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Field evaluation of biopesticides against tobacco caterpillar, *Spodoptera litura* Fab. infesting *Gloriosa superba* (Linn.)

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ABSTRACT

Field experiments were carried out from August, 2011 to December, 2011 to study the field efficacy of bio-pesticides against *Spodoptera litura* on *Gloriosa superba*. Results of the field experiments revealed that among the treatments, flavonoids recorded superiority in the management of *S. litura* starting from 3rd day after treatment and it was statistically on par with the standard chemical check, quinalphos. Pungam oil 3% was next in the order of efficacy, followed by neem oil 3% and NSKE 5%. Efficacy of *Bacillus thuringiensis* (*Bt*) at 2 ml/lit was realized only at seven days after treatment and persisted even after 14 days of second spray. Fourteen days after treatment, *Bt* was next in the order of efficacy after chemical pesticides and flavonoids. From the findings of the field trials, flavonoids showed the best in control of *S. litura* compared with the tested agents. We recommend flavonoid to be the alternative to chemical pesticides in gloriosa eco-system and to be used as one of the components in organic pest management.

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INTRODUCTION

The World Health Organization has estimated that over 80 percent of the world's population meets their primary health care needs through traditional medicine (Lambert, 1997). *Gloriosa superba* (Linnaeus) is an important medicinal plant of immense value in the traditional systems of medicine in India. The seeds are of economic value and possess many medicinal and curative properties, which contain alkaloid called colchicine and thiocolchicocide (Chaudari and Thakur, 1998). The commercial cultivation of this plant is gaining momentum in many other states at present as it fetches reasonable profit to the growers. Like any other plant, medicinal plants are also ravaged by a few major insect pests. Rathikannu (2005) reported that lily caterpillar, *Polytela gloriosae* (Fabricius), semilooper, *Plusia signata* (Fabricius) and tobacco cutworm, *Spodoptera litura* (Fabricius) were the major defoliators infesting *G. superba*. Tobacco cutworm, *Spodoptera litura* Fab. (Noctuidae: Lepidoptera), a serious but sporadic insect pest causes economic loss in gloriosa ranging from 25.8 to100 percent (Dhir *et al*., 1992) depending on the stage of the crop. The pest has developed resistance against a variety of insecticides belonging to almost all the insecticide groups used (Kranthi *et al*., 2002). Adverse effects due to synthetic pesticides on pests and their subsequent impact on ecological imbalance (Zadoks and Waibel, 1999) demands eco-friendly alternatives (Parmar, 1993). Changing scenario in pest management concept has brought the natural products to the forefront as an effective and reliable pesticidal molecule in the control of pests among crops. Botanical pesticides are one such alternative and an important component in Integrated Pest Management (IPM) due to its advantages such as availability, less toxicity to beneficial fauna, quick degradation and multiple functions (Isman, 2006).

Neem is a rich source of insecticide in the tropics and its potential for the management of several insect pests including *S. litura* had been well documented (Jotwani and Srivastava, 1989). Sublethal concentrations of azadirachtin affect the development of *S. litura*. The larval instars were prolonged and relative growth rate of the insect was

reduced (Carvalho, 1996). Muthuraman (1979) reported that 3%neem seed kernel extract (NSKE) caused maximum feeding inhibition, higher degree of starvation and reduction in defecation in the larvae of *S. litura*. Larval mortality to the extent of 77 to 89 percent was reported by Mukkerjee and Sharma (1993) when NSKE 7 % was used. Badge *et al*. (1999) proved NSKE 7 % resulted in cent per cent mortality of *S. litura* and prolonged the pupal period. The highest population reduction of *S. litura* registered 53.34 per cent in NSKE 5% after 5 days of application (Rathikannu, 2005). Field evaluation of neem product showed that Neem oil 3 % and NSKE 5 % bring about suppression of *S. litura* on green gram (Estoy *et al*., 1992) and on soybean (Soejinto, 1992). Flavonoids have a key role in stress response mechanisms in plants. The adaptive role of flavonoids in plant defense against bacterial, fungal and viral diseases as well as insects is beginning to gain importance in our understanding of plant defense. They act as anti-oxidants or as enzyme inhibitors, are involved in photosynthesis and cellular energy transfer processes, and may serve as precursors of toxic substances. Simmonds (2001, 2003) studied the bioactivity of different flavonoids and confirmed that these compounds could modulate the feeding and oviposition behavior of insects.

Gloriosa, being a medicinal plant, frequent and large scale application of insecticides for the management of insect pests often deteriorate the ecosystem. Use of these natural compounds in the place of conventional insecticides can reduce environmental pollution, conserve non-target organisms, and avert insecticide induced pest resurgence. Hence, considering the medicinal properties of gloriosa and commercial value with rapid expansion of drug industries, there is an urgent need to develop eco-friendly pest management practices. Keeping these aspects in view, the present investigations were carried out to test the field efficacy of bio-pesticides and flavonoids in order to combat the incidence of *S. litura* infesting *G. superba*.

