IMPACT OF REGIONS AND SEASONAL DYNAMICS ON CHEMICAL CHARACTERISTICS OF MULBERRY GROWING SOILS OF KASHMIR UNDER TEMPERATE CONDITIONS

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Abstract: ***Mulberry (Morus sp.), is a perennial deep rooted plant and the soil should be capable of supplying sufficient air, water and nutrients at the deeper layers upto which the root system penetrates. Mulberry, being a high biomass producing plant requires perpetual and balanced availability of these nutrients. However, high levels of biomass production coupled with non application of fertilizers have resulted in prolonged exhaustion of nutrients, seasonal variability in crop performances and imbalances in nutrient availability in soils. Understanding spatial changes in soil nutrients is important as they may differ markedly among identical locations subjected to natural and manmade disturbances.In the present study,"Impact of Regions and Seasonal Dynamics on Chemical Characteristics of Mulberry growing Soils of Kashmir under temperate conditions"chemical properties of soils at (0-60 cms) depth were assessed during 2014-2015, under temperate climatic conditions in the Northern, central and southern regions of Kashmir. The results indicated that Ph, E.C, O.C, N, P and K were significantly higher in the spring season and lowest during winter season.The present study revealed that chemical characteristics of mulberry soils were at optimum level during spring season due to the favourable temperature, moisture and high O.C content. In addition, northern region registered the highest values in terms of pH, E.C, N and P followed by central region, whereas, southern region in case of O.C and K and environmental factors such as pH, soil moisture, temperature, etc change soil chemical characteristics in mulberry gardens under temperate climatic conditions of kashmir.***

Keywords: - Chemical characteristics, Dynamics, Kashmir, Mulberry, Regions, Seasons, Soils, Temperate.

1. INTRODUCTION

Being perennial and luxuriant, mulberry (*Morus spp*.), the sole food plant cultivated mainly to rear the silkworm, *Bombyx mori* L. for cocoon production requires balanced and continuous supply of nutrients for its growth, development and production of biomass (leaf).The soil supplies all the nutrients to this plant and the compensatory source of these nutrients to the soil could be organic matter decomposition in the soil. During residue decomposition, plant nutrients released through mineralization process are influenced by nature and composition of residues, soil physico-chemical properties and environmental conditions (Elliott and Papendick, 1986).Plant tissues are the main source of soil organic matter, which influence the physico-chemical characteristics of soil such as texture, water holding capacity, pH and nutrient availability. Soil chemical properties have controlling effect on vegetation distribution and composition.

It is therefore, necessary that the site of litter decomposition is the main source of nutrients to the plant.Under temperate conditions of Kashmir, mulberry is grown in a scattered form and hardly gets any attention in terms of inputs like fertilizers, manures and other protective measures. But even then, the plant produces two flushes of leaf as against only one flush in almost all other tree species growing in this region.However, high levels of biomass production coupled with non application of fertilizers have resulted in prolonged exhaustion of nutrients, seasonal variability in crop performances and imbalances in nutrient availability in soils. The result therefore, is declined leaf production which is one of the limiting factors for cocoon production.Therefore, the present study entitled, "Impact of Regions and Seasonal Dynamics on Chemical Characteristics of Mulberry growing Soils of KashmirUnder Temperate Conditions" was undertaken to know the influence of seasons on chemical characteristics of mulberry soilsin different regions for sustainable growth of mulberry under temperate climatic conditions of Kashmir.

