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Biological Control of Insect Pests of Medicinal Plants - *Abelmoschus moschatus, Gloriosa superba* and *Withania somnifera* in Forest Nursery and Plantation in Madhya Pradesh, India

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Abstract: The present investigation was carried out to evaluate the parasitoids (*Trichogramma raoi*, *T. chilonis*), predator (*Chrysoperla cornea*) and biopesticides i.e. botanicals (neem based Gronim) / mocrobials (*Bacillus thuringensis* and *Beauveria bassiana*) against five major insect pests viz. *Polytela gloriosae, Anomis flava, Earias vitella, Dysdercus cingulatus* and *Aphis gossypi* of important target species of medicinal plants- A*belmoschus moschatus, Gloriosa superba* and *Withania somnifera* in forest nursery, Tropical Forest Research Institute, Jabalpur and Delakhari west Chhindwara forest division, Madhya Pradesh (India). The results revealed that *Bacillus thuringensis* 1% followed by neem based pesticide (Gronim) 1% was found to be most effective against defoliators *Polytela gloriosae* on *G. superba*, *Anomis flava* and shoot/fruit borer *Earias vitella* on *A. moschatus.* Neem based pesticide (Gronim) followed by *Bt* 1% was found to be most effective against red bug *Dysdercus cingulatus* on the fruits of *A. moschatus* and aphid, *Aphis gossypi* on *W. somnifera*. Predator, *Chrysoperla cornea* @ 500 per 100 sq m followed by parasitoid *Trichogramma chilonis* @1500 per 100 sq m was also found to be most effective for reduction of the larval population of defoliators *P. gloriosae* and *A. flava*.

Keywords: Insect Pests, Medicinal Plants, Parasitoids, Predator and Biopesticides

1. Introduction

Muskdana, *Abelmoschus moschatus* (Medic.) [syn. *Hibiscus abelmoschus* (Linn.)] is considered as an important medicinal plant in Indian system of medicine and perfumery. Kalihari, *Gloriosa superba* (Linn.) is used under threatened plant species and used as tonic, stomachic, anthelmintic and having the most important alkaloid colchicine. Cluster winter cherry or ashwagandha, *Withania somnifera* (L.) Dunal, is a high value medicinal plant, extensively exploited in Indian system of medicine and used as an adaptive with antistress, antioxidant, antiflammatory, mind boosting and rejuvenating properties [24]. Central India (Madhya Pradesh, Chhattisgarh and Maharashtra states) is known for their rich diversity of medicinal plants. State Forest Departments through Minor Forest Produce Federations are encouraging farmers to take up medicinal plants for additional income. During cultivation of medicinal plants. The quality and quantity of raw materials obtained from the medicinal plants are adversely affected by the attack of number of insect pests in cultivated areas. Use of chemical pesticides is hazardous and causes environmental pollution. Therefore, environmentally safe biological pesticides are to be involved for the management of insect pests of important cultivated medicinal plants. These potential medicinal plants are always under serious threat of insect attack. The major insect pests of *A. moschatus* are defoliator, *Anomis flava* (Fab.), shoot / fruit borer, *Earias vitella* (Fab.), sap sucker, *Dysdercus cingulatus* (Fab.) and their incidence varies from 50-62.5, 30-70 and 70-90 per cent respectively [1,8,15]. While *W. somnifera* suffers attack by insect pests like white grub, *Holotrichia serrata* (Fab.), mealy bug, *Coccidohystrix insolitus* (Green.) and spotted leaf beetle, *Epilachna vigintioctopunctata* (Fab.) [14,22]. No specific information is available on the biological control of insect pests of target species of medicinal plants viz. *A. moschatus, G. superba* and *W. somnifera*. Hence, the present study was undertaken to investigate the biological control of major insect pests of target species of medicinal plants.

2. Methodology

Egg parasitoid, *Trichogramma raoi* was reared and multiplied in the laboratory of Forest Entomology Division, Tropical Forest Research Institute (ICFRE), Jabalpur, India. The cards of parasitoid, *T. chilonis,* and predator, *Chrysoperla carnea* were procured from the laboratory of Entomology, Agriculture College, Nagpur (Maharashtra, India) and released in the forest nursery (experimental plot) at TFRI, campus Jabalpur and Delakhari (West Forest Division, Chhindwara, Madhya Pradesh, India). The observations on the intensity of damage caused by two different insect pests i.e. defoliators, *Polytela gloriosae* on *G. superba* and *Anomis flava* on *A. moschatus* were taken in the parasitoid and predator released areas and compared with non released (control) plots.

