World Journal of Pharmaceutical and Life Sciences
WJPLS
www.wjpls.org
SJIF Impact Factor: 5.088

MINERAL NUTRIENTS IN SOME MOSS SPECIES FROM MAHARASHTRA, INDIA

Wadavkar D. S.*, Murumkar C.V., Gawade P. D. and Chavan S. J.

Post Graduate Research Center, Department of Botany, Tuljaram Chaturchand College of Arts, Commerce and Science, Baramati, Dist- Pune, 413 102, Maharashtra, India.

***Corresponding Author: Wadavkar D. S.**
Post Graduate Research Center, Department of Botany, Tuljaram Chaturchand College of Arts, Commerce and Science, Baramati, Dist- Pune, 413 102, Maharashtra, India.

Article Received on 01/02/2019 **Article Revised on 22/02/2019** **Article Accepted on 12/03/2019**

ABSTRACT

The composition of mineral nutrients was studied in mosses from Maharashtra namely *Barbula unguiculata* Hedw., *Hypnum reflexum* F. E. Tripp., *Steeriophyllum anceps* (Bosch et. Lac.) Broth., *Fissidens crenulatus* Mitt., *Trachypodiopsis blanda* (Mitt.) Fleisch., *Funaria hygrometrica* Hedw., *Macromitrium sulcatum* Brid., *Brachymenium turgidum* Broth., *Bryum coronatum* Schwaegr. and *Hyophila involuta* (Hook.) Jaeg. growing in various habitats like Lonawala and Khandala, Mahabaleshwar, Sinhagad, Kaas Plateau and Aundh (Satara) . The study revealed that these eleven nutrients (Ca, Mg, N, K, S, P, Fe, Mn, Cu and Zn) showed differential accumulation from species to species. The level of Ca is usually more than the other macroelements viz. N, P, K, S, and Mg in mosses. It ranges from 10- 26.5 mg/g dry wt. N , P, K and Mg also important macronutrients ranges from 0.41-23.7, 0.8-3.3, 2.5-6.5, 3.3-8.6 mg/g dry wt. The level of S lowest among all those of macronutrients ranges from 1.8 - 5.3 mg/g. The level of Fe (10500-35300 µg/g dry wt.) is the highest and Zn (45-166 µg/g dry wt.) is the lowest among all the microelements in mosses as compared to remaining moss species with few exceptions.

KEYWORD: Accumulation, Mosses, Nutrients, Maharashtra, India.

INTRODUCTION

Mineral nutrients is performs a crucial role in growth and development of mosses. Shacklette (1965) determined the nutrient contents of 29 species of bryophytes and found that the concentrations of Al, Ba, Cr, Cu, Fe, Ga, Ni, Pb, Ag, V and Zn were higher in bryophytes than those in angiosperms. The heavy metal ions the retention efficiency order is $Cu^{2+} > Pb^{2+} > Ni^{2+} > Co^{2+} > Zn^{2+} > Mn^{2+}$ as shown for *Hylocomium splendens* by (Ruhling and Tyler, 1970). Pakarinen and Tolonen (1977) reported major nutrients (N, P, K, Ca, Mg, Na, and Fe) were analysed in 38 *Sphagnum* and water samples taken mainly from bogs and poor fens. The nutrient accumulation in *Sphagnum* mosses observed by (Aulio, 1980, 1982; Wojtun 1993; Tomas and Adamec, 2009) Saxena *et al.* (2005) detected chemical constituents like Copper, Nickel and Iron from corticalous mosses from Mahabaleshwar in Western Ghats. The effect of some heavy metals their toxic effect has been studied in mosses. (Kaur *et al.*, 2010; Saxena and Arfeen, 2010) Lou *et al.* (2013) studied that the content of the heavy metals Pb, Cr, and Cu in the moss *Haplocladium microphyllum.*

MATERIAL AND METHOD

The moss species like *Bryum ghatens* Broth. et Dix., *Hypnum reflexum* F. E. Tripp., *Steeriophyllum ancens* (Bosch et Lac.) Broth., *Fissidens crenulatus* Mitt., *Trachypodiopsis blanda* (Mitt.) Fleisch., *Funaria hygrometrica* Hedw., *Macromitrium sulcatum* Brid., *Brachymenium turgidum* Broth., *Bryum coronatum* Schwaegr. and *Hyophila involuta* (Hook.) Jaeg. collected from various localities such as Lonawala and Khandala, Mahabaleshwar, Sinhagad, Kaas Plateau and Aundh (Satara) during July, 2018 to September, 2018 from moist shady places in rainy season. Before evaluation, material has been cleaned along with water and dried at room temperature for 24 hrs. After that this dried powdered material was used for analysis nutrients.

