J. Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 2 (2): 171 - 182, 2011

CONCENTRATIONS OF NICKEL, LEAD AND CADMIUM IN RICE PLANT AS AFFECTED BY FARMYARD MANURE

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ABSTRACT

The concentrations of cadmium (Cd^{2+}), nickel (Ni^{2+}) and Lead (Pb^{2+}) in different organs of rice plant were investigated by field experiments. Data showed that the highest yield of rice grain was recorded by the application of 21.42 tons farmyard manure (FYM) plus 357 kg urea.ha^{-1} as compared with the other treatments. Roots accumulated more Pb^{2+}, Ni^{2+} and Cd^{2+} than straw and grains at harvest stage of rice growth. Pb^{2+}, Ni^{2+} and Cd^{2+} concentration in rice plant organs (root, straw and grain) increased with increasing levels of FYM either alone or in combined with urea compared with the control. Pb^{2+} concentrations in straw do not exceed the critical limits of pollution with FYM added to the soil either separated or combined with urea. However, rice grains were slightly polluted at 21.42 tons FYM plus 238 kg urea.ha^{-1} and 21.42 tons FYM plus 357 kg urea.ha^{-1}. Ni^{2+} concentration in rice grain and straw do not exceed the critical limits with all treatments .Cd^{2+} concentration in rice straw do not exceed the critical limits of Cd^{2+} at all addition levels of FYM added to the soil whether levels separated or integrated with urea, however Cd^{2+} concentration in rice grain was polluted at 21.42 tons plus 238 kg urea.ha^{-1}, 14.28 tons FYM plus 357 kg urea.ha^{-1} and 21.42 tons FYM urea.ha^{-1}. Integration of 14.28 tons FYM plus 238 kg urea.ha^{-1} do not exceed the critical limits of the concentration of Pb^{2+}, Ni^{2+} and Cd^{2+} in different organs of rice plant.

INTRODUCTION

All trace elements are toxic and in small quantities may are essential for plant growth (Fe, Mn, Mo and Zn). However excessive quantities will cause undesirable accumulation in plant tissue and growth reduction. Lead, Nickel and Cadmium are metals which have been found to have deleterious effects on both plant metabolism and human (Allinson and Dzilo 1981). Lead cause changes in the permeability of cell membrane and reactions of sulphydral groups (-SH) (Kabata Pendias and Pendias 1992) . There is no evidence of an essential role of Ni^{2+} in plant metabolism, although the reported beneficial effects of Ni^{2+} on plant growth have stimulated speculation that this metal may have some function (Mengel and Kirkby 1987). Cadmium is phytotoxic, as it can interfere with photosynthetic and respiratory activities, mineral nutrition, enzymatic activities, membrane functions and hormone balance (Chen, 2000). The critical concentrations of Pb^{2+}, Ni^{2+} and Cd^{2+} in plant ranged between 10 to 20 mg Pb . kg^{-1} , 10 to 100 mg Ni. kg^{-1} and 5 to 30 mg Cd^{2+}. kg^{-1} dry matter respectively (Mengel and Kirkby 1987 and Alloway 1995). Based on the levels of Pb and Cd^{2+} in polished rice grains, Kanso *et al.*(2000) divided lowland rice areas into three categories : Pb $^{2+}$ < 0.5 and Cd^{2+} <0.12 ppm unpolluted grains, Pb^{2+} 0.5- 1 and Cd^{2+} 0.12-0.24 ppm slightly polluted grains and Pb $^{2+}$ > 1 ppm and Cd^{+2} >0.24 ppm polluted grains. The food chain is considered the main tract for transfer of trace elements to humans. The excess of Pb^{2+} may cause several health effects; nervous system disorder, hematologic effects, kidney disease, hypertension. The Ni^{2+} excess caused mainly gastric, liver and kidney defects, neurological effects, emphysema and lung cancer. Cd^{2+} is one of the most toxic metals to humans, which cause cardiomyopathy, pneumonitis and osteomalacia (Kabata pendias and mukherjee 2007).

