		
Cd mg/Kg soil	8.10	8.15

The analysis of compost showed that the C:N ratio was 18.68 and 18.9 with 1.82 and 1.9 % N, 0.78 and 0.75% P, 1.93 and 1.96 % K, 29 and 31ppm Pb,18.6 and 19.4 ppm Ni and 0.6 and 0.615 ppm Cd in season 2007 and 2008 respectively.

RESULTS AND DISCUSSION

Cadmium (Cd) concentration in rice plant organs:

Data in Tables 3, 4, 5 and 6 represent Cd concentration in rice plant organs through different rice growth stages as affected by the application of CRS and urea treatments and their combinations. Results indicate that Cd concentration in plant organs progressively increased with increment CRS level whether separated or combined with urea at all stages as compared to the control. This is may be due to:

1) The Cd content of CRS.
2) The mobility of Cd in soil due to the formation of complexes or metal chelates.

Table 3: Cd concentrations (ppm) in rice plant organs as affected by the studied treatments at different stages of growth in season 2007.

Treatments	Urea kg.fed^{-1}	CRS t.fed^{-1}	Maximum tillering		Panicle initiation		Flowering	
			Roots	Shoots	Roots	Shoots	Roots	Shoots
N_0C_0	0	0	30.45	11.90	34.20	12.20	26.70	7.52
N_0C_1	0	3	33.07	13.07	38.32	15.30	30.32	10.30
N_0C_2	0	6	36.58	15.90	40.75	18.10	32.07	12.50
N_0C_3	0	9	40.92	21.80	43.15	21.90	35.20	13.90
Mean			**35.25**	**15.66**	**39.10**	**16.87**	**31.07**	**11.05**
N_1C_0	100	0	30.92	12.30	35.80	12.90	27.01	7.92
N_1C_1	100	3	35.77	16.20	40.35	18.30	31.30	11.07
N_1C_2	100	6	38.93	17.95	44.85	20.53	33.10	12.90
N_1C_3	100	9	43.20	21.23	47.12	24.23	36.80	14.08
Mean			**34.01**	**16.92**	**42.03**	**18.99**	**32.05**	**11.49**
N_2C_0	150	0	31.50	12.67	36.30	13.12	28.20	8.12
N_2C_1	150	3	37.60	17.87	42.80	19.63	33.30	12.11
N_2C_2	150	6	41.98	18.23	46.30	22.50	36.80	13.50
N_2C_3	150	9	46.90	22.72	51.90	25.70	41.30	15.20
Mean			**39.49**	**17.87**	**44.32**	**20.23**	**34.90**	**12.23**

Also, Srivastava and Gupta (1996) found that the fixation of Cd by organic matter is operative under the acidic condition (soil pH 4-6) but the solubilization of Cd by organic matter occurs in the range of the soil pH (7-8).

It is clear from the data that the highest values of Cd concentration were found with the treatment of 9 tons CRS plus 150 kg urea.fed^{-1} at all stages of growth. Results also, indicated that the high Cd concentrations in plant (roots and shoots) were found at panicle initiation stage at all treatments as compared to the other stages. This probably due to that the available Cd in soil at panicle initiation was higher than the other stages.

Data also show that the shoots accumulated higher Cd than seeds. This may be due to that translocation of Cd from roots to shoots through the xylem is easier; however in the later stages Cd translocation from leaves to seeds is usually slow (Srivastava and Gupta., 1996).

Data reveal that roots accumulated higher Cd level than shoots, straw and grains at all stages (Tables 3, 4, 5 and 6). These results agreed with the findings of Kabata- Pendias and Pendias (2000) and Kabata-Pendias and Mukherjee, (2007) who found that usually Cd concentration is the highest in roots and decreases towards the top plants.

Table 4: Cd concentrations (ppm) in rice plant organs as affected by the studied treatments at different stages of growth in season 2008.

