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EFFECT OF ORGANIC MATTER AND PHOSPHORUS ON CONTENT OF NUTRIENT AND HEAVY METALS IN OAT PLANTS AND SOIL IRRIGATED WITH INDUSTRIAL EFFLUENT

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ABSTRACT

A field experiment was conducted at Bichpuri (Agra) to study the effect of organic matter and phosphorus on the chemical composition of oat plants and soils irrigated with industrial effluent. The results indicated that the major nutrients (N, P, K) and heavy metals (Cd, Cr, Pb) contents in oat plants increased significantly with industrial effluent irrigation over canal water. Application of organic matter and phosphorus levels tended to decrease the heavy metal contents in plants while they increased the amounts of N, P, K in plant over controls. Irrigation with industrial effluent as such increased significantly the amounts of available N, P, K and heavy metals (Cd, Cr, Pb) over canal water irrigated soils. Organic matter and phosphorus application increased the availability of N, P, K in soil over no organic matter and no phosphorus respectively. Application of organic matter reduced the availability of heavy metals in soil over no organic matter. Similarly, phosphorus levels also reduced the availability of heavy metals and minimum amounts of Cd (0.011), Cr (0.11) and Pb (0.76) were noted with 200 kg P_2O_5 ha^{-1}. Addition of organic matter proved more effective in reducing heavy metals than that of phosphorus.

Keywords: Organic matter, phosphorus, heavy metals, industrial effluent, oat, soil

INTRODUCTION

Increasing industrialization and urbanization are resulting in degradation of natural resources. The effluents generated by the industries are unfit not only for their use in houses, but also for disposal in to nearly water courses or cultivable agricultural lands and are likely to cause excess accumulation of metals resulting in phyto-toxicity. To lesson the deleterious effect of industrial waste water application of a suitable treatment is generally recommended. Addition of phosphorus (Sung et al. 1977) and organic matter (Miller et al. 1983) proved more effective in reducing the concentration of heavy metals in plant and soil. Therefore, the objective of present study was to asses the responses of organic matter and phosphorus on the chemical composition of oat plants and soils irrigated with industrial effluent.

MATERIALS AND METHOD

A field experiment was conducted in micro plots (1x1 m) at the research farm of R.B.S. College Bichpuri, Agra during rabi seasons of 2002-04. The soil of experimental site was sandy loam in texture with pH 8.5, organic carbon 3.6 g kg^{-1}, available N 160 kg ha^{-1}, available P 9.2 kg ha^{-1}, available Cd 0.01 mg kg^{-1}, available Cr 0.11 mg kg^{-1} and available Pb 0.69 mg kg^{-1}. The experiment was laid out in a split plot design having irrigation in main plots and organic matter and phosphorus in sub plots with three replications. The treatments consisted of four levels of organic matter (0, 10, 20 and 30 t ha^{-1}), four levels of phosphorus (0, 50, 100 and 200 kg P_2O_5 ha^{-1}) and three levels of effluents (canal water, effluent as such, 50% dilution). The effluent had pH 7.8, EC 2.68 dSm^{-1}, total solid 3232.0 mg/L, phosphate 0.03 mg/L, sulphate 3.0 mg/L, NH_4-N 13.80 mg/L and NO_3-N 0.029 mg/L. Each micro plot was separated by poly ethylene sheet up to 60 cm depth. Between one and other micro plot a bund of half meter was left. The doses of phosphorus and organic matter were added as per treatments. The oat variety Kent-1 was sown on November 2002 and 2003. Irrigating with effluents collected from W.S. factory the crop was raised. The plant and soil samples were collected from each plot after harvest of the crop. The nitrogen in the plant was determined by Kjeldahl method (Jackson 1973). Phosphorus in the di-acid extract (HNO_3 and $HClO_4$) was determined by vanadomolybadate yellow colour method, K by flame photometer, S by turbidimetric method (Chesnin and Yien

1951) and heavy metals (Cd, Cr, Pb by atomic absorption spectrophotometer). Available N, P, K in soil was determined by standard procedures (Jackson 1973). DTPA extractable Cd, Cr and Pb were determined with the help of AAS.