The objective of this study was to examine the effect of FYM under irrigation with wastewater on:

1) Rice grain yield.
2)Concentration of Pb^{2+}, Ni^{2+} and Cd^{2+} in different rice plant organs at harvest (Roots, Straw, Whole grain, husk and white grain).

MATERIALS AND METHODS

Two field experiments were conducted at Rice Research & Training Center (RRTC) at the farm of Kafr El-Sheikh using rice plant (*Oryza Sativa*), Giza178 variety during 2007 and 2008 seasons. The present work at the first experiment aimed to study the effect of waste water and Farm yard manure on 1) Rice grain yield and 2) Concentration of Pb^{2+}, Ni^{2+} and Cd^{2+} in different rice plant organs at harvest (Roots, Straw, Whole grain, husk and white grain). Soil sample was taken and subjected to chemical analysis followed the standard procedures by cottenie *et al.*, (1979) and page *et al.*, (1982) and the results were presented in Table 1.

Farm yard manure (FYM) 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 (15%) at the rate of 100 $kg.fed^{-1}$ before flooding. The experimental design system of layout was randomized complete block with four replications .The treatments at the first experiment were as follows:

1) Control denoted as N_0F_0.
2) 7.14 tons farm yard manure (FYM) $.ha^{-1}$ denoted as N_0F_1.
3) 14.28 tons (FYM) $.ha^{-1}$ denoted as N_0F_2.
4) 21.42 tons (FYM) $.ha^{-1}$ denoted as N_0F_3.
5) 109.48 kg N. ha^{-1} (238 Kg $urea.fed^{-1}$) denoted as N_1F_0.
6) 109.48 kg N. ha^{-1} + 7.14 tons (FYM) denoted as N_1F1.
7) 109.48 kg N. ha^{-1} + 14.28 tons (FYM) denoted as $N1F_2$.
8) 109.48 kg N. ha^{-1} + 21.42 tons (FYM) denoted as N1F3.
9) 164.22 kg N. ha^{-1} (357 Kg $urea.fed^{-1}$) denoted as N_2F_0.
10) 164.22 kg N. ha^{-1} + 7.14 tons (FYM) denoted as N_2F_1.
11) 164.22 kg N. ha^{-1} + 14.28 tons (FYM) denoted as N_2F_2.
12) 164.22 kg N. ha^{-1} + 21.42 tons (FYM) denoted as N_2F_3.

The nursery was fertilized with recommended dose of N, P and Zn. It's irrigated with drainage water (wastewater + agricultural drainage water). Plants in each plot 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. Water irrigation was sampled then analyzed and the values were 6.23, 6.3 ppm Pb^{2+} and 0.439, 0.45ppm Ni^{2+} and 0.032, 0.037 ppm Cd^{2+} in 2007 and 2008 seasons respectively. All plant samples were oven dried at 70 c for 48 hours then grounded and kept in plastic pages for analysis and determined using the model of atomic absorption. The analysis of FYM showed that the Pb^{2+} was 45 and 46.1 ppm with 9.2 and 9.23 ppm Ni^{2+} and 3.8 and 3.82 ppm Cd^{2+} in season 2007 and 2008 respectively.

Table 1: Some mechanical, chemical characteristics of the used soil in season 2007 and 2008.

Tested characteristics	Value(2007)	Value(2008)
Particle size distribution		
Sand %	27.3	13.20
Silt %	28.64	32.00
Clay %	44.06	55.80
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	3.10
OM (organic matter) %	1.65	1.60
Soluble cations, $meq.l^{-1}$(soil paste):		
Ca^{++}	9.50	10.00
Mg^{++}	3.94	3.98
K^+	1.76	1.80
Na^+	14.8	15.20
Soluble anions, $meq.l^{-1}$(soil paste):		
CO_3^-	-	-
HCO_3^-	6.00	6.75
Cl^-	8.30	8.44
SO_4^{--}	15.70	15.79
Available Pb mg/kg soil	1.60	1.63
Available Ni mg/kg soil	1.12	1.10
Available Cd mg/kg soil	0.015	0.15
Aqua- Regia extracted elements (Total)		
Pb mg/kg soil	21.3	21.7
Ni mg/kg soil	26.4	26.2
Cd mg/kg soil	8.10	8.15

