A COMPARATIVE STUDY OF REGIONAL VARIATION VIS-A-VIS DEHYDROGENASE AND UREASE ENZYMATIC ACTIVITIES IN VARIOUS NURSERIES OF MULBERRY GROWING SOILS OF KASHMIR

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ABSTRACT

A study in different mulberry nurseries was undertaken during 2014-2015 in Kashmir valley to reveal the effect of different regions (viz North, Central & South) on Dehydrogenase and Urease enzyme activities in soil under laboratory conditions. The study revealed that Central region registered the highest activity (22.47 $\mu\text{g TPF}/24\text{hr/g soil}$ & 8.18 $\mu\text{NH}_4/\text{g soil}$) both in terms of Dehydrogenase and Urease activities and lowest activity (18.93 $\mu\text{g TPF}/24\text{hr/g soil}$) was recorded in Northern region in terms of Dehydrogenase activity while as in Urease activity lowest activity (6.94 and 6.35 $\mu\text{NH}_4/\text{g soil}$) was registered by Northern and Southern regions (at par with each other) amongst the 3 regions of the valley. In Northern region, in case of Dehydrogenase activity, amongst the 3 Nurseries, Bandipora nursery registered the highest activity, in Central region the highest activity was recorded in Galander nursery and in Southern region the Dehydrogenase activity was highest in Y.K.Pora nursery respectively where as in case of Urease activity, the same Nurseries showed the highest activity except in case of Southern region where Krungsoo nursery recorded highest Urease activity. Amongst all the 9 Nurseries of the valley, Y.K.Pora nursery (Southern region) and Galander nursery (Central region) recorded the maximum activity (23.80 and 23.16 $\mu\text{g TPF}/24\text{hr/g soil}$) in terms of Dehydrogenase activity, however, in case of Urease activity highest activity (8.64 & 8.56 $\mu\text{NH}_4/\text{g soil}$) was shown by Galander and Srinagar nurseries of the valley

KEYWORDS: Nursery, Regions, Mulberry, Dehydrogenase, Urease, Soil, etc

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1.INTRODUCTION

Kashmir region covers the valley of Kashmir comprising of major Sericulture districts such as Anantnag, Pulwama, Srinagar, Baramullah, Bandipora, Ganderbal and Kupwara. The meteorological features show that the zone receives 1069 mm of annual rainfall of which nearly 70% is received during spring and winter seasons (Lateef, et al 2018). Sericulture usually includes all phases of raw silk production and has a long history of developing several mulberry techniques. Recently adoption and implementation of new ideas by research institutions in mulberry cultivation and silkworm rearing, the industry is now practiced as a main profession. Under temperate conditions of Kashmir, mulberry plant does not get due attention as far as the application of nutrients and other mulberry protection techniques are concerned. Majority of the people involved in Sericulture are from rural and economically poor background, though they are given instructions from time to time and made to understand the importance of application of fertilizers/inputs, yet are very reluctant in the application of these fertilizers. This generally results in inferior quality of leaf devoid of essential nutrients (required for the healthy growth of silkworm larvae) which finally limits the cocoon production. In recent years, thrust is given and new strategies are devised to increase the mulberry production both qualitatively and quantitatively, ensured by the fertility status of soil. The sustenance of

mulberry plant demands balanced supply of nutrients which in its case is rare. Despite low inputs, mulberry plant being a deep rooted plant, produces more foliage as against other tree species of the region. This may be because of the microbial activities which finally enhance the enzymatic activities in the soil. Microbial communities are important for the functioning of the soil ecosystem (Patra, et al., 2005) both in terms of direct interactions with plants and with regard to nutrient and organic matter cycling including the active role of enzymes. Soil enzymes are involved in most biochemical functions and are very sensitive to changes in environmental conditions, microbial population, vegetation, temperature, moisture, topography (Ley, et al., 2004; Malchair and Carnol, 2009) etc and are been used as parameters to evaluate the overall microbial activity in soil (Nannipieri, *et al*, 2012). Among the soil enzymes, Dehydrogenase activity has been recognized as important indicator of the metabolic activity in soil as it is extracellular and linked to viable cells. Soil Urease is involved in mineralization and supplying nitrogen to plants from natural and fertilizer sources. It plays a vital role in the hydrolysis of urea into CO₂ and H₂O. In soils with low organic carbon and high pH, Urease activity estimation is essential to improve the fertilizer use efficiency. In this way these enzymes contribute in maintenance and productivity of agro ecosystem by their influence on soil fertility. Therefore, this research investigation entitled: A Comparative Study of Regional Variation vis-à-vis Dehydrogenase and Urease enzyme Activities in Various Nurseries of Mulberry Growing Soils of Kashmir” aims to study, if there exists significant variation in Dehydrogenase and Urease enzyme activities in different regions and Nurseries of Kashmir as the activities differ markedly among locations subjected to natural and manmade disturbances.

