Assessment of Macro and Micronutrients in Rhizospheric Soil of two Medicinally Important Plants Digitalis purpurea L. and Swertia petiolata D. Don. of Kashmir Himalaya

Mansoor A. Malik, Abdul Hamid Wani, Nayeema Jan and Mohd Yaqub Bhat

Research Journal of Agricultural Sciences
An International Journal

P- ISSN: 0976-1675
E- ISSN: 2249-4538

Volume: 13
Issue: 02

Res. Jr. of Agril. Sci. (2022) 13: 378–382

CARAS

Res. Jr. of Agril. Sci. (Mar-Apr 2022)
13(2): 378–382

ISSN: 0976-1675 (P)
ISSN: 2249-4538 (E)

www.rjas.org

Full Length Research Article

Assessment of Macro and Micronutrients in Rhizospheric Soil of two Medicinally Important Plants *Digitalis purpurea* L. and *Swertia petiolata* D. Don. of Kashmir Himalaya

Mansoor A. Malik*[1], Abdul Hamid Wani[2], Nayeema Jan[3] and Mohd Yaqub Bhat*[4]

Received: 01 Jan 2021 | Revised accepted: 24 Feb 2022 | Published online: 12 Mar 2022

ABSTRACT

Soil is one of the important components of environment which affect growth and development of plants. The soil testing is one of the chemical processes in which the suitability of essential nutrients is determined. The objective of this research is to analyze physiochemical properties including pH, electrical conductivity, salinity, soil moisture, organic carbon, macronutrients (P, K, S) and micronutrients (Mn, Fe, Cu, Zn) in order to understand the suitability of soil for growth of threatened medicinal plant species in the study area. A total of 15 composite rhizospheric soil samples of two medicinal plants were collected and categorized into low, medium and high altitudinal soils. Variation existed in the estimated chemical parameters due to varied ecological conditions. The soil samples collected from low land and medium land soils were neutral to slightly alkaline, while those of high land were acidic. All soils were high in organic carbon and medium in available nitrogen, phosphorus and potassium. However, the study data showed that soil exchangeable manganese was maximum in Gulmarg and Doodhpathri whereas least was found in KUBG. Likewise, the higher iron, zinc and copper contents were reported at Gulmarg and least at other two studied sites. Therefore, the present study may act as baseline for artificial cultivation and conservation of the studied threatened medicinal plants by making appropriate soil amendments in near future after proper investigation.

Key words: Physiochemical parameters, Soil quality, Macronutrients, Micronutrients

Soil is the most significant component for the survival of plants, as it provides nutrients and water in addition to anchorage. However, the plants in turn, indirectly affect their neighbors as well as soil properly like its change in the biotic, physical and chemical characteristics of soils [1]. Climate, another dominant ecological factor, is responsible for successive shifts in soil production by acting on parental material. Many morphological, physical, geological, biochemical and macro-chemical, and microbiological reactions and processes occur concurrently and interactively in soils that not only influence the soil's character slowly and gradually but also affect the immediate ecosystem. The plant diversity supports in terms of nourishment as well as its rhizospheric microbial diversity. In addition, many natural factors, such as atmosphere, organism, parent material, get modified to a large extent by the relief characteristics such as slope and altitude [2]. Besides, the fertility of the soil is another important factor that determines plant development. Which in turn, is determined by the presence or absence of macro and micronutrients [3]. All the nutrients are stored in varying amounts by the plants in their bodies. However, plants need these mineral elements in large quantities for growth and survival to regulate the productivity of the soil, influence the crop yields, and therefore are agronomically important [4].

The soil's composition, mineral matter, soil organic matter or humus, soil water/soil solution, soil atmosphere, and biological system are the different components of soil that are significantly affected by soil organic matter which includes the plant and animal residues and thus plays a crucial role in preserving the sustainability of cropping systems by improving physical (texture, structure, bulk density, and water holding capacity), chemical (accessibility of nutrients, cation exchange capacity, reduced aluminum toxicity, and allelopathy) and biological (mineralization of nitrogen) properties [5]. Nestled in the North-Western Himalaya, (Kashmir Himalaya) directly influenced by rhizospheric soil fungi harbors a rich floristic diversity of immense scientific interest and tremendous economic potential which changes along with different soil types altitudinal ranges and above all depends upon the type of