RESULTS AND DISCUSSION

Yield and yield attributes:

Grain and straw yield:

Data in Tables 2 and 3 shows the effect of farmyard manure (FYM) and urea treatments and their combinations on grain and straw yield of Giza178 rice variety during 2007 and 2008 seasons. Data showed that, there is a significant increase in yield under all treatments over the control. The highest yield of rice grain was recorded by applications of 21.42 tons FYM plus 357 kg $urea.ha^{-1}$ without significant differences with using 21.42 tons FYM plus 238 kg urea. ha^{-1} but the lowest yield was observed under the treatment which received no fertilizer. The increase in grain yield with the combined use of both those source is advantageous and substantial amount of inorganic N can be saved. These mainly could be attributed to that the combined use of FYM and chemical fertilizer increase nutrients availability for plant through their growth stages. Confirmed these results (Cooke 1977 and Hammad *et al.*, 2006).

Data illustrated that grain yield increased up to 21.42 tons FYM plus 357 kg urea.ha^{-1}. Data reported also, that 21.42 tons FYM alone and 21.42 tons FYM.ha^{-1} plus 238 kg urea. ha^{-1} gave higher grain yield as compared to 357 kg urea fed^{-1} alone but any addition from urea to FYM gave higher grain yield than that observed with FYM alone at the same treatment. The straw yield followed the similar trend as that of rice grain.

Table 2: Means of grain yield and straw yield (kg. ha^{-1}) as affected by the applications of farmyard manure (FYM) and urea treatments at harvest in 2007 season.

Treatments	Urea kg. ha^{-1}	FYM t. ha^{-1}	Grain kg. ha^{-1}	% increase or decrease	Straw kg. ha^{-1}	% increase or decrease
N_0F_0	0	0	6913.9 h	-	8181.25 h	-
N_0F_1	0	7.14	8901.20 f	28.74	9939.59 g	21.49
N_0F_2	0	14.28	9282.0 e	38.12	11314.99 e	38.30
N_0F_3	0	21.42	11197.7 b	61.96	11824.31 d	44.52
N_1F_0	238	0	8146.74 g	17.83	9936.5 g	21.45
N_1F_1	238	7.14	10072.16 d	45.67	11638.2 d	42.25
N_1F_2	238	14.28	10805.2 c	56.28	12292.7 c	50.25
N_1F_3	238	21.42	11501.35 ab	66.36	12619.95b	54.25
N_2F_0	357	0	10231.62 d	34.25	10680.25 f	30.54
N_2F_1	357	7.14	10692.15 c	54.64	11650.1 d	42.40
N_2F_2	357	14.28	11278.10 ab	63.12	12608.05 b	54.10
N_2F_3	357	21.42	11596.55 a	68.08	13163.185 a	60.89

Table 3: Means of grain yield and straw yield (kg. ha^{-1}) as affected by the applications of farmyard manure (FYM) and urea treatments at harvest in 2008 season.

Treatments	Urea kg. ha^{-1}	FYM t. ha^{-1}	Grain kg. ha^{-1}	% increase or decrease	Straw kg. ha^{-1}	% increase or decrease
N_0F_0	0	0	7057.48 g	-	8330h	-
N_0F_1	0	7.14	9111.42 d	29.10	10124.52g	21.54
N_0F_2	0	14.28	9440.65 c	33.76	11608.04e	39.51
N_0F_3	0	21.42	11641.36 b	64.95	11840.5 d	42.30
N_1F_0	238	0	8540.22 f	21.00	9983.29 g	19.98
N_1F_1	238	7.14	10422.80c	47.68	1078.14 de	41.51
N_1F_2	238	14.28	10933.72b	54.92	12344.25c	48.19
N_1F_3	238	21.42	11696.10a	65.72	12669.25 b	52.09
N_2F_0	357	0	103337.91c	46.48	10700.48f	28.45
N_2F_1	357	7.14	10845.66b	53.67	11686.58de	40.29
N_2F_2	357	14.28	11499.35a	62.93	12669.52b	52.09
N_2F_3	357	21.42	11798.44a	67.17	13224.85a	58.76

Lead (Pb^{2+}) concentration in rice plant organs:

High Pb concentration has found to inhibit seed germination, stomata opening, shoot transpiration, CO_2 uptake, apparent photosynthesis, and photorespiration in plant (Poskuta *et al*, 1987).