2.METHODOLOGY

The study was conducted at Biofertilizer Research Laboratory, FoA, Wadura, SKUAST-K as per the following experimental details:-

Details of Experiment

Y e a r	2 0 1 4 - 2 0 1 5
R e g i o n s	N o r t h e r n , C e n t r a l a n d S o u t h e r n
Number of Nurseries	0 9 (0 3 f r o m e a c h r e g i o n)
N u r s e r y n a m e s	TSRI-Mirgund farm, P ₄ BSF-Manasbal Nursery & Bandipora Nursery Poohu Nursery, CSB-Galander Nursery & SDD-Srinagar Nursery SDD-Y.K.Pora Nursery, SDD-Krungsoo Nursery & SDD- Bijbehara Nursery
S a m p l e s p e r n u r s e r y	0 5 (C o m p o s i t e)
S a m p l i n g m o n t h s	A p r i l , J u l y , O c t o b e r , J a n u a r y
D e s i g n o f s u r v e y	P u r p o s i v e s a m p l i n g

2.1 Sample Collection and Estimation

For estimation of enzyme activities, soil samples were collected from January to December during 1st week of April, July, October, and January during the entire period of two years in three (3) different regions of mulberry nurseries/farms of Kashmir valley. From each region, 15 soil samples were collected at (5) five spots of each nursery from the soil adhering to the roots of mulberry (making a total of 45) in sterilized polythene bags with proper labels and as soon as possible were refrigerated at 4°C to avoid microbial fluctuations and were brought to lab to observe the effect of different regions on enzymatic activities in various nurseries of mulberry growing soils of Kashmir

2.2 Methods

2.2.1:-By 2, 3, 5-Triphenyltetrazolium chloride (3%) method (Klein, 1971)

Dehydrogenase activity($\mu\text{g TPF}/24\text{hr/g soil}$) was measured by adding ten (10) grams of soil in a sterile stoppered test tube followed by 0.2 ml of 3% 2, 3, 5-triphenyl tetrazolium chloride (TTC) to saturate the soil. After this 0.5ml of 1percent (%) glucose solution was added to each tube and the bottom of each tube was gently trapped to drive out the trapped oxygen. Incubation of tubes was done at $28\pm0.5^{\circ}\text{C}$ for 24 hours. 10 ml of methanol was added to each tube after incubation and shaken vigorously for some time. Then were allowed to stand for six (6) hours. The supernatant clear pink in color was withdrawn and with the help of a spectrophotometer readings were taken (485nm).

2.2.2: Urease activity ($\mu\text{gNH}_4/\text{h/g}$) was measured by Indophenol blue method (Mc Garity and Myers, 1967)

One (1) milliliter of toluene was added to ten (10) grams of soil and left for about 15 minutes for penetration of toluene into the soil sample. Then ten (10) milliliter of buffer solution (pH 7.0) and five (5) milliliter of urea (10%) were added and incubated at 37°C for three hours. Then the volume was made upto (50) milliliter with distilled water and filtered through Whatman's No.5 filter paper. Ammonia released as a result of Urease activity was determined by Indophenol blue method by adding ten (10) milliliter of sample (filtrate) to labeled screw capped test tubes. Then 0.4 milliliter of phenol solution was added to all the tubes followed by the addition of 0.4milliliter of Nitroferricyanide and 1milliliter of oxidizing reagent. All the tubes were mixed well and allowed to develop for three (3) hours in darkness. Periodically, the samples were mixed till there was development of bluecolor and at 630nm in a spectrophotometer optical density was noted.