2. MATERIALS AND METHODS

The study entitled, "Impact of Regions and Seasonal Dynamics on Chemical Characteristics of Mulberry growing Soils of Kashmir Under Temperate Conditions" was conducted at Division of Soil Science, Shalimar- Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir as per the following experimental details:-

2.1 Experimental details

1. Regions : 03- North (Baramulla and Bandipora),
   Central(Srinagar and Pulwama north) and
   South (Anantnag and Kulgam districts)
2. Number of locations : 03 from each region
3. Location names : North (TSRI-Mirgund, P_4 BSF-Manasbal and Sericulture Development Department (SDD) - Bandipora).
   : Central (SDD-Poohu, Central Silk Board-Galander and SDD-Srinagar)

: South (SDD-Y.K. Pora, SDD-Krungsoo and SDD-Bijbehara)

4. Samples per location : 05 (Composite)
5. Year : 2014-2015
6. Seasons : 04 (Spring, Summer, Autumn, and Winter)
   Spring → 1st fortnight of April
   Summer →1st fortnight of July
   Autumn →1st fortnight of October
   Winter →1st fortnight of January
6. Design of survey : Purposive sampling.

2.2 Soil sampling

Soil samples were collected during spring, summer, autumn and winter from 9 different mulberry gardens of Kashmir valley. For chemical analysis, soil samples were collected randomly up to a depth of 0-60 centimeters from pits between the mulberry plants in a row from the selected sampling spots along the drip line. From each location, during each season, five samples were collected to minimize the effect of inherent site variability. Thus a total of 180 samples were collected in all the four seasons and brought to the laboratory for further analysis. The soil samples collected from all the locations during each season were processed to study the following parameters.

2.3 Chemical characteristics

i. Soil pH was measured in 1:2.5 soil water suspensions with the help of a glass electrode pH meter (Jackson, 1973).
ii. Electrical Conductivity (EC) of the soil was measured in 1:2.5 overnight soil water suspensions by conductivity meter (Jackson, 1973).
iii. Organic Carbon was determined by Rapid Titration method (Walkley and Black, 1934).
iv. Available Nitrogen was estimated by Alkaline Potassium Permanganate method (Subbiah and Asija, 1956).
v. Available Phosphorous was extracted with 0.5 Sodium bicarbonate at pH of 8.5 (Olsen, 1954) and estimated as per Jackson (1973) using Ammonium Molybdate method.
vi. Available Potassium was extracted with neutral normal ammonium acetate and determined by Flame Photometer (Jackson, 1973).

3. STATISTICAL ANALYSIS

Data recorded during different seasons and from different regions and location as compiled and analyzed statistically to find differences among the seasons, regions and locations. The experimental data was processed using SAS statistical package licensed to SKUAST-K. All the results are expressed as means of the F values for which $p<0.05$ were considered significant.

4. EXPERIMENTAL FINDINGS

During the study period, "Impact of Regions and Seasonal Dynamics on Chemical Characteristics of Mulberry growing Soils of KashmirUnder Temperate Conditions" observations recorded on various parameters under the study entitled are described below:-

4.1 Soil reaction (pH)

The soils were slightly acidic to slightly alkaline with varying pH among the regions and the seasons. The pH in general was higher during spring (7.24) which was statistically different from the pH recorded during the other three seasons having pH of 7.05, 6.88 and 6.55 for summer, autumn and winter respectively. Amongst the three regions (north, central and south) the central region recorded the highest value with an average pH of 7.04 being statistically at par with the pH recorded in the northern region but significantly higher than the pH recorded in the southern region (Table-1).

4.2 Electrical conductivity (dSm^{-1})

Electrical conductivity was maximum (0.22) during the spring season which also showed a gradual and significant decrease as we proceeded to the other three seasons with the values of 0.19, 0.15 and 0.12 registered respectively for summer, autumn and winter. Among the three regions, the northern region recorded the maximum (0.19) value of electrical conductivity which was statistically at par with the southern region and significant over the value recorded in the central region (0.16) (Table-2).