MATERIALS AND METHODS

Field trials were carried out in the Department of Medicinal and Aromatic Crops, TNAU, Coimbatore and in the farmer's holdings at Vellipalayam, Coimbatore during August, 2011 to December, 2011 to assess the efficacy of selected bio-pesticides and flavonoids against *S. litura* on *G. superba*. The experiments were conducted in randomized block design (RBD) with seven treatments and three replications. *G. superba* was sown at a spacing of 60 × 45 cm. The plot size for each replication was 24 m^2. Each treatment was imposed in three randomized plots. Recommended package of practices were followed to raise good crop.

When the pest population crossed the economic threshold level (ETL), two rounds of sprays were given at 15 days interval. Pre-treatment count of pest population was taken before spraying. Post-treatment counts were taken at one, three, five, seven and fourteen days after spraying. Fourteenth day count was taken as pre-treatment count for the second spray. Ten plants were selected at random from each plot and the larval count was recorded and expressed as number per plant. Treatment details are: NSKE 5% (T_1), Azadirachtin (10,000 ppm) 1% (T_2), Pungam oil 3 % (T_3), *Bt* formulation -2 ml / litre (T_4), Flavonoids [– Distilled purified flavonoids (6 %), Adjuvant spreader (42 %), Surfactant (22 %), Aqua (30 %)] (Max Ranger - D2) - 1 ml / litre (T_5), Quinalphos (2 ml / litre) (T_6) and control ($T_{7)}$. .The data from field observations were analyzed following the procedure described by Panse and Sukatme (1969). Wherever necessary, the pest load in number was transformed into square root of x + 0.5 values before carrying out the analysis.

RESULTS AND DISCUSSION

Results of the field experiment conducted in the farmer's holding at Vellipalayam revealed that the pre-treatment count of larval population ranged from 2.5 to 2.8 larvae per plant. At one day after spraying, there was no significant difference among the treatments in the larval population except flavonoids and standard check quinalphos, which registered 2.57 and 2.53 larvae per plant, respectively. Similar trend was observed on 3rd day after treatment (3 DAT) also. At 5 DAT, significant population reduction was observed in all the treatments except *Bt.* Significant reduction in larval population was observed in flavonoids and quinalphos treated plots which recorded 0.63 and 0.10 larvae per plant at 5 DAT. At 7 DAT, 100

percent reduction in larval population was observed in flavonoids and quinalphos treated plots. Neem oil, neem seed kernel extract and *Bt* were next in the order of efficacy with a larval population of 0.90, 1.43 and 1.47 larvae per plant, respectively at 7 DAT. At 14 DAT, significant reduction in larval population was observed in *Bt* treated plots (0.70 larvae per plant) (Table 2). Rathikannu (2005) reported that NSKE 5%, NEEMAZAL T/S 1% 900 ml ha^{-1} and Neem oil 3% were found to be more effective recording 35.12, 43.16; 25.03, 42.48 and 30.79, 37.82 per cent reduction in larval population at 3 and 5 days after first application, respectively.

Pre-treatment population count during second spraying ranged from 0.0 to 1.9 larvae per plant. There was no larval population in flavonoids and quinalphos treated plots during pre-treatment count of the second spray. There was no significant difference in the larval population of other treatments at one day after spraying. Similar trend was observed at third day after second spray also. At 5 DAT, significant reduction in larval population was observed in *Bt*, neem oil and neem seed kernel extract. At 7 DAT, significant reduction in larval population was observed in *Bt* treated plot followed by neem oil and neem seed kernel extract. At 14 days after second spraying, significant reduction in larval population was observed in *Bt* treated plots. Reduction in the larval population of *S. litura* in flavonoids treated plot was found to be on par with the standard chemical check quinalphos (Table 1).

Experimental results of the field trial conducted in the Department of Medicinal and Aromatic Crops, TNAU, Coimbatore revealed that the pre-treatment larval count ranged from 3.63 to 4.03 larvae per plant (Table 3). There was no significant reduction in larval population at one day after spraying.

Table 1. Efficacy of bio-pesticides against *Spodoptera litura* on *Gloriosa superba* at Vellipalayam

