Jr. of Industrial Pollution Control 21 (1)(2005) pp 139-146
© Enviromedia

ENVIRONMENTAL DEGRADATION DUE TO MARBLE MINING DUST ON THE SOIL QUALITY OF MAKRANA, NAGAUR (RAJ.), INDIA

A.K. PANDEY, S.DUTTA AND K.C. SHARMA

Department of Environmental Studies, MDS University, Ajmer (Raj.), India

Key words : Makrana marble mines, Physico-chemical parameters

ABSTRACT

Due to the surface mining at Makrana, the flora, hydrological relations and soil biological systems are drastically disturbed. In Makrana the main cause of Environmental pollution is Marble mining dust particulates and stone crusher dust. Analysis of the samples showed that the soil of Makrana is saline sodic because of high pH value and excess sodium presence. The agricultural field near these Marble mines and stone crushers areas show poor growth and yield of crops and vegetable crops was noticed inspite of the best effort by the farmers high concentration showed toxicity impact whereas at low concentration it showed a beneficial impact. Hence, it is suggested that the distillery effluent can be diluted to low concentration and used for agriculture.

INTRODUCTION

Ecosystem destruction by mining is an invitable part of industrialization and civilization (Jha and Singh, 1993). In recent years proliferation of industrial concern and other anthropogenic activities increased the concentration of different pollutant in various ecosystem causing environmental degradation (Geeta and Balakrishna, 1983 and Kumar, A. 1996). During surface mining (At Makrana) the flora, hydrological relations and soil biological systems are drastically disturbed. The major adverse effect of surface mining are the disruption of the geology, soil plant stability circuit (Harthill and Mckell, 1979), disequilibrium in the geomorphic system (Soullire and Toy, 1986) and depletion of soil organic pool (Parkinson, 1979). In Makrana the main cause of Environmental pollution is Marble mining, dust particles and another factor of raising pollution is stone crusher dust. The dust of mining and stone crusher is a potential phytotoxic pollutant and creates serious pollution problem causing major damage to the ecosystem. The mining and its allied activities significantly affect the flora of mining area and also affect growth and yield of crop plants through changes (Singh, 2000). So the original vegetation is completely stripped off. the natural recovery is frequently a slow process (Bradshow and Chadwick 1980; Marss *et al.*,1981 and Roberts, *et al.*, 1981). These dust particulate spread over nearby areas and affect the vegetation, soil and other natural resources. Soil is a mixture of mineral and organic matter that is capable of supporting plant life. It is the main reservoir of the mineral and organic matter that is capable of supporting plant life. The availability of minerals affects the specific enzymatic activity directly and eventually adversely affect plant growth (Sharma *et al.* 1999).

Air pollutant (Marble dust) from the Marble mines forms a thin layer of deposition over the adjacent agricultural field in Makrana. For such investigation, a survey is essential which should include detailed analysis of Physico-chemical characteristics of soil (Adak and Purohit, 2001). Keeping the above objective in view the analysis of contaminated soil of the area was done to study the status of fertility due to the dust depositions from the marble.

Study Area

Makrana is about 6 km far from Manglana Chauraha in Nagaur district in Rajasthan. It is 187 Km far from Ajmer. The geographical extension of study area is between 26_0 57′ N to 27_0 03′ N Latitude and 74^0 40′ E to 74^0 45′ E Longitude. In this area about approx. 550 Marble mines are exploiting the Marble stone continuously from last seven centuries. These are effecting the soil environment and nearby vegetation very badly.

MATERIALS AND METHODS

Forty soil samples (0-40 cm depth) were collected in the month of March 2001 from twenty different locations. The locations of sampling points are shown in Map no 1. The collected samples were brought to the laboratory and air dried at 80^0C temperature in an oven for 48 hours and the stored in polythene bags. The physico-chemical properties were determined using the standard procedures (Jackson, 1958 and Trivedy and Goel 1986).

