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STUDIES ON THE IMPACT OF MINING ON AGRICULTURAL SOILS OF BICHOLIM TALUKA, GOA

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A total of 49 soil samples from various agricultural fields affected by mining rejects in the bicholim Taluka of Goa were collected and examined for physico-chemical characteristics, soil enzymes and soil microbial populations. An attempt was made to correlate the microbial populations with soil enzyme activities and content of heavy metals, both affected and unaffected soils were analyzed to make a comparative analysis.

The state of Goa has rich Iron ore and Manganese resources, which are mostly situated in the agricultural and forested areas of the Western Ghats. Efforts to exploit this deposit have caused drastic degradation of the ecosystem in Bicholim taluka which is the most mined taluka in Goa (46.12% of its total area is under mining lease). Although mining is considered to contribute largely to Goan economy, unplanned mining has also come into focus as a destroyer of the environment for 3 main reasons : Firstly : large scale mining in forested areas has lead to rapid destruction of vegetation; Secondly : surface mining has caused land degradation and led to pollution; Thirdly : creation of dumps of mining rejects has polluted the waters and rendered neighbouring farm and forest lands fallow or reduced the productivity due to low nutrient status caused by mining rejects and heavy metal toxicity. Thus due to lower soil quality, not only in the mining regions but also in the surrounding areas, land is becoming infertile and unsuitable for plant growth. Despite the importance of microbial activities to fertility of soils around the mining regions and its genesis, relatively few studies have examined microbial characteristics of these soils. The present study is an endeavour to estimate the various parameters and assess the impact of mining on the soil fertility of Bicholim taluka, prior to implementing bioremedial measures.

EXPERIMENTAL RESULTS AND DISCUSSION

Soil properties : The physicochemical properties of different soil samples collected from different areas in Bicholim Taluka are given Table 1.

The analysis of the soils revealed that some soils from Mayem, Dignem, Piligao and that of the undisturbed areas of Aturli and Naroa were acidic in nature having pH ranging from 5.21 6.0. The remaining areas viz. Surla, Mulgaon, Lamgaon, Cudnem and Veguem varied to a lesser extent from pH 6.4 to 6.6. The lower pH could account for the oxidation of the ferrous (+2) form to the insoluble ferric (+3) form which under natural conditions is normally unavailable to plants. (Nambiar 1987, Bohn 1985). Also the partially disturbed areas of Mayem and Dignem and the undisturbed area had a low total Iron and Manganese content which could be due to the fact that these areas are less affected by the mines.

Table 1 Physico Chemical Properties of soil

Properties	Soil collected from					
	Lamgāon	Disnem	Cudnem	Velguem	Piligao	Undis-turbed area
No. of sampies	4	3	10	5	3	2
	Range	Range	Range	Range	Range	Range
pH	6.13-7.17	5.6-6.0	5.0-7.6	5.7 7.36	5.77 6.34	5.7-5.8
Moisture Cont.	19.328-26.81	26.87-36.63	31.34-67.3	9.34-19.18	- -	- 46.0
Organic Carbon (%/g)	0.0128-0.0443	0.0133-0.0342	0.0153-0.0441	0.0062 0.072	0.0105 0.0197	0.0382 0.04179
Total Nitrogen (mg)	48.76-77.49	85.84-96.53	4.25-43.754	20.7-62.124	71.5-106.0	40.74-99.53
Phosphorus (P_2O_5 kg/acre)	0.174-1.436	0.137-0.180	0.005-0.119	-	-	0.130
Manganese (mg/g)	0.275-8.248	0.1648-0.4394	0.2197-7.70	5.49-8.95	0.5493-1.373	1.647 3.845
Total iron (mg/g)	0.75-8.75	0.375-1.25	0.25-4.25	1.5-15.75	18.25-31.25	0.5-0.75
Fe^{+2} (µg/g)	100-760	600-1000	160-1000	200-1000	700-1500	300-400
Fe^{+3} (µg/g)	300-1400	50-1200	200-1149	480-800	1300-4600	2500-2700

Key : - = Absent

The moisture content of the soil varied according to the status of the fields i.e. cultivated fields showed a higher moisture content compared to the uncultivated regions.

