SUSTAINABLE MANAGEMENT OF PAPAYA MEALYBUG IN SMALL SCALE PAPAYA FARMING SYSTEM ASSOCIATED WITH PAPAIN INDUSTRY IN TAMIL NADU, INDIA

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Papaya cultivation taken up by about 550 farmers of small holdings of 1-2.5 acres in Tamil Nadu are supplying latex to Senthil Papain and Food Products Ltd (SPFP), Coimbatore, for papain production since 2004. The onslaught by the new invasive papaya mealybug(PMB)- *Paracoccus marginatus* Williams and Granara de Willink) in 2006 seriously affected papaya crop (Regupathy, A. and Ayyasamy, R. 2010 causeing major concern in papain production in 2010(Regupathy, A. and Ayyasamy, R. 2012) . The need for repeated application of insecticides and dearth of labour for application of insecticides made it difficult for the farmers to maintain the crop and forced many farmers to even abandon papaya crop cultivation altogether (Ayyasamy and Regupathy, 2010 ;Regupathy, A. and Ayyasamy, R. 2009) . Considering the serious threat posed to cassava ,silk and papain industries affecting tapioca,mulberry and papaya apart from other field crops like cotton, strategy planning was made in *National Consultation meeting on Strategies for Deployment and Conservation of Imported Parasitoids of Papaya Mealybug* . on Ocober,10, 2010 National Bureau of Agriculturally Important Insects, Bangalore (Rabindra and Shylesha, 2011). As a follow up NBAII (National Bureau of Agriculturally Important Insects, Bangalore) imported three specific parasitoids *viz.,Anagyrus loecki* Noyes, *Acerophagus papayae* Noyes and Schauff, and *Pseudleptomastix mexicana* Noyes and Schauff (Hymenoptera: Encyrtidae) through USA consulate at New Delhi (Mark Gilkey) and Dr.R. Muniappan, Director- IPM, CRSP and reared in quarantine laboratory of NBAII for inoculative releases. Inoculative releases of the parasites multiplied in NBAII and Department of Entomolgy, Tamil Nadu Agricultural University (TNAU) done during 2010 in the papaya fields of severe PMB infestation, subsequent monitoring after every 18 days to see the emergence of *A.papayae*, and *A.loecki* and 25 days in case of *P. Mexicana as* per the protocol prepared by NBAII, and the follow up survey for parasitization 3 and 6 months after initial release of the parasitoids indicated the effectiveness of *A.papayae* and desirability of this parasitoid for furthering the PMB control programme (Ayyasamy and Regupathy, 2012.). To equip with required knowledge and technology , field staff of SPFP were deputed for the training progrmme organized on October, 30, 2010 by NBAII on management of PMB and deployment of introduced parasitoids and mass multiplication during February, 2011in the Department of Entomology, Tamil Nadu Agricultural University(TNAU .), Coimbatore. Mass multiplication at field level was accomplished by SPFP availing heavily infested fields. Initial releases of the parasitoids obtained from NBAII/TNAU were concentrated in heavily infested papaya fields . Despite of the fact that the heavily infested papaya fields were non-productive, the farmers cooperated to retain the crop for three more months for establishing the parasitoids. Though for classical biocontrol programme , carpet coverage is not needed, in the anxiety to revive wet latex production on fast track , steps were taken by SPFP for quick and fast spread of the parasitoids in various clusters of the fields in different areas. Farmers adjacent to fields where mass production of parasitoids in field level has been taken up, were encouraged to carry the parasitzed infested fruits and leaves and fix them in their infested fields facilitating farmers for dissemination from mass field multiplication. SPFP assisted by providing logistic support through their field staff. By regular visits, field staff of SPFP educated the farmers on the the need for conservation of the released parasitoids and naturally occurring predators like *S.epius* and coccinellids by avoiding the use of chemical pesticides on papaya .PMB was successfully controlled due to availability of effective and specific biological control agent, ideal crop niche, non intervention of insecticide application and excellent industry-scientists-farmer linkage (Regupathy and Ayyasamy, 2012). *P. marginatus* incidence was as low as 7-33 per cent with very low intensity in parasitoid released fields compared to cent per cent incidence with very high intensity in abandoned fields. Avoidance of insecticide spraying resulted in the appearance of notable number of biocontrol organisms in papaya fields in Tamil and enhanced biodiversity (Regupathy and Ayyasamy, 2011).