Bremner (1960) estimated Nitrogen content using Kjeldahl distillation method. Phosphorous determined by Spectrophotometrical method (Chapman and Pratt, 1961). Drosdoff and Nearpass (1948) determined the Magnesium content by Spectrophotometrical method. Sulphur is estimated Spectrophotometrical method by (Tabatabai and Bremener, 1970) and Toth *et.al.* (1948) determined Calcium, Potassium and Sodium are by Flame photometrically. The Microelements namely Iron,

Manganese, Zinc, Copper were estimated using Atomic Absorption Spectrophotometer (Perkin-EImer-3030).

RESULT AND DISCUSSION

Nitrogen content of various mosses is mentioned in Table 1. It is evident from the results that nitrogen content is maximum in *Hyophila involuta i.e*. 23.7 mg/g dry wt. and *Bryum coronatum* (0.41 mg/g dry wt.) have less amount of nitrogen. Rastorfer (1974) has reported that the concentration of nitrogen in different Alaskan Artic mosses ranges from 9-15 mg/g dry wt. The maximum amount of P was found in *Trachypodiopsis blanda* (3.3 mg/g dry wt.) and minimum amount in *Brachymenium turgidum* (0.8 mg/g dry wt.) as compared to remaining mosses. P content of mosses from Alaskan Artic region was in the range of 1.8 - 2.3 mg/g dry wt. (Rastorfer, 1974). It is evident from the present results that as compared to this optimum level the level of phosphorus relatively very high in all mosses. The maximum amount of potassium was found in the *Macromitrium sulcatum* (6.5 mg/g) while lowest in *Fissidens crenulatus* (2.5 mg/g) among all mosses. Rastorfer (1974) has reported 5.4 - 8.8 mg/g potassium in the mosses. According to Sawant (2010) concentration of K in the hornwort i.e. *A. subtilis* is (1.7 mg/g) while maximum amount is found in the liverwort *A. wallichiana* (21.3 mg/g). Level of P is more or less similar in *P. intermedium* (15 mg/g) and *C. cavernarum* (10.4 mg/g) while it is the lowest in *T. hypophylla* (5.6 mg/g) among all liverworts. The Maximum amount of Ca is found in *Macromitrium sulcatum* and minimum amount in *Bryum coronatum* as compared to remaining mosses. Rastorfer (1974) has reported 1.5-10.2 mg/g Ca in mosses.

Mg is the also lowest among macronutrients studied. It ranges from 3.3 - 8.6 mg/g dry wt. with the highest concentration in *Funaria hygrometrica* (8.6 mg/g dry wt.), while its concentration is lower in case *Bryum coronatum*. The level of Mg in the mosses studied higher than the optimal levels of Mg given by Mengel and Epstein for higher plants. Rastorfer (1974) has recorded the concentration of Mg in mosses from Artic region which ranges from 1.3- 4.5 mg/g.The level of sulphur lowest among all those of macronutrients studied. It ranges from 1.8 - 5.8 mg/g. The *Brachymenium turgidum* is the lowest (1.8 mg/g) among all studied mosses while it is maximum in case of *Hyophila involuta* (5.8 mg/g) and there is no much difference in all other cases. It can be said that the level of sulphur less in all mosses. Rastorfer (1974) reported that sulphur content of the mosses from Artic regions is 0.89-1.045 mg/g. The total sulphur content in the tracheophyte tissues is in the order of 2-5 mg/g in dry matter (Mengel and Kirkby, 1982).

It is clear from the present results (Table 2) that the level of iron is the highest among all the microelements in mosses. Which is also similar in case of mosses studied (369-1056 ppm) from Artic regions (Rastorfer, 1974). *Steeriophyllum anceps* has the highest concentration of Fe (35300 µg/g dry wt.) and with the lowest concentration in *Brachymenium turgidum* (10500 µg/g dry wt.). It is also evident from the present study that the level of Fe is higher than that reported by Rastorfer (1974). Levels of Fe higher than 1550 µg/g have been reported in bryophytes (Rao and LeBlance, 1967).

There is diverse range of manganese concentration from 310 to1020 µg/g dry wt. *Funaria hygrometrica* and *Barbula unguiculata* accumulate more manganese (1020 µg/g dry wt.) and *Bryum coronatum* accumulate minimum (310 µg/g dry wt.). According to Stout (1961) and Epstein (1972), critical level of manganese is 30-50 µg/g dry wt. for tracheophytes.

