

STATUS OF MOLYBDENUM IN SOILS AND FODDER CROPS IN AGRA DISTRICT OF WESTERN UTTAR PRADESH

PRANAY KUMAR THAKUR AND VIPIN KUMAR

Department of Agricultural Chemistry and Soil Science, Raja Balwant Singh College, Bichpuri, Agra (U.P.) - 283 105

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ABSTRACT

Status of molybdenum and its relationship with soil properties and Mo status in forage crops were evaluated in Agra district of western Uttar Pradesh. The soils were alkaline in reaction having variations in EC ($0.06 - 0.41 \text{ dSm}^{-1}$) and organic carbon ($2.8 - 6.6 \text{ g kg}^{-1}$). The total and available molybdenum ranged from 1.00 to 2.75 mg kg^{-1} and 0.04 to 0.65 mg kg^{-1} , respectively in forage soils of Agra district. In about 16 per cent of the samples, the available Mo was below the critical limit. The variation in total Mo content in soil was associated with the amount of calcium carbonate and soluble salts. Molybdenum content in forage crops ranged from 1.2 to 5.0 mg kg^{-1} with a mean value of 2.3 mg kg^{-1} . On an average, berseem plants had the highest amount of Mo in its vegetative parts. None of the plant samples was toxic to animals. Plant Mo had significant and positive relationship with soil available Mo.

Keywords: Molybdenum, soil, fodder crops, Agra district Uttar Pradesh

INTRODUCTION

Molybdenum is an essential element for plants and animals, beyond certain critical amounts in forages; it is toxic to plants causing molybdenosis in animals. Molybdenum, is of especial significance due to its contribution in activation of several enzyme systems and physiological activities encountered inside the plant body. Molybdenum is a constituent part of the enzyme nitrate reductase concerned with the reduction of nitrate to nitrite in both microorganism and higher plants. It is also a constituent of nitrogenase and sulphide reductase enzymes. It helps in biological nitrogen fixation and affects development of anthers and formation and viability of pollen grain in plants. Availability of Mo to plants is influenced by soil parameters like pH, organic matter, clay content etc. (Behera et al. 2011). According to Dick (1956), 5 ppm Mo in plants is toxic for animals under low sulphur content of the forages. Since cattle husbandry contributes a major share in the economy of Uttar Pradesh, it is essential to grow healthy fodders for sustaining a good cattle population. Therefore, the present study was initiated to assess the status of Mo in soils and fodder crop in Agra district of western Uttar Pradesh.

MATERIALS AND METHODS

Fifty samples of each of the fodder crop, namely, berseem (*Trifolium alexandrinum*) lucerne (*Medicago sativa*) and oat (*Avena sativa*) were collected from Agra district of Uttar Pradesh. Soil samples were also collected from the same sites. The soil samples were air dried, pulverized to pass through 2 m.m. sieve and analyzed for some physico chemical properties by following standard methods (Jackson 1973). Total and available Mo in soils were

extracted with perchloric acid and Grigg's reagent (Grigg 1953), respectively. Plant samples were washed with tap water, rinsed with distilled water and dried in an oven at $60-70^{\circ}\text{C}$. The plant samples were wet digested in di-acid ($\text{HNO}_3\text{-HClO}_4$) mixture and analysed for Mo content by thiocyanate method (Jackson 1973).

RESULTS AND DISCUSSION

Molybdenum in soils

Variations in pH, organic carbon, EC, CaCO_3 contents of these soils are presented in Table 1. All the soils are alkaline in reaction ($7.0 - 8.8$) having variation in salt concretion in ($0.06 - 0.41 \text{ dSm}^{-1}$) calcium carbonate ($5 - 35 \text{ g kg}^{-1}$). The soils are generally poor ($2.8 - 6.6 \text{ g kg}^{-1}$) in organic carbon. In general, oat soils were relatively more alkaline in nature. On the other hand, no marked variations were recorded in EC and values in these soils. The lower organic carbon content of these soils may be due to rapid oxidation of organic matter in arid and semi arid regions. The total content of Mo in these soils ranged between 1.00 and 2.75 mg kg^{-1} with a mean value of 1.68 mg kg^{-1} . The ranges of variation within the soils growing berseem, lucerne and oat were 1.00 to 2.75 , 1.05 to 2.70 and 1.05 to 2.60 mg kg^{-1} , respectively.