Data in Tables 4 and 5 Show Pb^{2+} concentrations in rice plant organs as affected by the application of FYM and urea treatments and their combinations.

The obtained results showed that generally, Pb^{2+} concentrations in organs of rice plant progressively increased with increase FYM addition levels to the soil either alone or in combinations with urea as compared with the control. These results are in harmony with those obtained by Hala (2005) who observed that the organic manures led to more significantly positive increase in the concentrations of Pb^{2+}, Ni^{2+} and Cd^{2+} in roots, shoots and grain of corn plant. The highest values of Pb^{2+} concentrations were attained at 21.42 tons FYM plus 357 kg urea ha^{-1} . Means of Pb^{2+} concentrations were 4 folds approximately for roots with compared to the rice straw at all treatments. While means of Pb^{2+} concentrations were 10 folds approximately for straw compared to grains at FYM added alone or FYM plus 238 or 357 kg urea.ha^{-1}.

The critical levels of Pb^{2+} concentration ranged between 30 to 300 ppm (Alloway 1995). Data in Tables 5 and 6 also, indicated that Pb^{2+} concentration in rice straw do not exceed the safety limits (less than 30 ppm) of Pb^{2+} at all addition levels of FYM added to the soil either alone or in combinations with urea. Concerning to, the chemical analysis of rice grain, data show that the Pb^{2+} concentrations increased with increasing levels of FYM added to the soil whether, alone or integrations with urea in whole grain, husk and white grain, according to, Pb^{2+} limits in rice grains which, reported by (Kasno, 2000). It can be notice that Pb^{2+} concentration in white rice grains was slightly polluted at 21.42 tons FYM plus either 238 or 357 kg urea.ha^{-1} treatments, while Pb concentration in rice grains were unpolluted at all addition levels of FYM added to the soil alone except the treatment of 21.42 ton FYM .fed^{-1} . These results agreed with the findings of Kashem and Singh (2001). It is clear from the data these treatments of FYM under this condition did not reach the critical levels of Pb concentrations in rice straw and grains. This may be due to organic matter is known to increase the capacity of the soils to adsorb Pb (Hala 2005). Data also, illustrated that the highest values of Pb concentrations were recorded with rice husk as compared to Whole and white grains at all different levels of FYM added to the soil either alone or in combinations with urea.

Nickel (Ni^{2+}) concentration in rice plant organs:

There is no evidence of an essential role of Ni^{2+} in plant metabolism, although the reported beneficial effects of Ni^{2+} on plant growth have stimulated speculation that this metal may have some function in plant.

Table 4: the Lead (Pb) concentration (ppm) in rice plant organs as affected by the application of farmyard manure (FYM) and urea treatments at harvest stage in 2007 season.

Treatments	Urea $kg.ha^{-1}$	FYM $t.ha^{-1}$	Roots	Straw	Whole grain	Husk	White grain
N_0F_0	0	0	30.17	6.42	0.556	0.783	0.318
N_0F_1	0	7.14	37.12	8.50	0.753	0.925	0.413
N_0F_2	0	14.28	50.45	12.40	1.226	1.873	0.489
N_0F_3	0	21.42	61.55	14.55	1.426	2.353	1.030
Mean			44.82	10.46	0.990	1.480	0.562
N_1F_0	238	0	32.45	6.80	0.605	0.809	0.403
N_1F_1	238	7.14	42.92	10.02	0.878	1.253	0.467
N_1F_2	238	14.28	54.97	12.90	1.428	1.986	0.523
N_1F_3	238	21.42	68.37	15.57	1.536	2.330	1.250
Mean			49.67	11.32	1.110	1.590	0.656
N_2F_0	357	0	31.07	6.44	0.570	0.789	0.630
N_2F_1	357	7.14	54.07	12.37	1.160	1.735	0.506
N_2F_2	357	14.28	58.95	13.60	1.350	1.838	0.817
N_2F_3	357	21.42	68.40	16.50	1.505	2.417	1.430
Mean			53.12	12.22	1.460	1.690	0.778

Table 5: Lead (Pb) concentration (ppm) in rice plant organs as affected by the application of farmyard manure (FYM) and urea treatments at harvest stage in 2008 season.