RESULTS AND DISCUSSION

Thirteen physico-chemical parameters were determined for each soil sample collected from twenty different sites and their values are given in Table 1. The amount of water present at a particular soil moisture tension varies considerably from one soil to another soil as large amounts of clay and organic matter hold more water than soils with small amount of these constituents. Another important factor in this relation is whether the particular water content is reaching by adding water to a dry soil or by removing water from the soil. The soil moisture of the analyzed samples varied 1.2 (sp. no,. 5) to 4.3 (sp. no. 18) in surface soil and 2.9 (sp. no. 2 and 15) to 8.12 (sp. no. 18) in underlying soil. Results are clearly showing that soil moisture are increasing with depth.

The pH, moisture and microbial population in the soil are inter-related to one another (Dwivedi, 1970). The soil pH influences the rate of plant nutrient. pH is therefore, a good guide for predicting which plant nutrient are likely to be deficient. The deficient elements can be supplied only by fertilizers applications in such places. So the soil can be amended to a more favorable pH. The pH value of all the soil were within the range of 7.3 to 9.14 in surface soil and 7.10 and 8.0 are usually associated with saline soil (those containing excess soluble salt) and if the pH value is above 8.5 it indicated the presence of considerable Na+ and dispersed soil colloids called saline sodic soil. In both condition plant growth in markedly reduced because of shortage of water available and presence of dispersed colloids. Therefore the indicating pH value shows the soil by nature is saline sodic.

Specific conductivity gives a clear idea of soluble salts present in the soil. Soil have traditionally been classed as saline if the conductivity of the soil exceed 4 mili mhos/cm (Sharma and Kaur, 1994). In present analysis of the soil conductivity varied from 5.32 to 9.21 m mho/ cm in surface soil and 6.32 to 9.10 m mho/ cm in underlying soil. Electric conductivity of the soil at different sites have been found to be above 4 m mho/cm therefore the soil can be described as a saline sodic.

The problems resulting from soil acidity are strictly chemical in nature, but the problem resulting from soil alkalinity can be physically as well as chemical. Alkaline soil contain such high concentration of soluble salts that plants have difficulty absorbing water, the osmotic concentration can become higher in the soil solution than in normal plant. Salinesodic soil usually have pH values between 8 and 8.5 . This sodic soils are the most alkaline of all soils and the hardest to reclaim of the alkaline solid. They have dispersed colloids, very low permeability and little or no plant growth. The alkalinity values of the analyzed sample varied from 11.36 to 24.12 percent in surface soil and 8.06 to 21.99 percent in underlying soil.

Chlorine is a micronutrient for plant. Plants use chlorine in the chloride (Cl^- form, not in OCL^- and Cl_2 because both are toxic to plants. Chloride are highly soluble compounds can stimulate mineralization and inhibit nitrification in acid soil (Goos, 1987). Adequate chloride also helps improve resistance to many plant diseases. Soils of dry or arid region that contain large amount of chlorides in solution. The chloride content in soil was within the range of 0.0296 to 1.926 percent in surface soil and 0.289 to 1.936 percent in underlying soil hence not suitable for the vegetation growth. With regard to alkalinity, due to high Alkalinity the amount of Bicarbonate increases which hampers the plant growth (Pujari and Sinha, 1993). Maximum value was recorded in sample No. 18 i.e. 1.45% and 1.30% in surface and underlying soil.

All soils contain some organic matter, but relatively few contain enough to be classified as organic soils. Soil have been classified as low (0.5), medium

Table - 1
Physico-chemical analysis of soil in different depth at study sites in Makrana