The experiments on the efficacy of some biopesticides against the key insect pests were laid out in Randomized Block Design (RBD) with three replications. Biopesticides i.e. microbial agents- *Bacillus thuringiensis, Beauveria bassiana,* and botanicals- commercial neem based pesticides (Gronim) were tested for their efficacy against the key insect pests i.e. defoliator, *Polytela gloriosae* on *Gloriosa superba*; defoliator *Anomis flava*, shoot/fruit borer *Earias vitella,* fruit sucker/ red cotton bug, *Dysdercus cingulatus* on *A. moschatus* and leaf sap sucker / aphid, *Aphis gossypi* on *W. somnifera*. Data thus obtained were subjected to statistical analysis for better interpretations of results [4].

3. Result and Discussion

The results of the field experiments on the efficacy of different biopesticides against major insect pests are described separately.

3.1. Effect of Selected Biopesticides Against Defoliators, *Polytela gloriosae (Fab.)* on *G. superba* and *Anomis flava (Fab.)* on *A. moschatus*

The data pertaining to larval mortality are presented in Table 1. The data pertaining to the mortality of larvae after 7 days of treatment revealed that all the four treatments were significantly superior over control in respect of larval mortality. Observations showed that the mortality of larvae of *P. gloriosae* varied from 13.33 to 73.33 per cent. The highest mortality of larvae was observed in the treatment T4 *Bacillus thuringensis* (Dipel) 1% (73.33 per cent) followed by T1 Neem based (Gronim) 1% (60.00 per cent). All the biopesticides tested, caused larval mortality of *P. gloriosae.* Among the treatments, *Bacillus thuringensis* (Dipel) 1% followed by Neem based (Gronim) 1% was significantly superior. This trend was not recorded by [20], because the evaluation of insecticides against *P. gloriosae* was entirely different from those biopesticides tested in the present study. According to them chlorpyrifos 0.02 per cent and quinalphos 0.05% were proved most effective in rapidly killing *P. gloriosae* in laboratory conditions. Since the work was not done on the evaluation of biopesticides against *P. goriosae*. Use of biopesticides in medicinal plants for control of the insect pests [5]. The use of chemical insecticides be restricted in medicinal plants as they affect the quality of medicines [19].

In case of *A. flava*, Table 1 revealed that all the treatments were significantly superior when compared to untreated control in the protection of plants. The treatment T4 *B. thuringensis* 1% followed by T1 Neem based (Gronim) 1% ; T3 *B. bassiana* (Traps) $1x10^8$ + Neem based (Gronim) 1% resulted in 72.22, 69.44, 69.44, per cent larval mortality respectively. Treatments T3 and T1 found equally effective. Fenvalerate 0.01% was found to be most effective against defoliator, *Anomis flava* on *A. moschatus* [8].

Table 1. *Effect of selected biopesticides against defoliators, Polytela gloriosae and Anomis flava.*

Treatment	Mean (%) larval mortality after 7 days of treatment	
	P. gloriosae	*A. flava*
T1. Neem based (Gronim) 1%	60.0	69.44
T2. *Beauvaria bassiana* (Traps) $1x10^8$	13.33	68.33
T3. *B. bassiana* $1x10^8$ + Neem based(Gronim)1%	26.66	69.44
T4. *Bacillus thuringensis* (Dipel) 1%	73.33	72.22
T5. Control (Untreated)	0.0	0.00
S E m ±	8.36	6.58
CD at 5%	19.29	14.35

3.2. Effect of Selected Parasitoid / Predator Against Defoliators, *P. gloriosae* and *A. flava*

The data pertaining to per cent damaged plants and reduction of population of defoliator, *P. gloriosae* on *G. superba* are presented in Table 2. The per cent incidence on damaged plants and reduction of larval population varied from 10.56 to 30.32 per cent and 4.66 to 79.44 per cent respectively. The lowest per cent incidence of damaged plants and highest per cent reduction of larval population observed in plots released with T3 predator, *Chrysoperla carnea* (10.56 and 79.44 per cent) followed by T2 parasitoid *Trichogramma chilonis* (14.30 and 70.83 per cent). All the treatments were found to be significantly superior over untreated control. The lowest per cent incidence of damaged plants of *G. superba* and highest per cent reduction of larval population of *P. gloriosae* were observed in plots released with predator, *Chrysoperla carnea* @500 /100 sq m followed by parasitoid *Trichogramma chilonis* and *T. raoi* @1500/sq m. *T. chilonis* @1.5lakh per hectare reduced fruit borer, *Earias vitella* damage in okra [3]. Release of *T. chilonis* comprised with other treatments reduced fruit borer infestation in okra [7]. Release of *T. raoi* @ 1.25 lakh / ha to minimize the attack of teak skeletonizer *Eutectona machaeralis* in in natural teak forest areas in west Mandla forest division, Madhya Pradesh [16]. Release of parasitoid and predator against defoliator, *Polytela gloriosae* was not reported on *G. superba* so far.