3.RESULTS

Dehydrogenase activity varied from the minimum of $18.93\mu\text{g TPF}/24\text{hr/g soil}$ to the maximum of $22.47\mu\text{g TPF}/24\text{hr/g soil}$ in three regions of Kashmir (North, Central and South).The maximum activity was recorded in the central region ($22.47\mu\text{g TPF}/24\text{hr/g soil}$) which was statistically significant ($P\leq0.05$) followed by the southern region ($21.64\mu\text{g TPF}/24\text{hr/g soil}$) while as the minimum activity was recorded in northern region ($18.93\mu\text{g TPF}/24\text{hr/g soil}$).

Among the 3 Nurseries of the Northern zone, Bandipora nursery showed the highest activity ($20.57\mu\text{g TPF}/24\text{hr/g soil}$) than the other Nurseries throughout the year with the intermediate activity of ($19.48\mu\text{g TPF}/24\text{hr/g soil}$) recorded in Mirgund nursery and the lowest activity ($16.75\mu\text{g TPF}/24\text{hr/g soil}$) was recorded in Manasbal nursery. In Bandipora nursery, themaximum activity ($24.54\mu\text{g TPF}/24\text{hr/g soil}$) was recorded in the month of April among all the Nurseries of the region while the minimum ($14.38 \mu\text{g TPF}/24\text{hr/g soil}$) was recorded in the month of January in Manasbal nursery (Table: 1).

Among the Nurseries of Central zone, Galander nursery recorded the maximum activity of ($23.16\mu\text{g TPF}/24\text{hr/g soil}$) throughout the year which was significant ($P\leq0.05$) over the other two Nurseries registering the activity of ($22.64\mu\text{g TPF}/24\text{hr/g soil}$) in Poohu nursery and Srinagar (Tulsibagh) nursery recorded the minimum ($21.60\mu\text{g TPF}/24\text{hr/g soil}$) activity. However, it can be noted here that Galander nursery recorded the maximum activity ($27.84\mu\text{g TPF}/24\text{hr/g soil}$) in the month of April among all the Nurseries while as the minimum activity was registered in the month of January by all the 3 Nurseries of the region being statistically at par with each other (17.98 , 17.42 and $17.34 \mu\text{g TPF}/24\text{hr/g soil}$) respectively by Galander, Srinagar and Poohu nursery (Table: 2).

In the Southern zone, Y.K.Pora nursery recorded the maximum ($23.80\mu\text{g TPF}/24\text{hr/g soil}$) activity throughout the

year being significant over the Krungsoo (20.93 μ g TPF/24hr/g soil) and Bijbehara nurseries (20.21) μ g TPF/24hr/g soil which are statistically at par with each other. Among all the Nurseries and in the sampling months, the maximum activity (28.74 μ g TPF/24hr/g soil) was recorded in the month of April in the same Nursery while as in the month of January the minimum activity (16.54 μ g TPF/g/24hr/ soil) was recorded in Bijbehara nursery (Table: 3).

However, among all the 9 Nurseries of the 3 zones/regions of Kashmir, highest dehydrogenase enzyme activity was found in Y.K.Pora nursery (23.80 μ g TPF/g/24hr/ soil) followed by Galander nursery (23.16 μ g TPF/g/24hr/g soil) while as the least activity was recorded in Manasbal nursery (16.75 μ g TPF/24hr/g soil).

Table 1: Regional variation in Dehydrogenase activity (μ g TPF/24hr/g soil) in different nurseries of Northern region

Region	Month	N u r s e r y		N a m e		M e a n
		Mirgund nursery	Manasbal nursery	Bandipora nursery		
NORTHERN REGION	A p r i l	2 2 . 7 6	1 8 . 7 6	2 4 . 5 4		2 2 . 0 2
	J u l y	1 8 . 1 6	1 6 . 2 6	1 9 . 9 6		1 8 . 1 2
	O c t o b e r	2 1 . 5 2	1 7 . 6 0	2 1 . 3 0		2 0 . 1 4
	J a n u a r y	1 5 . 4 8	1 4 . 3 8	1 6 . 5 0		1 5 . 4 5
	M e a n	1 9 . 4 8	1 6 . 7 5	2 0 . 5 7		1 8 . 9 3

