

Impact of limestone mining activity on soil properties

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ABSTRACT

Dust emanated from the limestone mining activity gets deposited on the soil surface over a period of time in the vicinity of the mining activity. A study was conducted on the impact of dust on properties of soil close to the mining activity in comparison with soils in 1 km + distance. It was found that there was significant increase in pH close (1 km) to the mining activity. In general available N, P and K values were lower in soils close to (1 km) the mining activity compared to that of soils in 1 km+ zone. The change was significant in case of Nitrogen content which could be due to cultivation of exhaustive crops without applying enough fertilizers. Exchangeable Ca and Mg content were significantly higher in soils close (1 km) to the mining activity compared to soils in 1 km + zone. This could be cumulative effect of dust fall due to mining activity over a period of time. However, the changes in N, P, K, Ca and Mg contents were neither to deficiency or toxicity level.

Key words : Limestone dust, contamination and soil properties

Introduction

Pollution is increasing day by day because of ever increasing population. One of the major causes of the increased pollution is industrialization. Among different industries cement industries and mining activities cause dust pollution of agricultural soils. Accumulation of alkaline dusts in the soil can increase soil pH which affects crop growth. Dust deposited on the ground may produce changes in soil chemistry, which on the longer term result in changes in plant chemistry. To prepare cement commercially limestone is obtained from the limestone mines. At the time of mining activities, the dust released will travel to distances through wind movement and gets deposited on the top of the soil surface. Through rainfall, the deposited dust will go down into deeper layers of the soils, depending upon the soil type. If this happens for months to years, soil loses its natural properties and finally becomes unproductive.

To know the effect of dust released from the limestone mining activity on soil properties a study was conducted in limestone mining area of a Cement Industry in Malkapur village of Ranga Reddy dis-

trict. Andhra Pradesh,

Materials and Methods

A survey was conducted in limestone mining activity area of a Cement Industry, Malkapur village of Ranga Reddy district, Andhra Pradesh. Soils were collected from 0 - 15 cm depth from 9 locations, Locations 1, 2, 4 and 5 were close to the limestone mining activity and locations 3, 5, 7, 8 and 9 locations were one kilometer away from the mining activity. Soil samples after processing were analyzed for physical *viz.*, mechanical composition, water retention at field capacity (0.33 bars) and wilting point (15 bars); physico-chemical *viz.*, soil reaction (pH) and electrical conductivity (EC); and chemical properties *viz.*, available N, P₂O₅ & K₂O, exchangeable Ca and Mg. Standard methods were employed to analyze all these parameters (Black, 1965 and Jackson, 1973).

Results and Discussion

Impact on soil physical properties

Mechanical composition: The results presented in Table 1 showed that in soils which were close to the

mining activity the mean values of sand, silt and clay were 14.62, 34.75 and 50.63% and the mean values of sand, silt and clay of soils at 1 km - distance from the mining activity were 14.87, 34.40 and 50.73%. Appreciable difference in soil texture was not there among the soils adjacent to the mining activity and one kilometer away from the mining activity, which was evident from the soil mechanical composition. Soils from all locations both within and beyond 1 km distance from the mining activity fall under the group of clay loam texture. There was no significant change in mechanical composition of soils close to and away from the mining activity.

Soil water retention

The mean moisture content of soils was 15.79 and 15.98 at field capacity, 9.15 and 9.21 at wilting point in soils within and beyond 1 km distance from the mining activity, respectively. No significant change in moisture content at field capacity and wilting point was recorded within and beyond 1 km distance from the mining activity as shown in Table 2. In this survey, the mechanical composition and water retention properties did not show any adverse effect on the soil quality.

Impact on soil physico-chemical properties

Soil reaction (pH)

The soil reaction was recorded in terms of pH. The average pH value indicated that the soils within 1 km⁺ distance were moderately alkaline (7.81 to 8.50) and soils beyond 1 km distance were slightly alkaline (7.31 to 7.80) as shown in Table 3. There was sig-

Table 1. Effect of mining activity on soil mechanical composition

Location No.	Sand%	Silt%	Clay%
Close to the site (1 km)			
1	15.50	34.34	50.16
2	15.34	33.66	51.00
4	14.67	35.00	50.33
5	13.00	36.00	51.00
Mean	14.62	34.75	50.63
A way from the site (1 km ⁺)			
3	15.00	34.34	50.66
6	14.34	34.66	51.00
7	15.66	34.00	50.34
8	14.00	35.00	51.00
9	15.34	34.00	50.66
Mean	14.87	34.40	50.73
t test	0.07 ^{NS}	0.43 ^{NS}	0.41 ^{NS}

NS - Non significant.

