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Climate Change and its Impact on Sericulture

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SUMMARY

The intensified human activities resulted in the use of natural resources which has contributed significantly to the global warming (climate change). Global warming lead to the increase in the concentration of greenhouse gases, namely carbon dioxide, methane, chlorofluorocarbons and nitrous oxide in the atmosphere. The sericulture practiced in tropical environmental regions such as Karnataka, Tamil Nadu, Andhra Pradesh, West Bengal, Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Bihar, Jharkhand and Assam will be severely affected, however, small to marginal loss can be noticed in Jammu Kashmir and Sub-Himalayan region of North-Eastern India.

INTRODUCTION

Global climate change indicates a change in either the mean state of the climate or in its variability, persisting for several decades or longer. This includes changes in average weather conditions on Earth, such as a change in average global temperature, as well as changes in how frequently regions experience heat waves, droughts, floods, storms, and other extreme weather. So “Climate change refers to a statistically significant variation in either the mean state of the climate or in its variability, persisting for an extended period (typically decades or longer). Climate change may be due to natural internal processes or external forcing or to persistent anthropogenic changes in the composition of the atmosphere or in land use”.

What's the difference between climate change and global warming?

Climate is commonly defined as the average weather for a specific location, region or the entire globe over an extended period of time (usually three decades). Climate change refers to a long-term shift in climate measured as a change in some or all of the features associated with weather, such as temperature, wind, precipitation. This can involve both changes in average conditions (e.g. mean daily temperature) and in the variability of the weather. For the term climate change to properly apply, the shift in conditions should continue over an extended period of time. Climate change can result from either natural or anthropogenic (human-influenced) causes. It should be noted that in a political context, the United Nations Framework Convention on Climate Change uses the term climate change to refer specifically to human-induced climate change. The term "global warming" refers to a sustained increase in global average surface temperature and so, is just one aspect of climate change. Global warming is often misunderstood to imply that the world will warm uniformly. In fact, as with any "average", there will be places that warm more or less than the average. Some areas may even cool. Also, an increase in average global temperature will be associated with changes in other aspects of the climate system as well, such as precipitation and winds, affecting weather patterns around the world. Therefore, the more correct term to use would be "climate change", even when discussing the observed increase in global average temperature. Nevertheless, the term "global warming" is commonly used since it rapidly conveys one of the main ways in which the climate has changed.

Reasons for Climate Change:

Climate is influenced by a variety of factors, both human-induced and natural. The increase in the carbon dioxide concentration has been the principal factor causing warming over the past 50 years. Its concentration has been building up in the Earth’s atmosphere since the beginning of the industrial era in the mid-1700s, primarily due to the burning of fossil fuels (coal, oil, and natural gas) and the clearing of forests. Human activities have also increased the emissions of other greenhouse gases, such as methane, nitrous oxide, and halocarbons.

A) Human Influences

Carbon dioxide:

CO_2 concentration has increased due to the use of fossil fuels in electricity generation, transportation, and industrial and household uses. It is also produced as a by-product during the manufacturing of cement.

Deforestation provides a source of carbon dioxide and reduces its uptake by trees and other plants. Globally, over the past several decades, about 80 percent of human-induced carbon dioxide emissions came from the burning of fossil fuels, while about 20 percent resulted from deforestation and associated agricultural practices. The concentration of carbon dioxide in the atmosphere has increased by roughly 35 percent since the start of the industrial revolution.

Methane:

Methane concentration has increased mainly as a result of agriculture; raising livestock (which produce methane in their digestive tracts); mining, transportation, and use of certain fossil fuels; sewage; and decomposing garbage in landfills. About 70 percent of the emissions of atmospheric methane are now related to human activities

Nitrous oxide:

Nitrous oxide concentration is increasing as a result of fertilizer use and fossil fuel burning.

Halocarbon:

Halocarbon emissions come from the release of certain manufactured chemicals to the atmosphere. Examples include chlorofluorocarbons (CFCs), which were used extensively in refrigeration and for other industrial processes before their presence in the atmosphere were found to cause stratospheric ozone depletion. The abundance of these gases in the atmosphere is now decreasing as a result of international regulations designed to protect the ozone layer. Continued decreases in ozone-depleting halocarbon emissions are expected to reduce their relative influence on climate change in the future. Many halocarbons replacements, however, are potent greenhouse gases, and their concentrations are increasing

Ozone:

Ozone is a greenhouse gas, and is continually produced and destroyed in the atmosphere by chemical reactions. In the troposphere, the lowest 5 to 10 miles of the atmosphere near the surface, human activities have increased the ozone concentration through the release of gases such as carbon monoxide, hydrocarbons, and nitrogen oxides. These gases undergo chemical reactions to produce ozone in the presence of sunlight. In addition to trapping heat, excess ozone in the troposphere causes respiratory illnesses and other human health problems. In the stratosphere, the layer above the troposphere, ozone exists naturally and protects life on Earth from exposure to excessive ultraviolet radiation from the Sun. As mentioned previously, halocarbons released by human activities destroy ozone in the stratosphere and have caused the ozone hole over Antarctica Changes in the stratospheric ozone layer have contributed to changes in wind patterns and regional climates in Antarctica.