*1 **Mohd Yaqub Bhat**
myaqub35@gmail.com

*2 **Mansoor A. Malik**
malikmansoor011@gmail.com

1-4 Section of Mycology and Plant Pathology, Department of Botany, University of Kashmir, Hazratbal - 190 006, Srinagar, Jammu and Kashmir, India

plant to which they remain associated [6]. Medicinal plants grow in various soil types at different elevations and are used as herbal remedies for the treatment of different health related disorders by many communities. Medicinal plants, for which the preservation of soil chemical fertility is a crucial prerequisite, need to be commercially grown to meet the increasing demand for medicinal plants for indigenous systems of medicine and the pharmaceutical industries. The medicinal property of these plants is also subservient to the fungal flora associated with their roots as well as endophytes [7]. Therefore, the present study was carried out to estimate the physicochemical properties of soil samples of threatened medicinal plants, in terms of pH, organic carbon, available nitrogen, phosphorus, and potassium, and the fungal diversity associated with some threatened medicinal plants. Thus, the present research will produce valuable information regarding artificial cultivation and conservation of these studied threatened medicinal plants after making proper soil amendments.

MATERIALS AND METHODS

The present study was conducted to study the physicochemical properties of rhizospheric soil associated with two important medicinal plants such as *Swertia petiolata* D. Don and *Digitalis purpurea* L. collected from three different locations viz., Gulmarg, Doodhpathri and Kashmir University Botanical Garden (KUBG). The study was carried out during 2019 and 2020. For this study 6 to 8 spots were selected in each location. Samples from two depths were taken into a separate, dry, and clean plastic bucket and mixed thoroughly by hand. For the composite sample, one kg of soil from each bucket was taken into separate polythene bags and labeled. These samples were brought into the laboratory of Soil Science MRCFC-Khudwani, SKUAST Kashmir for further processing. Further, to complete the different environmental variable affecting the performance of selected medicinal plants, origin software (version 2022) was used to evaluate the correlation plot.

Table 1 Salient features of the selected sites of *Swertia petiolata* D. Don. and *Digitalis purpurea* L. along with their geographical locations.

Sampling site	District	Elevation (AMSL)	Annual rainfall (mm)	Latitude	Longitude
Gulmarg	Baramulla	2650	1049	34º 03′ 141″ N	74º 23′ 88″E
Doodhpathri	Budgam	2850	669.1	33º 50′ 67″ N	74º 35′ 15″ E
KUBG*	Srinagar	1591	720	34 º 09′ 66″ N	74º 50′ 77″ E

*KUBG-Kashmir University Botanical Garden

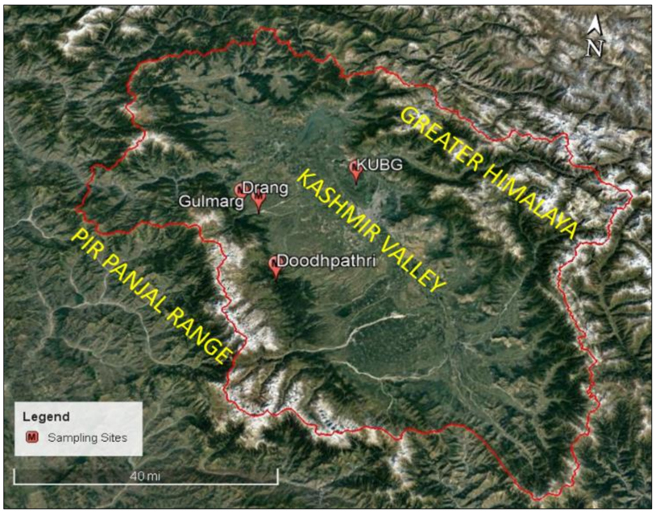

Fig 1 Map of the study area

In the study, following methods were applied for analysis of different physiochemical parameters of rhizospheric soil associated with two threatened medicinal plants:

The pH was accessed by standard pH meter in a 1:2 soil-water solution and the data was recorded by using the measurements of soil pH, electrical conductivity, and salinity by Electrometric method [8]. The soil moisture content was measured by the Gravimetric method given by Michael [9]. Similarly, organic carbon content was calculated using a fast titration method of Walkley and Black [10]. Subbiah and Asija's Alkaline potassium permanganate technique was used to assess available nitrogen [11]. Olsen's technique was used to extract the available phosphorus [12]. Schollerberger and Simon's Flame photometer method was used to determine available or exchangeable potassium in ppm [13]. Using an Atomic Absorption Spectrophotometer, the micronutrients (Zn, Fe, Mn, and Cu) were determined [14].

