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A review on integrated pest management in medicinal and aromatic plants in India

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Abstract
The trend of poor health index of all age groups is increasing across the world due to various reasons and incidents of death due to non communicable diseases are rising at an alarming rate. Hence, the opportunities which are available in ancient medical systems are being stressed upon to take into account an individual's total internal, social and external environment while considering disease prevention, promotion and treatment. Therefore, medicinal and aromatic plants play an important role in achieving the goal of personal and public health care globally. Since antiquity, these medicinal and aromatic plants have been conserved and protected for their medicinal properties and hence Indian sub-continent is a rich repository of these plants. However, several biotic factors like insects, mites, disease causing organisms, nematodes and abiotic factors limit the successful cultivation of these plants in vast areas as well in new areas. Among these factors insects and mites are key components that cause considerable damage to these plants and sometimes the entire crop could be lost due to their increasing population. Hence, conservation and protection of medicinal and aromatic plants from the ravages of pests is a daunting task. As the chemicals used for the management of pests are toxic and could depreciate the therapeutic values of these plants, their use needs utmost care. Integrated pest management is the best strategy that could be tapped upon as it involves monitoring of pest populations below economic threshold levels, identify and choose combination tactics to keep the pest population at bay. These include cultural, mechanical, physical, biological and chemical management methods in combination or alone to arrest the pest population.

Keywords: Medicinal, aromatic, integrated pest management

Introduction
Medicinal and aromatic plants play an important role in achieving the goal of personal and public health care globally as the trend of poor health index across all age groups around the world and the incidents of death due to non communicable diseases are rising at an alarming rate. Since antiquity, these medicinal and aromatic plants have been conserved and protected for their medicinal properties and hence Indian sub-continent is a rich repository of these plants. Like any other plant, medicinal and aromatic plants are attacked by a plethora of insect and mite pest species that depreciate the quality and quantity of raw materials and the therapeutic values in these plants. A quick review into the literature indicates that *Henosepilachna vigintioctopunctata* and *Phenacoccus solenopsis* as major pest of ashwagandha, *Psilogramma menephron* on sarpagandha, *Syngamia abruptalis* on mint, *Papiliomachaon* and *Hyadaphis coriandri* on *Anethum graveolens*, *Polytela gloriosae* on *Gloriosa superba*, *Spodoptera litura on brahmi*, *Helicoverpa armigera*and *Plusia orichalcea on kalazira*, *Parasaisettia nigra* on kalmeg and among mites the predominant mite species attacking medicinal and aromatic plants are *Tetranychus urticae* and *Brevipalpus* spp.
Use of chemical pesticides will not only leave toxic residues in the plant system, but also cause environmental pollution. Therefore, environmentally safe integrated pest management is the best strategy that could be tapped upon as it involves monitoring of pest populations below economic threshold levels, identify and choose combination tactics to keep the pest population at bay. These include cultural, mechanical, physical, biological and chemical management methods in combination or alone to arrest the pest population. The practices or the tactics used to manage these pests on medicinal and aromatic that could be integrated and are eco-friendly

are discussed in this review.

Integrated pest management of medicinal and aromatic plants

Indian gooseberry

Least population density of *B. stylospora* (11 larvae per 10 trees) in resistant cultivars of gooseberry versus 27 larvae in local, *G. acidula,* 8 larvae versus 28 larvae in local, 1 hole due to *I. quadrinotata* versus 8 holes in local and resulted in fruit yield of 65 kg per tree versus 45 kg in local and weight of fruit 38.4 g versus 31.2 g in local (Meshram and Soni, 2011) [12]. Similar field trials on local and exotic genotypes are to be undertaken in other agro-climatic regions to recommend the resistant cultivars for common cultivation. For all insect pests of Indian gooseberry, field sanitation is important to avoid spread of pest infestation such as cliffing of infested leaves and discarding damaged fruits. This can be included in routine cultural practices. NSKE (0.045%) containing 1500 ppm of azadirachtin completely destroyed gooseberry aphid, *Schoutedeniaemblica* populations on Indian gooseberry a week after spraying (Sridhar, 2011) [30].

