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ORIGINAL ARTICLE

Correlation Analysis between Mulberry Sprouting and Weather Parameters under Changing Climate Scenario

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ABSTRACT

The current global climate change has been reported to affect some agricultural crops including mulberry culture in one or other way posing an environmental threat to the global community (IPCC 4th AR, 2007).Climate change due to human activities has been witnessed for at least the last 100 years and is projected to continue for centuries to come. Climate change has been seen to affect some physiological processes of the plant which includes dormancy, bud break and sprouting behavior. As a result of climate change there has been fluctuations in the temperature which has a direct effect on the physiology of the plant. The present study was undertaken to study the impact of climate change on the sprouting behavior of mulberry and the correlation analysis between mulberry sprouting and weather parameters. The present study revealed that as a result of climate change there is an advancement of 10 days in the sprouting of mulberry and a positive correlation exists between the sprouting percentage of mulberry, temperature and sunshine hours whereas there was a negative correlation between sprouting of winter buds in mulberry with relative humidity. However there wasno correlation between sprouting percentage and rainfall.

KEY WORDS: *Climate change, Mulberry, Sprouting, Temperature, Sunshine, Rainfall, Correlation.*

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INTRODUCTION

Mulberry (*Morus Sp.)* is a typical East Asian plant which can be trained as bush, dwarf and tree. It is widely distributed in varied ecological and geographical zones from intensive cultivation in temperate, subtropical and tropical areas to natural occurrence in forests throughout the world. This clearly indicates that mulberry possesses a high degree of adaptability to changes in environment. The crop production is highly influenced by fixed inherent characteristics of the plant itself, the cultivation technique and the environmental conditions during the growth of the plant. Mulberry leaf is a major economic component in sericulture since the quality and quantity of leaf produced per unit area has a direct bearing on cocoon harvest [3]. The leaf of mulberry is only food to silkworm (Bombyx mori L.) reared to get silk.It is estimated that mulberry silk accounts for around 90 percent of the total global raw silk production contributing significantly to the livelihood of many people across the globe [4]. Among various constraints, the scarcity of quality mulberry leaf comes in the way of improved silk production in the region besides the clash between sericulture and other agricultural activities while brushing the worms as per the conventional schedule (Ist week of May). On the other hand current global climate change has been reported to affect all agricultural crops in one or the other way posing an environmental threat to the global community [5] with mulberry being no exception. Climate change due to human activities has been witnessed for at least 100 years and is projected to continue for centuries to come. Climate change involves the whole climate system, including not only our atmosphere but also our hydrosphere, cryosphere, land surface and biosphere. Greenhouse gases and atmospheric concentrations have exponentially increased since the start of the Industrial Era (1750).Moreover, from this time the CO_2 concentrations have increased by 41% mostly due to the global use of oil fuel. Climatic models have predicted 1.0 to 5.8^{0}C average increase in temperature up to the end of this century and its impact depends upon the combined effects of temperature, precipitation, humidity, soil moisture, atmospheric CO_2 and troposphere ozone (O_3) [5].Climate change has been seen to affect the agro ecological system, cropping patterns and even some shift in the land use pattern. Jammu and Kashmir is not an exception

and climate change has been seen to affect some physiological processes of the plant which includes dormancy, bud break, sprouting, flowering and ripening etc. During the last few decades, as a result of climate change, the temperature during the autumn season has been somewhat low from the normal but during spring it has been somewhat higher than the normal temperature. This change in the temperature during autumn and spring season affects the plants to undergo dormancy somewhat earlier and triggers the plant to break the dormancy somewhat earlier. It has been seen that climatic change affects the mulberry plant in various ways which is likely to have an impact on the sericulture calendar in the region. Sprouting behavior is one of the visual effects due to some physiological changes as a consequence of changes in climatic conditions like temperature, relative humidity, precipitation etc. Although considerable work has been done in India and abroad on the correlation analysis of weather parameters with the sprouting behavior of mulberry in response to the climate change, hardly any work has been done on these aspects under temperate climatic conditions which led to the conception of the idea of studying the correlation analysis between sprouting behavior of mulberry with the weather parameters in the changing climatic scenario.

MATERIAL AND METHODS

The present study was carried out at College of Temperate Sericulture, Mirgund during spring 2017 & 2018.Eight mulberry genotypes available in the Germplasm Bank of CTS, Mirgund *viz*; SKM-31, Goshoerami, Ichinose, SKM-27, Zust, Mandaliya, Kanva-2 and Local mulberry were screened for their sprouting behavior. Observations on the sprouting behavior of these varieties were recorded twice a week from the first week of March up to the second week of Aprilto observe the bud sprouting to find out if there is any change in the sprouting of these varieties. During the present investigation data on average temperature, relative humidity, rainfall and sunshine hours was collected on weekly basis from first week of March till completion of sprouting from Meteorological Department Srinagar(Table-1) to find out the correlation of weather parameters with the dormancy and growth of mulberry sprouts as well as bud sprouting percentage mulberry varieties under study. Data collected was subjected to statistical analysis by following statistical procedures [3].