Treatments	Urea kg.fed^{-1}	CRS t.fed^{-1}	Maximum tillering		Panicle initiation		Flowering	
			Roots	Shoots	Roots	Shoots	Roots	Shoots
N_0C_0	0	0	31.8	12.30	36.3	13.10	27.80	7.9
N_0C_1	0	3	34.8	13.53	39.20	15.83	33.40	11.50
N_0C_2	0	6	38.9	61.90	43.0	19.50	35.8	13.70
N_0C_3	0	9	45.3	22.98	45.80	23.33	37.20	14.90
Mean			**37.70**	**16.42**	**41.07**	**17.94**	**33.55**	**12.0**
N_1C_0	100	0	32.50	12.60	36.70	13.30	27.90	8.15
N_1C_1	100	3	38.50	16.60	42.40	19.90	32.4	11.75
N_1C_2	100	6	42.50	18.50	47.20	23.50	35.30	13.45
N_1C_3	100	9	45.00	23.00	50.03	25.30	89.20	15.30
Mean			**39.62**	**17.67**	**44.08**	**20.5**	**33.70**	**12.16**
N_2C_0	150	0	32.30	12.55	37.10	13.50	29.00	8.30
N_2C_1	150	3	39.50	18.00	44.30	20.20	34.50	12.60
N_2C_2	150	6	42.80	19.30	48.10	23.80	38.20	14.80
N_2C_3	150	9	46.30	23.80	52.50	26.30	42.50	16.5
Mean			**40.22**	**18.41**	**45.50**	**20.95**	**36.05**	**13.05**

Table 5: Cd concentrations (ppm) in rice plant organs as affected by the studied treatments at harvest stage in season 2007.

Treatments	Urea kg.fed^{-1}	CRS t.fed^{-1}	Roots	Straw	Whole grains	Husk	White grains
N_0C_0	0	0	4.80	1.350	0.370	0.6000	0.250
N_0C_1	0	3	4.78	1.501	0.423	0.780	0.290
N_0C_2	0	6	5.20	1.801	0.523	0.805	0.330
N_0C_3	0	9	6.40	2.000	0.630	0.9000	0.400
Mean			**5.29**	**1.650**	**0.486**	**0.770**	**0.318**
N_1C_0	**100**	**0**	**4.95**	**1.450**	**0.400**	**0.670**	**0.275**
N_1C_1	**100**	**3**	**5.93**	**1.900**	**0.520**	**0.800**	**0.350**
N_1C_2	**100**	**6**	**6.80**	**2.500**	**0.700**	**0.910**	**0.420**
N_1C_3	**100**	**9**	**7.90**	**2.900**	**0.830**	**1.090**	**0.480**
Mean			**6.39**	**2.18**	**0.612**	**0.870**	**0.810**
N_2C_0	150	0	5.10	1.470	0.410	0.730	0.300
N_2C_1	150	3	6.40	2.100	0.590	0.815	0.400
N_2C_2	150	6	7.86	2.700	0.780	0.990	0.490
N_2C_3	150	9	8.89	3.46	1.000	1.200	0.530
Mean			**7.03**	**2.350**	**0.695**	**0.933**	**0.430**

Table 6: Cd concentrations (ppm) in rice plant organs as affected by the studied treatments at harvest stage in season 2008.

Treatments	Urea kg.fed	CRS	Roots	Straw	Whole grains	Husk	White grains
N_0C_0	0	0	4.95	1.431	0.381	0.653	0.270
N_0C_1	0	3	5.20	1.548	0.462	0.793	0.307
N_0C_2	0	6	6.00	1.873	0.545	0.871	0.346
N_0C_3	0	9	6.80	2.140	0.687	0.985	0.446
Mean			**5.98**	**2.04**	**0.600**	**0.890**	**0.380**
N_1C_0	100	0	5.25	1.487	0.421	0.685	**0.289**
N_1C_1	100	3	6.80	1.989	0.561	0.881	**0.375**
N_1C_2	100	6	8.50	2.589	0.785	0.969	**0439**
N_1C_3	100	9	9.70	2.990	0.901	1.151	**0.492**
Mean			**7.10**	**2.41**	**0.682**	**0.960**	**0.554**
N_2C_0	150	0	5.23	1.503	0.420	0.745	0.334
N_2C_1	150	3	7.30	2.20	0.620	0.875	0.438
N_2C_2	150	6	9.00	2.789	0.815	0.993	0.496
N_2C_3	150	9	11.00	3.536	1.120	1.310	0.563
Mean			**7.97**	**2.65**	**0.826**	**1.120**	**0.652**