In case of *A. flava*, the data pertaining to per cent damaged plants and reduction of larval population of *A. flava* presented in Table 2. The per cent incidence on damaged plants and reduction of larval population varied from 13.45 to 23.20 per cent and 58.89 to 82.22 per cent respectively after 30 days of release of parasites and predator. The lowest per cent incidence of damaged plants and highest per cent reduction of larval population were observed in plots released with T3 predator, *Chrysoperla carnea* (13.45 and 82.22 per cent) followed by T2 parasitoid *Trichogramma chilonis* (18.25 and 71.03 per cent). All the treatments were found to be significantly superior over untreated control. The lowest per cent incidence of damaged plants of *A. moschatus* and highest per cent reduction of larval population of *A. flava* were observed in plots released with predator, *Chrysoperla carnea* @ 500 /100 sq m followed by parasitoid *Trichogramma chilonis* and *T. raoi* @1500/sq m. T. *chilonis* @1.5 lakh per hectare reduced fruit borer, *Earias vitella* of o damage in okra [3]. Release of *T. chilonis* comprised with other treatments reduced fruit borer infestation in okra [7]. Release *T. raoi* @ 1.25 lakh / ha to minimize the attack of teak skeletonizer *Eutectona machaeralis* in in natural teak forest areas in west Mandla forest division, Madhya Pradesh, India [16]. Release of parasitoid and predator against defoliator, *A. flava* was not reported on *A. moschatus* so far.

Table 2. *Effect of selected parasitoid/predator against defoliators, P. gloriosae and A. flava (after 30 days of treatment).*

Treatments	*Polytela gloriosae*		*Anomis flava*	
	% Damaged plants	% reduction of larval population	% Damaged plants	% reduction of larval population
T1. Parasitoid *Trichogrmma raoi* (1500 eggs per 100 sqm.)	18.37	46.66	23.20	58.89
T2. Parasitoid *Trichograma chilonis* (1500 eggs per 100 sqm.)	14.30	70.83	18.25	71.03
T3. Predator *Chrysoperla cornea* (500 eggs per 100 sqm)	10.56	79.44	13.45	82.22
T4. Control (Untreated)	30.72	0.00	55.98	0.00
SE m ±	1.96	3.76	5.00	7.74
CD at 5%	4.79	9.209	12.23	18.96

3.3. Effect of Selected Biopesticides Against Shoot/Fruit Borer, Earias vitella (Fab.) on A. moschatus

The data pertaining to shoot and fruit borer are presented in Table 3. All the treatments were found to be significantly superior over control in respect of infested shoots and fruits. The infestation of *E. vitella* on shoots and fruits varied from 7.90 to 25.38 and 10.28 to 28.55 per cent. The lowest infested muskdana shoots and fruits was observed in plots treated with treatment T1 *Bacillus thuringensis* 1% (7.69 and 10.28 per cent) followed by T3 Neem based (Gronim) 1% (8.30 and 12.90 per cent) as compared to control (untreated). Other treatments like release of predator *Chrysoperla carnea,* parasitoid *Trichogramma chilonis* and *T. raoi* also reduced the infestation of shoot and fruit borer as compared with control. The lowest infested shoots and fruits of *A. moschatus* was observed in plots treated with treatment *Bacillus thuringensis* 1% followed by Neem based (Gronim) 1% as compared to control (untreated). Other treatments like release of predator *Chrysoperla carnea,* parasitoid *Trichogramma chilonis* and *T. raoi* also reduced the infestation of shoot and fruit borer as compared with control. Fenvalerate 0.01% was found to be most effective against shoot / fruit borer *E. vitella* in on *A. moschatus* [8]. Least bhendi fruit damage by *E. vitella* due to the application of *Bacillus thuringiensis* [10] . Release of *T. chilonis* comprised with other treatments reduced fruit borer infestation in okra [3,5].