S.No.	Soil Moisture % depth(cm)	pH	Conductivity m mho cm-1	Alkalinity meq / 100g	Cl-2 %	CaCO3 %	Organic ontent %	Ca+2 %	Mg+2 %	Na+ %	K+ %	N %	PO4-3 %
1. Surface	2.2	8.12	7.14	14.02	0.61	0.41	0.48	6.32	2.18	3.132	1.015	0.167	0.061
Underlying	3.8	7.96	7.86	12.86	0.586	0.38	0.73	4.311	2.096	4.012	0.921	0.098	0.172
2. Surface	1.6	8.56	6.32	22.96	1.24	1.06	0.26	5.12	2.03	2.628	0.093	0.078	0.031
Underlying	2.9	8.1	7.12	18.96	1.239	1.03	0.48	3.011	1.068	3.102	0.062	0.128	0.482
3.Surface	2.3	7.96	8.14	13.92	0.31	0.32	0.53	1.24	0.96	0.368	0.018	0.011	0.028
Underlying	5.3	7.62	8.32	13.01	0.301	0.28	0.63	0.968	0.616	0.461	0.011	0.008	0.136
4.Surface	2.1	7.64	8.41	14.68	0.38	0.48	0.58	1.96	0.82	0.821	0.041	0.031	0.611
Underlying	4.8	7.1	8.21	11.16	0.289	0.39	0.72	0.789	0.821	0.962	0.128	0.021	0.912
5.Surface	3.1	8.82	6.23	12.92	0.29	0.78	0.69	0.92	0.26	0.122	0.011	0.016	0.031
Underlying	5.3	8.78	7.06	10.82	0.311	0.69	0.7	0.543	0.239	1.012	0.231	0.012	0.088
6.Surface	2.1	7.82	7.21	13.56	0.54	0.31	0.48	2.31	0.67	0.108	0.032	0.138	0.012
Underlying	5.8	7.88	8.09	16.92	0.489	0.3	0.59	1.012	0.438	1.098	0.021	0.142	0.046
7.Surface	1.4	7.43	9.62	18.36	0.58	0.32	0.29	4.31	1.23	0.768	0.061	0.056	0.328
Underlying	3.2	8.12	9.43	15.38	0.529	0.29	0.31	2.866	0.938	0.821	0.162	0.148	0.642
8.Surface	2.7	8.25	7.82	16.32	0.43	0.43	0.31	2.13	0.32	0.322	0.013	0.011	0.119
Underlying	5.9	7.65	7.96	17.86	0.411	0.38	0.48	1.011	0.192	0.412	0.322	0.006	0.531
9.Surface	2.1	8.13	8.62	17.32	0.62	0.29	0.71	2.82	0.12	0.431	0.041	1.023	0.033
Underlying	4.3	7.91	9.02	18.09	0.596	0.22	0.96	1.098	0.122	0.531	0.114	0.923	0.122
10.Surface	3.2	7.62	8.12	19.23	1.11	1.16	0.58	0.86	0.1	0.039	0.063	0.32	0.013
Underlying	6.8	7.18	8.03	20.11	1.118	1.02	0.78	0.398	0.096	0.049	0.263	0.289	0.239
11.Surface	1.3	9.02	7.06	23.06	1.92	1.22	0.16	4.41	1.03	1.312	0.053	0.046	0.029
Underlying	3.1	8.93	7.82	15.98	0.986	1.19	0.43	1.462	0.986	1.998	0.826	0.126	0.126
12.Surface	1.8	8.74	8.01	14.32	0.82	0.88	0.19	6.23	1.63	2.038	0.098	0.082	0.511
Underlying	4.01	8.71	7.19	17.96	0.793	0.87	0.28	2.896	0.398	2.298	0.068	0.011	0.821
13.Surface	2.5	8.15	9.21	21.36	1.63	1.32	0.68	1.89	0.96	0.963	0.07	0.201	0.231
Underlying	3.16	8.02	8.96	14.38	0.983	1.3	0.79	0.813	0.686	0.998	0.128	0.211	0.286
14.Surface	3.1	7.31	8.32	19.21	1.08	1.1	0.62	2.12	0.76	0.988	0.069	0.102	1.123
Underlying	5.3	7.62	8.88	16.88	0.988	1.01	0.91	0.921	0.438	1.029	0.389	0.002	1.461
15.Surface	1.2	9.51	7.92	24.12	2.1	1.34	0.26	6.02	1.77	3.112	1.01	0.829	0.64
Underlying	2.9	9.01	7.63	20.12	1.936	0.93	0.43	2.453	1.798	3.036	1.212	0.902	0.538
16.Surface	2.1	8.12	5.86	11.36	0.31	0.69	0.31	3.17	1.01	1.013	0.098	0.662	0.381
Underlying	4.7	8.62	6.38	8.06	0.321	0.48	0.48	1.018	1.021	1.112	0.128	0.421	0.289
17.Surface	3.7	8.76	8.77	15.32	0.53	0.86	0.53	1.68	0.32	0.343	0.016	0.012	0.598
Underlying	7.06	8.59	8.71	17.86	0.501	0.91	0.68	0.096	0.231	0.981	0.014	0.011	0.612
18.Surface	4.3	7.52	8.1	21.96	1.86	1.45	0.78	0.23	0.06	0.098	0.069	0.012	0.632
Underlying	8.1	7.31	8.33	21.99	1.798	1.08	0.93	0.128	0.128	0.698	0.065	0.008	0.712
19.Surface	2.8	8.36	5.32	19.02	0.98	0.88	0.43	4.89	1.03	1.167	0.041	0.013	0.098
Underlying	5.7	8.38	6.32	13.52	0.931	0.63	0.58	3.826	0.898	1.038	0.089	0.212	0.138
20.Surface	1.9	9.14	8.32	13.86	0.73	0.43	0.32	5.89	1.6	2.113	0.098	0.039	1.098
Underlying	3.8	9.22	9.1	9.08	0.638	0.41	0.52	2.598	1.091	3.011	0.182	0.021	1.108