Treatments	Urea $kg.ha^{-1}$	FYM $t.ha^{-1}$	Roots	Straw	Whole grain	Husk	White grain
N_0F_0	0	0	31.50	6.84	0.563	0.791	0.325
N_0F_1	0	7.14	39.90	9.30	0.768	0.953	0.426
N_0F_2	0	14.28	54.40	12.90	1.435	1.898	0.496
N_0F_3	0	21.42	63.60	15.66	1.473	2.452	1.110
Mean			47.35	11.17	1.05	1.52	0.589
N_1F_0	238	0	33.40	7.10	0.618	0.829	0.423
N_1F_1	238	7.14	45.90	11.12	0.891	1.355	0.478
N_1F_2	238	14.28	56.80	13.80	1.453	2.001	0.650
N_1F_3	238	21.42	71.80	17.0	1.582	2.410	1.310
Mean			51.79	12.25	1.15	1.66	0.715
N_2F_0	357	0	34.50	7.30	0.625	0.835	0.652
N_2F_1	357	7.14	57.30	14.0	1.225	1.863	0.662
N_2F_2	357	14.28	62.81	15.60	1.481	1.921	0.845
N_2F_3	357	21.42	73.80	17.80	1.601	2.513	1.501
Mean			57.10	13.67	1.233	1.783	0.915

Ni^{2+} is an essential component of the enzyme urease and stimulation effects of Ni^{2+} on the nitrification and mineralization of N compounds (Kabata – pendias and pendias 2000). Data in Tables 6 and 7 represent Ni^{2+} concentration in rice plant organs through different stages as affected by the application of FYM and urea treatments and their integrations. Results stated that, Ni^{2+} concentration in organs of plant progressively increased with increasing levels of FYM added either alone or in integrations with urea compared with the control. This could be attributed to:

1) Soil organic matter complexes Ni^{2+} and soluble organic compounds can increase the solubility and consequent increase the available Ni^{2+} and its absorption by plant
2) Nickel is readily translocated through xylem as negatively charged organic matter complex (Sarivastava and Gupata 1996).

The highest values of Ni^{2+} concentrations were recorded at 21.14 tons FYM plus 357 kg urea .ha^{-1}. Concerning to Ni concentration in rice plant organs, data also, state that roots accumulated more Ni^{2+} than straw and grains. These results agreed with the findings of Srivastava and Gupata (1996) who found that most of observed Ni accumulates in the roots. The concentration of Ni^{2+} is much lower in leaves, stems and seeds than roots. This finding might be attributed to the fact that plant roots are the first organs in contact with the toxic metal solute (Marchiol *et al.*, 1996). Means of Ni^{2+} concentrations were 3.6 folds approximately for roots as compared to straw at all treatments. The respective values of mean Ni^{2+} concentrations were about 6 folds for straw as compared to with grains at all treatments. Relating to, the chemical analysis of rice grain indicated that the Ni^{2+} concentration increased with increasing levels of FYM added to the soil either alone or in combinations with urea in whole grain, husk and white grain. These results are in harmony with those obtained by Hala (2005). The rice husk analyzed was higher in concentration of Ni^{2+} compared with whole and weight grains at all addition levels of FYM. This means that, heavy metals concentrated in husk than grains. These results agreed with the findings of Sarkunan *et al* (1991) and Howida (2004). Ni^{2+} concentrations in rice plant did not exceed the critical limits at all treatments. Also, the results are in harmony with those obtain by Chino (1981) who found that the toxic of Ni^{2+} concentrations in the foliage was found to be 20 to 50 ppm in rice.