Table1: Physico –chemical characteristics of soils of Agra

| Crops | pH | EC (dSm^{-1}) | CaCO_3 (g kg^{-1}) | Org. carbon (g kg^{-1}) |
|---------|---------|--------------------------|--|------------------------------------|
| Berseem | 7.0-8.8 | 0.10-0.40 (0.19) | 5.0-35.0 (11.8) | 2.8-6.6 (4.35) |
| Lucerne | 7.0-8.8 | 0.06-0.41 (0.22) | 5.0-30.0 (11.7) | 2.8-6.6 (4.58) |
| Oat | 7.2-8.8 | 0.08-0.36 (0.18) | 5.0-35.0 (11.1) | 2.8-5.6 (4.13) |

The mean values of total molybdenum for these three forage soils were 1.72, 1.70 and 1.63 mg kg⁻¹, respectively. In general, berseem soils contained relatively higher amount of total molybdenum as compared to soils of other forage crops. These great variations have most probably arisen due to differences in the local factors in relations to soil genesis, soil climate conditions including texture and cropping system. It seems most likely that low Mo content of these soils may be due to their low organic matter and light texture. These values are fairly comparable to the results reported by Verma et al. (1980) reported that total Mo content ranged from 2.0 to 7.5 ppm in citrus soils of Agra region. Rattan et al. (2009) reported traces to 12.3 mg kg⁻¹ total Mo in Indian soils.

Table 2: Status of molybdenum in forage soils of Agra district

| Fodder crops | Total Mo (mg kg ⁻¹) | Available Mo (mg kg ⁻¹) | Avail. Mo x 100 Total Mo |
|--------------|---------------------------------|-------------------------------------|--------------------------|
| Berseem | 1.00-2.75 (1.72) | 0.04-0.65 (0.15) | 2.3-23.6 (7.9) |
| Lucerne | 1.05-2.70 (1.70) | 0.04-0.65 (0.16) | 2.4-24.1 (7.9) |
| Oat | 1.05-2.60 (1.63) | 0.04-0.60 (0.13) | 2.5-24.0 (9.1) |

The quantities of available molybdenum ranged from 0.04 to 0.65, 0.04 to 0.65, and 0.04 to 0.60 mg kg⁻¹ in berseem, lucerne and oat soils respectively. The mean values of available Mo for these soils were 0.15, 0.16 and 0.13 mg kg⁻¹ respectively. Thus, on an average, the soils collected from lucerne soils were comparatively richer in available Mo than the remaining forage crops growing soils. The status of available molybdenum observed in the present study agrees well with the range of 0.104 to 1.408 ppm found by Kavimandan et al. (1964) for the soils of Vidharbha. Verma et al. (1982) found a range of 0.12 to 1.47 ppm available Mo with an average value of 0.70 ppm in soils of Agra district. Rattan et al. (2009) reported traces to 2.80 mg kg⁻¹ available Mo in Indian soils. Davis (1952) studied that at pH 6.8 and above, 0.05 ppm of molybdenum was sufficient to meet the needs of plants. Grigg (1953) suggested the critical limit of available molybdenum to be 0.14 ppm for soils below pH 6.3 and 0.05 ppm for neutral soils. None of the soils under study tested below pH 6.3. If his limit holds good for these soils, then about 16.0 per cent samples fell in deficient category. Bhandari and Randhawa (1985) reported a deficiency of Mo in 30 per cent of surface soils (range 0.04 to 0.39, mean 0.16 ppm). Behera et al. (2011) reported that 73% soils were found to be Mo deficient in 7 different bench marks sites of India.

The total Mo has a definite bearing on the levels of available Mo in these soils as indicated by significant and positive relationship ($r = 0.46^{**}$ and 0.40^{**} for berseem, lucerne and oil soils, respectively) between them. Sharma et al. (1988) also reported similar relationship between total and available Mo. The results (Table 3) indicate that total and available Mo content were significantly and positively related with soil pH, but this relationship appears to be less pronounced in oat soils. Verma et al. (1982) also reported positive relationship between pH and total Mo. Increase in available Mo with pH may be attributed to the replacement of MoO₄⁻ by OH⁻ ions. Grewal et al. (1969) also reported positive correlation between pH and available Mo content of the soils. Total and available Mo was significantly and positively correlated with soluble salt concentration. Similar relationship was reported by verma et al. (1992). The relationship between total and available Mo with organic carbon was non-significant. There existed significant and positive relationship between CaCO₃ and total available Mo (Table 3). The values of correlation coefficient were more or less similar in different soil groups of Agra district. Verma et al. (1982) also reported similar results.

Table 3: Correlation coefficients between soil properties and soil Mo

| Soil properties | Berseem | | Lucerne | | Oat | |
|-------------------|----------|-----------|----------|-----------|----------|-----------|
| | Total Mo | Avail. Mo | Total Mo | Avail. Mo | Total Mo | Avail. Mo |
| pH | 0.51** | 0.60** | 0.57** | 0.64** | 0.49** | 0.67** |
| EC | 0.21* | 0.23* | 0.20* | 0.24* | 0.22* | 0.27* |
| Org. carbon | 0.08 | 0.10 | 0.11 | 0.09 | 0.12 | 0.10 |
| CaCO ₃ | 0.27** | 0.30** | 0.25** | 0.28** | 0.26** | 0.25** |

Significant at 5%, ** significant at 1%

The ratio of available Mo/total Mo showed variations in soils of different forage crops of the Agra district. The maximum average value of this ratio was recorded in soils of oat growing areas. The average values of this ratio for the soils of berseem, Lucerne and oat soils were 7.9, 7.9 and 9.1 respectively. The corresponding ranges of this ratio were 2.3 to 23.6, 2.4 to 24.1 and 2.5 to 24.0. Out of these forage crops soils, the oat soils of were found to have maintained maximum fraction of total molybdenum in available form. It is also clear from the Table 2 that 2.3 to 24.1 per cent of total Mo of Agra soils could be extracted with acid ammonium oxalate (pH 3.3). Verma et al. (1980) also reported 24.46 to 43.67 per cent of total Mo of citrus soils of Agra region could be extracted with acid ammonium oxalate (pH 3.3).