Table 2: Regional variation in dehydrogenase activity(μ g TPF/24hr/g soil) in different nurseries of Central region

Region	Month	N u r s e r y		N a m e		M e a n
		P o o h u n u r s e r y	G a l a n d e r n u r s e r y	S r i n a g a r n u r s e r y		
CENTRAL REGION	A p r i l	2 7 . 3 0	2 7 . 8 4	2 4 . 8 8		2 6 . 6 7
	J u l y	2 1 . 9 8	2 2 . 6 6	2 0 . 7 6		2 1 . 8 0
	O c t o b e r	2 3 . 9 4	2 4 . 1 8	2 3 . 3 6		2 3 . 8 2
	J a n u a r y	1 7 . 3 4	1 7 . 9 8	1 7 . 4 2		1 7 . 5 8
	M e a n	2 2 . 6 4	2 3 . 1 6	2 1 . 6 0		2 2 . 4 7

Table 3: Regional variation in dehydrogenase activity(μ g TPF/24hr/g soil) in different nurseries of Southern region

Region	Month	N u r s e r y		N a m e		M e a n
		Y.K.Pora nursery	Krungsoo nursery	Bijbehara nursery		
SOUTHERN REGION	A p r i l	2 8 . 7 4	2 5 . 1 0	2 3 . 1 4		2 5 . 6 6
	J u l y	2 2 . 4 8	1 9 . 9 6	1 9 . 7 0		2 0 . 7 1
	O c t o b e r	2 4 . 5 0	2 1 . 5 4	2 1 . 4 6		2 2 . 5 0
	J a n u a r y	1 9 . 4 8	1 7 . 1 4	1 6 . 5 4		1 7 . 7 2
	M e a n	2 3 . 8 0	2 0 . 9 3	2 0 . 2 1		2 1 . 6 4

C.D($p \leq 0.05$)

Regions (north, central and south) : 0.52

Locations (north, central and south) : 0.52

Months (north, central and south) : 0.60

Urease activity of the 3 regions of Kashmir varied from minimum of 6.35 μ gNH₄/g soil to a maximum of 8.18 μ gNH₄/g soil in different study sites. Among the three regions highest activity was recorded in the central region which was statistically significant ($P \leq 0.05$) over the other regions with the activity of 6.94 μ gNH₄/g soil recorded in Northern region which was statistically at par with the southern region recording the minimum activity.

Among the Nurseries of Northern region, Bandipora nursery registered the maximum activity (7.92 μ gNH₄/g soil) throughout the year and was statistically significant ($P \leq 0.05$) over the Nurseries with the activities of (6.39 μ gNH₄/g soil)

and (6.52 $\mu\text{gNH}_4/\text{g soil}$) recorded in Mirgund and Manasbal nurseries being statistically at par with each other respectively. The maximum Urease activity (10.40 $\mu\text{gNH}_4/\text{g soil}$) however, was recorded in all the Nurseries of the region in the month of April but highest amongst them occurred in the Bandipora nursery whereas the minimum (4.24 $\mu\text{gNH}_4/\text{g soil}$) amongst all the Nurseries was recorded in the month of January in the Mirgund nursery (Table 4).

In case of Central region, Galander nursery recorded the maximum activity (8.64 $\mu\text{gNH}_4/\text{g soil}$) throughout the year which was statistically at par with the Srinagar (Tulsibagh) nursery registering the activity of (8.56 $\mu\text{gNH}_4/\text{g soil}$), however the least activity (7.34 $\mu\text{gNH}_4/\text{g soil}$) was found in case of Poochu nursery. Among the Nurseries of the central region, Galander nursery recorded the highest activity (11.36 $\mu\text{gNH}_4/\text{g soil}$) in the month of April being statistically at par with the Srinagar (11.14 $\mu\text{gNH}_4/\text{g soil}$) nursery (followed by October 9.62 $\mu\text{gNH}_4/\text{g soil}$) and lowest was found in case of Poochu and Srinagar nurseries 5.54 and 5.74 $\mu\text{gNH}_4/\text{g soil}$ in the month of January being statistically at par with each other (Table 5).