Table - 2 (a)
Correlation between surface soil of Makrana

S.No	S.MO.	pH	Cond.	Alk.	Cl-	Ca.CO3	Org.Cart	Ca+2	Mg+2	Na+	K+	N	PO4-3
S.MO.	1	-0.376079	0.031562	-0.084013	-0.063734	0.265995	0.720802	-0.710235	-0.68413	-0.589265	-0.311391	-0.290963	0.13189
pH		1	-0.268868	0.103303	0.249611	0.185805	-0.503307	0.531678	0.386233	0.520049	0.317661	0.150522	0.0341
Cond.			1	0.125031	0.071305	-0.075149	0.231846	-0.203794	-0.178397	-0.182704	-0.062223	0.024901	0.366064
Alk.				1	0.895998	0.730433	-0.075563	0.097546	0.085616	0.230219	0.168478	0.109752	0.001773
Cl-					1	0.842047	-0.09223	0.168071	0.152997	0.324857	0.298409	0.140335	0.142296
Ca.CO3						1	0.064922	-0.08607	-0.03609	0.139571	0.105456	0.007891	0.189014
Org.Carb.							1	-0.737578	-0.635795	-0.558819	-0.195194	0.039865	0.002588
Ca+2								1	0.870846	0.884006	0.54889	0.141979	0.11628
Mg+2									1	0.925053	0.592891	-0.021986	0.113573
Na+										1	0.740332	0.167617	0.199933
K+											1	0.366679	0.056015
N												1	-0.067086

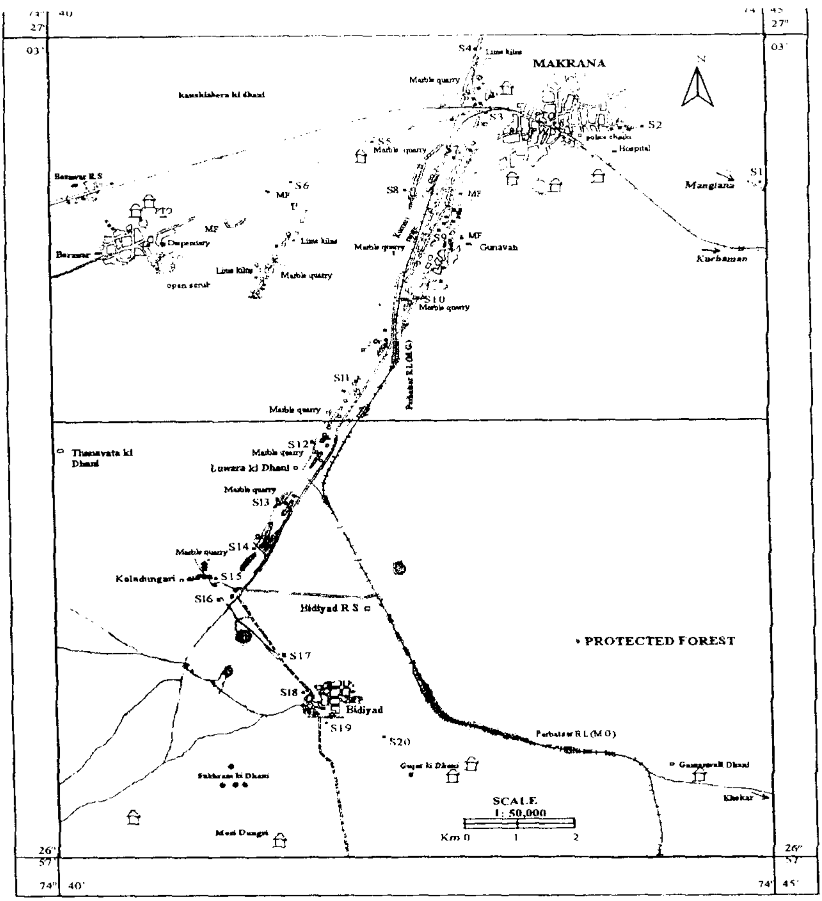
Table - 2 (a)
Correlation between underlying soil samples of Makrana

