Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(5): 426-429

Received: 07-07-2018
Accepted: 08-08-2018

Bharath Kumar Neelaboina
Central Sericultural Research and Training Institute, Central Silk Board, Govt. of India, Pampore, Jammu & Kashmir, India

Gulzar Ahmad khan
Central Sericultural Research and Training Institute, Central Silk Board, Govt. of India, Pampore, Jammu & Kashmir, India

Shiv kumar
Central Sericultural Research and Training Institute, Central Silk Board, Govt. of India, Pampore, Jammu & Kashmir, India

Mudasir Gani
Central Sericultural Research and Training Institute, Central Silk Board, Govt. of India, Pampore, Jammu & Kashmir, India

Mir Nisar Ahmad
Central Sericultural Research and Training Institute, Central Silk Board, Govt. of India, Pampore, Jammu & Kashmir, India

MK Ghosh
Central Sericultural Research and Training Institute, Central Silk Board, Govt. of India, Pampore, Jammu & Kashmir, India

Correspondence
Bharath Kumar Neelaboina
Central Sericultural Research and Training Institute, Central Silk Board, Govt. of India, Pampore, Jammu & Kashmir, India

Impact of climate change on agriculture and sericulture

Bharath Kumar Neelaboina, Gulzar Ahmad khan, Shiv kumar, Mudasir Gani, Mir Nisar Ahmad and MK Ghosh

Abstract
Agriculture and its allied sectors will inevitably face challenges caused by climate change in future which might lead to both global and local alteration. Enriched atmospheric carbon dioxide (CO_2) and temperature can have various effects at different tropic levels in ecosystems (plants, herbivores, predators and parasitoids). Global CO_2 concentration has been increased by approximately 30% since the industrial revolution resulted in increase of ~0.66 °C in mean annual global surface temperature. Many plant species respond to enriched CO_2 with enhanced photosynthetic rate and increased biomass. Alterations of CO_2 and temperature will affect the insect pests by decreasing their relative growth rate (RGR) and prolonged developmental time in Lepidoptera (leaf chewers) where as increased abundance and fecundity in homoptera (sap suckers). Changes in foliar chemistry under elevated condition are likely to alter interaction between herbivorous insect and their natural enemies. Though plant biomass increased but their nutritional quality gets deteriorated such as lower nitrogen (N) content, higher C:N ratio, starch, total soluble sugars and polyphenols that affect insect growth, consumption and digestibility. The effect of increased CO_2 and temperature on mulberry plants directly affects the lifecycle of silkworm. Like other lepidopterans silkworm may also feed more quantity of mulberry leaves to balance the deteriorated nutrition in mulberry leaves which may result in increased life cycle. Therefore, it will be interesting to observe the effect of increased feeding by beneficial insects such as mulberry silkworm which feed only on mulberry leaves.

Keywords: Climate change, mulberry, silkworm

Introduction
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 fourth assessment report of the Inter- Governmental Panel on Climate Change [8] reconfirmed that the atmospheric concentrations of carbon dioxide, methane, and nitrous oxide greenhouse gases have increased markedly since 1750. The report showed that these increases in greenhouse gases have resulted in warming of the climate system by 0.74ºC over the past 100 years. On the basis of the increase of these greenhouse gases, climatic models predict a 1.4 ºC to 5.8 ºC average increase in global warming from 1990 to 2100, probably leading to a more rapid increase in temperature at the surface of terrestrial zones and more extreme local variations [9]. Atmospheric concentrations of CO_2 have been steadily rising from approximately 315 ppm in 1959 to a current atmosphere average of approximately 385 ppm. Even if the annual flow of emissions did not increase beyond today's rate, the stock of greenhouse gases in the atmosphere would reach double preindustrial levels or 550 ppm CO_2 by 2050 and would continue growing thereafter [22]. Energy supply and Industry sectors accounts for 26% and 19% of annual GHG emissions respectively [8]. Sector wise annual GHG emissions are given in fig. 1. Out of total global GHG emissions CO_2 contributes 77% emissions which is almost two third of total GHG emissions however, contribution of CH_4 and N_2O emissions are 14% and 8% respectively (fig. 2). Legumes, being more responsive to elevated CO_2 than other plants, will have a competitive advantage when grown under elevated CO_2. Within legume species, N_2 fixers, are more responsive to elevated CO_2 than N_2 non-fixers [1].
Many plant species respond to enriched atmospheric CO_2 by enhanced photosynthetic rates and increase in biomass, as well as alterations in leaf quality factors. Insect and host plant

interactions change in response to the effects of CO_2 on nutritional quality and secondary metabolites of the host plants. In atmospheres experimentally enriched with CO_2, the nutritional quality of leaves declined substantially due to dilution of nitrogen (N_2) by 10-30% [3]. Lower foliar N content due to elevated CO_2 causes an increase in food consumption by herbivores by up to 40% [6].