Deep ploughing after harvest to expose the diapausing larvae have been recommended against stone borer, *Curculio* sp. and fruit midge, *Clinodiplosis* sp. for Indian gooseberry. Pruning and destruction of galls formed by the shoot gall maker, *Betousa stylophora* on Indian gooseberry effectively reduced the incidence. This practice followed by spraying of chlorpyriphos (0.05%) at the beginning of crop season can help to avoid further gall midge attack on Indian gooseberry (Prakash, 2012) [22]. Spraying of carbaryl (0.2%) or quinalphos (0.05%) were effective against stone borer and fruit midge on Indian gooseberry. Further, spraying of dimethoate 30 EC (0.06%) or spinosad (0.25 ml/l) was recommended whenever there is severe infestation of mealybugs (*Nipaecoccu sviridis, N. vestator and Ferrisia virgata*) on the Indian gooseberry trees (Prakash, 2012) [22].

The pomegranate butterfly, *Deudorix (Virachola) isocrates* is a common minor pest of gooseberry in places where pomegranate orchards are nearby. Release of an egg parasitoid, *T. chilonis* (250,000 eggs/ha) at an early stage of pest attack when egg lying takes place and repetition of four times at 10 days interval reduces its population. Otherwise, spraying of carbaryl 50 WP (0.2%) or spinosad (0.25 ml/l) on developing fruits can reduce pest populations. Further, leaf rollers, *Gracillaria acidula* and *Psorosticha ziziphy* which are currently minor pests of gooseberry under heavy infestation, the orchard should be sprayed with carbaryl 50 WP (0.2%) or chlorpyriphos 20 EC (0.04%) (Prakash, 2012) [22].

Alovera

In aloe plantations, farmers could successfully control all insect pests by using the juice of raw garlic, oil of neem (containing 10,000 ppm of azadirachtin) at 2-3 ml/l or tobacco decoction (20 ml/l) (Biswas, 2010) [1]. However, TNAU [33] recommended spraying of insecticidal soaps or plant oils (3%), acephate 75 SP (0.06%), malathion 50 EC (0.05%) or pyrethrin (0.2%).

Blond psyllium

Blond psyllium planted from October to December at a fortnightly interval *i.e*., planted in the third week of October (early planting) in the western region was least infested by *Aphis gossypii* indicating that it prevented peak population (Patil *et al.*, 2011) [21]. Integrated management consisting of seed treatment with neem leaf powder (1%) followed by foliar sprays of neem leaf extract in water (10%) resulted in 3.7 aphids per plant versus 9.5 aphids per plant in control in blond psyllium (Rathore and Sundria, 2011) [25]. Seed treatment with imidacloprid 17.8 SL @ 5g /kg of seeds managed the population of both aphid species and termites in blond psyllium (Rathore and Sundria, 2011) [25].

Corn aphid, *Rhopalosiphum maidis,* isa major pest attacking blond psyllium in the western region. Early sown crop (7 Nov.) had lower aphid population density (25.2 aphids/tiller) than crop sown on 28 November (59.0 aphids/tiller). Consequently, higher yield (4.40 q/ha) in the early sown crop was obtained compared to control (2.23 q/ha). Sprays with dimethoate 30 EC (0.03%) killed maximum insects and gave the highest yield (7.79/q ha), followed by imidacloprid 17.8 SL (0.005%). However, dimethoate was highly toxic to a major predator, *Coccinella septempunctata* L. (Khinchi and Kumawat, 2014) [9-10].

In order to control all pests of blond psyllium, Jat *et al*. (2015) [8] recommended 2-3 sprays of dimethoate (0.05%) against defoliators and malathion 50 EC (0.5%) + kelthane 50 WSP (0.3%) at 10-15 day-interval against sucking pests. Collection and destruction of grubs and adults of epilachna beetle, *H. vigintictopunctata*, followed by spraying carbaryl 50 WP (0.3%) + wettable sulphur 50 WP (0.2%) has been found effective. Further, removal of the affected plant parts during early pest attack combined with spraying dimethoate 30 EC (0.05%), methyl demeton 25 EC (0.05%) or malathion 50 EC (0.1%) and releasing coccinellid predators in the later stage of crop development effectively managed the mealybug, *Paracoccus marginatus* attacking blond psyllium (TNAU, Agri portal, 2016) [33].

Solanum nigrum

Profenophos was effective in managing the sucking pests and defoliators of black nightshade, *Solanum nigrum* with maximum leaf yield (21.75 kg leaf /12m^2/ harvest) and among the botanicals, azadirachtin (1%) and aqueous extract of *Andrographis paniculata* (2%) recorded maximum reduction in the pest population (Suganthy and Sakthivel, 2012) [31]. Infestation of red cotton bug *Dysdercus cingulatus* on plants of *S. nigrum, Planta goindica* etc can be reduced by shaking out the bugs out of plants into a bucket of soapy water (Chaudhary, 2015) [3].