S.No	S.MO.	pH	Cond.	Alk.	Cl-	Ca.CO3	Org.Carb.	Ca+2	Mg+2	Na+	K+	N	PO4-3
S.MO.	1	-0.47594	-0.01732	0.255601	-0.03101	0.00056	0.488314	-0.57446	-0.65489	-0.61018	-0.42186	-0.31016	0.015959
pH		1	-0.25532	-0.2956	0.034316	0.106503	-0.56307	0.359318	0.372377	0.525362	0.299157	0.179322	-0.0478
Cond.			1	0.173235	-0.04696	-0.09419	0.332489	-0.2735	-0.19313	-0.19139	-0.08101	-0.04376	0.372685
Alk.				1	0.668639	0.446731	0.138689	-0.15383	-0.31195	-0.11565	0.11735	0.209	0.05268
Cl-					1	0.675576	0.088348	0.101091	0.172209	0.260712	0.406856	0.325239	0.162362
Ca.CO3						1	0.110081	-0.19595	-0.0897	0.090527	0.189123	-0.07682	0.148852
Org.Carb.							1	-0.48854	-0.36511	-0.36188	-0.15134	0.072623	0.013145
Ca+2								1	0.722961	0.718769	0.333476	0.073838	-0.02033
Mg+2									1	0.80343	0.66908	0.213774	-0.0398
Na+										1	0.556153	0.053903	0.124068
K+											1	0.365465	-0.05016
N												1	-0.30217
PO4-3													1

(0.5-0.75) and high organic carbon content (more than 0.75). Makrana soil come under the class range of medium to slightly high, organic carbon in few regions i.e. sample No. 18 in surface soil and sample No. 9, 10, 13, 14 and 18 in underlying soil, except the rest of all. So it is clear that Makrana soil partially restrict the agricultural productivity and can give sufficient production by amending the soil.

Calcium, Magnesium and Sulfur are macronutrients in plant nutrition. Calcium occurs in soil and plant as the divalent cation Ca++. The exchangeable Calcium in a soil has an important relationship to soil pH and to availability of several nutrient elements. An excess Calcium usually results in low solubility of Phosphorus, iron, manganese, boron, and zinc and sometime causes deficiencies of one or more of these essential plant nutrient. Calcium capture Phosphorous and form Calcium tri-phosphate thus rending its non availability to plants (Devlin, 1976). The abundance of calcium in the dust affect soil decreases the availability of other nutrients needed for plant growth especially nitrogen to the plants which causes the low productivity of the dust affected area (Demooy and Pesek, 1966). In present investigation the analyzed samples varied from, 0.238 to 6.32 % to 0.096 to 4.32% in underlying soil.