The level of Zinc is the lowest among all the microelements in mosses. It ranges from 45-166 µg/g dry wt. The concentration of Zn for mosses from Artic region is in the range of 45-66 µg/g (Rastorfer, 1974). The highest concentration level of Zinc in *Hyophila involuta* (166 µg/g dry wt.) while its concentration is lower in case *Bryum coronatum* (45 µg/g dry wt). The result shows that the level of Zn in all mosses is near to the values given by Rao and Leblanc (1967).

The concentration of copper in the mosses was reported to be in the range of 71-541 ppm *Funaria hygrometrica* contains the highest amount of copper (541 µg/g dry wt) from among the remaining mosses and then lower with 71 µg/g dry wt of copper in *Macromitrium sulcatum.* It can be said that the level of copper in all mosses is higher than optimum level of dry plant material. Shacklette (1965) has determined the mineral content of 29 species of bryophytes and found that concentrations of Cu higher in bryophytes as compared to that in angiosperms.

Table 1: Composition of macronutrients (mg/g dry wt.) in moss species.

Sr. No.	Name of Extract Species	N	P	K	Ca	Mg	S
1	*Barbula unguiculata* Hedw.	1.1	1.4	4.5	17.1	7.1	2.7
2	*Hypnum reflexum* F. E. Tripp.	0.51	**2.2**	4.7	18.1	7.0	2.8
3	*Steeriophyllum* anceps (Bosch et. Lac.) Broth.	0.45	1.7	5.0	19.3	8.0	2.7
4	*Fissidens crenulatus* Mitt.	0.43	1.1	**2.5**	10.3	7.1	2.7
5	*Trachypodiopsis blanda* (Mitt.) Fleisch.	21.4	3.3	4.5	22.2	7.0	2.9
6	*Funaria hygrometrica* Hedw.	0.58	1.5	3.0	16.8	**8.6**	3.2
7	*Hyophila involuta* (Hook) Jaeg.	**23.7**	1.5	4.5	23.4	7.7	**5.3**
8	*Brachymenium turgidum* Broth.	6.9	**0.8**	3.0	13.6	4.5	**1.8**
9	*Bryum coronatum* Schwaegr.	**0.41**	1.2	4.0	**10.0**	**3.3**	2.0
10	*Macromitrium sulcatum* Brid.	0.58	1.1	**6.5**	**26.5**	4.4	3.0

*Values are mean of three replications expressed as mg/g dry wt.

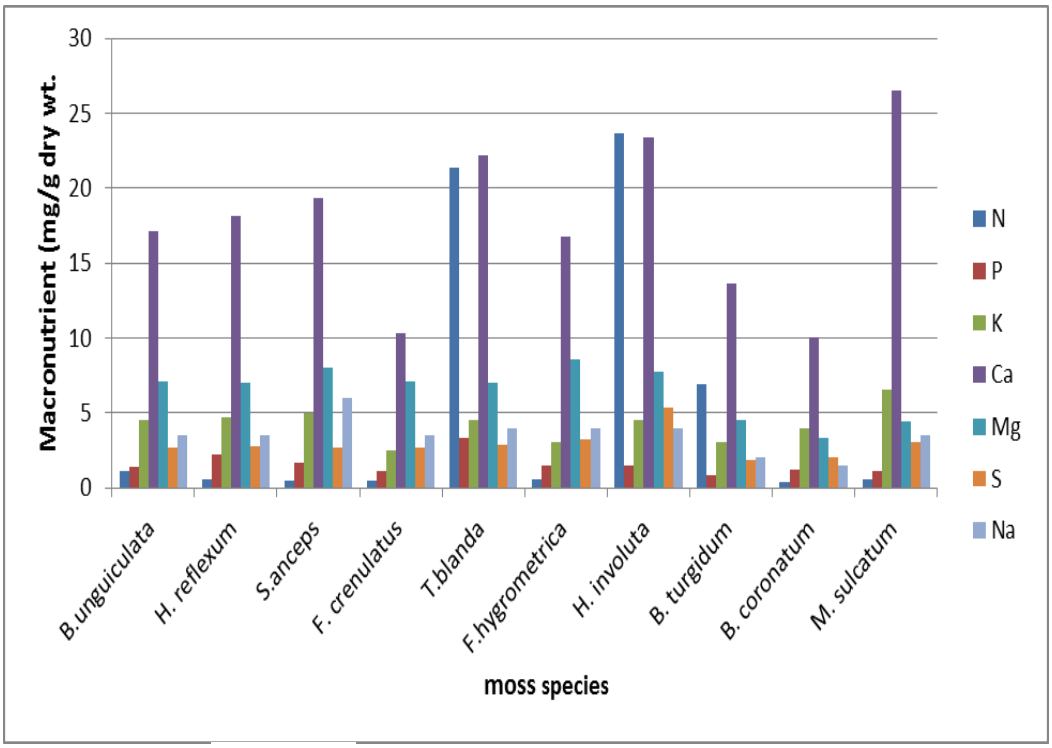

Fig. 1: Composition of macronutrients (mg/g dry wt.) in moss species.