RESULTS AND DISCUSSION

The soil samples collected and analyzed from all the three different study sites were presented in (Tables 2-4). It was revealed from the results that pH and electrical conductance does not show much variation from the three tested sites while as salinity and moisture contents associated with these medicinal plants at the three tested locations show much variation.

Table 2 Soil samples collected from three sites analyzed for pH, electrical conductivity, salinity and moisture contents

Name of sites	Plant name	pH	Ec (ds/m^{-1})	Salinity (ppt)	Moisture content %
1st Site	*Swertia petiolata*	6.03	0.22	0.13	34.67
(Gulmarg)	*Digitalis purpurea*	5.83	0.36	0.21	3.77
2nd Site	*Swertia petiolata*	6.70	0.23	0.13	14.08
(Doodhpathri)	*Digitalis purpurea*	5.03	0.41	0.24	12.18
3rd Site	*Swertia petiolata*	8.20	0.22	0.13	8.17
(KUBG)*	*Digitalis purpurea*	8.11	0.28	0.16	6.25

*Kashmir University Botanical Garden

Soil pH

It was quite evident from the results (Table 2) that the soils of Gulmarg and Doodhpathri were highly acidic in nature with an average pH of 6.03 and 5.83 associated with *Swertia petiolata* and *Digitalis purpurea*, respectively. Likewise, the pH values of 6.07 and 5.03 were recorded in the soil of Doodhpathri, in case of *Swertia petiolata* and *Digitalis purpurea*, respectively. However, KUBG soil samples were slightly alkaline, with pH values of 8.20 and 8.11, respectively, for *Swertia petiolata* and *Digitalis purpurea*. Thus, there was a significant disparity between the three study sites in terms of pH.

Electrical conductivity

It was also revealed from the results (Table 2) that the soil samples obtained from Doodhpathri exhibited the maximum electrical conductivity (0.23 and 0.41) followed by KUBG with an average electrical conductivity of 0.22 and 0.28 associated with *Swertia petiolata* and *Digitalis purpurea*, respectively. However, least electrical conductivities were recorded in the soil samples of Gulmarg with an average value of 0.21 and 0.36.

Salinity

The highest value of salinity was found in the soil samples of Doodhpathri 0.13 and 0.24 whereas the salinity value recorded in the soil samples of Gulmarg was 0.13 and 0.21. However, the KUBG noted the least value of soil salinity, 0.13 and 0.16. So, it is clear that there was a significant difference in the soil salinity noticed in the samples collected from the above-mentioned cites associated with rhizosphere of two important investigated medicinal plants.

Moisture content

The maximum moisture contents were recorded in case of soil samples collected from Gulmarg which were found to be 34.67 and 3.77 for *Swertia petiolata* and *Digitalis purpurea*. Similarly, moisture content ranged in the soil samples of Doodhpathri from 14.08 and 2.18, respectively. Likewise, the minimum moisture (8.17 and 6.25) contents were recorded in case of soil samples collected from the KUBG.

Soil organic carbon

It was observed from the results (Table 3) that organic carbon status showed a slight variation between Gulmarg, Doodhpathri and KUBG study sites. The maximum organic carbon contents were reported in KUBG soil samples at 10.2 and 10 g/kg. Likewise, organic content of soil samples from Gulmarg ranged 8.7 and 7 g/kg while as in case of Doodhpathri organic carbon in the range of 5 and 8 g/kg were recorded.

Available soil nitrogen

Soil nitrogen exhibited great variation in values as recorded in three zones. The highest soil nitrogen content was recorded at the Gulmarg site with an average value of 3.7 and 2.2 kg/ha followed by Doodhpathri with an average value of 2 and 1.8 kg/ha. Likewise, the least nitrogen content was recorded at KUBG study site with an average value of 1.5 and1.8 kg/ha as shown in (Table 3).

Available soil phosphorus

Similarly, it was also revealed from the results (Table 3) that available soil phosphorus also exhibited profound variation amongst all the three study sites. The KUBG site showed highest soil phosphorus levels during both research years, at 26.3 and 24.4 kg/ha on average. These findings were substantially greater than those of Gulmarg and Doodhpathri study sites which exhibited 20.3, 20.6 and 21.6, 24.5 values, respectively

.

Available soil potassium

Soil potassium content was recorded to be highest at KUBG with an average value of 228.6 and 223.8 kg/ha. However, there occurs slight variation regarding the available soil potassium contents amongst Gulmarg and Doodhpathri. The average values of 178.9, 169.7 kg/ha and 185.6, 190.3 kg/ha were recorded against *S. petiolata* and *S. petiolata* collected from Gulmarg and Doodhpathri, respectively.

