Status of molybdenum in soils of Palghar district of Maharashtra

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ABSTRACT
The surface soil samples representing six tehsils were collected from Palghar district during 2015-16. The available molybdenum content in soil varied from 0.01 to 0.65 mg Kg\(^{-1}\) with nutrient index value was found 1.93. In Palghar district 30 percent soil samples were deficient in available molybdenum. However, positive significant correlation between available molybdenum with pH (r=+0.714**) whereas, significantly negative correlation with organic carbon content (r= -0.815**) was observed.

Key words: Available molybdenum status, Nutrient index.

INTRODUCTION
Molybdenum is an important trace element found in the soil and is required for growth of most biological organisms including plants and animals. Molybdenum is an exception among micronutrients, in that, it is readily translocated in an ionic form and its deficiency symptoms are generally yellowing and stunting of the plant like N deficiency and inter venal mottling and cupping of the older leaves followed by leaves tips and margins. Root interception and mass flow are considered to be the important mechanisms controlling the movement of molybdenum to the plants roots. Without molybdenum plants cannot perform the biochemical process of making essential nitrogen compound. Molybdenum is involved in enzyme systems relating to nitrogen fixation by bacteria growing symbiotically with legumes.

Molybdenum is unusual among micronutrients and is becoming less available to plants at low pH. Availability of molybdenum for plants increases together with increasing soil pH. Available molybdenum shows significant positive correlation with soil pH (Adhikari and Patel, 2013). Molybdenum deficiency is usually associated with acid soils. (pH< 5.5), particularly those which are geologically old and highly leached soil. Soils with pH values more than 6.0 to 6.5 rarely require molybdenum.

MATERIALS AND METHODS
Location: Palghar district is a district in the state of Maharashtra in Konkan Division. Palghar district lies between 72° 45' and 73° 48' East longitude and 18° 42' and 20° 20 North latitude. The district is bounded by Thane and Nashik districts on the East and North East and by Gujrat state and Union Territory of Dadra & Nagar Haveli on the North. The Arabian Sea forms the Western boundary.

Soil type: The major portion of earth crust of the Palghar district is synthesised from the basaltic rocks. The soils of Palghar district divided into two categories first one is Vertisol i.e. black soil containing sand which present Palghar tehsil and second one is brownish black soil mostly observed in the plains of Wada tehsil.

Climate and weather condition: Palghar district is characterized by warm and humid climate. The district receives assured rainfall of about 2537 mm form South West Monsoon during the month of June to September. On an average temperature ranges from 16°C to 32°C. The humidity of district ranges from 61 to 86 percent throughout the year.

Collection of soil sample: Surface (0-20 cm) soil samples representing different soils were collected. The villages were selected randomly in the district, so the sampling sites scattered uniformly in each tehsils of the district. The soil samples were collected from all the tehsils of Palghar district of Maharashtra. Sixty soil samples were collected from the district.

Methods adopted for analysis: Soil pH was determined with the help of pH meter in 1: 2.5 soil water suspensions as described by (Jackson 1973). EC of the soil samples were determined in clear supernatant liquid obtained from 1:2.5 soil water suspension with the help of conductivity meter (Jackson 1973). Organic carbon of the samples was determined by Walkely and Black wet-oxidation method as given by Nelson and Sommers (1982). Calcium carbonate was determined by rapid titration method as given by Piper (1966). Available molybdenum was determined by Grigg’s reagent method given by Grigg (1953). The data pertaining to available micronutrient were categorized as low, medium, high based on their limits (Chadar, 2018). The nutrient indices were calculated by using formula given by Parkar.

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et al. (1951). Correlation of available molybdenum with pH, organic carbon and calcium carbonate were determined as described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The range of soil pH of Palghar district (Table 1) is from 5.86 to 7.08 indicating acidic to neutral reaction. Most of the soils were acidic to neutral in Konkan region of Maharashtra, Gajanan et al. (1978). pH of the soils in Konkan and North Maharashtra ranged from 5.30 to 8.2 (Patil and Ahire 2013). The electrical conductivity of the soils of Palghar district (Table 2) ranges from 0.09 to 0.57 dSm\(^{-1}\) with mean of 0.22 dSm\(^{-1}\). The calcium carbonate content (Table 3) ranged from 1.12 to 5.31 percent with mean value of 2.39 percent of the district. The organic carbon content (Table 4) was in the range of 4.22 to 11.11 g Kg\(^{-1}\) with mean value of 7.46 g Kg\(^{-1}\). Organic carbon in North Maharashtra and Konkan region varied from 3.7 to 9.7 g Kg\(^{-1}\) (Patil and Ahire 2013). Available nitrogen (Table 5) was found to be varied from 86.66 to 298.56 Kg ha\(^{-1}\) with mean value of 178.40 Kg ha\(^{-1}\) in Palghar district.