Table -1: Weekly Meteorological data during sprouting phase of mulberry under Kashmir climatic conditions pooled over years 2017 &2018

Week	Av. Temp (°C)	Rainfall(mm)	Relative Humidity (%)	Sunshine Hours
1 (Ist week of March)	5.85	2.06	69.6	3.58
2(2nd week of March)	7.905	2.6	72.5	1.89
3(3rd week of March)	7.02	8.44	69.39	3.74
4(4th week of March)	8.82	1.54	62.14	5.16
5(Ist week of April)	13.05	0.93	56.75	5.13
6(2nd week of April)	15.05	0.41	50.5	6.43

RESULTS AND DISCUSSION

The results of the experiment showed that all the eight selected mulberry genotypes *viz*: SKM-31, Goshoerami, Ichinose, SKM-27, Zust, Mandaliya, Kanva-2, and Local mulberry, SKM 31 sprouted earlier in both the years (2017 & 2018) and the initiation of sprouting was March 24 in the year 2017 and March 21 in the year 2018 for the genotype SKM-31.This was followed by Zust which sprouted on 24th March and 22nd March in 2017 and 2018 respectively. Ichinose was found to sprout somewhat later in both the years i.e. on 2nd April and 1st April respectively during the years 2017 and 2018. The date of sprouting of other varieties was recorded as 30th March during both the years(Goshoerami), 27th March & 25th March (Kanva -2), 25th March & 22nd March (SKM-27), 25th March & 23rd March (Mandaliya), 30th March & 27th March (Local mulberry) in the year 2017 and 2018 **(Table-2).**

Table 2: Date of mulberry sprouting during the year 2017 and 2018

S. No.	Mulberry genotype	Date of sprouting	
		2017	2018
01	SKM-31	24-03-2017	21-03-2018
02	Goshoerami	30-03-2017	30-03-2018
03	Ichinose	02-04-2017	01-04-2018
04	Zust	24-03-2017	22-03-2018
05	SKM-27	25-03-2017	22-03-2018
06	Mandaliya	25-03-2017	23-03-2018
07	Kanva-2	27-03-2017	25-03-2018
08	Local mulberry	30-03-2017	27-03-2018

Sprouting behavior of Goshoerami, Ichinose, SKM-31, SKM-27,Mandaliya,Zust,Kanva-2 and Local mulberry depicted that these eight mulberry genotypes sprouted 10 days earlier than their normal sprouting.The early bud break or bud bursting could be attributed to the response of physiology of these varieties to the increased temperature and better sunshine hours during spring season that accelerated the break in dormancy of these varieties and consequently resulted in somewhat earlier bud sprouting.In the present study the sprouting percentage of various mulberry varieties *viz*: Goshoerami, Ichinose, SKM-31, SKM-27, Mandaliya, Zust, Kanva-2 and local mulberry was positively correlated with the average temperature (r=0.929, r=0.925, r=0.866, r=0.873, r=0.807, r=0.855, r= 0.903 and r= 0.867) respectively and with the sunshine hours (r=0.860, r=0.878, r=0.814, , r=0.844, r=0.836, r=0.799, r= 0.840 and r= 0.811) respectively. This can be attributed to the fact that as a result of climate change, the temperature in the spring for past few years was higher than the normal coupled with longer sunshine hours which accelerated the growth and development of the bud and thereby helping in advanced bud bursting, sprouting and leaflet formation. Bultrose [1] studied the effect of light intensity and temperature on growth of grapevine and reported that there is a positive correlation between the average temperature and sprouting in grapevine. He also reported that the bud fruitfulness is positively correlated with the sunshine hours. Zhao and Schwartz [7] studied the effect of climate change on phenology of tropical plants in china and reported that bud break and sprouting is positively correlated with temperature. Conversely, the sprouting percentage of various mulberry varieties *viz*: Goshoerami, Ichinose, SKM-31,SKM-27, Mandaliya, Zust, Kanva-2 and local mulberry was negatively correlated with the relative humidity (r=-0.933, r=-0.942, r=-0.871, r=-0.892, r=- 0.836, r=-0.855, r= -0.908 and r=- 0.868) respectively. Root *et al.* [6] studied the impact of global warming on plants and reported that significant positive correlations exist between temperature and spring phenological phases such as bud burst, leaf unfolding and flowering. However no correlation was found between the sprouting percentage of various mulberry varieties under study and the rainfall.

Table 3: Correlation Analysis of weekly sprouting percentage with weather parameters (Pooled over the years 2017 &2018)

Variety	Average Temp(C^0)	Rainfall(mm)	Relative Humidity(%)	SSH
Goshoerami	0.929**	-0.356	-0.933**	0.860*
Ichinose	0.925**	-0.371	-0.942**	0.878*
SKM-31	0.866**	0.307	-0.871*	0.814*
SKM-27	0.873 **	-0.322	-0.892*	0.844*
Mandaliya	0.807**	-0.331	-0.836*	0.836*
Zust	0.855**	-0.280	-0.855*	0.799*
Kanva 2	0.903**	-0.337	-0.908**	0.840*
Local mulberry	0.867**	-0.277	-0.868*	0.811*

*Significant at 5% level
**Significant at 1% level

CONCLUSION

The present findings concluded that the sprouting percentage of mulberry varieties under study was positively correlated with the average temperature and sunshine hours.This indicated that the higher temperature and more sunshine hours are responsible for triggering early sprouting and bud break in mulberry varietiesviz: Goshoerami, Ichinose, SKM-31, SKM-27, Mandaliya, Zust, Kanva-2 and local mulberry. Conversely the sprouting percentage of these mulberry varieties was negatively correlated with relative humidity. However no correlation was found between the sprouting percentage of various mulberry varieties under study and the rainfall.

CONFLICT OF INTREST

There is no conflict of interest among the authors.

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