Table 1: Seasonal variation in the soil reaction (pH) of mulberry soils of Kashmir

Region /season	North				Central				South				Overall mean
	Mirgund	Manasbal	Bandipora	Sub Mean	P oohu	Galander	Srinagar	Sub mean	Y.K.Pora	Krungsoo	Bijbehara	Sub mean	
Spring	7.44	7.29	7.44	**7.39**	7.12	7.49	7.31	**7.31**	7.17	7.27	6.63	**7.02**	**7.24**
Summer	7.26	7.01	7.12	**7.13**	6.95	7.41	7.00	**7.12**	6.94	6.90	6.86	**6.90**	**7.05**
Autumn	7.01	6.79	6.99	**6.93**	6.73	7.47	6.83	**7.01**	6.80	6.79	6.47	**6.69**	**6.88**
Winter	6.58	6.52	6.60	**6.57**	6.43	7.27	6.43	**6.71**	6.39	6.47	6.21	**6.35**	**6.54**
Mean	**7.07**	**6.90**	**7.04**	**7.00**	**6.80**	**7.41**	**6.89**	**7.04**	**6.83**	**6.86**	**6.54**	**6.74**	

C. D (p≤0.05)

Seasons : 0.11

Regions : 0.10

Table 2: Seasonal variation in electrical conductivity (dS/m) of mulberry soils of Kashmir

Region/ season	North				Central				South				Overall mean
	Mirgund	Manasbal	Bandipora	Sub Mean	P oohu	Galander	Srinagar	Sub mean	Y.K.Pora	Krungsoo	Bijbehara	Sub mean	
Spring	0.24	0.23	0.24	**0.24**	0.21	0.19	0.20	0.20	0.24	0.24	0.23	**0.24**	**0.22**
Summer	0.20	0.20	0.19	**0.19**	0.18	0.17	0.16	0.17	0.22	0.19	0.18	**0.20**	**0.19**
Autumn	0.19	0.16	0.16	**0.17**	0.14	0.14	0.12	0.13	0.17	0.14	0.15	**0.15**	**0.15**
Winter	0.13	0.12	0.12	**0.12**	0.11	0.11	0.10	0.10	0.13	0.12	0.12	**0.12**	**0.12**
Mean	**0.19**	**0.18**	**0.18**	**0.19**	**0.16**	**0.15**	**0.15**	**0.16**	**0.19**	**0.17**	**0.17**	**0.18**	

C. D (p≤0.05)

Seasons : 0.007

Regions : 0.006

4.3 Organic carbon (%)

Organic carbon also showed a decreasing trend from spring season to winter. During spring organic carbon in the soil was maximum (1.36) which was statistically significant over the values recorded during the other three seasons and the least (0.69) was recorded during winter. Among the three regions, southern region in general registered the maximum (1.21) soil organic carbon and was significant over the other two regions with the least value (0.91) recorded in central zone (Table-3).

4.4 Available nitrogen (kg/ha/yr)

Soil nitrogen also followed the same trend during the seasons and showed a significant decrease from one season to the other season. It was the highest (105.49) during spring which was statistically significant over the rest of the seasons of the year ranging from 86.14 in winter to 102.94 in summer season. Amongst the regions, northern region recorded the maximum value (101.0) for soil nitrogen and was statistically significant over the other two regions with the least value (95.8) recorded in southern region (Table-4).

4.5 Available phosphorus (kg/ha/yr)

Soil phosphorus too was maximum (11.85) during spring season being statistically significant over the rest of the seasons of the year ranging from 7.24 in winter to 9.74 during summer. Among the three regions, maximum value (10.06) for phosphorus was observed in northern region which was significant over other two regions with the least value (8.59) for soil phosphorus registered in the southern region (Table-5).

4.6 Available potassium (kg/ha/yr)

Soil potassium was maximum (181.88) during spring which was significantly more than the other seasons of the year where it ranged from 126.41 in winter to 169.07 in summer. Among the regions, southern region registered the maximum value (160.00) of potassium and was significant over the rest of the regions with the least value (144.66) registered in the central region (Table-6).

