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Original Research Article

Incubation Study of Cobalt with and Without FYM at Various Day Intervals

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A B S T R A C T

Incubation experiment was carried out to study the effect of cobalt (Co) and farm yard manure (FYM) on DTPA- Co at 0, 7, 14, 21, 28, 35 and 42 days after incubation to know DTPA extractable Co of soil. At Department of Agricultural Chemistry and Soil Science, BACA, AAU, Anand with five levels of Co (0, 10, 20, 40 and 80 mg kg^{-1}) and two levels of FYM (0 and 1 %) on loamy sand (Typic Ustrochrepts) soil. The experiment was laid out in a CRD (factorial) with three replications. In incubation study, DTPA- cobalt was reduced at each level of cobalt with advanced in incubation period. The maximum reduction in DTPA-cobalt content was observed in highest level of cobalt at 42nd day over 0day. The FYM application @ 1% showed fixation of cobalt over no FYM application.

Keywords

Cobalt, FYM, Days, DTPA-Co, Incubation

Introduction

The sources of heavy metals as the old smelters affect seriously the surrounding environment and the agricultural production in the area could exceed the permitted limits due to possible entering of trace elements into the food chain. The total heavy metal cannot be measure of their availability for plants as only free metal ions are considered as being the most toxic. Metals that are complex with organic compounds may be less available due to the formation of metal-enriched organic particles, and thus an increase of stabilization and sequestration of metals in the soil (Zhang *et al.*, 2001). In addition, long-term permanence of toxic metals in soil increases binding to clay particles (Kamitani *et al.*, 2006) or to Fe/Mn oxides or carbonate complexes (Reddy *et al.*, 2010) and therefore decreases their biological availability.

Farm yard manure provides long-term immobilization of the metals because these minerals will not be degraded and so will bind the metals for much longer. Altogether an improved biological quality of the soil will be obtained by improved nutrient levels though the Farm yard manure as well as a reduced toxicity of the soil through immobilization of the metals. Chemical immobilization is the remediation technique of contaminant in soil that decreases the concentration of dissolved contaminants by sorption and or precipitation (Basta and McGowen, 2004).

Materials and Methods

Incubation experiment was carried out to study the effect of cobalt (Co) and farm yard manure (FYM) on DTPA- Co at 0, 7, 14, 21,

28, 35 and 42 days after incubation to know DTPA extractable Co of soil. At Department of Agricultural Chemistry and Soil Science, BACA, AAU, Anand with five levels of Co (0, 10, 20, 40 and 80 mg kg^{-1}) and two levels of FYM (0 and 1 %) on loamy sand (Typic Ustrochrepts) soil. The experiment was laid out in a CRD (factorial) with three replications.

The soil was filled in plastic cups, each plastic cup contain 150 gm soil. Before transferring the soil to cups, calculated amount of FYM and cobalt were applied.

Cobalt was applied in the form of cobalt chloride ($CoCl_2$) making solution to the soil. Soil was regularly watered and maintained at field capacity of soil till 42 days of incubation. Soil sample were taken at 0, 7, 14, 21, 28, 35 and 42 days after incubation to know DTPA extractable Co of soil.

Results and Discussion

Effect of incubation period

The gradual decreasing trend was found in terms of incubation periods. As incubation periods increased Co content was significantly decreased in soil (Table 1). The lowest availability was noted at the end of the incubation periods (Day 42).

The percentage in decreasing was 46.07 at 42 days after incubation as conducted to initial concentration. Results were conformity with the finding of Gad and Zaghloal (2006). They observed decreasing concentration of available cobalt with the increasing in incubation periods.

Effect of cobalt

With increasing rates of Co application, there was a significant increase in the available Co content of soil (Table 1). The maximum Co content (49.06 mg kg^{-1}) was found under Co_5 (80 mg kg^{-1}) level and minimum Co content (0.04 mg kg^{-1}) was found under Co_1 (0 mg kg^{-1}) level in soil.

The findings are agreement with Sarkunan *et al.,* (1991). Hooda and Alloway (1993) also reported increased DTPA-extractable Co due to Co addition through sludge in different soils.

Effect of FYM

Application of FYM significantly decreased the availability of Co in the soil (Table 1). The decrease in the availability of Co (14.34 per cent over control) in soil was obtained under F_1 level (1 %) of FYM application. Jones and Johnson (1989) documented that application of manure affect the soil organic matter content, which may retain Co in the soil against leaching and crop uptake. Erikson (1990) also reported increasing sorption capacity of soil in addition of organic matter. Sarkunan *et al.,* (1991) observed decreased DTPA-extractable Cd in the soil due to addition of compost.

Interaction effect

The D × F, D × Co, F × Co and D × F × Co interactions for incubation study (Table 2, 3, 4 and 5) were found to be significant.

Effect of D X F interaction

Combined effect of incubation days and FYM on the availability of Co in the soil is given in the Table 1.

Application of FYM @ 1 % reduced the availability of Co in soil. With increasing incubation days, there was significantly decreasing DTPA-Co content found in all the levels of cobalt.

