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CITRUS MEALY BUG (*PLANOCOCCUS CITRI* RISSO) MANAGEMENT - A REVIEW

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ABSTRACT

Mealy bugs are destructive to citrus causing severe losses in Peninsular and North-Eastern India. Apart from citrus, mealy bugs attack curry leaf plant, cotton, banana, coffee, cocoa, ginger, mango etc. The citrus plants of all the ages even the pruned young citrus seedlings in cage house and nursery besides grown-up trees are attacked by mealy bugs. Besides arresting the plant growth it also causes leaf and fruit drop. Various methods of control like mechanical, cultural, chemical, biological and use of pheromones and IGR's which have been tried against the pest world over have been reviewed in this article. Development of forecasting models, working out ETL levels (location and species-wise), correlation of weather parameters with population dynamics etc. have been visualized as the future research strategies.

Mealy bugs pose a serious threat for the cultivation of many fruit crops. It occasionally attains epidemic forms in citrus. A total of nine mealy bug species are reported on citrus. Among them, *Planococcus citri* (Risso) is destructive causing severe losses to citrus in peninsular India (Mani and Krishnamoorthy, 1996) and North-East region (Pathak *et al.*, 1999). *P. citri* is found to be economically important pest of Khasi mandarin in Meghalaya (Shylesha and Pathak, 1999) and Kinnow in Punjab (Arora *et al.*, 1999). The incidence of the pest is observed in some pockets of Nagpur mandarin with low to medium level in central India (Kalidas and Shivankar, 1994). Lately, the pest has been gaining ground in the prime land of Nagpur orange i.e. Morshi, Paratwada Talukas of Amravati District (Shivankar and Rao, 2004 Personal observation).

HOST RANGE: The mealy bugs are known to feed on a number of plants, often not closely related to citrus. It is of common occurrence on curry leaf plant, *Murraya koenigii* Lin., *Poinsettia* spp. and other flowering plants (Atwal, 1976). It also attacks annona, arabica, robusta coffee, cotton, banana, carambola, cocoa, ginger and mango (Jayma and Ronald, 1992).

DAMAGE: The pest feeds on the new leaves, flowers, stem end of small fruits and also on the big fruits, making them drop prematurely. Heavy infestation is observed during the month of April-May. The citrus plants of all the ages even the pruned young seedlings in cage house and nursery, at joints of leaves or two branches besides grown up trees were found invariably attacked by the pest (Jadhav and Pujari, 1999).

Injuries like split bark along the stem of the declining trees appeared to be the preferred site of attack. Nymphs and females usually feed on underside of the leaves causing heavy damage to nursery and grown up plants. At times the citrus flowers do not set fruits due to severe infestation. The young berries are found dead before they grow turning black or dark red. The mealy bugs also excrete honey-dew on which a black mould grows which interferes with photosynthesis. Black ants also are attracted to the honey-dew and become a nuisance. The leaves appear crinkled due to its feeding. Horticulturally important feature, such as variegation can increase the abundance of the pest (Bindra, 1970; Mani and Krishnamoorthy, 1996).

SEASONAL INCIDENCE: In central India, the pest incidence was heavy during

February-May (74.89 to 100%) and low during monsoon August-October (57%). Heavy infestation during April-May causes more than 50% per cent fruit drop of *Ambia* (Shivankar and Shyam Singh, 2000). In NEH region, 2.95-74.3% infestation was recorded on various citrus species (Pathak *et al.*, 1999). Tree strata (0-0.91, 0.92-1.83 and 1.84-2.74 m) or quadrant (N, E, S and W) has little effect on the population size of mealy bug and that fruit was the optimum sample unit for indexing population densities; underneath the calyx is the best place to search when there are extremely low population densities (Meyerdirk *et al.*,1981). The weather parameters *viz.*, maximum and minimum temperatures, relative humidity and rainfall did not show any significant relationship with the mealy bug population (Mani and Krishnamoorthy, 1999).