Table 3 Macronutrient and organic carbon status of rhizospheric soil samples associated with two medicinal plants from three study sites

Name of sites	Plant name	OC (g kg^{-1})	Available N (Kg ha^{-1})	Available P (Kg ha^{-1})	Available K (Kg ha^{-1})
1st Site	*Swertia petiolata*	20.2	12.7	20.3	178.9
(Gulmarg)	*Digitalis purpurea*	7.00	2.00	20.6	169.7
2nd Site	*Swertia petiolata*	5.00	1.8	21.6	185.6
(Doodhpathri)	*Digitalis purpurea*	8.00	2.2	24.5	190.3
3rd Site	*Swertia petiolata*	10.2	1.5	26.3	228.6
(KUBG)*	*Digitalis purpurea*	10.00	1.8	24.3	223.8

*Kashmir University Botanical Garden

Table 4 Micronutrient status of rhizospheric soil collected from three study sites

Name of sites	Plant name	Zn (ppm)	Fe (ppm)	Mn (ppm)	Cu (ppm)
1st Site	*Swertia petiolata*	0.73	26.3	1.76	1.10
(Gulmarg)	*Digitalis purpurea*	0.70	25.8	1.68	1.06
2nd Site	*Swertia petiolata*	0.68	24.6	0.68	0.55
(Doodhpathri)	*Digitalis purpurea*	0.66	24.9	0.73	0.61
3rd Site	*Swertia petiolata*	0.86	21.63	0.61	0.32
(KUBG)*	*Digitalis purpurea*	0.84	20.89	0.59	0.33

*Kashmir University Botanical Garden

Zinc content

It was revealed from the cited (Table 4) that the KUBG showed the highest values of Zn (0.86 and 0.84) while as the soil samples of Doodhpathri exhibited the lowest Zn contents (0.68 and 0.66). However, the Zn content found in the soil samples of Gulmarg were reported to be 0.73 and 0.70, respectively. So, it is quite evident from the results that there occurs a noteworthy difference in the availability of Zn content at the three study sites.

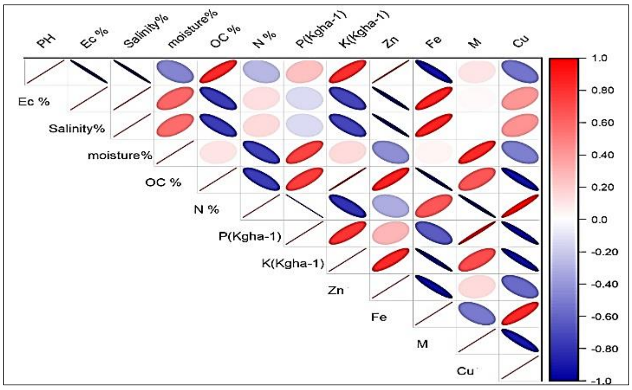

Fig 2 The plot showing correlation between the different environmental variables at selected study sites in Kashmir Himalaya

Iron content

It was observed from the results (Table 4) that the soil samples from Gulmarg showed the presence of rich iron content with an average value of 26.3 and 25.8 whereas the soil samples collected and analyzed from Doodhpathri recorded the iron content of 24.6 and 24.9, associated with *Swertia petiolata* and *Digitalis purpurea* medicinal plants. Likewise, minimum iron content was found in the soil samples at KUBG with an average value of 21.63 and 20.89, respectively.

Manganese content

From the above cited (Table 4) it was observed that, the highest content of Mn was recorded in the soil samples collected from Gulmarg with an average value of 1.76 and 1.68 followed by Doodhpathri which exhibited Mn content in the range of 0.68 and 0.73. However, the least content of Mn was found in the soil samples at KUBG with 0.61 and 0.59 values.

Copper content

The copper content also exhibited a strong variation amongst all the three studied sites. The maximum copper contents were found in the soil samples collected from Gulmarg study site with an average value of 1.10 and1.06. Similarly, Doodhpathri revealed the copper contents of 0.55 and 0.61, associated with *Swertia petiolata* and *Digitalis purpurea* medicinal plants, respectively. However, the minimum values noticed in the soil samples at KUBG were 0.32 and 0.33.