The obtained results also, show that mean value of Cd concentration was approximately 2 folds for roots as compared with shoots at maximum tillering, panicle initiation and flowering stages of all treatments. Whereas, Cd concentration mean was approximately 3 and 10 folds for roots as compared to straw and grains respectively at harvest stage of all treatments. The chemical analysis of rice grains show that the concentration of Cd increased with increasing levels of added CRS separately or combined with urea in whole grains, husk and white grains. In Japan, the maximum level of Cd in unpolished rice grains is 1.00 ppm mg Cd. kg^{-1}. In Taiwan, it is 0.50 mg Cd. kg^{-1} while in mainland China the maximum permitted level is 0.40 Cd.kg^{-1} in polished rice grains (Chen, 2000). According to, Cd limits in rice grains as mentioned before it could be observed that Cd concentration in rice grains was unpolluted at all addition levels of CRS which added whether, alone or in combination with urea.

Results also, show that the rice husk analyzed was higher in concentration of Cd as compared with whole and white grains at all addition levels of CRS. This means that, Cd concentrated in husk than grains. These results agreed with findings of Sarkunan *et al.*(1991) and El-Habet Howida (2004).

Cd translocation through rice plant organs:

Cadmium together with other elements is recognized as being the trace elements which are readily translocated to plants after absorption through the roots (Chaney and Giordano., 1977). The transfer Coefficient of Cd through rice plant organs as affected by the applications of CRS, urea treatments and their combinations at different stages are shown in Table 7 and 8. Data demonstrate that there are increases of the Cd translocation values through all rice plant organs (TC_{MT}, TC_{PI}, TC_F, TC_1 and TC_2) with increasing different levels of CRS either alone or integrated with urea as compared with the control. Results clearly reveal a general dependency of Cd concentration in plant tissues on the presence of soil Cd concentration.

With respect to, the translocation coefficient of Cd in rice plant organs within different stages of growth, data in Tables 7 and 8 illustrate that Cd translocation from roots to shoots (TC_{MT}, TC_{PI}, and TC_{F}) at maximum tillering, panicle initiation and flowering stages respectively was higher than its translocation from roots to straw at harvest. These results agreed with the findings of Srivastava and Gupta.,(1996) who stated that the translocation of Cd from roots to shoots through xylem was easier than translocation from leaves to seeds.

Table 7: Translocation coefficients (%) of Cd within rice plant organs as affected by the studied treatments at different stages of growth in season 2007.

Treatments	Urea kg.fed-1	CRS t.fed-1	Maximum tillering	Panicle initiation	flowering	Harvest	
			TC_{MT}	TC_{PI}	TC_{F}	TC_1	TC_2
N_0C_0	0	0	39.24	35.67	28.16	28.10	27.40
N_0C_1	0	3	39.52	39.92	33.97	31.40	28.18
N_0C_2	0	6	43.46	44.41	38.97	34.63	29.03
N_0C_3	0	9	53.27	50.75	39.48	32.25	31.50
N_1C_0	100	0	39.78	36.03	29.32	29.29	27.50
N_1C_1	100	3	45.77	45.35	35.36	32.04	27.36
N_1C_2	100	6	46.93	45.77	38.97	36.76	28.00
N_1C_3	100	9	49.14	51.42	38.26	36.70	28.62
N_2C_0	150	0	40.22	36.14	29.40	28.82	27.89
N_2C_1	150	3	47.52	45.86	38.34	32.81	28.09
N_2C_2	150	6	43.25	48.59	36.68	34.35	28.88
N_2C_3	150	9	48.44	49.51	38.90	35.43	28.81

Table 8: Translocation coefficients (%) of Cd within rice plant organs as affected by the studied treatments at different stages of growth in season 2008.