BIOLOGY: The adult female is wingless, with a flattened thick body and short, waxy filaments along the margins covered with white mealy powder. They are found during January to April and descend down to the ground in April- May. The females lay yellow eggs in soil within ovisac. There may be 300-800 eggs in one mass. The eggs hatch in 10 to 20 days and the amber colour nymphs crawl out and start feeding by inserting their mouthparts in the lower surface of the leaves. A waxy white covering and filaments are soon formed on their bodies. A female nymph is full-grown in six to eight weeks with 3 moults. The male is winged, greyish in colour, midge-like with long antennae and has no mouthparts; consequently, it does not feed. The male nymphs spin cotton-like cocoons, two or three weeks after hatching and pupate before transforming themselves into winged adults with 4 moults, completing 3 overlapping generations in a year (Bindra, 1970).

MANAGEMENT

MECHANICAL AND CULTURAL: 1) Pruning of affected shoots during winter, opening up of the canopy from the centre to allow sufficient sun light interception below the canopy 2) Destruction of ant colonies in the orchards as they act as the carriers of mealy bugs to their feeding sites 3) Raking the soil around trunk during summer months helps in the desiccation of eggs and exposing the mealy bugs to natural enemies 4) Sticky band of 7-8 cm should be smeared around the trunk at about 0.5 meter height from ground during second week of December since it traps the ascending nymphs; these bands should be renewed whenever necessary 5) Debarking and destruction of the harbouring population also helps in checking the pest (Shivankar and Shyam Singh, 2000). Smearing an adhesive material around the trunk can be combined with other methods into the integrated mealy bug management (Michelakis *et al.*, 1995).

TOLERANCE: On screening citrus germplasm against mealy bug, three micro propagated varieties in Meghalaya *viz.*, Assam lemon (*Citrus limon*), Satkara (*C. macroptera*) and Pumelo (*C. grandis*) were found to be highly resistant to *P. citri* (2.95% to 17.72% leaf infestation), which can be used as rootstock in multiplication programmes. Two more varieties namely, Soh bitara (*C. sinensis*) and Sweet lime (Sour mutant) (*C. limmettioides*) were moderately resistant (20.65% to 30% leaf infestation). Indian wild orange, *C. indica* shows moderate susceptibility. The varieties Jaintia lemon *C. limon,* Khasi papeda *C. latipes*, Adajamir *C. assamensis*, Volkamer lemon *C. volkameriana*, Khasi mandarin *C. reticulata* and Sohmyndong *C. jambhiri* are highly susceptible to *P. citri* and suffered 61.2% to 74.3% foliage infestation (Pathak *et al.*, 1999).

CHEMICAL: The intervention threshold for *P. citri* on Nagpur mandarin was reported to be 5 - 10% infested fruits in summer and 15% infested fruits in autumn (Shyam Singh *et al.*, 2002). Spraying of dimethoate @1.5 ml + kerosene oil @ 2.5 ml

in 1 litre of water or Carbaryl @ 1 ml + Kerosene oil @ 1 ml or Malathion @ 2 ml in 1 litre of water checks mealy bugs effectively. Spraying with chlorpyriphos 0.05%, Carbaryl 0.1 % or fenitrothion 0.05% (Jadhav *et al.*, 1997) and also with 2 ml of dichlorvos + 25g of fish oil rosin soap/ litre water resulted in 75% reduction in mealy bug population. Since the pest harbours under the loose bark, debarking followed by pasting with chlorpyrifos and methyl parathion (both at 4 ml/lit) helps in minimizing the pest population (Mani and Krishnamoorthy, 1996). Crawler settlement on the plant was reduced by Carbaryl swabbing (1%) undertaken for trunk borer management (Shylesha and Pathak, 1999).

Citrus oil mixed with chlorobenzilate is effective against first-instar nymphs of the pseudococcid in an integrated control programme (Meyerdirk *et al.*, 1981). Neem oil and pongamia oil (both at 4%) are effective against *P. citri* (Hessian *et al.*, 1996).

BIOLOGICAL: *Anagyrus* sp., *Blepyrus insularis* (Cam.), *Diversinervus* sp., *Tetrastichus* sp., *Microterys* sp., *Cryptochaetum* sp., *Scymnus coccivora* Ayyar, *Pullus pallidicollis* Mst., *Nephus* sp., *Chrysopa* sp., *Micraspis cardoni* (Wse.), *Pseudaspidimerus uttami* Kap., *Cryptolaemus montrouzier* Muls. and *Spalgis epius* Westwood were recorded in Kodagu, Karnataka (Singh, 1990). *Coccidoxenoides peregrinus* (Timberlake) (Krishnamoorthy and Mani, 1989b), *Mallada boninensis* (Okamoto), *Plesiachrysa lacciperda* (Kimmins), *Anisochrysa basalis* Walker and *Chrysoperla carnea* (Steph.) (Krishnamoorthy and Mani, 1989a) were recorded in Karnataka. In Assam, *C. montrouzieri* and *Entomophthora fumosa* Speare were observed on *P. citri* (Chowdhury and Majid, 1954).

