Awareness on Climate Change and Resilience of Horticulture Crops

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PEST DYNAMICS AND THEIR MANAGEMENT STRATEGIES UNDER CLIMATE CHANGE

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There is a growing concern about the global warming caused by excess emission of several naturally occurring gases like carbon dioxide, methane, nitrous oxide and ozone into the atmosphere, due to human activities. Persistent and significant change in the average pattern of weather in a place for an extended period is known as climate change. Elevated temperatures and carbon dioxide in the environment; occurrence of extreme weather events like floods, drought, uneven distribution of rains, cold waves, heat waves *etc.* will have direct effect on insects or by effecting the host plants.

Pests and climate change

Insects are poikilothermic *i.e.,* their development depends on the surrounding temperatures. As the global climate change is a reality, the change in pest status is inevitable. The distribution and intensity of current key pests may be affected, leading to changed effects on yield and on efficacy of various management tactics likeuse of biocontrol agents, pesticidesetc. The changes in climatic conditions, mainly elevated temperature could profoundly affect the population dynamics and the status of insect pests of various horticultural crops.

Impact of climate change on horticultural crop pests

Various climate change factors might affect the pests either positively or negatively. Various implications of climate change on pests can be categorized as follows under the heads Direct effects and Indirect effects.

1. *Direct effect of climate change on pests*

These effects are those which directly act on the insects mainly by change in the temperatures of the prevailing temperatures in various geographical regions ultimately effecting the insects by

- Expansion of habitat range of pests

- Changes in migrating behaviour
- Changes in over wintering success
- Changes in interaction between species
- Effect of pest-natural enemy interactions

Elevated temperatures due to climate change may limit their range, over wintering, population growth rate, number of generations per annum, length of growing season, crop-pest synchronisation, intraspecific interaction, dispersal, migration and availability of host plants and may alter host physiology and resistance.

2. *Indirect effect through host plants on insects*

These are the effects of climate change which influences the host plants first, which in turn effect the insect and other pests of the crops.

- Effect of increased temperature
- Effect of increased CO_2
- Effect of increased pollutants (ozone and nitrous oxide)
- Effect of changes in host plant distribution

Under high CO_2 conditions, Carbon to Nitrogen ratio will be high in host plants. Pests will be feeding high on these crops for deriving sufficient amino acids. Also, under increased CO_2 levels, insect development may become slow and increase in the length of life stages vulnerable to attack by parasitoids will be more. Some species of aphids (*Brevicorynebrassicae*) produced significantly less offspring at elevated CO_2, whereas the opposite effect was found with *Myzuspersicae* on the same host.

Climate change and pest problems in horticulture – some expected trends

- *Helicoverpaarmigera* is appearing in severe proportions once in 5-6 years may be due to change in the migration behaviour and shift in the host plants as influenced by climate change.

- Whitefly,*Bemisiatabaci*menace has been increasing in the last two decades because of climate change coupled with change in the crop varieties and new agronomic practices. Development of temperature tolerant 'B' biotype is recorded in tomato from Kolar region of Karnataka.The B biotype was first recorded in Kolar district of Karnataka during summer season in the year 1999 and from since then the biotype was spread to various parts of Karnataka and Andhra Pradesh.

- Because of change in temperature regimes, crops and pests may spread into newer areas, where hitherto are not suitable for their development and multiplication. Eg. Fruit fly, *Bactrocera*sp.

- Introduced pests like American leaf miner, *Liriomyza* may spread to new areas northwards with the increase in temperatures particularly, warmer winters.

- Non-indigenous pests may become established initially in protected crops, as lot of plant material is being imported for protected cultivation, particularly ornamentals. Gradually these pests will establish in field crops subsequently, as the climate changes.

- Incidence of thrips has been increasing on onion, rose, grapes and mealy bug on grapes in the recent past.

- Red spider mite, *Tetranychusurticae*, which was considered as minor pests two decades back, has been regularly appearing on crops like tomato, grape and other ornamental crops. This is the pest which likes higher temperatures for its multiplication and will get much benefit with the raising temperatures for its multiplication and more number of generations.

- On mango, extensive rains triggers vegetative shoots and also the incidence of leaf miner, *Rhynchaenusmangiferae*and shoot borer, *Chlumetiatransversalis*.