Table 6: The nickel (Ni) concentration (ppm) in rice plant organs as affected by the application of farm yard manure (FYM) and urea treatments at harvest stage in 2007 season.

Treatments	Urea kg.ha^{-1}	FYM t.ha^{-1}	Roots	Straw	Whole grain	Husk	White grain
N_0F_0	0	0	34.87	8.67	1.31	1.60	0.356
N_0F_1	0	7.14	42.07	11.14	1.85	1.93	0.489
N_0F_2	0	14.28	52.07	13.22	2.25	2.68	0.612
N_0F_3	0	21.42	61.32	16.57	2.80	2.90	0.859
Mean			47.58	12.40	2.07	2.27	0.579
N_1F_0	238	0	42.82	10.95	1.83	1.92	0.396
N_1F_1	238	7.14	48.32	12.65	2.28	2.60	0.501
N_1F_2	238	14.28	56.80	15.45	2.72	3.00	0.790
N_1F_3	238	21.42	6352	17.50	2.98	3.23	0.983
Mean			52.86	14.40	2.45	2.68	0.667
N_2F_0	357	0	45.12	11.44	1.87	2.11	0.480
N_2F_1	357	7.14	51.15	14.12	2.41	2.80	0587
N_2F_2	357	14.28	63.05	18.05	2.97	3.25	0580
N_2F_3	357	21.42	69.67	20.07	3.27	3.63	1.150
Mean			57.24	15.92	2.63	2.94	0.770

Table 7: The nickel (Ni) concentration (ppm) in rice plant organs as affected by the application of farm yard manure (FYM) and urea treatments at harvest stage in 2008 season.

Treatments	Urea $kg.ha^{-1}$	FYM $t.ha^{-1}$	Roots	Straw	Whole grain	Husk	White grain
N_0F_0	0	0	35.80	8.92	1.34	1.67	0.362
N_0F_1	0	7.14	45.07	12.80	1.90	2.07	0.490
N_0F_2	0	14.28	55.80	14.80	2.31	2.78	0.663
N_0F_3	0	21.42	65.70	18.00	2.91	3.08	0.890
Mean			50.59	13.63	2.31	2.27	0.601
N_1F_0	238	0	43.80	11.80	1.80	1.88	0.382
N_1F_1	238	7.14	50.80	13.75	2.35	2.81	0.563
N_1F_2	238	14.28	58.99	16.17	2.89	3.19	0.8.01
N_1F_3	238	21.42	66.80	18.90	2.97	3.25	0.993
Mean			55.09	15.15	2.502	2.78	0.684
N_2F_0	357	0	46.12	11.80	1.80	2.15	0.450
N_2F_1	357	7.14	53.52	15.10	2.52	2.91	0.601
N_2F_2	357	14.28	63.80	17.83	3.12	3.53	0.631
N_2F_3	357	21.42	71.80	21.90	3.27	3.63	1.150
Mean			58.81	16.65	2.67	3.055	0.708

Cadmium (Cd^{2+}) concentration in rice plant organs:

Regular consumption of plants containing 3 ppm Cd^{2+} can poison man and animal, it interferes with and other proteins. In livestock, it accumulates in kidneys, spleen and liver (Tuker *et al.*, 2003). Data in Tables 8 and 9 represent Cd^{2+} concentration in rice plant organs through different stages as affected by the application of FYM and urea treatment and their combinations. Results indicated that Cd^{2+} concentration in plant organs progressively increased with increment FYM levels added to the soil whether separated or combined with urea at all stages as compared to the control. This is may be due to:

1- The content of FYM from Cd^{2+}

2-The mobility in alkaline soil due to the formation of complexes or metal chelats, 3-The plant uptake of Cd^{2+} may be indepented of the pH (Kitagishi and Yamane 1981). Also, Srivastava and Gupta (1996) who found that the fixation of Cd by organic matter is operative under the acidic condition (soil pH 4-6) but the solubilization of Cd^{2+} by organic matter occurs in the range of the soil pH 7-8. The highest values of Cd^{2+} concentration were achieved at 9 tons FYM plus 357 kg urea.ha^{-1}. As compare the Cd^{2+} concentrations in different plant organs, data in Tables 9 and 10 revealed that roots accumulated higher Cd^{2+} level than shoots, straw and grain at all stages. These results agreed with findings of Kabata- Pendias and Pendias (2000) and Kabata-pendias and Mukherjee (2007) who found that usually Cd^{2+} concentration is the highest in roots and decreases towards the top plants. The obtained results also, showed that mean Cd^{2+} concentration was approximately 3 and 10 folds for roots as compared to straw and grains respectively at all treatments at harvest stage. The normal range of Cd^{2+} concentration in plants was 0.10 to 2.40 ppm, while the critical level ranged between 5 to 30 ppm (Alloway 1995).The obtained data also, illustrated that Cd^{2+} concentration in rice straw don't exceed the critical levels of Cd^{2+}

at all addition levels of FYM added to the soil whether, separated or in integrated with urea accordance with limits as mentioned before. The chemical analysis of rice grain showed that the concentration of Cd^{2+} increased with increasing levels of FYM added separated or combined with urea in whole grains, husk and white grains.

In Japan, the maximum level of Cd^{2+} in unpolished rice grain is 1.00 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 mg Cd. kg^{-1} in polished rice grain (Chen ,2000).

According to, Cd limits in rice grain as mentioned before and limits reported by (Kasno 2000).It can be observed that Cd concentration in rice grain was polluted at 21.14 tons FYM plus 238 kg urea.ha^{-1} (0.530 ppm), 14.28 tons FYM plus 357 kg urea.ha^{-1} (0.701 ppm) and 21.14 tons plus 357 kg urea.ha^{-1} (1.10 ppm).

Results also, showed that the rice husk analyzed was higher in concentration of Cd^{2+} compared with whole and white grain at all addition levels of FYM. This means that, Cd $^{2+}$ concentrated in husk than grains. These results agreed with findings of Sarkunan *et al* (1991) and Howida (2004). In fact, it is clear that the integration of 14.28 tons FYM plus 238 kg urea.ha^{-1} was safe for all heavy metals under this study.

Table 8: The cadmium (Cd^{2+}) concentration (ppm) in rice plant organs as affected by the application of farmyard manure (FYM) and urea treatments at harvest stage in 2007 season.

Treatments	Urea kg.ha^{-1}	FYM t.ha^{-1}	Roots	Straw	Whole grain	Husk	White grain
N_0F_0	0	0	4.93	1.60	0.450	0.730	0.275
N_0F_1	0	7.14	5.52	1.93	0.560	0.810	0.367
N_0F_2	0	14.28	6.19	2.15	0.640	0.920	0.400
N_0F_3	0	21.42	7.30	2.50	0.750	1.100	0.480
Mean			5.98	2.04	0.600	0.890	0.380
N_1F_0	238	0	5.10	1.67	0.480	0.750	0.289
N_1F_1	238	7.14	6.60	2.10	0.590	0.890	0.392
N_1F_2	238	14.28	7.73	2.60	0.740	0.993	0480
N_1F_3	238	21.42	9.00	3.30	0.921	1.230	0.530
Mean			7.10	2.41	0.682	0.960	0.554
N_2F_0	357	0	5.80	1.83	0.545	0.810	0.320
N_2F_1	357	7.14	7.50	2.50	0.760	0.920	0.520
N_2F_2	357	14.28	8.60	2.90	0.900	1.200	0.701
N_2F_3	357	21.42	10.00	3.50	1.200	1.560	1.100
Mean			7.97	2.65	0.826	1.120	0.652

Table 9: The cadmium (Cd^{2+}) concentration (ppm) in rice plant organs as affected by the application of farmyard manure (FYM) and urea treatments at harvest stage in 2008.