The available molybdenum (Table 6) ranges from 0.01 to 0.65 with mean of 0.28 mg Kg\(^{-1}\). Available molybdenum in acid soil of Srivardhan area of Kolaba and Karjat varied from 0.05 to 0.20 and 0.15 to 0.45 mg Kg\(^{-1}\), respectively (Chavan et al. 1980). Mean value of available molybdenum for Talsari tehsil (0.42 mg Kg\(^{-1}\)) was observed to be highest while that for Jawahar-Vikramkhad (0.18 mg Kg\(^{-1}\)) was lowest. In Palghar district 30 percent soil samples were low in category, 46.66 percent soils were in medium category while 23.34 percent samples were in high category. Nutrient index was 1.93 for molybdenum. All the tehsils of the Palghar district showed deficiency of molybdenum in

### Table 1: Status of pH (1:2.5) of soil in Palghar district.

| Tehsil              | No. of soil Samples | Range     | Mean   | Acidic | Neutral | Alkaline |
|---------------------|---------------------|-----------|--------|--------|---------|----------|
| Mohanda             | 10                  | 6.00-7.03 | 6.59   | 5 (50.00) | 5 (50.00) | 0 (0.00) |
| Jawahar-Vikramghad  | 10                  | 6.00-7.02 | 6.51   | 5 (50.00) | 5 (50.00) | 0 (0.00) |
| Dhanu               | 10                  | 6.20-7.04 | 6.67   | 5 (20.00) | 5 (80.00) | 0 (0.00) |
| Talsari             | 10                  | 6.63-7.03 | 6.82   | 2 (0.00)  | 8 (100.00) | 0 (0.00) |
| Palghar             | 10                  | 5.86-7.01 | 6.76   | 3 (30.00) | 7 (70.00) | 0 (0.00) |
| Wada                | 10                  | 5.98-7.08 | 6.68   | 4 (30.00) | 6 (70.00) | 0 (0.00) |
| Palghar district    | 60                  | 5.86-7.08 | 6.67   | 24 (40.00) | 36 (60.00) | 0 (0.00) |

(Figures in parenthesis indicate percentage).

### Table 2: Status of electrical conductivity of soil in Palghar district.

| Tehsil               | No. of soil Samples | Range   | Mean   | Low | Medium | High |
|----------------------|---------------------|---------|--------|-----|--------|------|
| Mohanda              | 10                  | 0.10-0.24 | 0.17    | 10(100.0) | 0(0.00) | 0(0.00) |
| Jawahar-Vikramghad   | 10                  | 0.09-0.29 | 0.16    | 10(100.0) | 0(0.00) | 0(0.00) |
| Dhanu                | 10                  | 0.14-0.50 | 0.25    | 10(100.0) | 0(0.00) | 0(0.00) |
| Talsari              | 10                  | 0.15-0.54 | 0.27    | 10(100.0) | 0(0.00) | 0(0.00) |
| Palghar              | 10                  | 0.10-0.57 | 0.28    | 10(100.0) | 0(0.00) | 0(0.00) |
| Wada                 | 10                  | 0.09-0.48 | 0.22    | 10(100.00) | 0(0.00) | 0(0.00) |
| Palghar district     | 60                  | 0.09-0.57 | 0.22    | 60(100.0) | 0(0.00) | 0(0.00) |

(Figures in parenthesis indicate percentage).

### Table 3: Status of calcium carbonate of soil in Palghar district.

| Tehsil              | No. of soil Samples | Range       | Mean   | Low | Medium | High |
|---------------------|---------------------|-------------|--------|-----|--------|------|
| Mohanda             | 10                  | 1.56-3.01   | 2.19   | 9(90.00) | 1(10.00) | 0(0.00) |
| Jawahar-Vikramghad  | 10                  | 1.31-3.12   | 2.15   | 9(90.00) | 1(10.00) | 0(0.00) |
| Dhanu               | 10                  | 1.81-2.53   | 2.79   | 7(70.00) | 3(30.00) | 0(0.00) |
| Talsari             | 10                  | 1.93-5.31   | 2.78   | 8(80.00) | 2(20.00) | 0(0.00) |
| Palghar             | 10                  | 1.12-3.25   | 2.03   | 9(90.00) | 1(10.00) | 0(0.00) |
| Wada                | 10                  | 1.56-3.44   | 2.42   | 8(80.00) | 2(20.00) | 0(0.00) |
| Palghar district    | 60                  | 1.12-5.31   | 2.39   | 50(83.33) | 10(16.67) | 0(0.00) |