The growth and development of plants, depend on nutritional and other physicochemical properties of soil and commonly has a positive correlation with soil nutrient status [15-16]. In the study, differences in soil status amongst the three study sites like Gulmarg, Doodhpathri and KUBG were investigated which revealed the great variation in different physiochemical parameters, especially in terms of macro and micronutrients. In a similar study, Lone *et al.* [17] and Deoli *et al.* [18] also investigated macro and micronutrient composition of soil samples from other sampling sites, in order to understand suitability of soil for artificial cultivation of different threatened medicinal plants. In the present study, Gulmarg and Doodhpathri study sites were found to be highly acidic in nature while as that of KUBG were recorded to be slightly alkaline. These findings were in line with the work of Minhas and Bora [19] who also reported more or less similar results and suggested that the acidic pH of soil samples of Gulmarg could be due to baseline leaching and fluctuation in organic matter. Similarly, the findings of our study were in accordance to the outcomes of Wani [20] and Dar [21] who also investigated the macro and micronutrient composition of the orchid soil samples of Kashmir valley and revealed the similar results as were reported in our study.

Organic carbon is a measure of soil fertility and productivity, hence maintain quality of soil [22]. Likewise, organic soil carbon appears to be a key factor in crop production and long-term viability of these plants [23]. Besides, it also supports to produce the ideal soil structure, which impacts aeration and moisture retention capacity [24]. In comparison to Gulmarg, the KUBG region has the most organic carbon in the soil due to the mixing of fertilizers, manures, agricultural residues, and fallen leaves into the soil system, whereas Gulmarg has fewer leaves and no fertilizers, etc., resulting in low organic carbon in the soils. The findings of our study were in line with the work of [25] and [26] who also reported that organic carbon content in the soil is increased because of continuous addition of leaves, and other plant materials.

The soil samples of Gulmarg study site had the most accessible nitrogen, followed by Doodhpathri, while KUBG had the least available nitrogen. Similarly, phosphorus and potassium contents also showed strong variations in three agro-climatic zones studied. Besides, the soils samples with more clay, absorb more phosphorus and potassium because they have more organic matter, which is a key source of phosphorus and nitrogen. These findings were consistent with the studies of [25] and [27] who also found the same results while investigating the macronutrient compositions associated with other plants. In the present study, it was also found that soil exchangeable manganese was highest in Gulmarg, followed by Doodhpathri, and lowest in KUBG soils. Furthermore, higher iron, manganese, and copper contents reported in Gulmarg than other two studied agroclimatic zones.

CONCLUSION

This elemental analysis of rhizospheric soil fungi of medicinal plants growing in the Kashmir valley for the purpose of exploring micro and macronutrients revealed that the estimated chemical parameters varied depending on the environmental conditions (primarily altitude) where the study soil samples were collected. Higher altitude soils were shown to be more appropriate for plant growth than low and medium altitude soils, due to the buildup of sufficient organic matter and subsequent increase in soil moisture due to increased precipitation in the form of rain and snow. Besides, the present study form baseline for artificial cultivation and conservation of the studied threatened medicinal plants by making soil amendments in near future.

Acknowledgement

The authors are thankful to Head, Department of Botany, University of Kashmir for Assistance during manuscript preparation and multiple scholars for assistance in sample and metadata collection for the completion of this research article.

Conflict of interest

There are no conflicts of interest to declare related to this study.