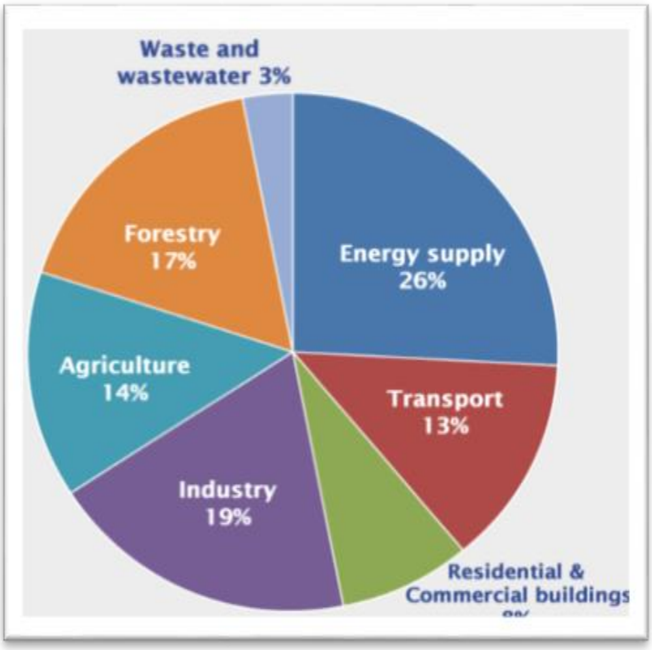

Fig. 1: Greenhouse Gas Emissions by Source

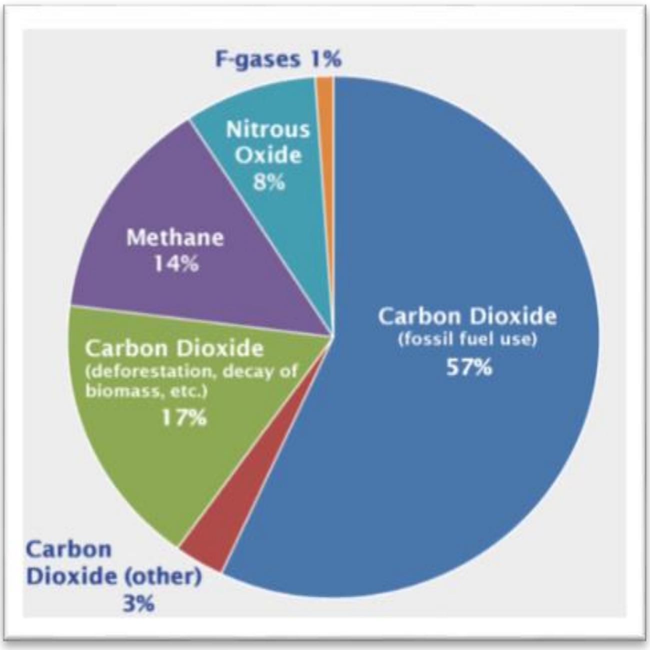

Fig 2: Global Greenhouse Gas Emissions by Gas

Mulberry silkworm, *Bombyx mori* L. (Lepidoptera: Bombycidae) is economically important monophagous insect which feed on mulberry leaves and produce silk from Silk glands (modified Salivary glands) through spinneret in the form of cocoon. Silk is a high value but low volume products accounting for only 0.2% of world's total textile production. 95% of total global silk output is from Asia countries. China occupies first position in production of silk followed by India. This paper focuses mainly on the impact of climate change on Agriculture and allied sectors like Sericulture.

Impact of climate change on insect pests

Climate change could profoundly affect the abundance, distribution or status of insect pests of crops. The impact of climate change on insect pest populations include changes in phenology, distribution, community composition and ecosystem dynamics that finally leads to extinction of species. There might be expanded pest host ranges, disruption of synchrony between pests and natural enemies, and increased frequency of pest outbreaks and upheavals. Due to the dynamic behaviour of insect populations they respond differently to the forces of climate change and accordingly change their pest status. The enhanced CO_2 level in the atmosphere will result in the more vegetative growth, larger crop canopy and denser foliage will create more relative humidity, thereby making micro-environment more favorable to pests. Increases in food quality, i.e. increase in the nitrogen content of plants due to high temperature, can results in sudden resurgence of population of pests. Moreover under condition of stress, plant defensive systems are less effective and they become more susceptible to pest attack [4]. The effect of temperature on insect pests varies and depends on the development strategy of an insect species [2].