Treatments	Urea kg.fed-1	CRS t.fed-1	Maximum tillering	Panicle initiation	flowering	Harvest	
			TC_{MT}	TC_{PI}	TC_{F}	TC_1	TC_2
N_0C_0	0	0	38.67	36.08	28.41	28.90	26.62
N_0C_1	0	3	38.87	40.38	34.43	29.76	29.84
N_0C_2	0	6	43.44	45.34	38.26	31.21	29.57
N_0C_3	0	9	50.55	50.93	40.05	31.47	32.10
N_1C_0	100	0	38.76	36.23	29.21	28.90	28.31
N_1C_1	100	3	43.11	46.93	36.26	29.25	28.20
N_1C_2	100	6	43.52	49.78	38.01	30.45	30.32
N_1C_3	100	9	51.11	50.56	39.03	30.82	30.13
N_2C_0	150	0	38.85	36.38	28.60	28.73	27.94
N_2C_1	150	3	45.56	45.59	36.50	30.13	28.18
N_2C_2	150	6	45.09	49.48	38.74	30.98	29.22
N_2C_3	150	9	51.40	50.08	38.82	32.11	31.67

Also, Kabata- Pendias and Pendias (2000) observed that the Cd in plants is relatively very mobile.

Available cadmium (Cd) (ppm):

Available cadmium (Cd) values in soil (ppm) as affected by the application of CRS and urea treatments and their integrations at different stages are presented in Table 9 and 10. Data reveal that, at all stages of rice growth, available Cd in soil increased with increasing added levels of CRS to the soil either separately or combined with urea compared with the control. These might be first, due to, the decomposition of CRS which have more Ca and Mg that compete with Cd. 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 cationic exchange sites. These results are in quite agreement with those reported by Alloway (1995) and Kabata- Pendias and Pendias (2000). Also, Abou Elkhir (2000) revealed that a significant positive correlation between organic matter and available cadmium (Cd), and nickel (Ni) (r = 0.464**, 0.410*) respectively.

Table 9: Available Cd (ppm) in soil as affected by the studied treatments at different stages of rice growth in season 2007.

Treatments	Urea kg. fed^{-1}	CRS t. fed^{-1}	Maximum tillering	Panicle initiation	Flowering	Harvest
N_0C_0	0	0	0.185	0.198	0.178	0.174
N_0C_1	0	3	0.212	0.231	0.194	0.177
N_0C_2	0	6	0.233	0.250	0.201	0.191
N_0C_3	0	9	0.251	0.279	0.211	0239
N_1C_0	100	0	0.205	0.228	0183	0.158
N_1C_1	100	3	0.232	0.244	0.201	0.188
N_1C_2	100	6	0.256	0.273	0.218	0.203
N_1C_3	100	9	0.268	0.283	0.227	0.248
N_2C_0	150	0	0.216	0.229	0.193	0.163
N_2C_1	150	3	0.241	0.256	0.212	0.194
N_2C_2	150	6	0.270	0.284	0226	0.211
N_2C_3	150	9	0.279	0.291	0.234	0.266

Table 10: Available Cd (ppm) in soil as affected by the studied treatments at different stages of rice growth in season2008.