Predators: The exotic natural enemy, Australian ladybird beetle, *Cryptolaemus montrouzieri* (Muls.) is used (20/plant) against mealybugs (*P. citri, Nipaecoccus viridis, Maconellicoccus hirsutus* Green) attacking acid lime, lemon and mandarins in Karnataka and Tamil Nadu (Mani and Krishnamoorthy, 1996). *C. montrouzieri* consumed an average of 3330.6 eggs of *P. citri*. Eggs of mealybug as well as other stages are essential in the diet for successsful development of the predator (Oncuer and Bayhan, 1982). The number of eggs laid by *C. montrouzieri* was largest at 20^{0}C which decreased progressively with increase in temperature. It was multiplied and released @ 30/plant for the suppression of the spherical mealybug, *N. viridis* on acid lime (Mani and Krishnamoorthy, 1999). The chrysopids, *Mallada boninensis* (Okamoto) *Chrysopa lacciperda* (Kimmins) [*Plesiochrysa lacciperda*], *Anisochrysa basalis* (Walker) [*M. basalis*] and *Chrysoperla carnea* (Stephens) can be used to control pseudococcids, *P. citri* (Krishnamoorthy and Mani, 1989a).

Parasitoids: *P. citri* is usually attacked by two encyrtid parasitoids, the exotic *Leptomastix dactylopii* Howard and the indigenous, *Coccidoxenoides peregrinus* (Timkerlake). However, *C. peregrinus* is more abundant causing 10-30% parasitism (Mani, 1994). Although, the encyrtid attacks other mealybugs, development was successfully completed only on *P. citri*. All nymphal instars, including crawlers and both sexes, are attacked (Krishnamoorthy and Mani, 1989b). *N. viridis* is also attacked by the encyrtids, *Anagyrus agraenis* Saraswat, *L. dactylopii* and *A. mirzai* Agarwal. The impact of these natural enemies on the population of spherical mealybug was moderate (Mani and Krishnmoorthy, 1999). A parasitic wasp, *Prospatella perniciosi* (Tower) has been successfully established in Kashmir where it has given fairly effective control of *P. citri*.

A parasitoid, *L. dactylopii* was introduced into India in 1983 on mandarins. It became established within 2 months causing

up to 100% parasitism (Krishnamoorthy and Singh, 1987). Both the adult beetle and larva feed voraciously on all stages of mealybugs but it does not do well in severe winter. The parasitoid could disperse over a distance of 5 km from the release site (Mani, 1994). Field release of the parasitoid, *L. dactylopii* @ 5000-7000 adults/ha gave complete control of *P. citri* within 3-4 months (Krishnamoorthy and Mani, 1994). It is able to control *P. citri* but has to be released periodically since it cannot survive in winter (Longo and Benfatto, 1982).

PHEROMONES: Synthetic pheromone [(1R-cis)- 2, 2-dimethyl -3-(1-methylethenyl) cyclobutyl methyl acetate] at doses of up to 19 mm g/108 cm3 on discs of filter paper in petri dishes elicited positive responses from males, but higher doses resulted in reduced response. The half-life of the synthetic sex pheromone of *P. citri* in the field was about 2 weeks with the maximal male catches by the doses of 400-700 mg (Hefetz and Tauber, 1990).

IGR: Buprofezin, an insect growth regulator, showed strong ovicidal activity resulting in over 80% inhibition of egg hatch and 91 - 99% nymphal mortality (Mendel *et al.*, 1991).

FUTURE LINE OF RESEARCH

Studies on identification of hot spots for citrus mealy bugs and working out location wise/crop wise economic threshold/action threshold levels is the need of the hour. Correlation of weather parameters and pest population is an important pre requisite for preparing pest forecasting model based on which pest incidence can be predicted, so that an effective pest management strategy can be planned in advance to prevent the pest reaching an action thresholed level. Indepth studies on hyper parasitism as well as tri-trophic interactions help in understanding the general equilibrium level of insect pest- natural enemy complex. A detailed comprehensive study regarding various combinations of pest management tactics including cultural, mechanical, chemical, biological would help in evolving IPM schedule for citrus mealy bugs. Development of molecular markers for the resistant cultivars/root stocks against citrus mealy bug is the pre requisite in the development of mealy bug resistant transgenic citrus plants which is an important aspect of future study.

