Fruits and Vegetables

TROPIC FRUIT CROPS

1. Biocontrol technology for management of papaya mealybug

- Three parasitoids, *viz.*, *Acerophagus papayae*, *Anagyrus loeckii and Pseudleptomastix mexicana* were imported from USA with the help of Indian Council of Agricultural Research (ICAR) through AICRP-BC & NBAII and National Bureau of Agricultural Insect Resources Important Insects (NBAIRI), Bengaluru, for the management papaya mealybug.
- Three species of parasitoids were mass produced in TNAU and released in the field. Within a period of five months, 300,000 parasitoids were mass multiplied by TNAU and released in farmers field @ 100 parasitoids/village at free of cost in all the 32 districts of Tamil Nadu. This management technology was adopted as a role model and later followed by other states of India**.**
- *Acerophagus papayae* was very effective in reducing more than 95% of mealybug population in almost all released fields as compared to unreleased field. The parasitoids were release at free of cost in all the 32 districts of Tamil Nadu in crops like papaya, mulberry and cassava.
- Due to release of the parasitoid, an amount of Rs. 244.5 crores was benefited annually by not recommending chemical pesticides in Tamil Nadu.
- The parasitoid, *A. papayae* was mass multiplied and released at 1500 adults per acre in Pune and at 1000 adults per acre in Jalgaon, Dhule and Thane districts free of cost during the first fortnight of October, 2010. There was 85-92 per cent decline in the mealy bug incidence in the Pune region, 70 per cent reduction in Thane and 38-40 per cent reduction in the Dhule and Jalgaon regions within three months. The papaya mealy bug was under control within six months after inoculative release of the parasitoid during 2010-11.
- Presently, the parasitoid, *A. papayae* is well established and evenly distributed in papaya orchards in Maharashtra providing effective control of the mealy bug.
- Economic impact analysis of *A. papayae* for the management of papaya mealybug *Paracoccus marginatus* revealed that an amount of Rs. 199 crores was benefitted in Maharashtra due to release of *Acerophagus papayae*.

- Papaya mealy bug, *P. marginatus* infestation was most serious on Papaya, Mulberry and Tapioca in Kerala. The encyrtid parasitoid of the mealy bug, *A. papayae* was introduced in Kerala by the AICRP centre in October 2010.
- Assuming that at least 25 per cent of the 78 lakh homesteads in Kerala is having at least one papaya plant per homestead, the population of papaya plants in Kerala was estimated to be 20 lakhs. Average yield of a papaya plant being five kg and average cost being Rs. 5/kg, the monetary benefits of the introduction of the encyrtid parasitoid was approximately Rupees five crores per annum.
- Mulberry is cultivated in about 300 acres in Kerala, mainly in Idukki, Wayanad and Palakkad districts. During 2009-10 periods. Mulberry cultivation was severely infested by papaya mealybug. Average cocoon production per year is 105000 kg per year at the rate of 350 kg/ acre. At an average cost of Rs. 200/ kg cocoon, the gross income from 300 acres comes to about 2.1 crores. This industry was virtually saved from collapse by the timely introduction of the parasitoid.
- Tapioca is cultivated in an area of 75000 ha in Kerala, with average productivity of 30t/ha. Assuming prevention of yield loss by 5% across 5% of infested area, the introduction of the parasitoid has resulted in annual saving of Rs. 5.6 crores (Cost of tapioca Rs. 10000/t).
- Following the success of the parasitoid in Kerala, it was also released in Lakshadweep in 2012, where again it was successful in controlling the mealy bug infestation.
- The mealybug, *Paracoccus marginatus* population was very low during 2016-17 to 2019-20 due to establishment of the exoctic parasitoid, *Acerophagus papayae* and parasitism up to 80 to 90%.