Treatments	Urea kg. fed^{-1}	CRS t. fed^{-1}	Maximum tillering	Panicle initiation	Flowering	Harvest
N_0C_0	0	0	0.180	0.192	0.171	0.173
N_0C_1	0	3	0.217	0.237	0.199	0.179
N_0C_2	0	6	0.237	0.259	0.210	0.197
N_0C_3	0	9	0.259	0.282	0.217	0241
N_1C_0	100	0	0.201	0.225	0179	0.153
N_1C_1	100	3	0.235	0.250	0.215	0.192
N_1C_2	100	6	0.262	0.279	0.225	0.211
N_1C_3	100	9	0.271	0.289	0.230	0.251
N_2C_0	150	0	0.210	0.220	0.190	0.159
N_2C_1	150	3	0.244	0.262	0.219	0.201
N_2C_2	150	6	0.275	0.289	0232	0.220
N_2C_3	150	9	0.282	0.297	0.240	0.269

Data also, indicate that the highest values of available Cd were recorded with combinations of urea at the rate of 150 kg. Plus 9 tons CRS.fed^{-1} at maximum tillering, panicle initiation, flowering and harvest stages.

Concerning to the changes of available Cd in soil through different stages of rice growth, data stated that the available Cd increased at all treatments with lapse of time at maximum tillering and panicle initiation, they trended to decrease at later stages of rice growth (flowering and at harvest). This increase of available Cd during maximum tillering and panicle initiation may be due to the organic acids released from the organic matter fermentation resulted in a decrease of soil pH. These results are in harmony with those obtained by (Yanni 1979).

It is clear from the data that the lowest values of available Cd in soil were attained at harvest stage as compared with the other stages at all treatments. It may be attribute to:

1) Increase the 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 complex with Cd and Ni and immobilize them as sulphide salts (Ven Den Berg *et al*, 1998).
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).

Total Cd concentration in soil (ppm):

It is clear from the data (Table 11 and 12) that the total Cd concentration increased with increasing CRS up to the third levels of CRS either added to the soil in separated form or integrated with urea as compared to the control. These results are agreement with those obtained by Kandil Hala (2005) who found that the total heavy metals (Cd, Ni and Pb) significantly increased by increasing the rate of organic manures (banana composted and cotton composted). Results also, reveal that the highest values of the total Cd concentration at maximum tillering, panicle initiation, flowering and harvest stages were found at 9 tons CRS plus 150 kg urea.fed^{-1}.

Table 11: Total Cd concentration (ppm) in soil as affected by the studied treatments at different stages of rice growth in 2007 season.

Treatments	Urea kg. fed^{-1}	CRS t. fed^{-1}	Maximum tillering	Panicle initiation	Flowering	Harvest
N_0C_0	0	0	0.913	1.000	1.311	1.450
N_0C_1	0	3	1.070	1.156	1.293	1.480
N_0C_2	0	6	1.402	1.559	1.672	1.899
N_0C_3	0	9	1.873	2.000	2.230	2.530
N_1C_0	100	0	1.100	1.233	1.435	1.500
N_1C_1	100	3	1.382	1.572	1.788	2.001
N_1C_2	100	6	1.725	1.930	2.125	2.410
N_1C_3	100	9	1.935	2.310	2.485	2.736
N_2C_0	150	0	1.270	1.300	1.650	1.750
N_2C_1	150	3	1.503	1.789	1.958	2.231
N_2C_2	150	6	1.893	2.158	2.435	2.803
N_2C_3	150	9	1.980	2.305	2.805	2.920

Table 12: Total Cd concentration (ppm) in soil as affected by the studied treatments at different stages of rice growth in 2008 season.