As a result of this many minor pests have assumed the status of major pests, many pests have changed from secondary to primary and several new pest problems have appeared in certain regions. There has been an overall decline in the severity of *Helicoverpa armigera* (Hubner), the incidence of mealy bugs, particularly *Phenacoccus solenopsis* Tinsley and *Paracoccus marginatus* on cotton; sugarcane woolly aphid, *Ceratovacuna lanigera* Zehntner on sugarcane; tobacco caterpillar, *Spodoptera litura* (Fabricius) on several crops; *Spodoptera mauritia* Boisduval on rice; many species of mirid bug on cotton; *Maruca vitrata* (Geyer) on pigeonpea; silver leaf whitefly, *Bemisia argentifolii* on several crops; grey weevil, *Myllocerus* spp. and sugarcane leafhopper, *Pyrilla perpusilla* Walker on sorghum and pearl millet; wasp, *Tanaostigmodes cajaninae* on pigeonpea; diamondback moth, *Plutella xylostella* (Linnaeus) on cruciferous vegetables; Rhinoceros beetle, *Oryctes rhinoceros* (Linnaeus) on coconut and oil palms; Tea mosquito bug, *Helopeltis antonii* Signoret on cashew; and Sapota seed borer, *Trymalitis marginatus* Meyric is on the rise. Climate change will show mostly a negative influence on organisms and over all biodiversity [12, 14, 20, 24, 5]. According to survey of over 1700 species 50% of these wild species are already affected by climate change [14] and even a mid-range climate warming Scenario predicts that 15% to 37% of the species may become extinct by 2050 [24]. The causes of pest emergence are multiple and quite complex, but it is generally accepted that human activities (e.g. trade of plants, accidental introduction of vectors for some pathogens, modifications of agricultural practices or land use) play an important role. The introduction of pests into new areas can have serious economic and environmental impact. For example, the costs of official control against fireblight (*Erwinia amylovora*) in Switzerland have been estimated to be 19 million euros from 1989 (first detection of the disease) to 2007.

Impact of climate change on Sericulture

The silkworm *Bombyx mori* (Lepidoptera) is a poikilotherm, 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 CO_2 whereas enzymes of C4 plants located in the mesophyll are efficient in fixing CO_2. In C3 plants CO_2 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 CO_2 concentrations [18].

Increased levels of CO_2 will effect plants yield through photosynthesis and stomatal conductance [10, 15] whereas the growing evidence suggesting that C3 crops, may respond positively to increased atmospheric CO_2 in the absence of other stressful conditions [11] but the beneficial direct impact of elevated CO_2 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 [7].

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 mealybug (*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* [18]. 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 [19]. 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 [13, 21] and October to December in Salem area [25]. Similarly, the pest caused the leaf yield loss of 12.8% with average incidence of 21.77% [16]. The phenotypic expression is greatly influenced by environmental factors such as temperature, relative humidity, light, and nutrition [23, 17].

Conclusion

In the context of increasing trade and climate change, the issue of emerging pests is of particular concern on all continents. There is a growing concern that these emerging species are not only causing direct crop losses to agriculture and allied sectors but may also threaten ecosystems and responsible for biodiversity losses. Emerging pests are clearly challenges for all plant health stakeholders (citizens, researchers, growers, plant protection services, international bodies, etc.). Further research is needed to better understand the biology and epidemiology of emerging pests, and to better understand the mechanisms of pest emergences. There is also a need to develop and further improve tools to predict patterns of spread and establishment potential of pests. In addition, the timely detection and availability of suitable diagnostic tools is a key element in the management of emerging pests. Because these species can threaten both cultivated and non-cultivated environments, efforts should continue to be made to facilitate information exchange and cooperation between the different regions of the world. The effect of climate change on sericulture is based on prediction and not yet proven. It can be concluded that tropical regions such as Karnataka, Tamilnadu, Andhra Pradesh, West Bengal, Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Bihar, Jharkhand and Assam will be severely affected due to climate change however, marginal loss can be noticed in Jammu Kashmir and Sub-Himalayan region of North-Eastern India.