RESULTS AND DISCUSSION

Nutrients content in oat plants: Nitrogen, P, K content in the plants of oat was affected by various effluent levels (Table 2). Among the different effluent levels, Industrail effluent as such recorded significantly higher N, P, K content in oat plants as compared to canal water and 50% dilution during both the years. Canal water recorded the least N (1.68%), P (0.24%), K (1.47%) contents in oat plants. In general, samples of oat crop grown on as such industrial effluents treated soil had higher nutrient content than the oat plants grown with canal water and 50% diluted industrial effluents. Singh and Bhati (2005) reported similar results. In pooled data canal water recorded 19.74 and 7.92 % less phosphorus content than effluents as such and 50% dilution respectively. Application of various level of organic matter affected the N, P, K contents in oat crops. The highest nitrogen content (1.96%) was recorded with 30 t organic matter ha-1. Among the various levels of organic matter, (10 t ha^{-1}) recorded the least N, P, K content (1.67, 0.26, 1.49%). While it produced significantly higher N, P, K content in plants over control, (no organic matter).

Table 1: Effect of industrial effluent organic matter and phosphorus on content and heavy metal in oat

Treatments	N content (%)	P content (%)	K content (%)	Cd ppm	Cr ppm	Pb ppm
Effluent levels						
Cannel water	1.68	0.24	1.47	0.61	4.05	38.92
Effluent as such	1.81	0.30	1.54	0.86	4.69	52.74
50% dilution	1.75	0.27	1.51	0.76	4.38	48.32
CD (P=0.05)	0.045	0.008	0.038	0.013	0.011	1.36
Organic matter (t ha^{-1})						
O_0	1.47	0.23	1.39	0.80	4.52	47.37
O_{10}	1.67	0.26	1.49	0.75	4.45	46.69
O_{20}	1.90	0.29	1.55	0.73	4.32	46.50
O_{30}	1.06	0.31	1.59	0.68	4.20	46.09
CD (P=0.05)	0.052	0.009	0.044	0.016	0.125	NS
Phosphorus levels (kg ha^{-1})						
P_0	1.50	0.24	1.44	0.81	4.54	47.65
P_{50}	1.74	0.27	1.48	0.75	4.47	47.11
P_{100}	1.86	0.29	1.53	0.71	4.29	46.16
P_{200}	1.90	0.30	1.57	0.69	4.18	45.82
CD= (P=0.05)	0.052	0.009	0.042	0.014	0.116	1.51

These findings are in close conformity with that of Singh and Bhati (2005). All the phosphorus levels had a significant influence on N, P, K content of oat crop. Application of 100 kg and 200 kg P_2O_5 ha^{-1} being at par produced significantly higher nitrogen content over 50 kg P_2O_5 ha^{-1}. Phosphorus content in oat crop increased by 10.9, 19.3 and 23.81% due to the 50, 100 and 200 kg P_2O_5 ha^{-1} over no phosphorus in pooled data. Similar, observations were made by Mishra and Shukla (1986).

Heavy metal contents of oat: All the treatments of effluent differed significantly from one another in respect of heavy metal (Cd, Cr, Pb) contents of the oat crop. The heavy metal content was significantly higher in industrial effluent as such treated crop as compared to canal water and 50% dilution treated crops. Similar results were reported by Singh and Singh (1994). Organic matter application had a marked effect in reducing the heavy metals of oat. The higher levels of organic matter (10 to 30 t ha^{-1}) reduced the heavy metals in oat crop significantly. Application of 30 t organic matter ha^{-1} recorded the lowest chromium content in oat plants. Application of organic matter had no significant effect on lead content of oat crop. The heavy metal (Cd, Cr, Pb) in oat crop were remarkably decreased with increasing levels of phosphorus.

