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Lead and cadmium content of Indian flue-cured tobacco

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Summary Studies on levels of lead and cadmium of Indian flue-cured tobacco indicated that the leaf contained very low amounts of these heavy metals as compared to tobacco from other countries. Indian tobacco can therefore be adjudged as 'safe and clean' and least hazardous to the smoker. Of the two heavy metals, lead content of soils is higher than cadmium. But in the leaf, cadmium content is more than lead indicating that soil cadmium may be more available to tobacco and hence more readily absorbed by the plant than lead.

Introduction

Lead and cadmium are the trace element pollutants commonly occuring in plant species. These metals are hazardous to human health. In the case of tobacco, there are reports of their transfer to smoke[2,8,10]. In view of this, the levels of lead and cadmium were determined in Indian flue-cured tobacco and compared them with their levels in tobaccos from certain other principal tobacco producing countries of the world (Table 3). Results of these investigations are reported in this communication.

Materials and methods

These studies were taken up on the flue-cured tobacco crop grown in the year 1982 on the farms of Central Tobacco Research Institute located at Katheru and Devarapalli. The soil of Katheru farm is a vertisol while at Devarapalli, it is an alfisol. Mechanical composition and other characteristics of these soils are presented in Table 1.

To find out the effect of phosphorus application on cadmium content of the leaf, samples were collected from no phosphorus (N + K) and phosphorus applied (N + P + K) plots of both the soil types. In the case of vertisols, farm yard manure (at 7.5 t/ha) and no farm yard manure treatments were superimposed over these P-treatments. N and K were applied at 20 and 42 kg/ha respectively in the case of vertisols in the form of $(NH_4)_2SO_4$ and K_2SO_4 while in alfisols, the crop received N and K at 45 and 67 kg/ha as $(NH_4)_2SO_4$ and K_2SO_4. Superphosphate to supply 50 and 35 kg P/ha was used as the source of P in vertisols and alfisols respectively. In vertisols, the crop was grown as a dry crop on the conserved soil moisture of monsoon and in alfisols the crop received irrigation at a level of 300 mm.

Tobacco leaf samples, composite of all primings, collected in quadruplicate from different locations were processed, avoiding contaminants and analysed for total content of cadmium and lead on AAS[9]. Surface and sub-soil samples were collected from both the soils and analysed for acid extractable ($6M$ HNO_3) cadmium and lead.

Table 1. Soil characteristics of two tobacco producing soil types

Depth	pH	Particle size distribution (%)			
		Coarse sand	Fine sand	Silt	Clay
Vertisols (Katheru) Black Soil					
0–22.5 cm	8.2	1.55	17.06	22.32	56.52
22.5–45 cm	7.5	0.67	11.48	25.17	61.87
Alfisols (Devarapalli) Northern Light Soil					
0–22.5 cm	6.3	68.26	20.08	8.55	6.44
22.5–45 cm	6.1	66.05	15.37	5.76	13.92

Table 2(a) Range of cadmium and lead concentration in ppm in dry matter in the flue-cured tobacco leaf lamina (Means in brackets) Mean of 24 samples

Treatment	Leaf lamina from	
	Vertisols	Alfisols
Cadmium		
NO FYM N + K (NO P)	0.100–0.347 (0.218)	0.306–0.602 (0.491)
NO FYM N + P + K	0.392–0.501 (0.455)	0.374–0.731 (0.494)
FYM N + K (NO P)	0.303–0.552 (0.432)	---
FYM N + P + K	0.394–0.426 (0.354)	---
Lead		
NO FYM N + K (NO P)	0.247–0.385 (0.311)	0.345–0.488 (0.400)
NO FYM N + P + K	0.231–0.464 (0.354)	0.355–0.452 (0.384)
FYM N + K (NO P)	0.293–0.545 (0.416)	---
FYM N + P + K	0.227–0.398 (0.248)	---

Table 2(b). Cadmium and lead concentration in soils (expressed as ppm on oven dry basis) (Means in brackets) Mean of 24 samples

Treatment	Soils	
	Vertisols	Alfisols
Cadmium		
NO FYM N + K (NO P)	0.093–0.117 (0.106)	0.0159–0.0228 (0.0186)
NO FYM N + P + K	0.087–0.142 (0.116)	0.0160–0.0250 (0.0200)
FYM N + K (NO P)	0.094–0.115 (0.104)	---
FYM N + P + K	0.090–0.115 (0.106)	---
Lead		
NO FYM N + K (NO P)	16.51–17.71 (17.06)	5.19–11.10 (8.10)
NO FYM N + P + K	16.55–17.93 (17.20)	6.00–11.40 (8.12)
FYM N + K (NO P)	16.64–17.52 (17.02)	---
FYM N + P + K	16.52–17.21 (16.88)	---

Table 3. Cadmium and lead concentration (ppm) in the tobacco leaf samples produced from different countries

	India*	America	Germany	New Zealand	Canada
Cadmium	0.218–0.494	1.7–2.9	1.07–2.3	0.23–0.56	1.25–7.02
Lead	0.311–0.416	0–200.0	2.4 –4.3	0.48–0.55	0.80–9.15

* Average figures of 24 samples

Results and discussion

Data presented in Table 2 (a and b) clearly indicated that concentration of the two heavy metals, in general, is quite low in both the soil types.

