https://doi.org/10.29321/MAJ.10.A03558

# Forms of Manganese and Their Distribution in Certain Profiles of Tamilnadu

*by*

A. GOPALSWAMY[1] and R. SOUNDARARAJAN[2]

**Introduction:** Among many transition elements, manganese plays a vital role in plant metabolism. The geology of the region, the weathering of the minerals, oxidation and reduction of $Mn^{++}$ are the important factors for the various forms of manganese in the earth's crust. Different forms of manganese have been studied by various workers in India and abroad. Few items of work have been done in Madras State to study the distribution of several patterns of manganese and their relation to soil properties in profile soils. Soundararajan *et al.* (1967) found out the amounts of different forms of manganese in the surface soils in Coimbatore district. Most of the soils utilised in their study are reported to have adequate amounts of available manganese. The present study aims at the investigation of different forms of manganese and their relationships with soil characteristics in profile samples in Tamilnadu.

**Material and Methods:** Twenty three profile samples from Tanjavur, Coimbatore & Nilgiris were utilised in this study. The samples were taken upto the depth of 88 inches. The mechanical components were estimated by the International Pipette method (Piper, 1950). Jackson's (1951) method was adopted for the determination of water-soluble + exchangeable and easily reducible forms of manganese (active manganese is the sum of these three forms). Total manganese was estimated by developing permanganate colour with Potassium periodate and colorimetrically measured (Willard and Greathouse, 1917).

The data on different forms of manganese along with the values for organic matter, clay, silt and pH are given in Table 1. The values were statistically analysed for obtaining relationships among different forms of manganese and as well with clay and organic matter. The results are tabulated in Table 2. Regression equations were worked out for highly significant relationships and regression lines are drawn (Figures 1 to 4.) Histograms showing the distribution of different forms of manganese throughout the profile in the four types of soils are given in figures 5 to 8.

---

1. Assistant in Chemistry and 2. Soil Chemist, Agricultural College and Research Institute, Coimbatore-3.

Received on 5-6-1968.

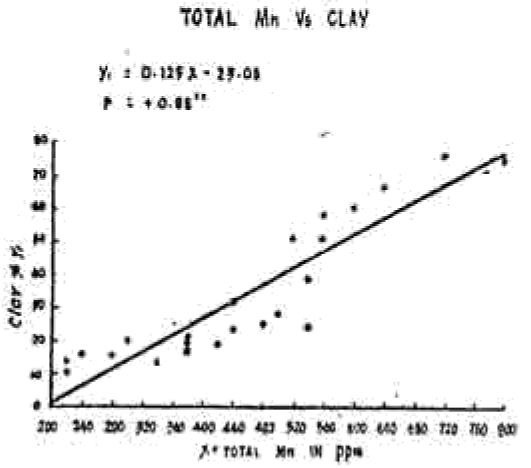
TABLE 1. *Distribution of different forms of manganese and soil characteristics in profiles*