The percentage of organic carbon content of all the soils was extremely low i.e. less than 0.07%. Values considered normal are between 0.52% - 0.72%. In contrast to organic carbon. nitrogen values were slightly higher.

The available phosphorous values were generally low or absent in most soil samples. It has been reported that high iron concentrations limit the availability of phosphate by fixing the

plant available phosphates into hard to dissolve iron phosphates at low pH levels (Shankar 1993).

Microflora : The comparison of microflora of different soil samples in an around the mining areas of Bicholim taluka, shows very low activity of most types of microbes in the mine soils, while the undisturbed area shows higher microbial population as compared to the rest.

The bacterial populations in the various regions varied greatly and bacterial counts were moderate to high in Cudnem. Dignem and Piligao and low in Mulgaon, Lamgaon, Surla and Velguem. This could be attributed to the pH of the soil since bacterial populations increased as the pH of the soils increased whereas fungal growth was decreased by increased pH. Earlier, Shirey, :1989 also demonstrated that number, diversity and respiration rate of microorganisms in mine soils were lower than in native soil.

A total of 25 ammonifying bacterial; 2 nitrifying bacteria and 3 phosphorus solubilizers having moderate to good activity have been isolated. Identification of these isolates is yet to be done on the basis of biochemical tests. The activity of the nitrifying bacteria is also markedly influenced by certain environmental conditions chief among them is soil pH (Shirey, 1989). It was observed that nitrifying activity was low in acidic soils of Mayem, Dignem and the undisturbed area with pH ranging from 5.2 - 5.8. The absence of phosphate solubilizing bacteria corresponded with the low levels of phosphorus present in the soil. Only Surla, Lamgaon, Cudnem and Velguem showed presence of few phosphate solubilizing bacteria.

Enzymology : Cellulase and Amylase activity is considered as an effective indicator of leaf litter decomposing activity (Satpathy *et al.* 1993). During the first stage of litter decomposition, the rate of degradation is correlated with fungal colonization. Due to massive deforestation caused by mining there is lack of decaying vegetation. This could account for the low cellulase activity as well as low fungal counts. The amylase activity showed a slight increase as compared to the low cellulase activity.

The phosphatase activity was moderate to low for all the soils and this was reflected in the low phosphorus content of the soils and the presence of few phosphate solubilizing bacteria.

The sulphur transfer reactions in the soil are catalyzed by the enzyme Rhodonase (Thiosulphate sulphur transferase). Surla, Lamgaon, Cudnem and Dignem showed appreciable levels of rhodonase activity which corresponded to a higher concentration of iron. This could be explained by the fact that the iron-ore extracted is of a pyritic (FeS_2) origin.

Dehydrogenase on the other hand is an indicator of the respiratory rate of microorganisms (Fukui, 1989) as it is a constitutive enzyme present only in living microorganisms. Appreciable dehydrogenase activity was only found in the undisturbed area and in Mayem which had relatively higher counts of microbial population as well as organic carbon content as compared to the remaining areas. Dehydrogenase is also known to be an indicator of organic pollution and is very high in those areas with plenty of decaying matter. The latter

being absent in mining regions it is but natural that the activity of dehydrogenase is also affected accordingly.

In the areas of Surla and Piligao of the mining belt where iron concentration is between 15.16 - 25.42 mg/g, the urease activity was considerably lower i.e. approximately 40-45 -µg urea N/ml compared to the areas of Mayem, Lamgaon, Cudnem and Velguem with a concentration of urea N between 110-180 -µg/ml corresponding to an iron concentration of 0.9-7.53 mg/g. This shows that ureas activity is adversely affected by the presence of heavy metals like iron. Decrease in urease activity is therefore an indicator of heavy metal pollution.

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