Treatments	Urea kg.ha⁻¹	FYM t.ha⁻¹	Roots	Straw	Whole grain	Husk	White grain
N_0F_0	0	0	5.07	1.65	0.460	0.750	0.280
N_0F_1	0	7.14	5.83	2.07	0.575	0.895	0.403
N_0F_2	0	14.28	6.45	2.29	0.715	0.992	0.445
N_0F_3	0	21.42	7.62	2.57	0.900	1.250	0.523
Mean			6.242	2.145	0.662	0.971	0.412
N_1F_0	238	0	5.22	1.69	0.507	0.781	0.297
N_1F_1	238	7.14	6.85	2.23	0.620	0.931	0.408
N_1F_2	238	14.28	7.91	2.73	0.781	1.071	0.510
N_1F_3	238	21.42	9.45	3.41	0.981	1.29	0.553
Mean			7.75	2.51	0.722	1.018	0.442
N_2F_0	357	0	5.84	1.90	0.563	0.890	0.367
N_2F_1	357	7.14	7.71	2.63	0.791	0.995	0.534
N_2F_2	357	14.28	9.00	2.98	0.987	1.301	0.762
N_2F_3	357	21.42	11.50	3.65	1.295	1.617	1.15
Mean			8.51	2.79	0.909	1.190	0.703

Conclusion

Generally Pb^{2+} , Ni^{2+} and Cd^{2+} concentrations in rice plant organs progressively increased with increasing the levels of FYM either alone or integrated with urea as compared with the control. Rice grain was polluted with lead and cadmium at higher levels of fertilizer, so it is important to use the recommendation level of FYM and urea to avoid the contamination such as 14.28 tons FYM plus 238 kg urea.ha^{-1}.

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تركيزات عناصر النيكل و الرصاص والكادميوم في نبات الارز تأثرا بالسماد البلدى.

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**مركز البحوث والتدريب فى الأرز- سخا- كفرالشيخ

أجريت تجربتين حقليتين في موسمي ٢٠٠٧و٢٠٠٨ في مزرعة مركز البحوث والتدريب في الأرز – سخا – كفر الشيخ مستخدما صنف الأرز جيزة ١٧٨ وذلك بهدف دراسة تأثير استخدام السماد البلدي والأسمدة الكيماوية (اليوريا) على تركيزات كلا من الكادميوم والرصاص والنيكل في الا جزاء المختلفة لنبات الارز. أوضحت النتائج ان اعلي محصول تم الحصول عليه عند استخدام ٢١.٤ طن سماد بلدي+ ٣٥٧ كجم يوريا/ هكتار بالمقارنة بالمعاملات الاخري. اظهرت النتائج ان كميات الرصاص والنيكل والكادميوم المتجمعة في الجذور اعلي منه في القش والحبوب. زادت تركيزات الرصاص والنيكل والكادميوم في اجزاء نبات الارز (الجذور والقش والحبوب) مع زيادة مستويات السماد البلدي سواء كان بمفرده او مخلوطا مع اليوريا بالمقارنة بمعاملة الكنترول. تركيزات الرصاص في القش لم تتجاوز النسب المسموح بها سواء اضيف السماد البلدي بمفرده اومخلوطا مع اليوريا بينما حبوب الارز كانت ملوثة الي حد ما مع استخدام ٢١.٤٢ طن سماد بلدي + ٣٥٧ و ٢٣٨ كجم يوريا /هكتار. لم تظهر اي تلوث بالنيكل مع المعدلات المرتفعة من الاسمدة. تركيزات الكادميوم في القش لم تتجاوز النسب المسموح بها سواء اضيف السماد البلدي بمفرده اومخلوطا مع اليوريا ولكن مع حبوب الارز ظهرت بعض التلوثات مع كلا من ٢١.٤٢ طن سماد بلدي + ٢٣٨ كجم يوريا / هكتار، ١٤.٢٨ طن سماد بلدي + ٣٥٧ كجم يوريا /هكتار و٢١.٤٢ طن سماد بلدي. استخدام ١٤.٢٨ طن سماد بلدي + ٢٣٨ كجم يوريا /هكتار لم يؤدي الي تجاوز الحدود المسموح بها لتركيزات كلا من الرصاص والنيكل والكادميوم في اجزاء نبات الارز المختلفة.

قام بتحكيم البحث

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