The Magnesium ion, Mg^{++} is chemically similar to the Calcium ion, Ca^{++}. Nevertheless there are important differences in the behavior of these ions in minerals and plants. The percentage of Ca^{++} and Mg^{++} ions in the soil solution are much lower than on the cation-exchange sites. Mokwaney and Melsted (1973, found the following distribution of Magnesium in the soil separates: Clay 51 to 70% of the total Mg present, Silt, 22 to 42% and Sand, 0.1 to 11%. They found that severe weathering, soil erosion and clay eluciations all tend to reduce the magnesium content of surface soil horizons. In present investigations the Magnesium values of the analyzed samples varied from 0.068 to 2.18% in surface soil and 0.096 to 2.096% in underlying soil. This clearly indicates that excess calcium percent reduce the magnesium availability.



Map ● I. Map of Makrana showing sites of study

Source SURVEY OF INDIA Toposheet No 45 I/12

High pH value indicates a high percentage of Sodium salt. Soil pH values above 8.0 to 8.5. It indicate the presence of considerable Na^+ and the likelihood of dispersed soil colloids. Vegetation growth is markedly reduced where collides are dispersed and is completely eliminated where the condition is severe. So high pH value inhibit plant growth and soil nutrient. In the present analysis the Sodium ion percentage is high and its fluctuated between 0.039 to 3.13% in surface soil and 0.049 to 4.012% in underlying soil.

Potassium is soluble at any pH but is removed from solution by sorption. Raising the pH may drive the Potassium into non-exchangeable positions and further suppress the potassium availability. In present analysis the increased pH value of all soil sample decrease availability of potassium. The Potassium value of soil sample determined to be very low and within the range of 0.0143 to 1.015% in surface soil and 0.011 to 1.212% in underlying soil.

The organic nitrogen in large complex molecules is built into protein and is unavailable to higher plants and would remain so if microorganisms not release it. Microbial activity gradually breaks down the complex organic material into simple inorganic ions that can be utilized by growing plants. Plants grow slowly when nitrogen is deficient. They appear spindly, stunted and pale yellows when compared with healthy plant. All part of the plants are affected including the roots as well as the tips. The reduced size of root system can, of course, have secondary effects such as reduced absorption of other plants nutrients and of water. The analyzed samples varied from 0.011 to 1.023% in surface soil and 0.066 to 0.023 % in underlying soil.

Phosphorus has been called " the key of life" because it is directly involved in most life processes. It is a component of every living cell as a part of the nucleo-proteins that carry the genetic code of living things. It tends to be concentrated in seeds and in the growing points of plants. But phosphorus is second only to Nitrogen, in frequency of use as a fertilizer elements. Phosphorus occurs in the soil in both mineral and organic forms. In present analysis the Phosphate concentration varied from 0.028 to 1.123 percent in surface soil and 0.046 to 1.461 percent in underlying soil.

To observe the relationship among various physico-chemical parameters, correlation analysis was performed and correlation matrix calculation is given in table 2. The value of correlation coefficient were found positive as well as negative. Positive correlation between pH, alkalinity, chloride, calcium, magnesium and potassium with the other parameters shows that soil is not perfect for better growth of vegetation because high percentage value of pH and calcium present only in saline soil. Soil also have pH above 8.5 which indicates the presence of Na^+ and dispersed soil colloids means that the soil is sodic also. So it is cleared that due to high percentage of pH, sodium, calcium and other factors, soil is saline sodic. Very high positive correlation found is of 0.531 (pH-Ca^{+2}), 0.366 and 0.231 (Cond- Org, Carb and cond- PO_4^{-3}), 0.842 (Cl^--$CaCO_3$), 0.189 ($CaCO_3$- PO_4^{-3}), 0.870 and 0.884 (Ca^{+2}-Mg^{+2} and Ca^{+2}-Na^+), 0.925 (Na^+-Na^+), 0.74 (K^+-K^+) and 0.366 in between (N-N) in surface soil. That means the due to high salinity all parameters clearly show the soil contamination. In underlying soil positive correlation found in between 0.525 and 0.359 (pH-Na^+ and pH- Ca^{2+}), 0.372 (Cond.- PO_4^{-3}), 0.668 (Cl^--Cl^-), 0.675 ($CaCO_3$- $CaCO_3$), 0.189 (Org. Carb.- K^+) 0.722 and 0.718 (Ca^{+2}-Mg^{+2} and Ca^{+2}-Na^+), 0.803(Mg^{2+}-Na^+), 0.556 (Na^+-K^+) and 0.365 (N-N) . Very high positive correlation found in pH with calcium and $CaCO_3$- PO_4^{-3}. The phosphate become available when the pH is above 8.5 because of high percentage of sodium phosphate salt. Raising the pH may drive the potassium into non-exchangeable position and further suppress the potassium availability.