| Place | Soil type | Depth (inches) | pH | Organic matter % | Finer fractions | | Manganese in ppm | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Silt % | Clay % | Total | Reducible | Water-soluble plus exchange-able | Active |
| Thambikottai (Thanjavur) | Alluvial | 0–5 | 7.4 | 1.1 | 0.5 | 16.0 | 240 | 51.0 | 9.0 | 60.0 |
| | | 5–12 | 7.7 | 0.7 | 8.8 | 18.3 | 420 | 88.0 | 10.5 | 98.5 |
| | | 12–19 | 8.2 | 0.7 | 1.5 | 16.5 | 280 | 42.0 | 4.5 | 46.5 |
| | | 19–34 | 8.5 | 0.6 | 0.2 | 13.6 | 220 | 94.0 | 4.0 | 98.0 |
| Millet Breeding Station (Coimbatore) | Red | 0–5.5 | 8.0 | 0.4 | 8.5 | 24.5 | 480 | 150.0 | 2.0 | 152.0 |
| | | 5.5–10.0 | 8.1 | 0.5 | 12.4 | 28.0 | 500 | 164.0 | 6.0 | 170.0 |
| | | 10.0–13.5 | 8.2 | 0.3 | 9.4 | 23.2 | 380 | 168.0 | 0.4 | 168.4 |
| | | 13.5–17.5 | 8.5 | 0.3 | 7.0 | 20.0 | 300 | 92.0 | 0.2 | 92.2 |
| | | 17.5–27.0 | 8.2 | 0.4 | 6.2 | 21.0 | 380 | 148.0 | 1.0 | 149.0 |
| | | 27.0–34.0 | 8.0 | 0.3 | 8.8 | 21.2 | 380 | 98.0 | 2.0 | 100.0 |
| | | 34.0–55.0 | 8.0 | 0.4 | 6.4 | 23.4 | 440 | 150.0 | 1.5 | 151.5 |
| Palladam (Coimbatore) | Black | 55.0–88.5 | 7.8 | 0.3 | 6.0 | 24.0 | 540 | 229.0 | 0.2 | 229.2 |
| | | 0–9 | 7.8 | 1.8 | 31.0 | 58.0 | 540 | 204.0 | 1.4 | 205.4 |
| | | 9–26 | 7.9 | 1.9 | 27.8 | 50.6 | 520 | 205.0 | 0.6 | 205.6 |
| | | 26–40 | 8.0 | 1.7 | 13.1 | 60.1 | 600 | 255.0 | 1.2 | 256.2 |
| | | 40–50 | 8.1 | 1.3 | 16.9 | 66.5 | 640 | 277.0 | 0.8 | 277.8 |
| | | 50–+ | 8.5 | 1.7 | 19.9 | 76.9 | 720 | 281.0 | 0.4 | 281.4 |
| Nanjanad (Nilgiris) | Laterite | 0–6 | 5.3 | 3.1 | 22.2 | 50.7 | 560 | 148.0 | 10.5 | 158.5 |
| | | 6–16 | 4.7 | 2.7 | 21.8 | 38.5 | 540 | 108.0 | 10.0 | 118.0 |
| | | 16–25 | 4.9 | 2.4 | 19.9 | 32.6 | 440 | 98.0 | 4.0 | 102.0 |
| | | 25–37 | 5.9 | 1.2 | 14.5 | 19.2 | 380 | 142.0 | 1.8 | 143.8 |
| | | 37–49 | 6.0 | 0.7 | 13.9 | 13.2 | 340 | 104.0 | 2.1 | 106.1 |
| | | 49–72 | 5.9 | 1.2 | 8.2 | 10.1 | 220 | 56.0 | 5.0 | 61.0 |

TABLE 2. *Correlation coefficients between different forms of manganese and factors affecting them*

| Factors correlated | Correlation value |
|---|---|
| Total Manganese Vs. Clay | + 0.88 ** |
| Total Manganese Vs. Active Manganese | + 0.88 ** |
| Total Manganese Vs. Reducible Manganese | + 0.86 ** |
| Total Manganese Vs. Water-soluble + Exchangeable Manganese | − 0.16 N.S. |
| Total Manganese Vs. pH | + 0.017 N.S. |
| Total Manganese Vs. Organic matter | + 0.46 * |
| Reducible Manganese Vs. Clay | + 0.72 ** |
| Water-soluble + Exchangeable Manganese Vs. Clay | − 0.18 N.S. |
| Water-soluble + Exchangeable Manganese Vs. Organic Matter | + 0.43 * |
| Water-soluble + Exchangeable Manganese Vs. pH | − 0.36 N.S. |

* Significant at 5 per cent level ** Significant at 1 per cent level N.S. — Not significant