Water vapour:

Vapour is the most important and abundant greenhouse gas in the atmosphere. Human activities produce only a very small increase in water vapour through irrigation and combustion processes. However, the surface warming caused by human-produced increases in other greenhouse gases leads to an increase in atmospheric water vapour, since warmer climate increases evaporation and allows the atmosphere to hold more moisture. This creates an amplifying "feedback loop," leading to more warming. Other human influences In addition to the global-scale climate effects of heat-trapping gases, human activities also produce additional local and regional effects. Some of these activities partially offset the warming caused by greenhouse gases, while others increase the warming. One such influence on climate is caused by tiny particles called "aerosols" (not to be confused with aerosol spray cans). For example, the burning of coal produces emissions of sulphur-containing compounds. These compounds form "sulphate aerosol" particles, which reflect some of the incoming sunlight away from often referred to as soot or black carbon, absorbs incoming sunlight and traps heat in the atmosphere. Thus, depending on their type, aerosols can either mask or increase the warming caused by increased levels of greenhouse gases. On a globally averaged basis, the sum of these aerosol effects offsets some of the warming caused by heat-trapping gases.

B) Natural influences

Two important natural factors also influence climate: the Sun and volcanic eruptions. Over the past three decades, human influences on climate have become increasingly obvious, and global temperatures have risen sharply. During the same period, the Sun's energy output (as measured by satellites since 1979) has followed its historical 11-year cycle of small ups and downs, but with no net increase The two major volcanic eruptions of the past 30 years have had short-term cooling effects on climate, lasting 2 to 3 years. Thus, these natural factors cannot explain the warming of recent decades; in fact, their net effect on climate has probably been a slight cooling influence over this period. Slow changes in Earth's orbit around the Sun and its tilt toward or away from the Sun are also a purely natural influence on climate, but are only important on timescales from thousands to many tens of thousands of years. Sulphate aerosols also tend to make clouds more efficient at reflecting sunlight, causing an additional indirect cooling effect.

Impacts of Climate Change on sericulture

The silkworm *Bombyx mori* (Lepidoptera) is highly sensitive to environmental temperature due to artificial domestication and indoor rearing. The most suitable temperature for silkworm development is approximately 24–28 °C. It is predicted that, global warming affects the cultivation area of various crops including mulberry. Mulberry (*Morus alba)* is a C3 plant and it is inefficient in utilizing the atmospheric CO2 whereas enzymes of C4 plants located in the mesophyll are efficient in fixing CO2. In C3 plants CO2 react with ribulose biphosphate (RuBP) in presence of the enzyme ribulose biphosphate carboxylase/oxygenase (RuBis CO), which is an inefficient enzyme with low substrate specificity. To overcome this inefficiency, stomata in C3 plants remain open for longer periods leading to increased evapotranspiration. Hence C3 plants grow better in cooler moist environments with elevated CO2 concentrations. Increased levels of CO2 will effect plants yield through photosynthesis and stomatal conductance whereas the growing evidence suggesting that C3 crops, may respond positively to increased atmospheric CO2 in the absence of other stressful conditions but the beneficial direct impact of elevated CO2 can be offset by other effects of climate change, such as elevated temperatures, higher tropospheric ozone concentrations and altered patterns of precipitation. The direct and indirect effect of climate change includes: (1) direct effects from changes in temperature, precipitation, or carbon dioxide concentrations, and (2) indirect effects through changes in soil moisture and the distribution and frequency of infestation by pests and diseases. In recent years, many pests and diseases have been reported to be the major limiting factors affecting production and productivity of mulberry leaves due to intensive cultivation practices and indiscriminate use of nitrogenous fertilizers and pesticides. There is also a change in the insect pest scenario in mulberry due to changes in climate and agro ecosystem. These pests are Bihar hairy caterpillar (*Diacrisia oblique*), Pink mealy bug (*Maconellicoccus hirsutus*,), Thrips (*Pseudodendrothrips mori*), Leaf webber (*Diaphania pulverulentalis*), Mites (Bud mites) and diseases are Root-knot disease (*Meloidogyne incognita*), Powdery mildew (*Phyllactinia corylea*), Leaf rust (*Peridiospora mori*) and Leaf spot (*Cercospora moricola*) etc . It has been reported that, pink mealy bug, *Maconellicoccus hirsutus* has got 346 host plants and in mulberry it causes leaf yield loss of 4500 kgs/ ha/year thus depriving the farmer a brushing of about 450 dfls/ha/year leading decline in cocoon production of 150 kg/ ha/year. The leaf webber, *Diaphania pulverulentalis* has been noticed as a serious pest in Karnataka since 1995 which has also spread to Tamil Nadu and Andhra Pradesh on local, M5, MR2, S36 and V1 varieties. The infestation of D. pulverulentalis is higher during October to February in Krishnagiri area and October to December in Salem area . Similarly, the pest caused the leaf yield loss of 12.8% with average incidence of 21.77%. The phenotypic expression is greatly influenced by environmental factors such as temperature, relative humidity, light, and nutrition.

Adaptation and mitigation Strategies to Climate Change

- Develop new cold and drought tolerant mulberry varieties.
- Develop silkworm races to adopt for increased temperature coupledv with high moisture situations.
- Develop effective management system for silkworm disease prevention/control as high temperature and moisture promote faster growth of pathogens.

- Develop suitable methods to manage high humidity and CO2 both during rearing and cocoon spinning.
- Creating economical conditions the farmers to be interested and able to make more capital investments in improving the mulberry cultivation and silkworm rearing facilities.

CONCLUSION

Climate change is a reality. Agriculture is likely to suffer losses in long run due to heat, erratic weather, and decreased irrigation availability. Adaptation strategies can help minimize negative impacts to some extent whereas mitigation options can help in long run.

Future thrust:

- Training and capacity building in ecosystem resilience, risk management and coping mechanisms.
- Strengthen social safety through insurance schemes and a understanding of existing local networks.
- Greater incorporation of scientific disciplines on knowledge of climate change, variability, adaptation and mitigation.

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