Coleus

A module consisting of 1. Before planting soil application of a mixture of vermicompost (2 t/ha) + cake of *M. pinnata* (250 kg/ha) + biofertilizer (2 kg/ha) + N: P: K (20:60:50 kg/ha). 2. Three releases of *C. carnea* (50,000 adults/ha) at 15, 30 and 105 DAP. 3. Two releases of egg parasitoid, *T. chilonis* (6.25 cc/125,000 eggs/ha) at 45 and 60 DAP. 4. Three sprays of *B. thuringienis* (750 g/ha) at 50, 80 and 140 DAP. 5. Five sprays of fish oil rosin soap (25 g/l) at 35, 55, 75, 95 and 115 DAP significantly reduced plant infestation of chillithrips (5.6% versus 16.7% in control), greenhouse scale insect (3.4% versus 8.2% in control) and defoliator (7.0% versus 9.8% in control) on coleus. Further, the yield of wet tubers increased by two-fold (25.62 kg/ha versus 12.41 kg/ha in control) (Thangavel *et al.,* 2012) [32].

Ashwagandha

Ashwagandha being an important medicinal plant, is attacked by several insect pests including spotted leaf beetle, *Epilachna vigintioctopunctata*. Application of farmyard manure (FYM) (12.5 t/ha) + Azophos (2 kg/ha) + neem cake

(1000 kg/ha) was found to be very effective in reducing the damage of spotted leaf beetle by 69.79 per cent. FYM + Azophos + neem cake combination was less preferred for oviposition which recorded 62.00 eggs/plants, coupled with a minimum feeding area (6.75 cm^2) (Ravikumar *et al*., 2008) [26].

Dimethoate 30 EC (1ml/l) showed the lowest infestation by the epilachna beetle and highest yield of (4.6q/ha) was recorded. Treatments, fenvalerate, quinalphos, chlorpyriphos, endosulfan and NSKE (5%) were also on par with dimethoate (Chandranath and Katti, 2010) [2]. Dicofol was the most effective treatment for reducing the per cent infestation of *T. urticae* (61.97%) infesting ashwagandha and ethion (58.67%) was found at par with dicofol (Sharma *et al*., 2013) [29].

Gronim followed by *B. thuringensis* was found to be the most effective against red bug and aphid on *W. somnifera*. Further, *Chrysoperla cornea* @ 500 per 100 m^2 followed by parasitoid *Trichogramma chilonis* at 1500 per 100 m^2) was also found to be the most effective for reduction of the larval population of defoliators (Meshram *et al.*, 2015) [13]. Jat *et al*. (2015) [8] recommended two sprays of oxydemeton-methyl 25 EC (0.025%) that could control *A. gossypii* and increased crop yield by 40 per cent with cost-benefit (CB) ratio of 1:16.8. The highest mean per cent reduction of *H. armigera* infestation on ashwagandha was recorded with Ha NPV at 250 LE (63.61), which was on par with nimbicidine at 3ml/L (56.66) followed by NSKE 5 per cent (47.42) and neem oil 5 ml/l (45.73) over control (Rehaman and Pradeep, 2016) [27].

The gram caterpillars, *H. armigera* bore into fruits and devour tender leaves of ashwagandha plants. As an integrated measure field release of *T. chilonis* (100,000 eggs/ha), spraying of *B. thuringiensis* (0.5 kg/ha) or HaNPV (250 LE/ha) and installation of pheromone traps (12 traps/ha) was suggested. Further, the hawk moth caterpillar, *Deilephila nerri* a minor defoliator, is controlled by soil digging to expose pupae, hand picking and destruction of larvae, installation of light traps (1 trap/ha) and planting of nerium (*Nerium oleander* L.) as trap plant around the field (TNAU, Agri portal, 2016) [33].

Glory Lily

Biopesticide, flavonoids were effective against *Spodoptera litura* infesting glory lily and was statistically on par with quinalphos (standard chemical check). Thus, flavonoids are adjudged as the best alternative to the chemical pesticides in *Gloriosa* eco-system and are recommended as one of the components in organic pest management (Suganthy and Sakthivel, 2013) [31]. *Bacillus thuringensis* (1%) followed by gronim (1 % neem based) was found to be the most effective against defoliators (Meshram *et al*., 2015) [13].