(Figures in parenthesis indicate percentage).
Table 4: Status of organic carbon content of soil in Palghar district.

| Name of Tehsil          | No. of Soil Samples | Range        | Mean       | Low         | Medium     | High        | Indices |
|-------------------------|---------------------|--------------|------------|-------------|------------|-------------|---------|
| Mohanda                 | 10                  | 4.5-10.01    | 7.88       | 2(20.00)    | 1(10.00)   | 7(70.00)    | 1.80    |
| Javahar-Vikramghad      | 10                  | 4.61-11.11   | 8.61       | 1(10.00)    | 3(30.00)   | 6(60.00)    | 1.20    |
| Dhanu                   | 10                  | 4.22-10.58   | 7.69       | 1(10.00)    | 3(30.00)   | 6(60.00)    | 1.00    |
| Talsari                 | 10                  | 4.49-10.99   | 6.23       | 4(40.00)    | 3(30.00)   | 3(30.00)    | 1.00    |
| Palghar                 | 10                  | 4.41-11.01   | 6.73       | 4(40.00)    | 3(30.00)   | 3(30.00)    | 1.00    |
| Wada                    | 10                  | 4.49-10.98   | 7.57       | 2(20.00)    | 3(30.00)   | 5(50.00)    | 1.00    |
| Palghar district        | 60                  | 4.22-11.11   | 7.46       | 14(23.33)   | 16(26.67)  | 30(50.00)   | 1.21    |

(Figures in parenthesis indicate percentage).

Table 5: Status of available nitrogen of soil in Palghar district.

| Name of Tehsil          | No. of Soil Samples | Range        | Mean       | Low         | Medium     | High        | Indices |
|-------------------------|---------------------|--------------|------------|-------------|------------|-------------|---------|
| Mohanda                 | 10                  | 86.66-290.36 | 200.92     | 2(20.00)    | 8(80.00)   | 0(0.00)     | 1.80    |
| Javahar-Vikramghad      | 10                  | 63.72-298.56 | 214.52     | 8(80.00)    | 2(20.00)   | 0(0.00)     | 1.20    |
| Dhanu                   | 10                  | 112.89-297.25| 174.25     | 10(100.00)  | 0(0.00)    | 0(0.00)     | 1.00    |
| Talsari                 | 10                  | 100.33-296.65| 162.86     | 9(90.00)    | 1(10.00)   | 0(0.00)     | 1.10    |
| Palghar                 | 10                  | 105.89-298.36| 160.89     | 9(90.00)    | 1(10.00)   | 0(0.00)     | 1.10    |
| Wada                    | 10                  | 102.36-300.12| 205.13     | 9(90.00)    | 1(10.00)   | 0(0.00)     | 1.10    |
| Palghar district        | 60                  | 86.66-298.56 | 178.40     | 47(78.33)   | 13(21.67)  | 0(0.00)     | 1.21    |

(Figures in parenthesis indicate percentage).

Table 6: Status of available molybdenum of soil in Palghar district.

| Name of Tehsil          | No. of Soil Samples | Range        | Mean       | Low         | Medium     | High        | Indices |
|-------------------------|---------------------|--------------|------------|-------------|------------|-------------|---------|
| Mohanda                 | 10                  | 0.03-0.59    | 0.23       | 3(30.00)    | 6(60.00)   | 1(10.00)    | 1.80    |
| Javahar-Vikramghad      | 10                  | 0.01-0.60    | 0.18       | 4(40.00)    | 6(60.00)   | 0(0.00)     | 1.60    |
| Dhanu                   | 10                  | 0.02-0.65    | 0.24       | 4(40.00)    | 4(20.00)   | 2(40.00)    | 2.00    |
| Talsari                 | 10                  | 0.09-0.59    | 0.42       | 1(10.00)    | 3(20.00)   | 6(60.00)    | 2.30    |
| Palghar                 | 10                  | 0.01-0.62    | 0.37       | 3(30.00)    | 4(20.00)   | 3(50.00)    | 2.20    |
| Wada                    | 10                  | 0.03-0.57    | 0.24       | 3(30.00)    | 5(50.00)   | 2(20.00)    | 1.90    |
| Palghar district        | 60                  | 0.01-0.65    | 0.28       | 18(30.00)   | 28(46.66)  | 14(23.34)   | 1.93    |

(Figures in parenthesis indicate percentage).

Table 7: Karl Pearson’s correlation of available molybdenum with soil properties.

| Parameters              | Molybdenum | Nutrient |
|-------------------------|------------|----------|
| pH                      | (r=+0.714**), 0.101* |         |
| EC                      | 0.001-0.35 |          |
| Ca CO3                  | NS         |          |
| Organic carbon          | (r= - 0.815**), NS |         |
| Available nitrogen      |            |          |

* - significant at 5 % level
** - significant at 1% level

soil (Table 6). The highest deficiency (40.00%) was found in Jawahar-Vikramghad and Dhanu tehsils.