Table 3: Seasonal variation in organic carbon content (%) of mulberry soils of Kashmir

Region/ season	North				Central				South				Overall mean
	Mirgund	Manasbal	Bandipora	Sub Mean	Poohu	Galander	Srinagar	Sub mean	Y.K.Pora	Krungsoo	Bijbehara	Sub mean	
Spring	1.22	1.13	1.64	**1.33**	1.30	0.68	1.53	**1.17**	1.46	1.17	2.06	**1.56**	**1.36**
Summer	1.22	1.06	1.53	**1.27**	1.19	0.55	1.42	**1.05**	1.39	1.12	1.86	**1.46**	**1.26**
Autumn	0.89	0.87	1.24	**1.00**	0.75	0.41	1.17	**0.78**	0.85	0.79	1.48	**1.04**	**0.94**
Winter	0.54	0.74	0.74	**0.67**	0.63	0.39	0.86	**0.63**	0.74	0.73	0.83	**0.77**	**0.69**
Mean	**0.97**	**0.95**	**1.29**	**1.07**	**0.97**	**0.51**	**1.24**	**0.91**	**1.11**	**0.95**	**1.56**	**1.21**	

C. D (p≤0.05)

Seasons : 0.025

Regions : 0.022

Table 4: Seasonal variation in available nitrogen content (kg/ha/yr) of mulberry soils of Kashmir

Region /season	North				Central				South				Overall mean
	Mirgund	Manasbal	Bandipora	Sub Mean	Poohu	Galander	Srinagar	Sub mean	Y.K.Pora	Krungsoo	Bijbehara	Sub mean	
Spring	111.2	110.0	106.8	**109.3**	103.9	105.2	105.9	**105.0**	103.0	101.7	101.4	**102.0**	**105.49**
Summer	104.3	108.2	104.9	**105.8**	102.4	104.0	100.3	**102.2**	101.6	100.9	99.3	**100.6**	**102.94**
Autumn	95.5	101.7	103.3	**100.2**	93.3	93.1	95.5	**94.2**	99.2	93.7	95.7	**96.2**	**96.90**
Winter	84.9	88.4	92.8	**88.7**	85.3	84.7	85.9	**85.3**	83.8	85.5	83.7	**84.3**	**86.14**
Mean	**99.01**	**102.10**	**101.99**	**101.0**	**96.28**	**97.01**	**96.94**	**96.7**	**96.95**	**95.45**	**95.06**	**95.8**	

C. D (p≤0.05)

Seasons : 0.99

Regions : 0.86

Table 5: Seasonal variation in available phosphorus content (kg/ha/yr) of mulberry soils of Kashmir

Region/ season	North				Central				South				Overall mean
	Mirgund	Manasbal	Bandipora	Sub Mean	Poohu	Galander	Srinagar	Sub mean	Y.K.Pora	Krungsoo	Bijbehara	Sub mean	
Spring	13.54	12.11	11.43	**12.36**	9.71	12.53	13.17	**11.80**	10.19	10.48	13.50	**11.39**	**11.85**
Summer	11.54	10.75	9.74	**10.68**	9.19	9.53	10.43	**9.72**	8.46	7.99	10.02	**8.82**	**9.74**
Autumn	9.95	9.99	7.84	**9.26**	7.57	8.44	8.44	**8.15**	7.05	7.27	8.10	**7.47**	**8.29**
Winter	8.41	8.77	6.64	**7.94**	6.53	7.30	7.43	**7.09**	6.35	6.72	7.00	**6.69**	**7.24**
Mean	**10.86**	**10.40**	**8.91**	**10.06**	**8.25**	**9.45**	**9.87**	**9.19**	**8.01**	**8.12**	**9.65**	**8.59**	

C. D (p≤0.05)

Seasons : 0.13

Regions : 0.11

Table 6: Seasonal variation in available potassium content (kg/ha/yr) of mulberry soils of Kashmir