Among the Nurseries of Southern region, Krungsoo nursery had the maximum activity (7.01 $\mu\text{gNH}_4/\text{g soil}$) round the year being statistically at par with the Bijbehara nursery (6.88 $\mu\text{gNH}_4/\text{g soil}$) but significant over the Y.K.Pora nursery registering the minimum activity of 5.16 $\mu\text{gNH}_4/\text{g soil}$. Bijbehara nursery recorded the maximum activity in the month of April 9.26 $\mu\text{gNH}_4/\text{g soil}$ amongst all the farms/nurseries of the region being statistically at par with the Krungsoo nursery and the minimum activity was recorded in the month of July in Y.K.Pora nursery (Table 6).

Among all the 9 Nurseries of the regions of Kashmir valley Galander nursery recorded the highest Urease enzyme activity (8.64 $\mu\text{gNH}_4/\text{g soil}$) which was statistically at par with the value registered in Srinagar (Tulsibagh) nursery while as the lowest value of activity was registered by Y.K.Pora nursery (5.16 $\mu\text{gNH}_4/\text{g soil}$).

Table 4: Regional variation in Urease enzyme activity ($\mu\text{NH}_4/\text{g soil}$) in different nurseries of Northern region

Region	Month	N u r s e r y				N a m e				M e a n								
		Mirgund nursery		Manasbal nursery		Bandipora nursery												
NORTHERN REGION	A p r i l	8	.	6	6	8	.	7	2	1	0	.	4	0	9	.	2	6
	J u l y	5	.	5	8	5	.	8	4	6	.	8	2	6	.	0	8	
	O c t o b e r	7	.	1	0	7	.	1	4	8	.	6	6	7	.	6	3	
	J a n u a r y	4	.	2	4	4	.	4	0	5	.	8	2	4	.	8	2	
	M e a n	6	.	3	9	6	.	5	2	7	.	9	2	6	.	9	4	

Table 5: Regional variation in Urease enzyme activity ($\mu\text{NH}_4/\text{g soil}$) in different nurseries of central region

Region	Month	N u r s e r y				N a m e				M e a n										
		Poohu nursery		Galander nursery		Srinagar nursery														
CENTRAL REGION	A p r i l	9	.	4	6	1	1	.	3	6	1	1	.	1	4	1	0	.	6	5
	J u l y	6	.	6	4	7	.	5	8	7	.	7	4	7	.	3	2			
	O c t o b e r	7	.	7	2	9	.	4	8	9	.	6	2	8	.	9	4			
	J a n u a r y	5	.	5	4	6	.	1	4	5	.	7	4	5	.	8	0			
	M e a n	7	.	3	4	8	.	6	4	8	.	5	6	8	.	1	8			

Table 6: Regional variation in Urease enzyme activity ($\mu\text{NH}_4/\text{g soil}$) in different nurseries of Southern region

Region	Month	N u r s e r y				N a m e				M e a n							
		Y.K.Pora nursery		Krungsoo nursery		Bijbehara nursery											
SOUTHERN REGION	A p r i l	7	.	0	0	9	.	2	0	9	.	2	6	8	.	4	8
	J u l y	3	.	9	8	6	.	1	6	6	.	2	4	5	.	4	6
	O c t o b e r	5	.	4	6	8	.	0	0	7	.	4	8	6	.	9	8
	J a n u a r y	4	.	2	0	4	.	7	0	4	.	5	6	4	.	4	8

	M	e	a	n	5	.	1	6	7	.	0	1	6	.	8	8	6	.	3	5

C.D(p≤0.05)

Regions (north, central and south) : 0.10

Locations (north, central and south): 0.10

Months (north, central and south): 0.12

4.DISCUSSIONS

The purpose of this study was to determine the Dehydrogenase and Urease activity in different regions and Nurseries of mulberry growing soils of Kashmir and their interaction with the sampling months. We assumed that the activity of soil microorganisms would be affected by the inputs added as well as litter inputs (the principle governors of microbial activity). There was a significant variation among the regions and Nurseries and in the months particularly influenced by the quantity of organic matter and moisture content of the soil.