Table 2: Composition of Micronutrients (µg/g dry wt.) in moss species.

Sr. No.	Name of Extract Species	Fe	Mn	Zn	Cu
1	*Barbula unguiculata* Hedw.	30100	**1020**	142	152
2	*Hypnum reflexum* F. E. Tripp.	32100	945	102	158
3	*Steeriophyllum* anceps (Bosch et. Lac.) Broth	**35300**	950	126	481
4	*Fissidens crenulatus* Mitt.	32000	785	69	264
5	*Trachypodiopsis blanda* (Mitt.) Fleisch.	21000	333	80	188
6	*Funaria hygrometrica* Hedw.	32100	**1020**	71	**541**
7	*Hyophila involuta* (Hook) Jaeg.	29000	770	**166**	500
8	*Brachymenium turgidum* Broth.	**10500**	340	49	120
9	*Bryum coronatum* Schwaegr.	11700	**310**	**45**	216
10	*Macromitrium sulcatum* Brid.	18200	390	75	**71**

*Values are mean of three replications expressed as µg/g dry wt.

TULJARAM CHATURCHAND COLLEGE * BARAMATI

Principal
Tuljaram Chaturchand College
Baramati

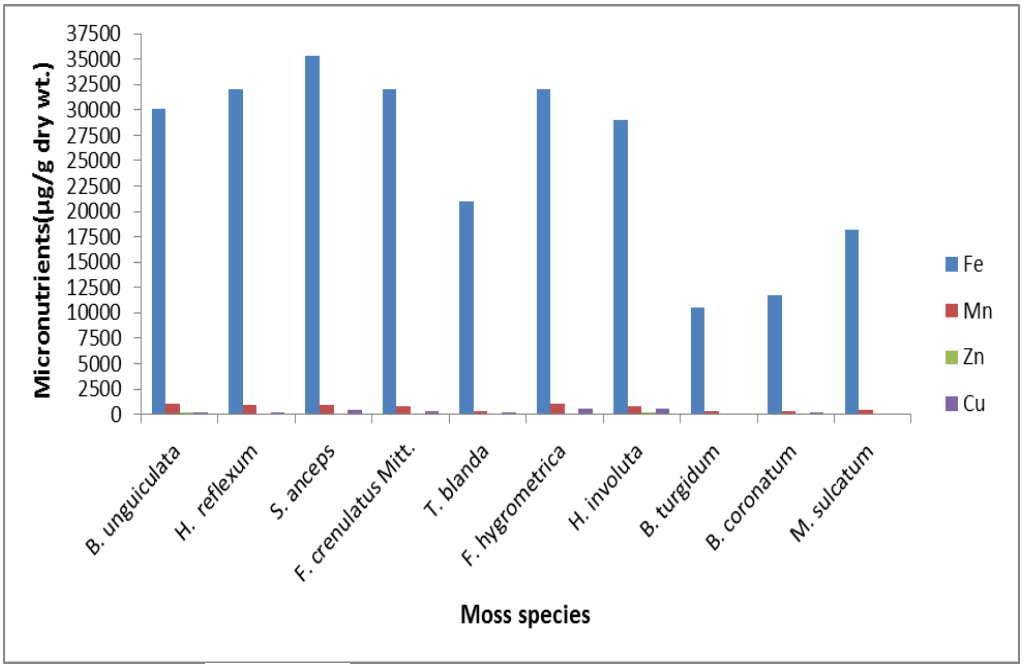

Fig. 2: Composition of Micronutrients (µg/g dry wt.) in moss species

CONCLUSION

The study revealed that these ten nutrients (N, K, P, S, Ca, Mg, Fe, Mn, Cu and Zn) showed differential accumulation from species to species. The nutrient content in *Steeriophyllum anceps* and *Hyophila involuta* was higher as compared to all moss species with few exceptions. The like Ca and Fe concentration was comparatively higher in all moss species. Accumulation of Ca in mosses takes part in regulation of water flow across plant membranes there by helps in stomatal movement to reduce water loss. Iron is an essential nutrient for plants. It accepts and donates electrons, and it plays important roles in the electron transport chains associated with photosynthesis and respiration.