Table 2: Soil analysis after crop harvest with reference to effluent, organic matter and phosphorus on available N, P, K, Cr, Pb, Cd

Treatments	Avail. N (kg ha^{-1})	Avail. P (kg ha^{-1})	Avail. K (kg ha^{-1})	Avail. Cd (mg kg^{-1})	Avail. Cr (mg kg^{-1})	Avail. Pb (mg kg^{-1})
Effluent levels						
Canal water	104.6	18.3	105.9	0.011	0.01	0.70
Effluent as such	293.2	33.2	175.5	0.031	0.16	1.01
50% dilution	264.7	30.8	120.1	0.020	0.13	0.94
CD= (P=0.05)	2.92	0.08	3.71	0.0007	0.004	0.023
Organic matter (t ha^{-1})						
0	198.0	19.2	117.5	0.023	0.17	1.01
10	219.6	26.6	128.2	0.020	0.14	0.90
20	231.3	31.6	142.2	0.017	0.13	0.84
30	266.2	42.6	195.0	0.014	0.12	0.79
CD= (P=0.05)	7.99	0.09	4.52	0.0011	0.005	0.026
Phosphorus levels (kg ha^{-1})						
0	206.7	21.4	128.4	0.030	0.17	1.02
50	218.9	26.4	133.1	0.020	0.14	0.90
100	225.9	30.4	135.6	0.014	0.12	0.83
200	230.8	31.6	138.3	0.011	0.11	0.76
CD= (P=0.05)	7.56	0.09	4.39	0.0010	0.004	0.024

A gradual and significant decrease in chromium content was observed with each added levels of phosphorus from 50 to 200 kg P_2O_5 ha^{-1}. The maximum and minimum amounts of lead were noted under no phosphorus and 200 kg P_2O_5 ha^{-1} treatment, respectively. Singh et al. (1977) reported similar results.

Nutrient status of soil: The soil samples collected from industrial effluent irrigated site showed a variation in available N, P, K content in soil. On an average soils irrigated with industrial effluent as such were found to contain relatively higher concentration of available N, P, K. All the samples fall in the category of high available nitrogen, phosphorus and potassium status. Soils irrigated with canal water were lowest in available N, P, K status. Data (Table 2) revealed that application of various organic matter levels had significant positive effect on available N,P,K status of soil after harvest of the crop. Application of 30 t organic matter ha^{-1} recorded, significantly higher available N, P, K in soil over lower levels of organic matter and control. The lowest amounts of available N, P, K in the soil were noted in control (no organic matter). These finding are in close conformity with those of Namede and Shrivastava (1997) for available phosphorus. Application of phosphorus significantly enhanced the available N, P, K in the soil. The highest amounts of available N, P, K were recorded with 200 kg P_2O_5 ha^{-1} over no phosphorus. Almost similar results were reported by Singh et al. (1977).

Heavy metal status of soil: Different effluent levels differed significantly from one another in respect of available Cd, Cr and Pb contents in the soil after harvest of the crop. The contents of heavy metals (Cd, Cr, Pb) were significantly higher in industrial effluent treated soil as compared to irrigation with canal water.Available Cd, Cr and Pb contents in industrial effluent treated soil was the highest (0.031 mg kg^{-1} Cd, 0.16 mg kg^{-1} Cr and 1.01 mg kg^{-1} Pb) while these heavy metals were lowest (0.011 mg kg^{-1} Cd, 0.01 mg kg^{-1} Cr and 0.70 mg kg^{-1} Pb) in the soil treated with canal water. Subbiah and Sreeramulu (1980) and Hemkens et al. (1980) also reported similar results for Cd and Cr, respectively. Available heavy metal (Cd, Cr, Pb) content in the soils decreased significantly with increasing levels of organic matter. All the levels of organic matter were found to be significantly inferior to control (no organic matter levels) in respect of available Cd, Cr, Pb content in the soil. The minimum amounts of these heavy metals were noted with 30 t organic matter ha^{-1} treatment as organic matter acts a chelating agent. Miller et al. (1983) reported similar results. The increasing levels of phosphorus resulted a significant decrease in available heavy metal contents in the soil. All the phosphorus levels were found to be significantly inferior in respect of available heavy metal (Cd, Cr, Pb) content in the soils over no phosphorus. The soil treated with 200 kg P_2O_5 ha^{-1} recorded the lowest amount of (0.011 mg kg^{-1} Cd, 0.110 mg kg^{-1} Cr, 0.76 mg kg^{-1} Pb) heavy metals. Almost similar results were also reported by Hemkens et al. (1980).

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