Table.1 DTPA-Co (mg kg^{-1}) as affected by levels of cobalt (Co), FYM (F) and Incubation period (D)

Treatments	Co content (mg kg^{-1})	Treatments	Co content (mg kg^{-1})
Days after incubation (D)		**Levels of FYM (F)**	
D_1: 00 days	23.51	F_0: 0 % FYM	19.46
D_2: 07 days	21.55	F_1: 1 % FYM	17.02
D_3: 14 days	20.21	**SEm ±**	**0.02**
D_4: 21 days	18.45	**CD (P=0.05)**	**0.06**
D_5: 28 days	16.58	**Levels of cobalt (Co)**	
D_6: 35 days	14.74	Co_1: 0 mg kg^{-1}	0.04
D_7: 42 days	12.68	Co_2:10 mg kg^{-1}	5.09
SEm ±	**0.04**	Co_3:20 mg kg^{-1}	11.81
CD (P=0.05)	**0.10**	Co_4:40 mg kg^{-1}	25.92
		Co_5:80 mg kg^{-1}	48.35
		SEm ±	**0.03**
		CD (P=0.05)	**0.09**
Significant Interactions		**D × F D × Co F × Co D × F × Co**	
CV %		**3.11**	

Table.2 Interaction effect of days and FYM (D × F) on Co (mg kg^{-1}) status in soil

D X F	D_1	D_2	D_3	D_4	D_5	D_6	D_7
F_0	24.29	22.75	21.52	19.77	17.95	15.91	14.07
F_1	22.73	20.34	18.89	17.13	15.21	13.58	11.28
SEm ± 0.05					**CD (P=0.05) 0.15**		

Table.3 Interaction effect of days and cobalt (D × Co) on Co (mg kg^{-1}) status in soil

D X Co	D_1	D_2	D_3	D_4	D_5	D_6	D_7
Co_1	0.10	0.04	0.04	0.03	0.04	0.03	0.03
Co_2	7.53	6.61	5.87	5.00	4.40	3.51	2.73
Co_3	16.40	15.06	13.49	11.63	10.26	8.76	7.10
Co_4	32.12	29.56	28.74	26.56	23.98	21.32	19.19
Co_5	61.41	56.48	52.89	49.02	44.23	40.10	34.34
SEm ± 0.08					**CD (P=0.05) 0.23**		

Table.4 Interaction effect of FYM and cobalt (F × Co) on Co (mg kg^{-1}) status in soil

F X Co	F_0	F_1
Co_1	0.03	0.05
Co_2	5.56	4.62
Co_3	12.68	10.95
Co_4	27.99	23.86
Co_5	51.06	45.64
SEm ± 0.04		**CD (P=0.05) 0.12**

Table.5 Interaction effect of days, FYM and cobalt (D × F × Co) on Co (mg kg^{-1}) status in soil

D X F X Co		Day-0	Day-7	Day-14	Day-21	Day-28	Day-35	Day-42
F_0	Co_1	0.03	0.04	0.04	0.03	0.04	0.03	0.03
	Co_2	7.84	7.11	6.53	5.33	4.93	4.01	3.18
	Co_3	17.11	15.93	14.20	12.65	11.12	9.65	8.08
	Co_4	33.79	31.13	30.68	28.92	26.45	23.15	21.78
	Co_5	62.68	59.54	56.13	51.90	47.21	42.69	37.26
F_1	Co_1	0.04	0.04	0.04	0.03	0.04	0.03	0.03
	Co_2	7.21	6.10	5.21	4.66	3.86	3.01	2.27
	Co_3	15.68	14.18	12.77	10.61	9.40	7.86	6.11
	Co_4	30.45	27.98	26.80	24.19	21.50	19.48	16.59
	Co_5	60.14	53.41	49.65	46.13	41.24	37.51	31.41
SEm ± 0.12						**CD (P=0.05) 0.33**		

Effect of D X Co interaction

Combined effect of incubation days and levels of Co on the availability of Co in the soil is given in the Table 2. Data pertaining to DTPA-Co content in soil as influenced by D × Co interaction showed increasing trend in DTPA-Co content in soil with the increasing levels of Co. But with increasing incubation days there was decreasing DTPA-Co content found significantly at all Co levels. The highest DTPA-Co found at 0 day and the lowest available-Co was found at day-42.

Effect of F X Co interaction

Combined effect of Co and FYM on the availability of Co in the soil is given in the Table 3. Application of FYM @ 1 % reduced the availability of Co in soil. This might be due to decomposition of FYM produced various acid like carboxyl, hydroxyl and phenoxy group which act as chelating agent and due to its chelating effect, the applied Co in soil was ultimately decreased its availability.

Effect of D X F X Co interaction

Data on interaction effect of days, FYM and Co with respect to Co status in soil found to be significant. The Co content was increased with increase in levels of cobalt with absence of FYM while application of FYM @ 1 % reduced the Co content in soil at all Co levels in soil (Table 4). The gradual decreasing trend was found in terms of incubation periods. As incubation periods increasing Co content was significantly decreasing in soil. Significantly the highest Co content (62.68 mg kg^{-1}) found in $D_1F_0Co_5$ (Day-0 + 0 % FYM + 80 mg Co kg^{-1}) treatment combination, while the lowest Co content (0.03 mg kg^{-1}) found in $D_0F_0Co_1$, $D_{21}F_0Co_1$, $D_{35}F_0Co_1$, $D_{42}F_0Co_1$, $D_{21}F_1Co_1$, $D_{35}F_1Co_1$ and $D_{42}F_1Co_1$ treatment combinations. On the basis of incubation study, the application of FYM and days of incubation reduced the DTPA-Co content in soil, while with increase in Co level increase the DTPA-Co in incubation study. An application of FYM reduces the availability of DTPA-Co and stabilizes Co in soil.

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