2. *Metarhizium anisopliae* and *Beauveria bassiana* formulation based biocontrol technology against mango hoppers

- In Tamil Nadu, three sprays of *Metarhizium anisopliae* @ $1xl0^9$ spores/ml (liquid formulation) sprayed during off season at weekly intervals recorded low mango hopper population of 31.6/ inflorescence with increased fruit set of 474.1 kg /tree and was on par with imidacloprid 0.3 ml/lit at pre-flowering stage with a mango hopper population of 15.6/ inflorescence and a fruit set of 496.9 kg/tree.
- *Beauveria bassiana* and *Metarhizium anisopliae* formulations were tested for their bioefficacy against hoppers, thrips and leaf webbers. *B. bassiana* and *M. anisopliae* formulations were tested against mango leaf webber and both the treatments were found on par at 7 days after the spray with 5.65 and 5.90 live webs/tree, respectively.

- In Maharashtra, spraying of *M. anisopliae* @ 1×10^9 spores/ml during off-season in the month of December followed by four sprays of the pathogen mixed with adjuvant (sunflower oil 1 ml/lit + Triton- X 100 @ 0.1 ml/lit) at weekly interval during flowering was superior over other treatments in suppressing the hopper population and increased fruit setting. The mean surviving population recorded as 11.0 hoppers and the fruit set was 11.8 per inflorescence against 54.4 hoppers and 6.0 fruit set per inflorescence in untreated control.

- In Kerala, *M. anisopliae* treatments caused significant reduction in the population of mango hoppers compared to control, with reduction ranging from 40 to 57.4 per cent over pre count. The results indicated that the oil formulation of *M. anisopliae* was significantly superior to both liquid and talc formulations.

3. Biological control of Root knot nematode of Pomegranate

- In Maharashtra, soil application of *Paecilomyces lilacinus* @ 20 kg/ha + organic manure found most effective in reducing the root knot nematode population (31.7%) and root galls/5 g roots (25.4%) and increased 15.6% fruit yield of pomegranate with 1: 17.3 ICBR. The technology was transferred to the pomegranate farmers in Nasik district in Maharashtra through demonstrations.

4. Bio pesticide based management of root-knot nematode in Guava

- Neem cake @ 50g/ 2 kg soil and CISH biopesticide @ 50g/ 2 kg soil were the best treatments, which significantly reduced root-knot index and increased plant growth as compared to control.

5. *Beauveria bassiana* formulation based biocontrol technology against Banana fruit and leaf scarring beetle

- Filling of banana leaf axil with *Beauveria bassiana* @ 5ml/lit reduced the population of fruit and leaf scarring beetle, *Nodostoma subcostatum* (9.10 /plant) with maximum per reduction (47.24%) over control. Cholropyrifos 20 EC @ 2.5ml/lit was significantly on par with the *B. bassiana* registering same level of beetle population (9.11/plant) and reduction (47.24%), respectively.

TEMPERATE FRUITS

1. Biological control of apple root borer, *Dorysthenes hugelii* in Himachal Pradesh

- Biological control of apple root borer by the use of *Metarhizium anisopliae* (10^{12} conidia/ cm^2 each) was demonstrated to the farmers in Shimla district, Kullu, Kinnaur and Lauhal and Spiti by YSPUHF, Solan. ***M. anisopliae* was used as substitute to chlorpyriphos (0.06%) which saved approximately Rs.15000/- per hectare, besides being eco-friendly and safe to the non-target organisms.**
- Soil application of *M. anisopliae* treatment resulted in 67.8 to 78.4% mortality of the apple root borer grubs in different orchards of Himachal Pradesh, while in chlorpyrifos (0.06%) treated plots showed mortality of 76.4 to 88.6%.

2. Biological control of apple codling moth

- Release of *Trichogramm cacoeciae* @ 2.5 lakh/ha (4 releases/ season) + Trunk banding + disposal of infested fruits + Pheromone traps+ spray of *Heterorhabditis pakistanense* (NBAIR isolate) was found to be best for the management of apple codling moth which provided 52.31% pest reduction in Jammu and Kashmir.