Treatments	Urea kg. fed^{-1}	CRS t. fed^{-1}	Maximum tillering	Panicle initiation	Flowering	Harvest
N_0C_0	0	0	1.100	1.203	1.300	1.500
N_0C_1	0	3	1.10	1.200	1.310	1.55
N_0C_2	0	6	1.440	1.632	1.697	1.920
N_0C_3	0	9	1.88	2.170	2.330	2.631
N_1C_0	100	0	1.120	1.235	1.473	1.560
N_1C_1	100	3	1.40	1.580	1.820	2.170
N_1C_2	100	6	1.733	1.970	2.233	2.50
N_1C_3	100	9	1.980	2.35	2.550	2.80
N_2C_0	150	0	1.290	1.300	1.701	1.782
N_2C_1	150	3	1.540	1.88	2.08	2.29
N_2C_2	150	6	1.930	2.25	2.56	2.930
N_2C_3	150	9	2.10	2.40	2.90	2.96

With respect to the total Cd concentration in soil through stage as compared with the other stages, data also, show that the obtained levels of Cd in soil at all stages with all treatments were still less than the tolerable level of Cd in soil (5 ppm) as reported by Tietjen (1975).

The obtained results show that the total Cd concentration increased at all treatments with lapse of time.

CONCLUSION

Cd concentration in rice straw and grains didn't exceed the critical limits of Cd at all addition levels of composted rice straw to the soil whether alone or in combination with urea under irrigation with contaminated water.

REFERENCES

Abou El-Khir, A.M.2000. Some soil properties and trace elements as influenced by some biochemical activities in the eastern Nile Delta Soils. J. Agric. Sci. Mansoura Univ., 25 (12): 8421-8431.

Alloway, B. J. 1995. Heavy metals in soils, 2nd ed. Blackie Academic and profeional, New York

Chaney, R. and P.M. Giordano. 1977. In soils for the management of organic wastes and waste water. eds. Elliot, Lf and Stevenson. F.J. Soil. Sci. SOC. Am. & Crop Sci. Am. Madison; 235-279.

Chen, Z. S. 2000 . Relationship between heavy metal concentration in soils of Taiwan and uptake by crops. Department of Agricultural chemistry. National Taiwan University. Taipei 106. Taiwan, ROC.

Chen, Y. and Y. Avnimelech 2002. The role of organic matter in modern agriculture. CRC. Press, Inc united states and Canada, 631086 C.R.

Cottenie, A.; R.Camerbynck; M. Verloo and A. Dhaere. 1979. Fractionation and determination of trace elements in plants. Soils and Sediments. Pure Appl. Chem. 52: 145-153.

El-Habet Howida. B. I. 2004. Effect of aerobic and anaerobic condition in polluted soil on heavy metals content of some crops. M. Sc. Thesis, Fac. of Agric. Minufiya. Univ., Egypt.

Kabata- Pendias, A. and H. Pendias 2000. Trace elements in soils and plants. Crs press, inc. Boca Raton London New York Washington, D.c.

Kabata- Pendias.A and A.B. Mukherjee. 2007. Trace Elements from soil to Human. CRC press, Inc. Library of Congress control Number 2007920909.

Kabata Perdias, A. And H.Pendias, 1999. Biogeochemistry of trace elements, 2^{nd} ed. WYD. Nauk PWN. Warsaw, 400(Po).

Kandil Hala, A.H. 2005. Impact of agricultural wastes compost on some heavy metals content in soil and plant. Ph.D. Thesis Fac of Agric., Cairo. Univ., Egypt.

Le Huy Ba,. 2001. Heavy metals pollution in paddy soils Near Ho Chi Minh City caused by wastewater discharge and the influence of cadmium on rice. C.F. Hort. CD. Computer research.

Page, A. L., R.H. Miller and D.R. Keeney.1982. Methods of soil Analysis – part 2. Amer. Sco. Agric. Inc. Madison.

Sarkunan, v. A. Kmisra and p.k. Nayar. 1991. Effect of cadmium, nickel and copper on yield and metal content in rice (Oriza sativa). J. Soil Sci: 28: 459-462.

Srivastava, P.C; and U.C. Gupta. 1996. Trace elements in crop production. Science Pulishers, Inc. 10 water street # 310 Lebanon, NH 03766, USA..

Tietjen, C. 1975. Principal problems of the use of city wastes for crop production and soil conservation. In F.A.O. Soils Bullietin 27: 221-226.