REFERENCES

Arora, P.K. *et al*. (1999). In: *Proceedings International Symposium on Citriculture* held at Nagpur during Nov. 23-27th, 1999, pp. 931-934.

Atwal, A.S. (1976). In: Agricultural Pests of India and South East Asia. Kalyani Publishers, Ludhiana, pp. 195-213.

Bindra, O.S. (1970). In: Citrus Decline in India, Jt. Publi. of PAU/OSU/USAID, Ludhiana, Punjab.

Chowdhury, S. and Majid, S. (1954). *Hand Book of Plant Protection*. Dept. Agri., Assam Publication, Shillong, pp. 177.

Hefetz, A. and Tauber, O. (1990). *J. Appl. Ent.*, **109**: 502-506.

Hessian, M.A. *et al*. (1996). *Insect Environment*, **2**: 73-74.

Jadhav, V.B and Pujari, C.V. (1999). In: *International Symposium on Citriculture* held at Nagpur during Nov., 23-27th, 1999, pp. 902-904.

Jadhav, V.B. *et al*. (1997). In: *Proc. National Symp. on Citriculture* held at Nagpur during Nov. 17-19th, 1997, pp. 362-363.

Jayma L. Martin and Ronald, F.L. Mau (1992). Citrus Mealy bug, *Planococcus citri* (Risso). In: Crop Knowledge Master. http://www.extento.hawaii.edu/kbase/crop/type/p_citri.htm.

Kalidas, P. and Shivankar, V.J. (1994). In: Final report of the project "Studies on Chemical Control of Insect Pests of Nagpur Mandarin with Special Reference to Citrus Blackfly, psylla and leaf miner," NRCC, Nagpur, pp. 35.

Krishnamoorthy, A. and. Mani, M. (1989a). *Curr. Sci.*, **58**: 155-156.

Krishnamoorthy, A. and Mani, M. (1989b). *Curr. Sci.*, **58**: 466.

Krishnamoorthy, A. and Mani, M. (1994). *Indian Hort.*, **39**: 12-13.
Krishnamoorthy, A. and Singh, S.P. (1987). *Entomophaga.*, **32**: 143-148.
Longo, S. and Benfatto, D. (1982). *Informatore Agrario.*, **38**: 19671-19676.
Mani, M. (1994). *J. Ento. Res.*, **18**: 351-355.
Mani, M. and Krishnamoorthy, A. (1996). *Indian Hort.*, **41**: 43-45.
Mani, M. and Krishnamoorthy, A. (1999). In: *Abstracts International Symposium on Citriculture* held at Nagpur during Nov. 23 – 27th, 1999, pp. 116.
Mendel, Z. *et al.* (1991). *Phytoparasitica.*, **19**: 103-112.
Meyerdirk, D.E. *et al.* (1981). *Southwestern Entomologist*, **6**: 49-52.
Michelakis, S. *et al.* (1995). *Israel J. Ento.*, **29**: 277-284.
Oncuer, C. and Bayhan, N. (1982). *Turkiye Bitki Koruma Dergisi*, **6**: 85-90.
Pathak, K.A. *et al.* (1999). In: *Proc. Intl. Symp. on Citriculture*, held at Nagpur during Nov. 23-27th , 1999, pp. 956-960.
Shivankar, V.J. and Shyam Singh (2000). In: Citrus Insect Pests. NRCC Publication, Nagpur, pp. 252.
Shyam Singh *et al.* (2002). In: Citrus 1001 Questions and Answers. Kalyani Publishers, New Delhi, pp. 226.
Shylesha, A.K. and Pathak, K.A. (1999). In: *Proc. National Symp. on Citriculture*, held at Nagpur during Nov. 17-19th , 1997, pp. 332-334.
Singh, S.P. (1990). In: *Proceedings of the Indo-USSR Joint Workshop on Problems and Potentials of Biocontrol of Pests and Diseases* held at Bangalore during June 26-28, 1990, pp. 294.