3. Biological control of apple mites

- Release of predatory bug, *Blaptostethus pallescens* @ 200 bugs/ plant against European red mite, *Panonychus ulmi* and two spotted spider mite *Tetranychus urticae* on apple reduced the pest population to the extent of 41.88 to 48.61 %, respectively.

VEGETABLES

1. BIPM module for pests of okra in Gujarat (AAU-A)

- BIPM consisting of timely sowing of the crop along with soil application of bio-nematicide, *Paecilomyces lilacinus* (1 x 10^8) @ 25 kg/ha, installation of pheromone traps @60 / ha, spraying of *Bt* (5 x 10^7 spore/mg) (1.5 kg/ha) and *Beauveria bassiana* (2x10^8 cfu/g) @30g/10 lit for the management of *Earias* spp. and *H. armigera*. Maximum fruit yield (110.78 q/ha) was harvested from BIPM practiced plots and the maximum net realization (Rs. 28344/ha) with higher ICBR (1: 3.48) was found in BIPM module than the module of farmer practices (Rs. 16060/- net realization with ICBR as 1: 2.55). BIPM modules are being practiced by many farmers.
- Three sprays of *B. thuringenises* @ 1 litre/ha was as effective as chlorpyriphos 0.04% in suppressing the pest population and damage caused by *Earias vitella* on okra.

2. BIPM for management of brinjal shoot and fruit borer in Assam (AAU-J)

- Two sprays of *Bt* formulation (delfin) @1 kg/ha, three releases of *T. chilonis* @ 100,000 / ha / week and installation of pheromone trap @ 15 / ha were found effective against Brinjal fruit and shoot borer, *Leucinodes orbanalis*. The technology was transferred to the farmers through KVK, AAU, Jorhat.
- In Brinjal, the percent fruit damage was significantly lower in the biocontrol field in comparison to farmer practice plots. Similarly the percent shoot damage was also significantly lower in the biocontrol field in comparison to farmer practice plots in U.P., Kerala, Tamil nadu, Gujarat and Arunachal Pradesh.
- Three sprays of *B. thuringenises* @ 1 litre/ha was as effective as chlorpyriphos 0.04% in suppressing the pest population and damage caused by *L. orbonalis* in brinjal.

3. Bio-intensive package for the pests of cole crops in Tamil Nadu (TNAU)

- IPM package comprising of fine pulverized mica (0.2%), release of *Chrysoperla zastrowi sillemi* (5 larvae/ plant), growing of boarder rows of mustard, spray of neem (1500ppm; 3ml/L) and *Bt* (1Kg/ha) along with mechanical destruction of egg masses and early gregarious larval instars of *Pieris brassicae* was effective for the management

of *Pieris brassicae* and *Brevicoryne brassicae* in cauliflower. **This technology reduced the pesticide sprays from 5 applications to one.**

- In cabbage, efficacy of BIPM practice was significantly superior in reducing the population of DBM by recording 0.46 larvae/plant after three rounds of Entomopathogenic fungus spray, while it was 1.62 and 7.66 larvae /plant in chemical treatment and control plot, respectively.

4. BIPM for management of Tomato sucking pests

- In Tomato, BIPM treatment recorded lowest sucking pests population *viz.*, whitefly 0.27/leaf, aphid 0.20/leaf, jassid 0.23/leaf and leaf miner 0.97/leaf followed by chemical module, However, lowest fruit damage by its borer complex was recorded in chemical control module (1.57%) followed by BIPM module (3.33%) in UP, Tamil Nadu, Gujarat, and Punjab.

5. Bio-intensive package for the management of chilli and Cucumber whitefly

- In Chilli and Cucumber, application of buprofezin 25SC ranked best in controlling the whitefly followed by *Lecanicillium lecanii* (NBAIR strain). Among the biopesticides, *L. lecanii* (NBAIR strain) was significantly superior in reducing the whitefly population and was on par with azadirachtin 10000 ppm.