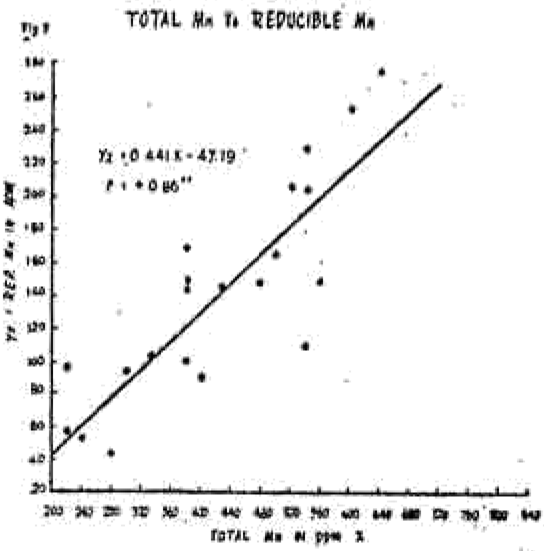
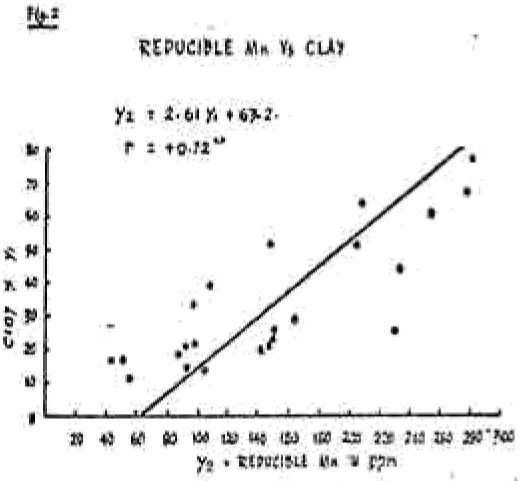
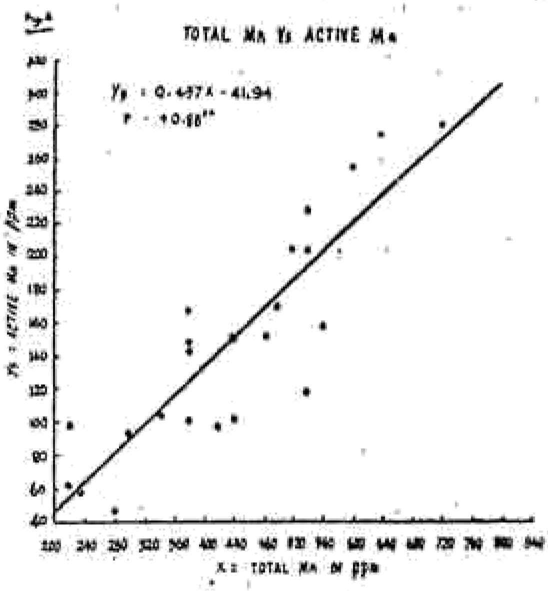