Table 4: Status of Mo in forage crops

| Fodder crops | Molybdenum (mg kg ⁻¹) | |
|--------------|-----------------------------------|------|
| | Range | Mean |
| Berseem | 1.2-5.0 | 2.3 |
| Lucerne | 1.2-4.1 | 2.2 |
| Oat | 1.2-4.0 | 2.0 |

Forage crops

Table 3 contains data pertaining to Mo content of forage crops. In general, molybdenum content showed a marked difference in the plants of various forages crops. In berseem crop, the range of variation in Mo content was 1.2 to 5.0 mg kg⁻¹ with an average of 2.3 mg kg⁻¹. In lucerne, the range of variation was 1.2 to 4.1 with an average of 2.2 mg kg⁻¹. The plants of oat, on the average, contained 2.0 mg kg⁻¹ Mo with a range of 1.2 to 4.0 mg kg⁻¹. Berseem plants had relatively higher concentration of Mo than other forage crops. Verma et al. (1982) analysed berseem plants collected from Agra district and reported that Mo content ranged from 1.00 to 11.50 ppm with an average value of 3.59 ppm. According to

Dick (1956), a level of even 5 ppm of Mo in plants may become toxic under low sulphur content of the forages. If this standard is applicable to present study, none of the plant samples was toxic to animals. The correlation studies indicate that there existed a high degree of inter-relationship between plant Mo and soil available Mo, the 'r' value being 0.75**, 0.71** and 0.68** for berseem, lucerne and oat, respectively. Pasricha and Randhawa (1971) and Verma et al. (1982) also reported that uptake of Mo by plants bear's positive and significant correlation with available Mo content of the soils. It can be concluded that fodder soils of Agra district contain adequate level of total as well as available molybdenum. Only 16% soil samples are deficient in available molybdenum. Availability of this element increases with increase in soil pH. Plants samples of all the three fodder crops contain adequate amount of molybdenum. None of the fodder crops was found to contain toxic amount of molybdenum in their vegetative parts.

REFERENCES

- Behera, S.K., Lakaria, M.V. and Somasundram, J. (2011) Molybdenum in soils, crop and fertilizers. *Indian Journal Fertilizers*, 7(5): 52-57.
- Bhandari, A.R. and Randhawa, N.S. (1985). Distribution of available micronutrients in soils of apple orchards in Himachal Pradesh. *Journal of the Indian Society of Soil Science*. 33: 171-174.
- Dick, A.T. (1956) Molybdenum in animal nutrition. *Soil Science*. 81: 229-236.
- Grewal, J.S. Randhwa, N.S., Bhumbla, D.R. (1969) Effect of micronutrient on the yield of paddy and maize. *J. Res. P.A.U.* 6: 38-45.
- Grigg, J.L. (1953) Determination of the available molybdenum of soils *N. Z.J. Sci. Technol.* 34A: 405-414.
- Jackson, M.L. (1973) *Soil Chemical Analysis*. Prentice Hall of India Pvt. Ltd., New Delhi.
- Kavimandan, S.K., Badhe, N.N. and Ballal, D.K. (1964) Available copper and molybdenum in Vidarbha soils. *Journal of the Indian Society of Soil Science*. 12: 281-288.
- Pasricha, N.S. and Randhawa, N.S. (1971) Available molybdenum status of some recently reclaimed saline-sodic soils and its effect on concentration of molybdenum, copper, sulphur and nitrogen in berseem (*Trifolium alexandrinum*) grown on these soils. *Int. Symp. Soil Fert. Evaluation, New Delhi* 1: 1017-1025.
- Rattan, R.K., Patel, K.P., Manjaiah, K.M., and Datta, S.P. (2009) Micronutrients in soil, plant, animal and human health. *Journal of the Indian Society of Soil Science*. 57(4):546-558.
- Sharma, C.M., Minhas, R.S. and Masand, S.S. (1988) Molybdenum in surface soils and its vertical distribution in profiles by some acid soils. *Journal of the Indian Society of Soil Science*. 36: 252-256.
- Verma, S.R., Mehta, V.S. and Singh, Vinay (1982) Molybdenum in soil and plant samples of Agra district. *Journal of Agricultural Sciences*. 52 (12): 845-847.
- Verma, V.S., Singh, Vinay and Mehta, V.S. (1980) Studies on molybdenum in citrus soils of Agra region. *Madras Agricultural Journal* 67: 61-64.