As PMB has wide green bridge of more than 50 host plants consisting field crops, avenue trees and weeds (Regupathy, A. and Ayyasamy, R. 2010)and crop-mosaic is the crop pattern in small scale farming system , continuous monitoring was done for the incidence of PMB on papaya , so that farmers could be suitably advised to release parasitoid avoiding insecticide application. On getting the report on the incidence of any other pest and disease from the farmers who visit latex collection centres twice in week for supplying latex, the field staff visits and assess the nature of the pest and disease and the intensity of attack .Recently the incidence of PMB was observed during March-June 2013 in certain fields due to warm weather prevailed in drought conditions and scanty rainfall in 8 fields .The severe incidence of spiraling whitefly, *Aleurodicus dispersus* Russell was reported in three fields. Congregation of nymphs and adults were observed on papaya leaves and fruits .Low incidence of PMB was also observed along with white fly. The sooty mould was observed on the leaf surfaces. The *A. dispersus* incidence was observed on neighbouring guava and cotton fields as well. Papaya ring spot virus (PRSV) disease was observed in 12 fields to the extent of 5- 100 per cent. PRSV (family *Potyviridae*, genus *Potyvirus*) is transmitted by several species of aphids such as *Aphis nerii* Boyer de Fonscolomb, *Aphis gossypii* Glover, *Aphis spiraecola* Pagenstecher ,*Myzus persicae* Sulz., *Toxoptera aurantii B.de*.F ,*Aphis craccivora* Koch, and *Rhopalosiphum maidis* Fitch. in a non-persistent manner . *M. persicae* (56%) and *A. gossypii*(53%) were significantly more efficient in transmitting PRSV than than *A.craccivora* (38%) (Kalleshwaraswamy and Kumar 2008). The incidence of leafcurl virus (LCV) transmitted by whitefly and *Bemisia tabaci* Gennadius was observed in 8 holdings to the extent of 1-8 per cent. In one field the disease was exceptionally high to the extent of 60 per cent. Disease symptoms caused by mycoplasma like organism vectored by leafhoppers were observed in two fields ; the extend being less than 1 per cent. Occurrence of a new invasive Jack Beardsley mealybug, *Pseudococcus jackbeardsleyi* Gimpel and Miller (Hemiptera: Pseudococcidae) on papaya in India had been reported (Mani et.al., 2013).Mealybug samples collected periodically were sent to TNAU for confirmation. So far the occurrence of *P. jackbeardsleyiwas* not observed in papaya fields associated with SPFP.Monitoring for this mealybug is continued.

Application of bufrofezin 25 EC 1 ml/ l (Applaud) / acepahate 75 SP 2g/l (Asataf)/ imidacloprid 17.8SL 0.5ml/l(Tatamida)or acetamiprid 20SP 0.5ml/l(Manik) after removing the heavily infested lower leaves effectively checked the whitefly. Under these circumstances, farmers are advised to release parasitoid *A.ppayae* 1 0 days after application of insecticides to manage whitefly and to sustain PMB control through parasitoid. Field staff of SPFP Coimbatore assist the farmers in getting parasitoid from TNAU which is multiplying and supplying the parasitoids free of cost on request by the farmers.

As none of the vectors of PRSV, LCV and MLO colonize on papaya, application of insecticides for the control aphids, whitefly and leafhoppers not recommended. Further spread of PRSV,LCV and MLO diseases was avoided by early detection and phytosanitation. Spraying any of the insecticides,dimethoate 30EC (Tafgor)2ml/l / acepahate 75 SP 2g/l (Asataf)/ imidacloprid 17.8 SL 0.5ml/l(Tatamida)or acetamiprid 20SP 0.5g/l(Manik) on diseased plants (not the entire field.) two days before pulling out of these plants to prevent the vector dispersal is adopted by the farmers.

The extent of PRSV disease varies depending on the intensity of the chlorosis symptom, i.e. loss of chlorophyll and photosynthetic area. Indian Institute of Horticultutal Research, (IIHR), Bengaluru recommends raising barrier crop with sesbania, banana, castor etc to prevent the alighting of aphids with virus inoculums landing on papaya in hot spot and endemic areas. To improve the yield in the infested garden, the best option is through supplementation of nitrogen and micronutrients especially boron and zinc and through microbial intervention. IIHR has developed Arka Microbial Consortium (N fixer, P solubilizer and Growth promoters) to improve yield and soil health on PRSV affected papaya . In a preliminary observation trial application of the commercial products RalliGold (unique Mycorrhizal rooting stimulant containing humic acids, VAM, Kelp, vitamins and amino acids.) @ 8 kg / acre, followed by application GlucoBeta (organic Supplement for major Primary, Secondary and Micro nutrients) @10 kg/acre 15-20 days after improved the yield of PRSV affected crop.

PMB is the major concern and priority is given to maintain parasitoid *A.papaye* which effectively keeps PMB under check. While managing other pests or vectored viral diseases as far as possible the intervention by insecticide application is avoided or restricted by spot application to conserve the *A.papaye* established through the successful classical biological control programme. If need the,release of *A.papaye* in insecticide applied field is followed.

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