Relationship of available molybdenum with soil properties: Positive correlation was observed between pH and available molybdenum (r=+0.714**) as shown in Table 7. Available molybdenum had highly significantly positive correlated with pH. (Gupta and Dabas, 1980). Available soil molybdenum increased with soil pH. Available molybdenum content below the critical level was found in acid soil with pH less than 6.5. In acid soils, much of the molybdenum may be associated with sesquioxides, especially the iron oxides. In highly leached acid soils of Mo combines very strongly with sesquioxides and clay minerals. Concentration of MoO42- increases 100-fold for each unit increase in pH (Lindsay et al. 1972).

The available molybdenum was found to have significant and negative correlation with organic carbon content (r= -0.815**) as depicted in Table 7. Available soil molybdenum decrease with increase in organic carbon content. Available molybdenum showed significant and negative correlation with organic carbon (r= -0.341**). Molybdenum is positively correlated with organic carbon in acidic soils whereas it is negatively correlated with organic
carbon in acid soil due to heavy rainfall. Similar observation was reported by Rawat and Mathpal, 1981.

CONCLUSION
From the present investigation, it is concluded that, soils of Palghar district were found acidic to neutral in reaction, non saline and slightly calcareous in nature, low to high in organic carbon and low in nitrogen content in soil. The available molybdenum in Palghar district ranges from 0.01 to 0.65 with mean of 0.28 mg Kg\(^{-1}\). In Palghar district 30 percent soils samples were deficient in available molybdenum content. All the tehsils of the Palghar district showed deficiency of molybdenum in soil. The highest deficiency of molybdenum was recorded in Jawahar-Vikramghad and Dhanu (40.00%) tehsils.

REFERENCES
Adhikari, T. and Patel K.P., (2013). Molybdenum status in selected benchmark of India and its relationship with soil properties. J. Indian Soc. Soil Sci. 61: 253-257.
Chadar BR, Vaidya PH, Kachave RR and Aundhakar AV, (2018). Characterizations, classifications and soil site suitability evaluation of soils of farm College of Agriculture, Latur, Maharashtra. Journal of Pharmacognosy and Phytochemistry. SPI: 166-170
Chavan, D.P., Bangar A.R. and Shingte A.K., (1980). Zn, Mn, B and MO distribution in soil profiles of different agroclimatic zones of Maharashtra. J. Maharashtra Agric. Univ. 5(3) : 183-189.
Gajanan, GN., Upadaya G.S. and Deshpande P.B., (1978). Factors affect in the lime requirement of coastal acid soils of Karnataka. J. Indian Soc. Soil Sci. 26: 301.
Grigg, J.L., (1953). Determination of available molybdenum in soils, N.Z. Soil News. 3: 37-40.
Gupta, V.K. and Dabas D. S., (1980). Distribution of molybdenum in some saline- sodic soils from Haryana. J. Indian Soc. Soil Sci. 28: 28-30.
Jackson, M. L. (1973). Soil Chemical Analysis (Eds) Prentice Hall of India Pvt. Ltd., New Dehi. pp: 69-182.
Lindsay, W.L. (1972). Inorganic phase equilibria of micronutrients in soils. In: [Mortvedt J.J., Giordano P.M. and Lindsay W.L. (eds)], Micronutrients in Agriculture. Soil Science Society of America, Madison, Wisconsin, USA. pp 41–57.
Nelson, D.W and Sommers L.E., (1982). In Methods of Soil Analysis, Part II, Chemical and microbial methods [by Pages, A.L, R.H. Miller and D. R. Keeney (Eds)], Agronomy monograph No.9 (2nd edition) American Society of Agronomy and Soil Science society of America, Madison, Wisconsin, USA : 570-572.
Panse, V.G. and Sukhatme P.V., (1985). Statistical Methods for Agriculture Workers. ICAR, New Delhi. pp 14-33.
Parker, F.W. Nelson E. W. and Miles K. F. (1951). The broad interpretation and application of soil test information. Agron. J. 43: 105-112.
Patil, A.A. and Ahire D.V., (2013). Studies on correlation of electrical properties of red soils with their physical and chemical parameters. J. of Chemical, Biological and Physical Sciences. 3(1) 840–848.
Piper, C.S. (1966). Soil and Plant Analysis. Hans. Pub.Bombay. Asian Ed. pp: 368-374.
Rawat, P.S. and Mathpal K.N., (1981). Micronutrient status of some soils of U.P hills. J. Indian Soc. Soil Sci. 29(2): 208-214.