Table 2. Effect of mining activity on soil water retention (% w/w)

Location No.	At field capacity (0.33 bars) Close to the site (<1 km)	At wilting point
1	17.20	9.20
2	14.80	9.16
4	15.60	9.20
5	16.30	9.27
Mean	15.98	9.21
Away from the site (1 km ⁺)		
3	15.34	9.07
6	16.20	9.07
7	15.43	9.20
8	16.20	9.20
9	15.80	9.20
Mean	15.79	9.15
t test	0.37 ^{NS}	1.44 ^{NS}

NS - Non significant.

nificant increase in pH values of soils close to the mining activity compared to the soils in 1 km⁺ zone from the mining activity. The average values recorded were 8.0 (moderately alkaline) and 7.7 (slightly alkaline) in near and away (1 km⁺) from the mining activity, respectively. This might be due to the cumulative effect of accumulation of mining dust from the nearby limestone slab quarries and limestone mining activities of the industry.

In this region over long time soils may become more alkaline and less productive. Similar increase in pH was recorded in soils in the vicinity of dolomite mining activity in Khammam district by Prabhu Prasadini and Singa Rao (2005), however it was beneficial in that region as the soils were inherently acidic. Similar observations were recorded by Mukunda Rao (1993) that the pH of cement dust polluted soils was higher than the soils of unpolluted control.

Salt content

The salt content was measured in terms of Electrical Conductivity (EC) and the data is shown in Table 3. The mean electrical conductivity values recorded were 0.18 and 0.15 dS m⁻¹ in near and away (1 km⁺) from the mining activity. The EC values indicated that there was no appreciable difference in soluble salt content in the soils near and far. Similar observations were recorded by Mukunda Rao (1993) that the EC of cement dust polluted soils were higher than the soils of unpolluted control. Prabhu

Table 3. Effect of mining activity on soil reaction (pH) and electrical conductivity (EC)

Location No.	Soil pH Close to the site (<1 km)	Soil EC (dS m ⁻¹)
1	7.83	0.15
2	7.97	0.17
4	8.06	0.19
5	8.06	0.22
Mean	8.00	0.18
	Away from the site (1 km [*])	
3	7.52	0.15
6	7.91	0.18
7	7.79	0.15
8	7.74	0.16
9	7.71	0.15
Mean	7.70	0.15
t test	2.84*	1.28 ^{NS}

* - Significant at 5% level; NS - Non significant

Prasadini and Singa Rao (2005) reported higher EC values close to the dolomite mining activity compared to soils in 1 km zone.

Impact on soil chemical properties

Nitrogen content

The mean available N content of soils within 1 km from the mining activity were 320.4, 322.2 and 332.4 kg ha⁻¹, at vegetative, flowering and harvesting stages of crop, respectively (Table 4). Available N content was significantly low in soils close to the mining activity. This could be due to cultivation of exhaustive crops without applying enough fertilizer. Low N content was observed in dust affected soils by Mukunda Rao (1993).

Phosphorous content

Phosphorous in terms of available P₂O₅ within 1 km distance from the mining activity were slightly lower *i.e.*, 26.2, 22.5 and 29.6 kg ha⁻¹ compared to those recorded at away 1 km distance from the mining activity *i.e.* 35.8, 25.7 and 42.4 kg ha⁻¹ at vegetative, flowering and harvesting stages of the crop, respectively (Table 4). This could be due to loss of available P to reserve because of higher soil pH in soils close to the mining activity.

Potassium content

In general, K content in soils was medium (150-300 kg ha⁻¹) to high (>300 kg ha⁻¹). The mean available K₂O content of soils within 1 km distance from the mining activity were 273, 259 and 253.1 kg K₂O ha⁻¹