- Temperature, especially the minimum (night) temperatures positively favour the incidence of fruit fly, *Bactrocera* spp. on mango.

- When flooding takes place in relatively larger area in mango belts, may result in the killing of the resting stages of pests (pupae) like fruit fly and may lower the incidence of these pests in the coming season.

- In India, fruit fly, *Bactrocerazonata* which was generally confined to north Indian conditions, of late is also observed in south India. Till late 1990's this fruit fly was over wintering in north India. But during the last 4-5 years, adults are being observed during winters in Uttar Pradesh most probably because of increase in soil temperatures due to climate change.

- Differential and protracted dry and wet weather mainly due to unseasonal rains in the latter half of 2009, induced off season flowering in mango which affected the hopper, *Idioscopusniveosparsus* negatively. However, if unseasonal rains occur between May-July, resulting in reduced temperatures and elevated humidities, enables weevils to survive in places where they were not surviving earlier (Eg. Rangareddy and Mehbubnagar districts in Andhra Pradesh)

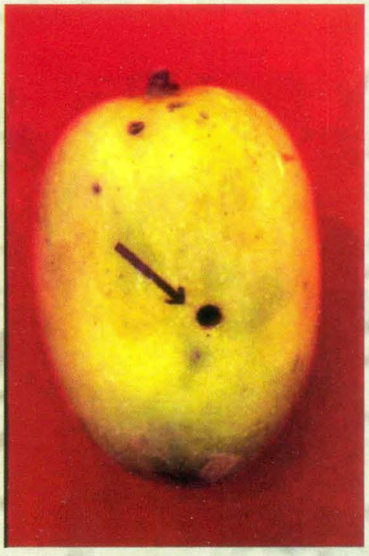
- Higher temperatures (more than 40°C coupled with lower humidity prevents establishment of stone weevil, *Sternochetusmangiferae*on mango.

- Extensive rainfall for a prolonged period followed by dry spells triggers the incidence of red scales, *Aonidiellaaurantia* on rose.

- When high temperature followed by high rainfall, which has happened in 2010 in some parts of Karnataka, resulted in the higher incidence of leaf webber on mango.

- Incidence of diamondback moth, *Plutellaxylostella* has come down and incidence of *Spodopteraexiqua* and *S.litura* infestation has increased on a number of horticultural crops in the past two decades.

- When two species of aphids are existing in the ecosystem, say *LiphaphiserysimiandMyzuspersicaeon* rapeseed-mustard, with the rise in temperature due to climate change, higher incidence of *M. persicae* may be witnessed, an example for changes in interacton between species during climate change.



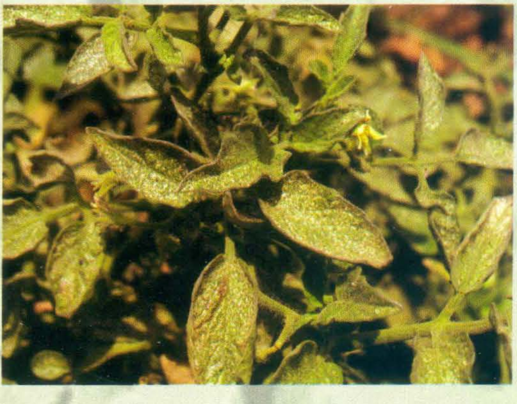
- Temperature and rainfall can influence the efficacy and performance of biocontrol agents like parasites, predators and microbials. With the increase in temperature, predators of aphids on *rabi* crops may become more active than at present. At the same time, many parasitoids may lose the "tracking"ability for the host caterpillars to deposit the eggs due to unsolicited appearance of heavy rains. Some species of aphids are adversely affected due to fungal outbreaks during the rains. Thus the consequence on population dynamics may lead to substantial increase in the use of agrochemicals and related load on the environments.

- Thrips, *Thripspalmi* used to be a pest of mango some years back. It has spread to crops like watermelon and other vegetables. It is also a vector of many plant diseases.

- Climate change during the past eight years has played a critical role in apple pollination failure particularly in Himachal Pradesh. Rains during the flowering season affected the pollination by wind and insects thus affecting the apple yield.

- Sapota borer used to be major pest only in the west coast of Gujarat. Slowly its incidence has started spreading over to S. India, includingdrier belts.