Isabgol

Aphid reduction due to the abundance of natural enemies has been reported from western India. The predatory coccinellid beetles, *Cheilomenes sexmaculata* were active from the third week of January to the first week of April with a peak of activity in the fourth week of March (Patel and Borad, 2006) [18]. Significantly lower pest populations of aphids was noted in carbosulfan 25 WP (0.05%) sprayed field (1.2 aphids/plant), neem-based product (1.5 aphids/plant) and water spray (1.8 aphids/plant) (Patil and Patel, 2013) [20]. In similar field trials conducted in 2012-13, two releases (@ 5,000 Beetles/ha) of three predatory coccinellids (*Coccinella transversalis*, *Menochilus sexmaculatus*, *Scymnus quadrellus* controlled aphid populations and increased crop yield (619 kg/ha versus 485 kg/ha without release) (CIMAP, 2007) [4].

Botanicals gronim (0.4%), neem oil (0.3%) and Neem Seed Extract (NSE 5%) were found most effective in suppressing the aphid infestation on isabgol. Gronim produced significantly higher (12.71 q/ha) seed yield followed by neem oil (12.06 q/ha) and NSE (9.78 q/ha). Maximum B: C ratio was found in the treatment of neem oil (1: 47.94) followed by NSE (1: 41.28) (Patel, 2014) [19].

Serpentine (Sarpagandha)

The components are deep ploughing in summer to expose larvae and pupae of black cutworm, *Agrotis ipsilon* to avian predators, 1-2 light traps/ ha or 20 pheromone traps/ha to trap moths, irrigation to expose larvae to predators and drenching collar region of plants in evening hours with chlorpyriphos 20 EC (2 ml/l) solution could kill the larvae (TNAU, Agri portal, 2016) [33].

Rose

Moncorotophos 0.05 per cent achieved the highest reduction (95.38%) of rose thrips, *Rhipiphorothrips cruentatus* under field conditions. However it was at par with phosphamidon 0.02 per cent and endosulfan 0.05 per cent (Nandanwar *et al.*, 1998) [14]. Hippe oil (1.5%), neem oil (1%) and hippe oil (0.75%) recorded the significantly low number of 1.33, 1.41 and 1.61 mites per rose leaflet, respectively followed by neem oil (2%) and honge oil (1.5%) (Onkarappa, 1999) [17]. Dadmal *et al.* (1999) [5] conducted a field experiment, to test the efficacy of NSKE (5%) and 1500 ppm azadirachtin (1%) along with insecticides against thrips on roses and reported that all treatments significantly reduced thrips populations but between the two botanicals, azadirachtin achieved 69.8 per cent reduction after 72 hour after treatment.

Among the twelve insecticides evaluated against thrips, *S. dorsalis* on Rose in polyhouse conditions, acephate 0.1 per cent was found to be the most effective treatment. Newer compounds like ethofenprox, cartap hydrochloride and imidacloprid also proved significant to control rose thrips (Rani and Reddy, 1999) [24]. Further, among the evaluated six botanicals against rose thrips under laboratory condition, neem seed kernel extract, aqueous extract of *Vitex negundo*, karanja oil (all at 2%) were found toxic to adult thrips causing 82.60, 73.72 and 77.18 per cent mortality, respectively at 48 hours after treatment (Satyanarayan, 2006) [28].

Jasmine

David *et al.* (1991) [6] evaluated certain chemical pesticides and neem oil against Jasmine blossom midge (*Contarinia* spp.) and reported that purple discolouration was lowest in bushes treated with monocrotophos 0.1 per cent, neem oil 2 per cent and chlorpyriphos 0.05 per cent.

The effectiveness of six plant extracts both were evaluated in the laboratory and field against Jasmine bud worm, *H. duplifascialis*. Neem cake extract 5 % was found to be effective followed by neem seed kernel extract 5 % and neem oil 1 per cent (Nelson *et al.*, 1993) [15]. Rani and Mohan (1994) [23] reported that soil application of neem cake (100 g/plant) and spraying of neem oil (2 %) or water extract of pongamia kernal 4 % significantly checked the damage of gallmite, *A. jasmini* on *J. auriculatum*. Similarly Umapathy and Rajendra (1999) [34] reported that soil application of neem cake at 250 kg/ha combined with foliar application of NSKE 10 per cent was effective in controlling *A. jasmine.* Carbosulfan (0.05%), fipronil (0.01%), *B. thuringiensis* var *Kurstaki* (1gm/lit) and cartaphydrochloride (0.05%) was highly effective in reducing bud worm damage followed by NSKE (5%), this was superior to azadirachtin 1500 ppm (0.0003%) (Neelima, 2005) [16].