Region/ season	North				Central				South				Overall mean
	Mirgund	Manasbal	Bandipora	Sub Mean	Poohu	Galander	Srinagar	Sub mean	Y.K.Pora	Krungsoo	Bijbehara	Sub mean	
Spring	211.14	179.43	188.84	**193.14**	110.62	236.75	176.10	**174.49**	110.91	189.62	233.50	**178.01**	**181.88**
Summer	133.63	130.23	216.19	**160.02**	137.50	144.19	141.13	**140.94**	129.06	274.95	214.76	**206.26**	**169.08**
Autumn	115.29	115.69	160.31	**130.43**	116.46	162.29	115.73	**131.49**	91.40	191.85	146.37	**143.21**	**135.05**
Winter	126.65	135.31	143.00	**134.98**	136.19	130.94	128.05	**131.73**	88.86	112.96	135.78	**112.53**	**126.42**
Mean	**146.68**	**140.17**	**177.09**	**154.64**	**125.19**	**168.55**	**140.25**	**144.66**	**105.06**	**192.35**	**182.61**	**160.00**	

C. D (p≤0.05)

Seasons : 2.64 Regions : 2.29

5 DISCUSSION

The results obtained in the study, "Impact of Regions and Seasonal Dynamics on chemical Characteristics of Mulberry growing Soils of KashmirUnder Temperate Conditions" are discussed below:-

5.1 pH: -In the present investigation, soil pH and were invariably highest during spring and the lowest during winter in all the regions. Sizable fluctuations occur in soil pH because of the changes in soil moisture, temperature and microbial activity. Ram *et al*. (2013) reported that the pH of the normal soils was highest in April (spring) and lowest in January (winter).The changed pH levels indicating increase in the spring seasons followed by decreasing trend could be attributed to seasonal variations which trigger mineralization/immobilization of certain macro and micronutrients. Soils become acidic because of warm temperature and high rainfall as under such conditions, soils weather quickly. This natural weathering process makes soil acidic and generally devoid of nutrients (Uchida and Hue, 2000).

5.2 Electrical conductivity:-E.C (dSm^{-1}) also was maximum during spring and lowest during winter, the maximum values recorded during spring may be because of the accumulation of soluble salts during the season due to the climatic conditions e.g. heavy rainfall (Dar *et al*., 2015) whereas, the decreased electrical conductivity during summer, autumn and winter seasons may be attributed to the lesser release of ions from mineral weathering under different temperature and moisture regimes (Kaushal *et al*., 1997).

There was also variation in soil pH and electrical conductivity amongst the regions, with central region being statistically at par with northern region in case of pH and in case of E.C, northern region was statistically at par with southern region. This may be because of the characteristics of soils that differ widely depending upon the geophysical constraints like nature of the rock, climate, topography and constituents of the parent rock (Brady, 1984).

5.3 Organic carbon: - OC was more during spring than the other three seasons with winter recording the least value for organic carbon. Amongst the regions, southern region registered the maximum value for OC, being significantly higher than the other two regions. The variation in organic carbon among the seasons and the regions could be due to the variation in the rate of decomposition of FYM and other organic matter which is influenced by climate, vegetation, nature and management of soil, kind of organic matter added and drainage conditions (Foth and Turk, 1973). Decline in organic carbon towards the summer season may be because organic carbon content decreases with increase in temperature (Kirschbaum, 1995) and decomposition rate (microbial respiration) doubles with every 10^{o}C increase in the temperature (Schlesinger, 1997). Further, the mulberry plants are pruned right from the crown base during summer, leaving least chances for addition of litter to the mulberry soils besides exposing them to very high temperature that leads to declining organic carbon content in the soil as we proceed to the other seasons.

5.4 Available nitrogen: - Available N content in the soil was highest during spring than the other seasons with the least value recorded during winter. Northern region had the maximum soil nitrogen where as southern region recorded the least content. Evidence exists to show that increased biological nitrogen fixation along with increased mineralization rates occur during the rainy season (Bergeron *et al.*, 2002) which might have resulted in increased N content during spring season. Higher values of nitrogen in the soil profile during rainy season reflects higher fixation, rain water input and higher rate of release of mineral N through microbial decomposition (Choudhri and Sharma, 1975). Singh and Singh (2006) reported that during dry periods, plant uptake of nutrients is greatly reduced and the nitrogen mineralization and nitrification are either immobilized in microbial biomass or accumulate in the soil as inorganic nitrogen. However, the highest content of available N in northern region may be attributed to adequate organic carbon content next only to southern region besides pH, E.C, phosphorus and moisture content, temperature and other microbial processes prevailing higher in the region than the other regions.