Table 3. *Effect of selected biopesticides against shoot/fruit borer, Earias vitella.*

Treatment	Average % infested shoot/fruits after 30 days of treatment	
	Shoot	Fruits
T1. Bacillus thuringensis 1%	7.90	10.28
T2. Trichogramma chilonis	15.50	20.50
T3. Neem based (Gronim) 1%	8.30	12.90
T4. Trichogramma raoi	12.90	18.28
T5. Chrysoperla carnea	11.54	15.52
T6. Control (Untreated)	25.38	28.55
SE m ±	0.54	0.55
CD at 5%	1.58	1.63

3.4. Effect of Selected Biopesticides Against Red Bug, Dysdercus cingulatus (Fab.) on A. moschatus

Table 4. *Effect of selected biopesticides against Dysdercus cingulatus on A. moschatus.*

Treatment	Average % reduction in population after treatment	
	3 days	**7 days**
T1. *Bacillus thuringensis* 0.5%	15.05	30.15
T2. *B. thuringensis* 1%	34.04	49.64
T3. Neem based (Gronim) 0.5%	21.59	33.53
T4. Neem based (Gronim) 1%	66.00	83.01
T5. *Beauveria bassiana*(Traps) 1x10^8	21.66	21.66
T6. Control (Untreated)	0.00	0.00
SE m ±	7.724	6.764
CD at 5%	16.830	14.739

The data (Table 4) on field trial showed that all the treatments were significantly superior to those of the control in reducing the population of bug after 3 and 7 days of application. T4 Neem based (Gronim) 1% followed by T2 *B. thuringensis* 1% proved highly effective by reducing 66.00, 83.01, 34.04, 49.64 per cent population of bug compared with untreated control. Among others T6 *Beauveria bassiana* 1% T3 Neem based (Gronim) 0.5%), T5 *Beauveria bassiana* (Traps) 0.7% and *B. thuringensis* 0.5% gave minimum bug population up to 23.33, 36.94, 21.59, 33.53,21.66,15.05, 30.15 per cent after 3 and 7 days of application respectively. Neem based (Gronim) 1% followed by *B. thuringensis* 1% was found superior to all other treatments for reduction of bug population after 3 and 7 days of treatment. Synthetic pyrethroid fenvalerate 0.01% and was found to be most effective against red cotton bug, *Dysdercus cingulatus* on *A. moschatus* [15]. The use of chemical insecticides should be restricted in medicinal plants as they deteriorate the quality of medicines [19]. Since the work was not done on the evaluation of biopesticides against *D. cingulatus* on *A. moschatus.*

3.5. Effect of Selected Biopesticides Against Aphid Aphis gossypii (Glover) on W. somnifera

The data presented in Table 5 revealed that the average reduction per cent of aphid population varied from 12.60 to 55.00 and 15.00 to 65.00 per cent per three leaves among the four biocontrol treatments which were significantly lower than the untreated (control). Highest population reduction of 55 and 65 per cent after 15 and 30 days of treatment was recorded in T2. Neem based (Gronim) 1% followed by T1. *Bacillus thuringensis* 1% (44.00 and 59.00 per cent) and T4. *Chrysoperla carnea* (20.30 and 35.00 per cent). All the treatments were found to be significantly superior over control in respect of per cent reduction of aphid population. Highest population reduction of aphid after 15 and 30 days of treatment was recorded in Neem based (Gronim) 1% followed by *Bacillus thuringensis* 1%. Neem, a phytopesticides obtained from *Azadirachta indica* is a safe pesticide. It proved good control against aphid. However, a suspension of neem seed was the best against *Aphis gossypii* in agriculture crops [2]. Similarly the highest mortality of aphid in *Verticillium lecanii* 0.3% compared to Neem seed kernel 4% and dimethoate on Gerbera aphid, *Myzus persicae* [9].

Table 5. *Effect of selected biopesticides against Aphis gossypii on W. somnifera.*

Treatment	Average % reduction in aphid population after treatment	
	15 days	30 days
T1. *Bacillus thuringensis* 1%	44.00	59.00
T2. Neem based (Gronim) 1%	55.00	65.00
T3. *Beauveria bassiana*(Traps) 1x10^8	12.60	15.00
T4. *Chrysoperla carnea* (1500 eggs)	20.30	35.00
T5. Control (Untreated)	0.00	0.00
SE m ±	5.20	5.70
CD at 5%	12.70	13.62

4. Conclusion

On the basis of field experiments it can be concluded that *Bacillus thuringensis* (Dipel) 1% followed by neem based pesticide (Gronim) 1% was found to be most effective against kalihari defoliator, *P. gloriosae,* muskdana defoliator, *Anomis flava* and shoot/fruit borer *Earias vitella*. Neem based pesticide (Gronim) followed by *Bacillus thuringensis* (Dipel) 1% was found to be most effective against red cotton bug/stainer, *Dysdercus cingulatus* on the fruits of *A. moschatus* and aphid, *Aphis gossypi* on Ashwagandha, *Withania somnifera*. Predator, *Chrysoperla cornea* @ 500 per 100 sq m followed by parasitoid *Trichogramma chilonis* @1500 per 100 sq m was also found to be most effective for reduction of the larval population of defoliator *P. gloriosae* on *G. superba* and *A. flava* on *A. moschatus.*

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