Thus the present study shows that marble mining and stone crusher dust acts as a potential pollutant. It is also a major cause of soil and environmental pollution in this area, causing constant damage to the environment.

REFERENCES

Adak, M.D. and Purohit, K.M. 2001. *Studies on soil profile for investigation of soil* pollution in the vicinity of mini cement plants in Mandiakudar, Orissa. *Journal of Environment and Pollution.* 8 (3) : 293 -298.

Bradshaw, A.D. and Chadwick 1980. The reconstruction of ecosystem *J. Appl. Ecol.* 20: 1-17.

Devlin, R.M. 1976. *Plant Physiology.* Affiliated East-West Press Pvt. Ltd. New Delhi. India. 2 (1) : 23 -27.

Dwivedi, R.S. 1970. Evaluation of methods for measuring productivity in wheat (*Triticum aestivum)* and maruel grass (*Dicanthium annulatum) Indian Journal of Agriculture Sciences.* 40 : 81-88.

Demooy, C.J. and Pesek, J. 1996. Nodulation response of soyabeans to added Phosphorus, Potassium and Calcium salts. *Agron. J.* 58 : 275 - 280.

Goos, K. 1987. Chloride fertilization. *Crops Soils.* 39 (6) : 12-13.

Geeta, P. and Balakrishna, K.P. 1983. Effect of sulphuric acid and nitric acid on the pollen grain of *Coceus nucifera.* IAWPC *Tech. Ann.* 10 : 193- 196.

Harthill, M. and McKell, C.M. 1979. Ecology stability is this a realistic goal for arid land rehabilitation pp. 557-567. In. M.K. Wali. Editor, *Ecology and coal resource development,* vol.2 Pergamon Press, New York.

Jackson, M.L. 1958. *Soil Chemical Analysis.* Prentice Hall of India Pvt. Ltd. New Delhi.

Jha, A.K. and Singh, J.S. 1990. Spoil characteristic and vegetation development of an age series of mine spoil in a dry tropical environment vegetation. 97: 63-76.

Kumar, A. 1996. Impact of industrial pollution on the population status of endagered Gangetic dolphin (*Paltanista gangetica)* in the river Ganga in Bihar. India. Pol/ Arch. *Hydrobiol.* 43 : 469-476.

Marrs, R.H., Roberts, R.D., Skeffington, R.A. and Bradshaw, A.D. 1981. Ecosystem development on naturally colonized china clay wastes. II. Nutrient compartmentation. *J. Ecol.* 69 : 163- 169.

Mokwanye, A.U. and Melsted, S.W. 1973. Interrelationship between soil Magnesium forms Commun . *Soil Sci Plant Anal.* 4 : 397- 405.

Pujari, G.K. and Sinha, B.K. 1999. Studies on the water and soil quality of some villages of Attabira area irrigated by bargarh main canal originated from Hirakud reservoir of Orissa. *Journal of Environmental and Pollution.* 6 (1) : 71-76.

Soulliere, E.J. and Toy, T.J. 1986. Rilling of hillslopes reclaimed before 1977 surface mining law, Dave Johnson mine,*Earth surface processes and landforms.*11:293- 305.

Singh, R.B. 2000. Impact of stone crusher dust pollution on tomato (*Lycopersicum esculantum)* in the Sonbhadra district of U.P. pp. 235- 238.

Sharma, B.K. & Kaur, H. 1994. *Environmental Chemistry,* 2nd ed. Goel Pub.House p. 405.

Trivedy, R.K. and Goel, P.K. 1986. *Chemical and biological methods for water pollution studies.* Env. Pub., Karad. 35-96.