LITERATURE CITED

1. Eaton WD, Farrell RE. 2004. Catabolic and genetic microbial indices, and levels of nitrate, ammonium, and organic carbon in soil from the black locust (Robinia pseudo-acacia) and tulip poplar (*Liriodendron tulipifera*) trees in a Pennsylvania forest. *Biology and Fertility of Soils* 39(3): 209-214.
2. Verma TP, Singh SP, Rathore TR. 2008. Effect of slope aspects and altitude on some soil characteristics in Garhwal Himalayas. *Journal of the Indian Society of Soil Science* 56(1): 42-48.
3. Nazif W, Perveen S, Saleem I. 2006. Status of micronutrients in soils of district Bhimber (Azad Jammu and Kashmir). *Journal of Agricultural and Biological Science* 1(2): 35-40.
4. Mahesh K, Singh SK, Raina P, Sharma BK. 2011. Status of available major and micronutrients in arid soils of Churu district of western Rajasthan. *Journal of the Indian Society of Soil Science* 59(2): 188-192.
5. Fageria NK. 2012. Role of soil organic matter in maintaining the sustainability of cropping systems. *Communications in Soil Science and Plant Analysis* 43(16): 2063-2113.
6. Dar GM, Khuroo A. 2013. Floristic diversity in the Kashmir Himalaya: progress, problems, and prospects. *Sains Malaysiana* 42(10): 1377-1386.
7. Lone PA, Bhardwaj AK, Shah KW, Tabasum S. 2014. Ethnobotanical survey of some threatened medicinal plants of Kashmir Himalaya, India. *Journal of Medicinal Plants Research* 8(47): 1362-1373.
8. Gliessman SR. 2000. The ecological foundations of agroecosystem sustainability. *Developing Practical Strategies* 3-14.
9. Michael AJ. 1984. Determination of stress from slip data: faults and folds. *Journal of Geophysical Research: Solid Earth* 89(B13): 11517-11526.
10. Walkley A, Black IA. 1934. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic acid titration method. *Soil Science* 37(1): 29-38.
11. Subbaiah BV. 1956. A rapid procedure for estimation of available nitrogen in the soil. *Current Science* 25: 259-260.
12. Olsen SR. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate *(No. 939)*. US Department of Agriculture, USA.
13. Jones Jr JB. 1998. Soil test methods: past, present, and future use of soil extractants. *Communications in Soil Science and Plant Analysis* 29(11/14): 1543-1552.
14. Lindsay WL, Norvell WA. 1978. Development of a DTPA soil test for zinc, iron, manganese, and copper. *Soil Science Society of America Journal* 42(3): 421-428.
15. Liu CC, Liu YG, Guo K, Wang SJ, Yang Y. 2014. Concentrations and resorption patterns of 13 nutrients in different plant functional types in the karst region of southwestern China. *Ann. Botany* 113: 873-885.
16. Wubs ERJ, Bezemer TM. 2017. Plant community evenness responds to spatial plant soil feedback heterogeneity primarily through the diversity of soil conditioning. *Funct. Ecology* 32: 509-521.
17. Lone PA, Bhardwaj AK, Shah KW, Bahar FA. 2016. Assessment of soil macronutrient status of some threatened medicinal plants of Kashmir Himalaya, India. *Res. Jr. Botany* 11: 18-24.
18. Deoli BK, Shefali A, Madhuben S, Anwar SN. 2020. Assessment of soil quality using physiochemical parameter of soil in Dehradun District of Uttarakhand. *International Journal of Scientific and Technology Research* 9(1): 1580-1590.
19. Minhas RS, Bora NC. 1982. Distribution of organic carbon and the forms of nitrogen in a topographic sequence of soils. *Jr. Indian Soc. Soil Science* 30(2): 135-139.
20. Wani GN. 2001. Studies on the distribution of secondary nutrient elements (Ca, Mg and S) in apple orchard soils of north Kashmir. *M. Sc. (Agri.) thesis,* Submitted to Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir, Shalimar, Srinagar. pp 75.
21. Dar MA. 2009. Effect of altitude on nutritional status of pear orchard soils of Kashmir valley. *Doctoral dissertation,* Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir, Shalimar, Srinagar, Kashmir.
22. Nagaveni V, Shree MP, Shivashankara BR. 2003. Comparative study of soil fertility status in mulberry gardens of Mandya, Tumkur, and Kolar districts of Karnataka. *In*: Nutritional Management and Quality Improvement in Sericulture. Proc. Natl. Sem. Mulb. Seri. Res. India, 2001. Eds. U.D. Bongale., *KSSRDI, Bangalor*. pp 175-178.
23. Lal R. 2004. Soil quality in industrialized and developing countries-Similarities and differences. Managing Soil Quality: *Challenges in Modern Agriculture*. pp 297-313.
24. Lahiri T, Chakravarti SK. 1989. Characteristics of some soils of Sikkim at various altitudes. *Journal of the Indian Society of Soil Science* 37(3): 451-454.
25. Malik MS, Abbasi MK, Rahim N. 2000. Laboratory study of physical-chemical characteristics and the nutrient status of soils collected from Rawalakot Azad Jammu and Kashmir. *Pak. Jr. Biol. Science* 3: 2082-2086.
26. Najar GR, Farida A, Rahman FH. 2005. Mineral nutrient status of apple orchards of Kashmir. *SKUAST Journal of Research* 7(2): 271-275.
27. Najar G. 2002. Studies on pedogenesis and nutrient indexing of apple (Red Delicious) growing soils of Kashmir. *Doctoral dissertation,* Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir, Shalimar, Srinagar, Kashmir.