The *in situ* vermiculture and vermiwash foliar application suppressed the activity of Bud borer, *Hendicasis duplifacialis* and Thrips, *Thrips orientalis*. Significantly less thrips population (2.0/flower) was recorded in the treatment vermicompost (2.0 t / ha) at the time of pruning + vermiwash application 1:3 (1, 4,7,10 weeks after pruning). Furthermore, bud borer population in *J. sambac* (Mangalore mallige) varied from 6.33 to 14.67 damaged flowers / plant. Damaged flowers in Mysore mallige were less compared to Mangalore mallige. In situ vermiculture and vermicompost-vermiwash application, respectively registered significantly higher flower yield (48.65 and 48.80 g/plant) (Meenatchi *et al.*, 2011) [11].

Evaluation of three fungal pathogens *viz., Beauveria bassiana*, *Metarhizium anisopliae* and *Nomuraea rileyi* against jasmine gallery worm, *Elasmopalpus jasminophagus*. *M. anisopleae* showed higher mortality percent (at conidial concentration of $2x10^9$ ml/l) in all the stages of larvae and was on par with the mortality caused by chemical check, indaxocarb and commercial BT product (Gopalakrishna *et al.*, 2016) [7].

Conclusion

A pest-management program could be enhanced by adopting prevention and suppression techniques. The methods that are most effective and environmental friendly have to be selected while implementing IPM program in order to minimize the health hazards. Among the pesticides, neem based pesticides prove to be better in reducing the pest population.

References

1. Biswas BC. Cultivation of medicinal plants: success stories of two farmers, *Fert. Marketing News*. 2010; 41(3):1-4.
2. Chandranath HT. and Katti P. Management of epilachna beetle on ashwagandha. Karnataka J Agric. Sci. 2010; 23(1):171.
3. Chaudhary V. Integrated pest and disease management in medical and aromatic plants. In *Advances in medicinal and aromatic plants research: Compendium* eds. Manivel P. and Smitha GR. ICAR, Anand, Gujarat. 2015, 166-178.
4. CIMAP. Organic cultivation of and *Bacopa monnieri* and *Ocimum santum.* Central Institute of Medicinal and Aromatic Plants, Resource Centre, Bangalore, India, 2007.
5. Dadmal SM, Ghawade SM, Taral BW, Mahajan RK. Efficacy of some chemical insecticides and plant products against rose thrips, *Rhipiphorothrips cruentatus* (Hood). Agricultrual Science Digest Karnal. 1999; 19(3):172-174.
6. David PM, Hanifa AM, Natarajan S. Evaluation of some insecticides and neem oil against jasmine blossom midge, *Contarinia* spp. Madras Agri. J. 1991; 78:82-84.
7. Gopalakrishna K, Pillai CJ, Nethravathi PN, Visalakshy G, Swathi C. Bio-efficacy of fungal pathogens against jasmine gallery worm, *Elasmopalpus jasminophagus* (Lepidoptera: Phycitidae). Pest Manag. Hort. Ecosyst. 2016; 22(1):67-70.
8. Jat RS, Reddy RN, Bansal R, Manivel P. Good agricultural practices: ashwagandha, isabgol. *Extension Bulletin*, Directorate of Medicinal and Aromatic Plants Research, Boriavi, Anand, Gujarat, India, 2015.
9. Khinchi SK, Kumawat KC. Effect of dates of sowing of blond psyllium, *Plantago ovata* on the incidence of aphid, Rhopalosiphum maidis. J Insect Sci. 2014; 37(2):246-249.
10. Khinchi SK, Kumawat KC. Newer synthetic and biorational insecticides against aphid, *Rhopalosiphum maidis* (Fitch) on *Plantago ovata* Forsk. Pesticide Res. J. 2014; 26(1):30-34.
11. Meenatchi R, Giraddi RS, Patil VS, Vastrad AS, Biradar DP. Effect of vermi technologies on jasmine insect pests. Karnataka J Agric. Sci. 2011; 24(3):312-315.
12. Meshram PB, Soni PK. Screening of certain varieties of *Emblica officinalis* Gaertn. For resistance to insect pests and diseases in central India. J Hort. For. 2011; 3(6):190-194.
13. Meshram PB, Mawai S, Malviya R. Biological control of insect pests of medicinal plants: *Abelmoschus moschatus, Gloriosa superba* and *Withania somnifera* in forest nursery and plantation in Madhya Pradesh, India. American J Agric. For. 2015; 3(2):47-53.
14. Nandanwar VN, Sharnagat BK, Kulut SS, Hiwase BJ. Chemical control of rose thrips, *Rhipiphorothrips cruentatus* (Hood). J Soil Crops. 1998; 8(1):105-106.
15. Nelson SJ, Venugopal MS, Janarthanan S, Natarajan S. Efficacy of certain plant products against jasmine budworm, *Hendecasis duplifascialis* Hmp. (Pyraustidae: Lepidoptera). Indian Perfumer. 1993; 37:26-239.
16. Neelima Y. Bioecology and management of jasmine pests. M.*Sc. (Agri.) Thesis,* Acharya N.G. Ranga Agric. Uni., Sri Venkateswara Agricultural College, Tirupati, Hyderabad, 2005.
17. Onkarappa S. Management of two spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) on rose. *Ph. D. Thesis*, Uni. Agric. Sci., Bangalore (India), 1999.
18. Patel HM, Borad PK. Impact of sowing periods and methods on incidence of *Aphis gossypii* infesting isabgol. J Med. Arom. Plant Sci. 2006; 27(2):262-264.
19. Patel SR. Seasonal abundance and eco- friendly management of aphid, *Aphis gossypii* Glover infesting isabgol, *Plantago ovata* Forskel. *M.Sc. thesis*, B. A. College of Agriculture, Anand Agricultural University, Anand, 2014.
20. Patil SJ, Patel BR. Evaluation of different synthetic and botanical insecticides against aphid, *Aphis gossypii* Glover infesting isabgol crop, *Bioscan.* 2013; 8(2):705-707.
21. Patil SJ, Patel BR, Chaudhary RK. Efficacy of synthetic and botanical insecticides against aphid, *Aphis gossypii* Glover in isabgol crop. *Pestology.* 2011; 35(1):32-34.
22. Prakash O. IPM schedule for aonla pests. *Ext. Bull. No. 5,* National Horticulture Mission, Ministry of Agriculture and Co-operation, Government of India, Delhi, India, 2012.
23. Rani BJ, Mohan NJ. Pest management in ornamental, medicinal and aromatic crops. *Annual Report*, IIHR, Bangalore. 1994, 57.
24. Rani JB, Reddy EJG. Efficacy of selected insecticides against thrips *Scirtothrips dorsalis* Hood on rose in polyhouse. *Pest Manag. Hort. Ecosyst.* 1999; 7(1):54-58.
25. Rathore BS, Sundria NM. Comparative efficacy of pesticides and botanicals against diseases and pests of blond psyllium. Indian Phytopathol. 2011; 64(1):97-99.
26. Ravikumar R, Rajedran C, Chinniah S, Irulandi RJ, Pandi. Evaluation of certain organic nutrient sources