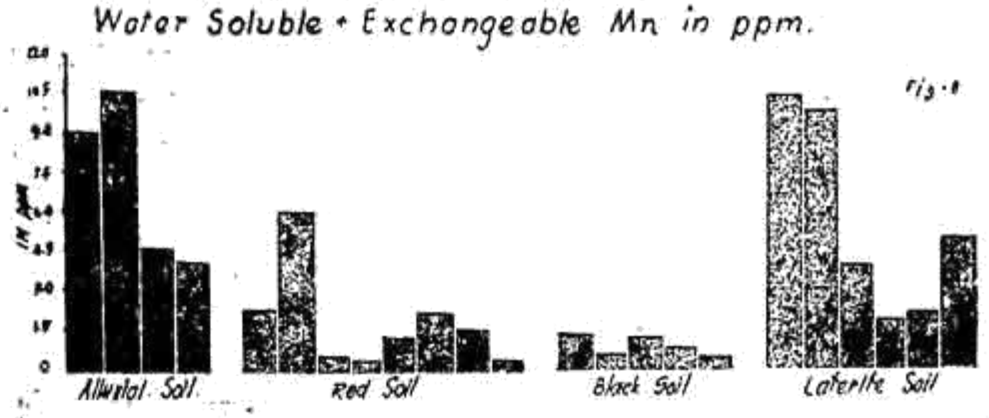

Fig. 2

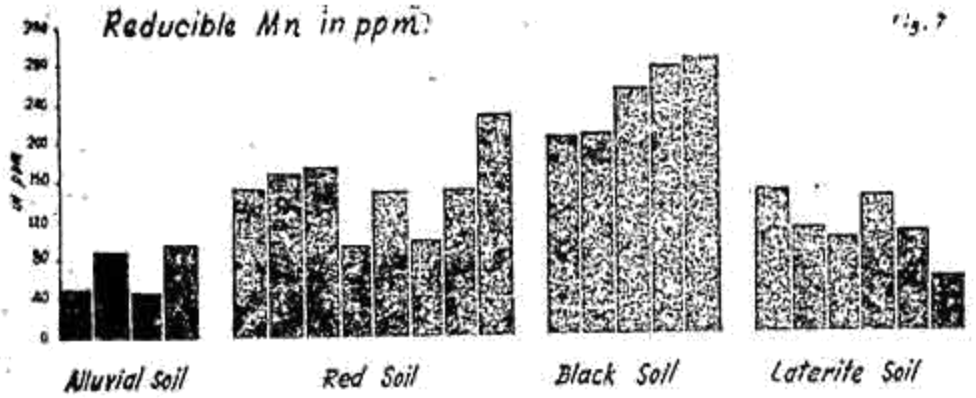


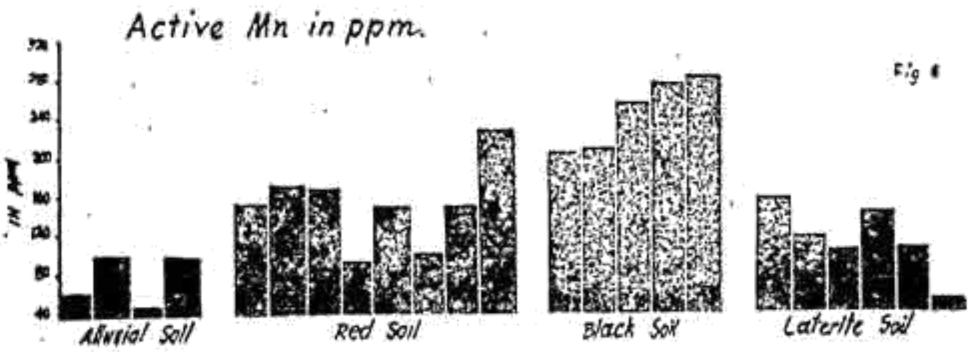




**Results and Discussion:** The soils are of four types (viz.) (1) Alluvial (Tanjore district), (2) Red soil (Coimbatore), (3) Black soil (Palladam), and (4) Laterite soil (Nilgiris). The pH values of these soils vary from 4.7 to 8.5. The distribution of different forms of manganese is discussed below.

*Total Manganese:* Total manganese content ranges from 220 to 720 ppm. Among the four types of soils, black soil contains higher amounts of total manganese followed by laterite soils. A gradual increase of values with depth of the profile in black soils and gradual decrease in laterite soils are seen. Almost uniform distribution is observed in red and alluvial soils. Inspite of the alkaline reaction and calcareous nature, the gradual increase in values in the black soils is seen and this is in agreement with the findings of Hoon and Dhavan (1943) and Randhawa *et al.* (1961). High amount of total manganese in black soils may be due to the influence of montmorillonitic type of clay minerals in fixing appreciable amounts of manganese.