4.1 Dehydrogenase Activity Amongst Regions of Valley: Dehydrogenase activity was significantly higher in the Central region in comparison to the Northern and Southern regions of mulberry growing soils of Kashmir. The reason for higher Dehydrogenase activity in the Central region could be due to the presence of adequate moisture, temperature, organic matter, water content, etc prevailing in the region providing favorable microclimatic conditions which results in increase in microbial growth and thereby accumulation of more number of enzymes which consequently change the plant nutrients to readily available forms and ultimately result in enhanced fertility of soil. Agnieszka Wolinska and Zofia Stepniewska (2012) & Everlon Cid Rigobelo and Ely Nahes (2004) reported higher Dehydrogenase activity in soils due to the presence of higher microbial population, organic carbon content, favorable moisture and temperature. It therefore, seems that Central region is inhabited by good density of suitable microorganisms which finally led to enhanced microbial interaction in the region as compared to other regions of mulberry soils of Kashmir, where vegetation and management of soil seems to be the main reason of lowest activity due to the variation in rate of decomposition of organic matter (Foth & Turk, 1973).

4.1.1:- Nurseries of Northern Region: Among the Nurseries, the activity was higher in the Bandipora nursery followed by Mirgund nursery and amongst the investigating months the same Nursery showed the highest activity in the month of April (monsoon season) followed by Mirgund nursery, possibly because of the characteristics of soils, topography, climate of the area (Brady, 1984). The major reason for increased Dehydrogenase activity in the Nursery could be attributed to the greater availability of soluble organic Carbon, nutrients and stimulated microbial activity. This is in agreement with the observation made by Adak et al. (2014) in mango orchard.

4.1.2:- Nurseries of Central Region:- Galander nursery had the maximum activity in the Central region followed by Poohu nursery throughout the year and in the month of April both of the nurseries showed the highest activity, as the rains are common in April and therefore, increase the rate of decomposition. Further, the greater supply of organic carbon derived from the application of various organic materials, mineral fertilizers, litter of the nurseries, the particular land use system of the area, the climate of the area, change the pH of soil and thereby the microbial population, as the microbes might respond differently to different factors prevailing in the area (Laik *et al.*, 2009 and Bhattacharya, 2012) which in case of soil of Srinagar (Tulsibagh) nursery might be low.

4.1.3:- Nurseries of Southern Region: Among the Nurseries of the Southern region highest activity was registered by Y.K.Pora nursery whereas the other Nurseries were at par with each other. The soil in Y.K.Pora nursery remains moisturized being situated nearby a stream, surrounded by lush green trees and hence did not dry to a great extent as compared to the other Nurseries of the region. This could have created a favorable microclimate which stimulated the exudation of organic substances from roots of plants and increased the microbial number and activities, which is in conformity with Volk, 1997, McCluskey *et al*, 2004. The activity however, remained at its peak in the month of April in the same Nursery because of the presence of organic matter, suitable moisture, seasonality of temperature which controlled the microbial activities in the Nursery (Gutknecht *et al.*, 2006).

4.1.4:- Nurseries of whole Valley: - However, Y.K.Pora nursery followed by Galander nursery (at par with each other) showed the significant variation by recording highest activity among all the 9 Nurseries of Valley Kashmir. It is related to the quality of incorporated organic amendments, high soil pH of the regions, which influenced the enzyme concentration as well as carbon content in soil and changed the physicochemical properties of the nursery (Ladd, 1978). Brady (1984) also reported that because of the constituents of parent rock, topography, nature of rock, the characteristics of soil differ which may be vice versa in case of other Nurseries.

4.2 Urease Activity amongst Regions of Valley: Data on Urease activity showed a significant variation in the 3 regions of mulberry growing soils of Kashmir which was expected. Central region was statistically significant over the other regions throughout the year. This could be due to the highest Dehydrogenase activity, highest pH, highest Nitrogen, moisture, etc prevailing in the region. Further, it can be attributed to the loamy rich nature of the soil consisting of organic matter, nitrogenous compounds and other plant nutrients as the Nursery is situated on the banks of Jhelum River. The result is in conformity with the observation made by Dar *et al*(2015) in plains of Jhelum valley.