ACKNOWLEDGEMENTS

The authors are grateful to the Principal and Head, Post-Graduate Research Center, Department of Botany, Tuljaram Chaturchand College of Arts, Commerce and Science, Baramati for providing necessary research facilities, encouragement, suggestions and advice throughout the research

REFERENCES

1. Aulio, K. Nutrient accumulation in Sphagnum mosses. I. A multivariate summarization of the mineral element composition of 13 species from an ombrotrophic raised bog. *Ann Bot Fenn*, 1980; 17: 307–314.
2. Aulio, K. Nutrient accumulation in Sphagnum mosses. II. Intra- and interspecific variation in four species from an ombrotrophic raised bog. *Ann Bot Fenn*, 1982; 19: 93–101.
3. Bremenar J. M. Determination of nitrogen in soil by the kjeldahal method. *Journal of agricultural Science*, 1960; 55: 11-33.
4. Chapman H. D. and Pratt F. P. "Ammoniumn vandate-molybdate method for determination of phosphorus" in Methods of Analysis for Soils Plants and Water pp 184-203. *California University Agriculture Division Oakland California USA*. 1st edition, 1961.
5. Drosdoff M. and Nearpass C. D. Quantitative microdetermination of magnesium in plant tissue and soil extracts *Ann Chem*, 1948; 20: 673-674.
6. Epstein E. Mineral Nutrition of Plants: Principles and Perspectives New York: Wiley, 1972.
7. Kaur, S. Rao, A. and Kumar, S. S. Study on some of the contents of some bryophytes-ii Musci. *International Journal of Pharmaceutical Sciences*, 2010; 5(3): 80-83.
8. Lou, Y., Cao, T., Zhang, Y., Zeng, Y., Cao, Y. A study of the characteristics of elements accumulation in tissue culture plants of the moss *Haplocladium microphyllum* under heavy metal stress by the SRXRF technique. Conference of the International Association of Bryologists, at Natural History Museum, London, UK, 2013.
9. Mengel, K. and Kirkby, E. A. Plant nutrients. In: Principles of plant nutrition, Berne, International potassh Institute of total sulphar in Plant material. *Agronomy Journal*, 1982; 62: 805-806.
10. Pakarinen, P. and Tolonen, K. Nutrient Contents of Sphagnum Mosses in Relation to Bog Water Chemistry in Northern Finland. *Lindbergia*, 1977; 4: 27-33.
11. Rao, D. N. and LeBlance, F. Influence of an iron-sintering plant on corticolous epiphytes in Wawa, Ontario. Bryologist, 1967; 70: 141-157.

12. Rastorfer, J. R. Comparative physiology of four west antartic mosses. Antarctic Terrestrial Biology, 1972; 20: 143-161.
13. Ruhling, A. and Tyler, G. Sorption and retention of heavy metals in the woodland moss *Hylocomium splendens* (Hedw.) Br. et Sch. *Oikos*, 1970; 21: 92-97.
14. Sawant U.J. Studies in allelopathic effect and pesticidal potential of some bryophytes of Western Ghats of Maharashtra. Thesis, Doctor of Philosophy. Department of Agrochemicals and Pest Management Shivaji University Kolhapur, 2010.
15. Saxena, D. K. and Arfeen, S. Metal deposition pattern in kumaon hills (india) through active monitoring using moss *Racomitrium crispulum*, Iran. *J. Environ. Health. Sci. Eng.*, 2010; 7(2): 103-114.
16. Saxena, D. K. and Harinder Potential of bryophytes in forest establishment. *Indian Journal of Forestry*, 2005; 28: 425-428.
17. Shacklette, H.T. Element content of bryophytes *U.S. Geol. Survey Bull*., 1965; 1198-D: 1-21.
18. Stout, P. R. Micronutrients in crop vigour. Proc. 9th Ann. Calif. Fertilizer Conf., 1961; 21-23.
19. Tabatabai M.A. and Bremener J.M. Simple turbidimetric method for determination of total sulphar in Plant material. *Agronomy Journal*, 1970; 62: 805-806.
20. Tomas, H. and Adamec, L. Mineral nutrient economy in competing species of *Sphagnum* mosses. *Ecological Research*, 2009; 24(2): 291–302.
21. Toth S.J. Prince A.L. Wallace A. and Mikkelsen D.S. Rapid quantitative determination of 8 mineral elements in plant tissue by systematic procedure involving use of a flame photometer. *Soil Science*, 1948; 66: 459-466.
22. Wojtun, B. Mineral content in *Sphagnum* mosses from ombrotrophic bogs of South Western Poland: Pattern in species and elements. *Acta Societatis Botanicorum Poloniae*, 1993; 62: 203-208.

Principal
Tuljaram Chaturchand College
Baramati