In Table 3 data of cadmium and lead contents of Indian leaf of both the soil types was compared with leaf from the other principal tobacco producers *viz.*, USA[1,11], Germany[7], New Zealand[12] and Canada[4]. Evidently both lead and cadmium contents of Indian leaf are much lower than the leaf from other countries. It has been demonstrated that most of the lead in green plant parts originate from deposition of air borne lead from automotive sources[13] and thus the lead content of tobacco leaves in India can be expected to be low as such occurences are minimum in India. In other words, leaf from India can be considered as 'safer' and 'cleaner'. Precise information on permissible limits of lead and cadmium in tobacco is not available. For food stuffs, 2 ppm lead has been fixed as the limit as per British and Canadian standards and lead content of Indian tobacco leaf is much lower than this permissible limit. The extent of transfer of cadmium and lead to smoke are much less[8]; thus by virtue of its lower concentration of these two heavy metals, Indian flue-cured tobacco can be adjudged as 'safe and clean' and least hazardous to the smoker.

Soil types

Of the two soil types, cadmium and lead contents are much higher in vertisol than in alfisols. Inspite of this fact, it is curious that leaf from vertisols had lower content of these two heavy metals than leaf from alfisols. Availability of these metals from soils and absorption by leaf are influenced by three soil factors *viz.*, pH, the content of finer fractions and $CaCO_3$. Davies[3] reported that the availability of soil lead and cadmium decrease as the pH increases; he also observed that adsorption of these metals by clay and silt fractions is high. In soils of pH 7.0 and above, HCO_3^- is the dominant anion in soil solution, which reduces the availability of lead and cadmium. An interplay of all these factors is responsible for lower cadmium and lead absorption by the leaf from the vertisols as compared to leaf from alfisols (Table 1).

Within the two heavy metals, cadmium appears to be more readily available to tobacco and more readily absorbed from the soil than lead. Studies by Lagerwerff[5] confirm these observations. Working with radish, he observed that the lead supply is to be increased ten-fold for doubling the content in plant while cadmium could be doubled in the plant with five-fold increase only. These observations would also explain the probable factors for high cadmium level in the leaf of both the soils as compared to lead, although, the soil lead level is many times higher than cadmium.

Interaction of cadmium with zinc and phosphorus

There are several reports of investigations which showed that the uptake of cadmium by plant is very much influenced by zinc. Similarly, cadmium accumulation in soils was reported to have direct relationship to the application of phosphatic fertilizers, particularly, super phosphate. But, results of the present study did not confirm these observations and the interactions of either zinc and phosphorus with cadmium did not follow any regular trend. Cadmium and lead absorption have not been influenced by the application of farm yard manure.

In conclusion, it can be mentioned that the problem of heavy metal pollution in Indian flue-cured tobacco is negligible.

References

1 Clarke B B and Brennan E 1983 Tobacco Sci. 27, 28–29.
2 Cogbill E C and Marcus E Hobbs 1957 Tobacco Sci. 1, 68–73.
3 Davies B E 1980 Trace Element Pollution. *In* Applied Soil Trace Elements. John Wiley and Sons.
4 Frank R *et al.* 1977 Tobacco Sci. 21, 74–80.
5 Lagerwerff J V 1971 Soil Sci. 111, 129–133.
6 Medrano J S and Jurinak J J 1975 Soil Sci. Soc. Am. Proc. 39, 851–856.
7 Mishra U C and Shaik G N 1983 J. Radio and Chem. 78, 385–390.
8 Nadkarni W D *et al.* 1970 Tobacco Sci. 14, 37–39.
9 Perkin-Elmer 1976 Analytical methods for atomic absorption Spectrophotometry. Norwalk, Connecticut, USA
10 Smoking and Health 1979 A report of the Surgeon General US Department of Health, Education and Welfare.
11 Tso T C 1972 Physiology and Biochemistry of Tobacco Plant, Dowden, Hutchinson and Ross, Inc., Strondsbury, Pa.
12 Brooks R R and Trow J M 1979 New Zealand J. Sci. 22, 289–91.
13 Tjell J C *et al.* 1979 Nature 280, 425–426.