4.2.1:- Nurseries of Northern Region: Bandipora nursery amongst the Nurseries recorded the enhanced microbial activity throughout the year. Under temperate conditions, organic matter content gradually increases with time and thus increases the enzymatic activity. It may be attributed to the high proportion of organic matter derived from litter inputs and root exudates which thus supports the highest microbial activity and thereby affect the Nitrogen mineralization of soil (Jia *et al.*, 2010 and Zantua *et al.*, 1977). The enzyme activity was however, higher during the month of April in the same Nursery during the investigation months due to the moisture, favorable temperature which results in mineralization of nutrients and increased activity (Tiwari, 1987).

4.2.2:- Nurseries of Central Region: Among the Nurseries of the region, Galander nursery registered the maximum activity throughout the year, being at par with the Srinagar (Tulsibagh) nursery. The Nursery is inhabited by wide range of big mulberry trees which perhaps by means of litter inputs, root exudates can affect both organic carbon and Nitrogen availability to plants and thus increase the enzyme activities. This is in accordance with Wardle *et al.*, 2004 who worked on above and belowground biota. The same Nursery registered the highest Urease activity in April followed by Srinagar (Tulsibagh) nursery preferably due to the increased pH of the region, accumulation of soluble salts, organic matter influenced by rains of the month which increase the microbial activity at favorable temperature (Wu *et al.*, 2016 and Zargar *et al.*, 2010).

4.2.3:- Nurseries of Southern Region: Y.K. Pora nursery showed significant variation, being registering highest activity among all the Nurseries of the region throughout the year. The highest activity in the Nursery is attributed to the highest content of organic carbon in the region. Soil with high level of organic matter will have more biological activity and more

organic carbon. The Nursery is a forest area and therefore litter fall act as a critical regulating component to enrich the microbial carbon and thus the activity (Dutta and Agarwal, 2002). The activity however, was maximum in April among all the sampling months during the investigation which may be attributed to higher litter decomposition due to favorable temperature and moisture in soil during this period as compared to other months (Schmitt *et al.*, 2010).

4.2.4:- Nurseries of Whole Valley: Urease activity varied significantly ($p \leq 0.05$) between the selected Nurseries of the valley. The highest activity was recorded at Galander nursery followed by Srinagar (Tulsibagh) and Bandipora nurseries. The highest microbial activity is highly correlated with below ground and above ground plant biomass which are considered as the main source of soil organic matter (Schnurer *et al.*, 1985).

5.CONCLUSIONS

It can be concluded that Dehydrogenase and Urease enzyme activities are strongly influenced by the organic matter, moisture content and temperature of the mulberry growing soils. The different response of enzyme activities between the regions and Nurseries support our hypothesis. Both Dehydrogenase and Urease activities were mostly concentrated in the Central region amongst the regions of Kashmir, only difference in the Nurseries of the region was the intensity of the activities. The activity was however maximum in the Y.K.Pora nursery followed by Galander nursery in case of Dehydrogenase activity where as the Galander nursery followed by Srinagar nursery showed the highest activity amongst the Nurseries throughout the valley in case of Urease activity. Such differences may be due to the inputs added to the particular Nursery, available moisture content, interaction between microbes and soil residues, other management practices like irrigation etc., as well as the quantity of litter-fall. The results indicate that the soil of Central region is rich in organic matter and the Southern region is adequate in moisture than the Northern region of Kashmir- as the highest enzyme activities are overall indicators of good soil productivity. During the investigation, significant differences in enzyme activities throughout the year indicate that the activities were lowest in dormant months of year (January) than during the growing months of year (April-October) due to the extent of addition of root and other residues. The knowledge about the activities of these enzymes could be useful in interpreting the results under different field conditions viz. in mulberry cultivation practices, predictions related to soil changes under flooded conditions (high moisture conditions) and might be helpful in optimization of growth conditions favorable for microorganisms which would lead to a bountiful harvest. Quality and quantity of litters of mulberry growing soils/Nurseries and below ground microbial diversity needs to be studied in future to unravel the reasons of variable microbial activity and soil quality.

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