Table 4. Effect of mining activity on available N, P and K content of soils

Location No.	Nitrogen (kg ha ⁻¹)			P ₂ O ₅ (kg ha ⁻¹)			K ₂ O (kg ha ⁻¹)		
	Vegetative stage	Flowering stage	Harvesting stage	Vegetative stage	Flowering stage	Harvest stage	Vegetative stage	Flowering stage	Harvesting stage
1	321.5	295.4	312.9	13.4	27.2	13.1	231.84	269.92	263.20
2	311.4	323.4	340.7	17.9	21.4	34.6	271.04	238.56	221.76
4	307.5	314.6	312.9	41.1	19.5	29	291.2	273.28	254.24
5	341.5	355.3	363.1	32.5	22.1	41.7	297.92	254.24	273.28
Mean	320.4	322.2	332.4	26.2	22.5	29.6	273.0	259	253.10
	Close to the site (< 1 km)								
3	389.30	401.50	405.70	16.40	28.70	41.70	247.52	249.76	286.72
6	393.10	413.70	421.90	21.20	29.70	24.30	299.04	238.56	292.32
7	415.20	409.10	396.20	50.00	28.90	25.10	327.04	258.72	290.08
8	398.40	415.30	402.15	63.10	18.70	54.30	446.88	292.32	278.88
9	402.90	420.20	399.70	28.60	22.70	66.80	256.48	272.16	294.56
Mean	399.70	411.90	405.10	35.80	25.70	42.40	315.30	262.30	288.50
t test	9.44*	7.77*	6.15*	0.83 ^{NS}	1.12	1.19 ^{NS}	0.99 ^{NS}	0.26 ^{NS}	3.44*
	Away from the site (1 km [*])								

* - Significant at 5% level; NS - Non Significant

Table 5. Effect of mining activity on exchangeable Ca and Mg content of soils

Location	Exchangeable Ca (c mol (p ⁺) kg ⁻¹)			Exchangeable Mg (c mol (p ⁺) kg ⁻¹)		
	Vegetative stage	Flowering stage	Harvesting stage	Vegetative stage	Flowering stage	Harvesting stage
Close to the site						
1	13.25	12.56	12.78	6.23	6.45	6.32
2	12.80	12.46	12.13	6.27	6.63	6.17
4	14.30	13.74	14.21	6.12	6.27	6.54
5	10.76	11.45	10.91	5.31	5.23	5.10
Mean	12.70	12.50	12.50	5.90	8.10	6.00
Away from the site (1 km ⁻¹)						
3	8.43	8.12	8.76	3.73	3.12	3.25
6	8.62	8.11	8.23	4.23	3.93	4.11
7	7.82	7.65	7.74	3.13	3.21	3.34
8	7.26	7.32	7.54	2.89	2.94	2.78
9	7.13	7.21	7.23	2.73	2.58	2.69
Mean	7.85	7.68	7.90	3.30	3.10	3.20
t test	6.69*	10.47*	6.81*	7.05*	8.01*	6.96*

* - Significant at 5% level

and beyond 1 km distance from the mining activity were 315.3, 262.3 and 288.5 kg K₂O ha⁻¹ at vegetative, flowering and harvesting stages of the crop, respectively (Table 4). K content was relatively low in soils close to the mining activity compared to soils in 1 km⁺ zone, however the difference was significant only at the harvest stage of the crop.

Calcium and Magnesium content

The exchangeable Ca content was higher in soils close to the mining activity throughout the growth of the crops (Table 5). The mean exchangeable Ca values in soils close to the site were 12.7, 12.5 and 12.5 c mol (p⁺) kg⁻¹ and beyond 1 km from the site were 7.85, 7.68 and 7.9 c mol (p⁺) kg⁻¹ at vegetative, flowering and harvest stages of the crops, respectively. The mean exchangeable Mg values in soils close to the site were 5.90, 8.10 and 6.00 c mol (p⁺) kg⁻¹ and beyond 1 km from the site were 3.30, 3.10 and 3.20 c mol (p⁺) kg⁻¹ at vegetative, flowering and harvest stages of the crops, respectively.

The overall % increase was 38.1 and 50.7 in exchangeable Ca and Mg content of soils, respectively. The dust of lime stone contains about 39 - 48.5% CaO and 0.5-1.0% MgO. The increase in exchangeable Ca and Mg content of soils could be cumulative effect of dust fall due to mining activity over a period of time. However, the values were not in the toxic range. Similar results were reported by Mukunda Rao (1993).

Dust from dolomite mining activity significantly

increased exchangeable Mg content of soils close to the mining site (Prabhu Prasadini and Singa Rao, 2005).

Conclusion

The lime stone mining activity caused changes in the physico-chemical and chemical properties of soils close to (within one kilometer) the site. However, it did not show any deleterious effect on the soils around the activity but over a period of time increase in pH may alter the soil quality. In this study available N content was significantly low in soils close to the mining activity the difference in K content of soils was significant only at the harvest stage of the crop which could be attributed to the management practices. Exchangeable Ca and Mg content in soils was found be high because of dust traveled from the lime stone mining activity zone.

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