Water Soluble + Exchangeable Mn in ppm.
Fig. 8
in ppm
Alluvial Soil
Red Soil
Black Soil
Laterite Soil


Reducible Mn in ppm.
Fig. 7
in ppm
Alluvial Soil
Red Soil
Black Soil
Laterite Soil


Active Mn in ppm.
Fig 6
in ppm
Alluvial Soil
Red Soil
Black Soil
Laterite Soil

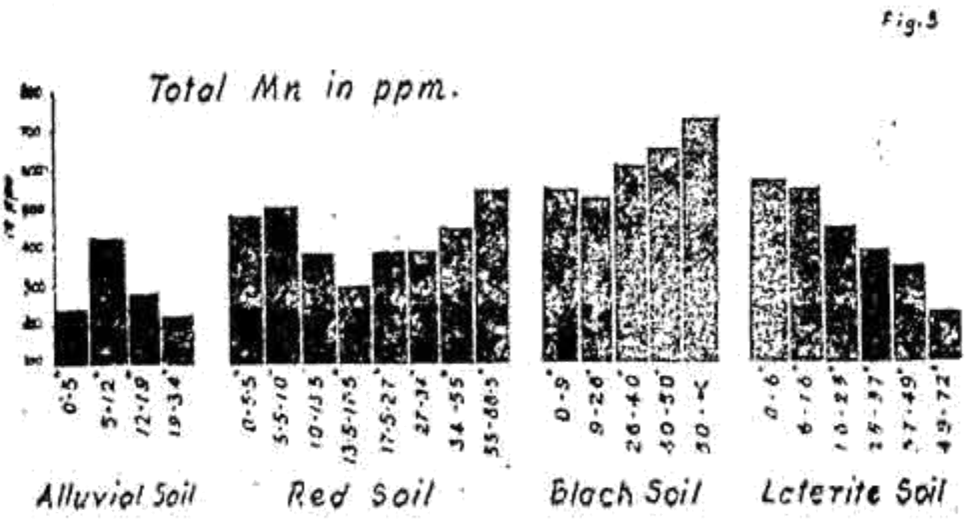


Fig. 5
Total Mn in ppm.
0-5
5-12
12-19
19-34
0-5.5
5.5-10
10-13.5
13.5-17.5
17.5-27
27-34
34-55
55-88.5
0-9
9-26
Alluvial Soil
Red Soil
Black Soil
Laterite Soil

*Active Manganese:* The values range from 46.5 to 281.4 ppm. The distribution of this form of manganese (water-soluble + exchangeable form + reducible form) is more or less similar to that of total manganese. This form is most important when availability to the plants is concerned. The gradual increase in active manganese with increasing depth is observed in black soil. The active manganese contents increase with increase in total manganese contents, the correlation coefficient between the two factors being 0.88 (Fig. 4).

*Reducible Manganese:* This fraction represents the manganese estimated by normal ammonium acetate solution containing 0.2% hydroquinone at pH 7.0 and is considered as "slowly available" form. The values range from 42 to 281 ppm. According to Leeper (1947) 100 ppm. of easily reducible manganese is optimum for healthy plant growth. The three types of soils other than alluvial are moderate to high in this form of manganese. The distribution of reducible manganese throughout the profile is similar to that of total Manganese.

*Water-soluble + Exchangeable Manganese:* As water-soluble and Exchangeable forms of manganese are considered to be the most mobile and readily available they were determined together by shaking the soil sample with normal ammonium acetate solution at pH 7.0. The values are low, ranging from 0.2 to 10.5 ppm., representing a very small fraction of the total manganese. Alluvial and Laterite soils contain more of this form than black and red soils. A gradual decrease in values throughout the profiiles is observed in alluvial and laterite soils. In black soils the values are uniform and low. Montmorillonite type of clay may be the reason for fixing up manganese which is not easily exchangeable. The trend of distribution of manganese in this fraction is quite contrary to that observed with all the other forms of manganese previously discussed. Maximum concentration occurs in the surface layers in all the profiles. Such a distribution was also observed by Leeper (1947), Biswas (1953), Yadev and Kalra (1964) and Mehta and Patel (1967).