References

1. Ainsworth EA, Rogers A, Nelson R, Long SP. Testing the “source- sink” hypothesis of down-regulation of photosynthesis in elevated CO2 in the field with single gene substitutions in Glycine max. Agricultural and Forest Meteorology. 2004; 122:85-94.
2. Bale JS, Masters GJ, Hodkinson ID, Awmack C, Bezemer TM. Herbivory in global climate change research: direct effects of rising temperature on insect herbivores. Global change Biology. 2002; 8:1-16.
3. Coley PD, Markham A. Possible effects of climate change on plant herbivore interactions in moist tropical forests. Climatic change. 1998; 39:455-472.
4. Coviella C, Trumble J. Effect of elevated atmospheric carbon dioxide on insect-plant interactions. Conserve. Biol. 1999; 13:700-712.
5. Franco AMA, Hill JK, Kitschke C, Collingham YC, Roy BD, Fox R *et al.* Impacts of climate warming and habitat loss on extinctions at species low-latitude range boundaries. Global change Biology. 2006; 12:1545-1553.
6. Hunter MD. Effects of elevated atmospheric carbon dioxide on insect-plant interactions. Agricultural Forest Entomology. 2001; 3:153-159.
7. International Panel on Climate Change (IPCC) The scientific basis. Contribution of working group I to the third assessment report of the intergovernmental panel on climate change. Cambridge, UK: Cambridge University Press, 2001.
8. Intergovernmental Panel on Climate Change (IPCC) the Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (eds Solomon S. *et al.*) 2007 (Cambridge Univ. Press, Cambridge, UK, 2007).
9. Karl TR, Trenbeth KE. Modern global climate change. Science. 2003; 302:1719-23.
10. Long SP, Ainsworth EA, Leakey ADB, Ort DR. Food for thought: Lower than- expected crop yield stimulation with rising CO2 conditions. Science. 2006; 312:1918-1921.
11. Long SP, Ainsworth EA, Rogers A, Ort DR. Rising atmospheric carbon dioxide: Plants FACE the future. Annual Review of Plant Biology. 2004; 55:591-628.

12. McLaughlin JF, Hellmann JJ, Boggs CL, Ehltich PR. Climate change hastens population extinctions. Proceedings of the National Academy of Sciences USA. 2002; 99:6070-6074.
13. Muthulakshmi M, Samuthiravelu P, Suresh A, Jayaraj S. Studies on development of sustainable pest management in mulberry. In: Sustainable Insect Pest Management (Ignacimuthu. S. and Jayaraj, S. eds.), Narosa Publications, New Delhi, 2003, 269-284.
14. Parmesan CR, Yohe G. A globally coherent fingerprints of climate change impacts across natural systems. Nature. 2003; 421:37-42.
15. Polley HW. Implications of atmospheric and climate change for crop yield. Crop Science. 2002; 42:131-140.
16. Rajadurai S, Sen AK, Manjunath D, Datta RK. Natural enemy fauna of mulberry leaf roller *Diaphania pulverulentalis* (Hamp.) and its potential. In abstracts of National Conference on Strategies for sericulture research and development, Central Sericultural Research and Training Institute. Mysore, 2000, 37p.
17. Ramesh C, Seshagiri SV, Rao CGP. Evaluation and identification of superior polyvoltine crossbreeds of mulberry silkworm, Bombyx mori L," Journal of Entomology. 2009; 6(4):179-188.
18. Ram RL, Maji C, Bindroo BB. Impact of Climate Change on Sustainable Sericultural Development in India. International Journal of Agriculture Innovations and Research. 2016; 4(6):110-118.
19. Ravikumar J, Samuthiravelu P, Qadri SMH, Hemanthkumar L, Jayaraj S. Integrated Pest Management (IPM) module for Tukra mealy bug, *Maconellicoccus hirsutus* (Green) and leafwebber, *Diaphania pulverulentalis* (Hamp.) in mulberry. Journal of Biopesticides. 2010; 3(1):354-357.
20. Root TL, Price JT, Hall KR, Schnuder SH, Rosenzweig C, Pounds JA. Fingerprints of global warming on wild animals and plants. Nature. 2003; 421:57-6.
21. Samuthiravelu P, Hemanthkumar L, Ravikumar J, Jayaraj S, Qadri SMH. Effects of non-edible oil cakes on mulberry leaf production and incidence of key pests and their natural enemies. In: Abstracts of National Symposium on recent trends in applied biology held at Avinashilingam Institute for Home Science and Higher Education for women, Coimbatore, Tamil Nadu, India on January 28th to 29th 2004, 87p.
22. Stern N. The Economics of Climate Change: The Stern Review. Cambridge University Press, 2007.
23. Thiagarajan V, Bhargava SK, Ramesh BM, Nagaraj B. Differences in seasonal performance of twenty-six strains of silkworm, Bombyx mori (Bombycidae). Journal of the Lepidopterists Society. 1993; 47:331-337.
24. Thomas CD, Cameron A, Green RE, Bakkenes M, Williams SE. Extinction risks from climate change, Nature. 2004; 427:145-148.
25. Qadri SMH, Balasaraswathi S, Masilamani S, Thirunavukkarasu T. Field testing of IPM package for the management of mulberry leaf webber *Diaphania pulverulentalis* (Hamp.). In: Sustainable Insect Pest Management (Ignacimuthu. S. and Jayaraj, S. eds.), Narosa Publications, New Delhi, 2003, 266-268.