against mealy bug, *Coccidohystrix insolitus* (Green) and the spotted leaf beetle, *Epilachna vigintioctopunctata* Fab. On ashwagandha, Withamia somnifera, J Biopest. 2008; 1:28-31.
27. Rehaman SK, Pradeep S. Effect of biopesticides on management of *Helicoverpaarmigera* in ashwagandha (*Withaniasomnifera* Linn.). *Pest Manag. Hort. Ecosyst.* 2016; 22(1):99-102.
28. Satyanarayan BH. Ecobiology and management of thrips and mite of rose underpolyhouse condition. *M. Sc. (Agri) Thesis*, Uni. Agric. Sci., Dharwad, 2006.
29. Sharma M, Sharma A, Ram N. Bio-efficacy of non-conventional pesticides against *Tetranychus urticae* Koch infesting ashwagandha (*Withania somnifera* Duval). *Pest Manage. Hort. Ecosyst*., 2013; 19(2):254-255.
30. Sridhar Y. Field evaluation of different insecticides against aonla aphid, Schoutedenia emblica. Indian J Plant Prot. 2011; 39:35-37.
31. Suganthy M, Sakthivel P. Field evaluation of biopesticides against tobacco caterpillar, *Spodoptera litura* Fab. Infesting *Gloriosa superba* (Linn.) J Biopest. 2013; 6(2):90-95.
32. Thangavel K, Muralibhaskar RK, Rajavel DS, Manisegaran S, Suresh K. Field evaluation of bio-intensive module for the management of major insect pests of coleus. J Biopest. 2012; 5:159-162.
33. http//www. http://agritech.tnau.ac.in/ TNAU, Agritech portal, 2016, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India.
34. Umapathy G, Rajendra B. Management of the Eriophyid mite, *Aceria jasmine* Chan. (Eriophyidae: Acari) on jasmine. Madras Agri. J. 1999; 86:83-86.