5.5 Available Phosphorus: - Soil available phosphorus content was maximum during spring season and showed a decline as we proceeded to winter which recorded the least value. Northern region registered the maximum value for soil phosphorus; whereas, southern region registered the least value. The decline in P content in soils along the seasons from spring to winter may probably be due to the fact that phosphatic fertilizer to mulberry gardens is applied during spring and goes on decreasing as we go to other seasons. Nipun (2013) have also reported that available phosphorus (P) in soil was maximum during spring season followed by summer and autumn months. Further, the increased P content in the soil during spring and summer could be due to adequate moisture and suitable temperature which increase the nitrogen fixation and decomposition process by various microorganisms (Shilpkar, 2010).

5.6 Available Potassium: - Likewise available potassium content was the highest during spring, being significantly higher than the other seasons and least during winter. Amongst the regions, southern region recorded the maximum content of available K; whereas, central zone registered the least value for K. The increased value of available potassium during spring may be due to the presence of dense vegetation affording the soil adequate cover, thereby reducing the loss in soil macro and micro nutrients that are essential for plant growth and energy fluxes (Iwara, 2011).The increased content of available K in the southern region may be due to higher organic carbon content in the particular region because there is a positive correlation between organic matter and available potassium (Chauhan, 2001).

The decreasing trend in the NPK content from spring to winter may also be due to the schedule of application of these fertilizers which is usually applied during spring comprising of half of nitrogen, full phosphorus and potassium and the remaining half of nitrogen in summer (Anonymous, 2003) and gets decreased due to its utilization by the plant and losses through other processes. This necessitates the splitting of chemical fertilizers for quality improvement under Kashmir conditions as also reported by Noor ul-Din (2012).

6 CONCLUSION

- Mulberry soils depict great variations among the seasons. In general most of the chemical parameters of the mulberry gardens showed highest values during spring and the lowest during winter, though the values in general fell in the range suitable for mulberry cultivation under temperate conditions.
- Favorable climatic conditions especially moisture, temperature, etc also had a pronounced influence on chemical characteristics of soils.
- Spring seems to be the most favourable season for the mineralization and availability of nutrients, thereby enhancing the soil health and activities in soil.

- Organic matter in the soil seems to have pronounced influence on the macronutrient status in mulberry growing soils.
- Northern region,amongst all the regions was leadingin terms of higher nutrient status except in case of O.C and K which were highest in case of southern region followed by northern region.
- We must exploit the potential of mulberry leaf from northern region being nutritionally rich for quality cocoon/silk productionand should apply inputs as per recommended dosagesesp. of Nitrogenous and Phosphatic origin in mulberry gardens of south Kashmiras the soils are not nutritionally rich.
- Cultural operations followed in the region especially input application and pruning have direct bearing with some of the properties of mulberry soils.
- The growth stage of the plant, soil type and the cultural operations followed too have a modifying effect on soil nutrient status.

7 LITERATURE CITED

[1] Anonymous, 2003.Package of practices for silkworm rearing and mulberry cultivation in Kashmir.Directorate of Extension Education, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar.

[2] Bergeron, Y., Leduc, A., Harvey, B. and Gauthier, S. 2002. Natural fire regime: a guide for sustainable management of the Canadian boreal forest. *Silva Fennica***36**: 81-95.

[3] Brady, N. C. and Weil, R. R. 1984. The Nature and Properties of Soils,pp 4-7.

[4] Chauhan, J.S. 2001.Fertility status of soils of Birla Panchayat Samiti of Jodhpur district (Rajasthan).M.Sc (Ag.)Thesis, MPUAT, Udaipur.