Tuker, M.R., D.H. Hardy andC.E. Catherine. 2003. Heavy metals in North Carolina soils: occurrence and significance. Raleigh` (NC) North Carolina Department of Agricultural and consumer services, Agronomic Division. ZP

Ven Den Berg. G.A., Loch J.P.G and Winkels H.J. 1998. Effect of fluctuating hydrological conditions on the mobility of heavy metals in soils of a fresh-water estuary in the Netherlands. Water Air Soil Pollu. 102: 377-388.

Yanni.Y.G.1979. Some microbiological and physicochemical studies on waterlogging soils with special reference to the transformation of some soil elements. Ph.D. Thesis, Fac. of Agric., Ain-Shams Univ., Egypt.

تركيز وانتقال عنصر الكادميوم في نباتات الارز المروية بمياه ملوثه وتأثره باستخدام الاسمده العضوية والغير عضوية.

سامى حماد ، السيد نعيم و هويدا بيومى الهابط
* كلية الزراعة – جامعة المنصورة
** معهد بحوث الأرز – سخا – كفر الشيخ

تم إجراء تجربتين حقليتين في موسم ٢٠٠٧ و٢٠٠٨ بمركز البحوث والتدريب في الارز بسخا – كفرالشيخ . حيث تم دراسة تأثير معدلات مختلفة من السماد العضوي(الكمبوست) واليوريا علي تركيز عنصر الكادميوم في أجزاء نبات الأرز المختلفة ومعامل إنتقالها خلال أعضاء نبات الأرز المختلفة وأيضا دراسة مدي تيسير عنصر الكادميوم (Cd) في اراضي الارز خلال مراحل نموه المختلفة. أوضحت النتائج أن تركيزات الكادميوم في أعضاء نبات الأرز المختلفة (الجذور، المجموع الخضري ، قش الأرز ، الحبوب) تزداد مع زيادة التسميد العضوي (الكمبوست) سواء أضيفت بمفردها أومختلطة مع اليوريا مقارنة بالكنترول. أظهرت النتائج أن الجذور أكثر قدرة علي تجميع الكادميوم من المجموع الخضري و قش الأرز و الحبوب وذلك في جميع مراحل نمو الأرز المختلفة. كما اظهرت النتائج ان تركيز الكادميوم في الحبوب غير ملوثة عند جميع مستويات الإضافة سواء بمفردها أو مختلطة مع اليوريا. معامل إنتقال الكادميوم خلال أعضاء نبات الأرز المختلفة يقل مع الوقت. يزداد تيسر الكادميوم Cd مع زيادة مستوي التسميد العضوي (الكمبوست) سواء أضيفت بمفردها أو مختلطة مع اليوريا مقارنة بالكنترول . أوضحت النتائج أيضا أن الكادميوم يزداد مع كل المعاملات مع الوقت حتي مرحلة بداية تكوين السنبلة ثم بعد ذلك يتجة الي النقص خلال المراحل المتأخرة للنمو (التزهير – الحصاد). يزداد التركيز الكلي للكادميوم Cd في الأرض حتي المستوي الثالث المضاف من الأسمدة العضوية (الكمبوست) سواء أضيفت بمفردها أو مختلطة مع اليوريا، أيضا اوضحت النتائج ايضا ان التركيز الكلي للكادميوم Cd زاد مع كل المعاملات بمرور الوقت وان اعلي قيمة لة وجدت عند الحصاد. اوضحت النتائج ايضا ان استخدام المياه الملوثه مع معدلات مرتفعة من السماد العضوي لم يؤدي لحدوث تلوث في الحبوب او القش تحت ظروف هذه الدراسة.

قام بتحكيم البحث

أ. د/ خالد حسن الحامدى	**كلية الزراعة – جامعة المنصورة**
أ. د/ أحمد عفت أحمد الشربينى	**خارجى**