- *Rhipiphorothrips* sp. was the major thrips species on horticultural crops like grapes and rose till late 1980's. From 1990's onwards, this pest was replaced by *Scirtothripsdorsalis*, both on these crops. Probably the changing temperature conditions are more congenial to *S. dorsalis* more than *R. cruentatus* which needs some studies, for establishing the reasons.



- Under dry spells, incidence of termites may increase in both vegetables and fruit crops.

- Under elevated CO_2 conditions, more defoliation by leaf feeding insects may be observed.

- Thrips transmitted diseases/tospovirus on crops such as watermelon, tomato, chilli and other horticultural crops may increase.

- In India, there may be a change in natural distribution range shifts of pests like fruit flies, *Bactocera* sp., green stink bug, *Nezaraviridula*, sweet potato weevil, *Cylasformicarious* which are presently in tropical and subtropical climates and may shift to temperate zone. Some of the pests like blossom midge, *Contariniamaculipennis* (Diptera:Cecidomyiidae) may result in expansion of host range from orchids to various other crops.

- Increase/decrease in soil temperatures at traditional localities may change the incidence of temperate nematode pests such as potato cyst nematode and encourage the nematode spread in the newer areas.

- In general, global warming may work in favour of natural enemies (except for spiders) by increasing the number of generations more than in their host species. However, this can't be made as a general statement, as tritrophic interactions are complex and depends on many other factors.

- Risk of phytotoxicitywith increase in the temperature. Eg. Fish Oil Rosin Soap, though effective for mealybugs may pose the problem of phytotoxicity.

- Problem due to invasive pests will become more than the native species.

- Unexpected rains during flowering season of apple affects the pollination by wind and insects and results in reduced yields. Similarly, pollinator activity will be significantly affected both in vegetables and fruits, in different horticultural crop ecosystems because of climate change.

- The chemical control measures may not be efficient as environmental conditions affect the efficacy of pesticide applications. The moisture status of the plant affects uptake and winds affect coverage. Extreme temperatures may affect the action of the pesticide or may cause phytotoxicity to the plant. Some biological pesticides made from viruses and fungi may be inactivated when exposed to sunlight, fungi and nematodes may require moisture to be effective.

Anticipated pest problems due to drought

- Drought may enhance the incidence of pests like termites, mites *etc.*
- Affects the diapause of insect stages and resulting in abnormal build-up of the pest in the next year.
- Drought stress may result in higher damage to plants due to insects eg. Leaf miners and thrips
- May affect the tritrophic interactions
- May affects the efficacy of biocontrol agents.

Management strategies under climate change scenario

- Increased surveillance of pest and diseases for taking timely plant protection measure is a prerequisite for management of pests effectively.
- Monitoring of pests through species specific pheromone/parapheromones helps in timely initiation for management of pests Eg. Fruit fly pests on mango and cucurbits;*Helicoverpaarmigera* and *Spodopteralitura* on tomato.
- Late-season or early-season pest problems may be avoided by planting shorter season varieties or manipulating the time of planting or harvest particularly in case of vegetables and seasonal flower crops.
- Refinement of the Pest Management technologies suitable for the changing climate situation.
- For the management of mango stem borer IIHR technology of Healer and Sealer may be used along with dichlorvos application.
- Exploring the changes in host-pest interaction under early, normal and late sown conditions in order to recommend optimum sowing dates for reduced pest pressure and increased yield of vegetable crops.
- For the management of termite menace, particularly in orchards, simple management of practice of cleaning of galleries and application of kerosene will bring down the menace.
- Breeding of cultivars for both pest and drought resistance in different vegetable crops is to be taken up.
- For the management of ants in orchards, spray dimethoate + dichlorvos.

- Wherever feasible, going for sprinkler irrigation will minimise the incidence of temperature loving pests like thrips on onion under open cultivation. Temperature regulation by misting of water underpolyhouse conditions minimises incidence of thirps and mites on rose.
- Effective insect vector management has to be initiated for the minimisation of losses due to plant diseases.
- Adjustment of pruning dates for the management of pests like thrips and mealybugs on grapes.
- Use of bio-control agents which have high temperature tolerance or the traits which are required for coping with the climate change situation.