[5] Choudhri, G.N. and Sharma, B.A. 1975. Study of nitrogen dynamics in salt affected (Usar) habitat near Varanasi. *Trop. Ecol*. **16**: 133-139.

[6] Dar, A.R., Rather, G.M. and Lone, S.A. 2015.Macronutrient status in soils of South Kashmir Himalayas. *International Journal of Advanced Research***3**(3) : 849-853.

[7] Elliott, L.F. and Papendick, R.I. 1986. Crop residues management for improved soil productivity. *Biological Agriculture and Horticulture***3**: 131-142.

[8] Foth, H.D.and Turk, L.M. 1973. *Fundamentals of soil science* (5thEd.) Willy Eastern Pvt. Ltd. New Delhi, pp: 454.

[9] Iwara, A.I., Ewa, E.E., Ogundele, F.O., Adeyemi, J.A. and Otu, C.A. 2011. Ameliorating effects of palm oil mill effluent on the physical and chemical properties of soil in Ugep, cross River state, south-Southern Nigeria. *Int. Appl. Sci. Technol*. **1**(5): 106-112.

[10] Jackson, M.L. 1973. Soil chemical analysis.Prentice Hall of India Pvt.Ltd., New Delhi.

[11] Kaushal, R., Bhandari, A. R., Sharma, J. C. &Tripathi, D. 1997. Soil fertility status under natural deodar (*Cedrus deodara*) forest ecosystem of north-west Himalayas.*Indian J. forestry***20**(2): 105-111.

[12] Kirschbaum, M.U.F. 1995. The temperature dependence of soil organic matter decomposition and the effect of global warming on soil organic storage.*Soil Biology and Biochemistry***27**: 753-760.

[13] Nipun Rasgotra, 2013. Studies on spatial and temporal variation in arbuscular mycorrhizal fungi in stone Fruit orchards of Solan and Sirmour Districts.M.Sc Thesis,College Of Horticulture, Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan-173230, (H.P.), India.

[14] Noor-ul-Din, 2012.Seasonal variation in nutrient components of mulberry leaf and their uptake in response to split application of npk under temperate conditions. Thesis submitted to Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (SKUAST-Kashmir), Shalimar, Srinagar.

[15] Olsen, S.R., Cole, C.V., Watanabe, F.S. and Dean, L.A. 1954. Estimation of available phosphorus in soils by extraction with Sodium bicarbonate.*USDA, CircularNo.***939**:1-19.

[16] Ram, R. L., Maurya, B. R. and Sharma, P.K. 2013.Seasonal variation in microbial composition at different depths of normal and sodic soils of Varanasi.*International Journal of Innovative Research and Development***2**(5): 1870-1880.

[17] Schlesinger, W.H. 1997. Biogeochemistry: An analysis of global change. 2nd ed. Academic Press. San Diego, California.

[18] Shilpkar, P., Shah, M.C., Modi, K.R. and Patel, S.M. 2010. Seasonal changes in microbial community structure and nutrients content in rhizospheric soil of *Aegle marmelos* tree. *Ann. For. Res*. **53**(2): 135-140.

[19] Singh, A. N. and Singh, J. S. 2006. Experiments in ecological restoration coalmine spoil using native trees in Sa dry tropical environment, India: a synthesis, *New Forest*25-39.

[20] Subbiah, B.V. and Asijaa, G.L. 1956. Rapid procedure for estimation of available nitrogen in soils. *Current Science***25**: 259-61.

[21] Uchida, R. and Hue, N.V. 2000.Plant nutrient management in Hawaii's soils, Approaches for tropical and subtropical agriculture (Eds. J.A. Silva and R. Uchida).College of Tropical Agriculture and Human Resources, University of Hawaii at Manoa.

[22] Walkley, A. and Black, J.A. 1934. An examination of the method for determining soil organic matter and proposed modification of Chromic acid titration method.*Soil Science***37**: 29-39.