*Relationship between soil characteristics and forms of Manganese:* In all the samples from different depths, comprising four types total manganese is highly and positively correlated with clay fraction, active manganese and reducible manganese. Irrespective of soil type, the finer fraction contains more of total manganese (Fig. 1). A positive correlation between clay content and total manganese was also obtained by Mehta and Patel (1967). Reducible manganese content is positively correlated with clay content and also with the total manganese content, the correlation coefficients being 0.72 in the former case and 0.86 in the latter case (Fig. 2 and 3). This is similar to the observation made by Mehta and Patel (1967). This form of manganese might have been fixed in clay minerals and this is revealed by its close relationship with clay content. On the contrary, water-soluble+exchangeable form has insignificant negative relationship with clay. But it is significantly correlated with organic matter (+0.43) indicating this form to be the major fraction of manganese in organic matter in soils (Lag and Dev, 1964). This form is also negatively correlated with total manganese, though it does not attain significant level.

Sherman and Harmer (1943) have suggested 3 ppm of exchangeable plus 100 ppm of reducible manganese as the critical limit below which deficiency conditions may exist. Considering on this basis laterite soils have sufficient quantity of both the forms. Black and red soils have low values of exchangeable plus water-solube manganese while alluvial soils have low values of reducible manganese. 10 20 ppm. reducible manganese, fixed by Jones and Leeper (1951), be accepted as a limit for a soil to be considered deficient in available manganese, all the soils studied have sufficiency of this form.

**Summary:** Certain profile soil samples in Madras State were analysed for different fractions of manganese to study the distribution of this element in the soils. Black, alluvial, laterite and red soils were considered and among them black soils were rich in total and active manganese. The patterns of total and active forms of manganese were similar in all the soil types. The mobile form of manganese i. e , water-soluble + exchangeable form, was lower in black and red soil compared to other two types. Total, active and reducible forms of manganese were highly correlated with the finer fractions of soils. Active and reducible forms seem to be a function of total manganese contents. Total and mobile forms are also significantly related to organic matter content.

## REFERENCES

Biswas, T. D. 1953. Distribution of manganese in profiles of some Indian Soils. *J. Indian Soc. Soil Sci.*, **1**:21-31.

Hoon, R. C., and C. L. Dhavan. 1943. Trace elements in relation to soil deterioration. *Indian J. agric. Sci.*, **13**: 601.

Jackson, M. L. 1951. *Soil Chemical analysis.* Constable and Co. Ltd., London.

Jones, L. P. M., and G. W. Leeper. 1951. Available Maganese oxides in neutral and alkaline soils. *Plant and Soil* **3**: 154-9.

Lag, J., and G. Dev. 1964. Distribution of exchangeable Manganese in some Norwegian podzol profiles. *J. Indian Soc. Soil Sci.*, **12** : 215.

Leeper, G. W. 1947. The forms and relations of Manganese in the soil. *Soil Sci.*, **63**: 79-94,

Mehta, B. V., and N. K. Patel. 1967. Forms of Manganese and their distribution in soil profiles of Kaira district in Guirat. *J. Indian Soc. Soil Sci.*, **15**: 41.

Piper, C. S. 1950. *Soil and analysis.* Adelaide, Australia.

Randhawa, N. S., J. S. Kanwar and S. D. Nijhawan. 1961. Distribution of different forms of Manganese in the Punjab soils. *Soil Sci.*, 92 : 106.

Sherman, G. D., and P. H. Harmer. 1943. Manganous-Manganic equilibrium in soils. *Proc. Soil Sci. Soc. Amer.*, 7 : 398-405.

Soundararajan, R., A. Gopalswamy, and R. Krishnamoorthy. 1967. A note on the Manganese status of the soils of Coimbatore District. (In Press).

Willard, H. H., and L. H. Greathouse. 1917. The colorimetric determination of Manganese by oxidation with periodate. *J. Amer. Chem. Soc.*, 39 : 366-377.

Yadav, J. S. P., and K. K. Kalra. 1964. Exchangeable Manganese in certain forest soils of India. *J. Indian Soc. Soil Sci.*, 12 : 225.

---