Treatments	Pest population (Larvae per plant)*											
	Days after First Spray						Days after Second Spray					
	1st day	3rd day	5th day	7th day	14th day	Mean	1st day	3rd day	5th day	7th day	14th day	Mean
NSKE (5%)	2.80^{bc}	2.70^{d}	2.23^{b}	1.43^{c}	1.90^{d}	2.2	1.80^{d}	1.63^{c}	1.03^{d}	0.83^{bc}	1.53^{c}	1.36
Azadirachtin (1%)	2.53^{bc}	2.23^{c}	2.00^{b}	0.90^{b}	1.33^{c}	1.8	1.20^{c}	1.00^{b}	0.80^{c}	0.63^{b}	1.33^{c}	0.99
Pungam oil (3%)	2.53^{bc}	2.23^{c}	2.03^{b}	1.63^{c}	1.93^{d}	2.1	1.90^{d}	1.77^{c}	1.43^{e}	1.10^{c}	1.80^{d}	1.60
Bt (2 ml / litre)	2.60^{c}	2.60^{d}	2.50^{b}	1.47^{c}	0.70^{b}	1.9	0.77^{b}	0.73^{b}	0.67^{b}	0.60^{b}	0.53^{b}	0.66
Flavonoids (1 ml / litre)	2.57^{a}	1.53^{b}	0.63^{a}	0.00^{a}	0.00^{a}	0.9	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0
Quinalphos (2 ml / litre)	2.53^{a}	0.67^{a}	0.10^{a}	0.00^{a}	0.00^{a}	0.6	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0
Control	2.77^{c}	2.90^{d}	3.10^{b}	3.23^{d}	4.10^{e}	3.2	4.13^{e}	4.90^{d}	5.27^{f}	5.43^{d}	6.53^{e}	5.25

In a column, means followed by a common letter (s) are not significantly different by DMRT (P=0.05), * Mean of three replications

At 3 DAT, significant reduction in larval population was observed in flavonoids and quinalphos treated plots, with the larval population of 1.20 and 1.13 larvae per plant, respectively. At 7 DAT, flavonoids

and quinalphos treated plots recorded 100 percent larval population reduction, followed by neem oil, pungam oil and neem seed kernel extract. At 14 DAT, *Bt* treated plots recorded significantly less number of *S. litura* (1.33 larvae per plant), as against 6.13 larvae per plant in untreated control plots. Flavonoids and quinalphos treated plots were completely free from the population of *S. litura* (Table 2).

Table 1. Efficacy of bio-pesticides against *Spodoptera litura* on *Gloriosa superba* at Vellipalayam

Treatments	Pest population (Larvae per plant)*											
	Days after First Spray						Days after Second Spray					
	1st day	3rd day	5th day	7th day	14th day	Mean	1st day	3rd day	5th day	7th day	14th day	Mean
NSKE (5%)	3.63^{b}	3.53^{b}	3.23^{b}	1.87^{b}	2.13^{c}	2.88	2.87^{c}	2.73^{c}	1.47^{cd}	1.20^{bc}	1.43^{c}	1.94
Azadirachtin (1%)	3.80^{c}	3.50^{b}	3.17^{b}	1.53^{b}	2.07^{b}	2.81	2.00^{c}	1.87^{c}	1.20^{b}	1.07^{b}	1.13^{c}	1.45
Pungam oil (3%)	3.87^{c}	3.67^{b}	3.30^{c}	2.37^{c}	2.93^{c}	3.23	2.07^{c}	1.97^{c}	1.83^{d}	1.63^{c}	1.77^{d}	1.85
Bt (2 ml / litre)	3.87^{c}	3.83^{c}	3.37^{c}	2.87^{c}	1.33^{b}	3.05	1.30^{b}	1.17^{b}	1.10^{b}	1.03^{b}	0.67^{b}	1.05
Flavonoids (1 ml / litre)	3.50^{a}	1.20^{a}	0.73^{a}	0.00^{a}	0.00^{a}	1.09	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0
Quinalphos (2 ml / litre)	3.63^{b}	1.13^{a}	0.70^{a}	0.00^{a}	0.00^{a}	1.09	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0.00^{a}	0
Control	3.80^{c}	3.97^{d}	4.10^{d}	4.47^{d}	6.13^{d}	4.49	6.13^{d}	6.77^{d}	7.00^{e}	7.13^{d}	8.33^{e}	7.07

In a column, means followed by a common letter (s) are not significantly different by DMRT (P=0.05), * Mean of three replications

Pre-treatment count of larval population before second spraying ranged from 0 to 6.13 larvae per plant. At 1, 3 and 5 DAT, flavonoids and the chemical check, quinalphos recorded their superiority in mortality. At 7 DAT, significant reduction in larval population was observed in *Bt* treated plots (1.03 larvae per plant) followed by neem oil (1.07 larvae per plant) and neem seed kernel extract treated plots (1.20 larvae per plant). Significant larval reduction was observed in *Bt* treated plots (0.67 larvae per plant) at 14 DAT. Reduction in larval population in flavonoid treated plots were statistically on par with the chemical check quinalphos even at 14 days of second spraying (Table 1).

Most studies on the use of flavonoids as natural insecticides were concentrated on chewing larvae and/ or adults of lepidopteran, coleopteran and hymenopteran insects (Sosa *et al*., 2000; Simmonds, 2001, 2003; Upasani *et al.,* 2003; Salnuke *et al.*, 2005). Wood *et al.,* (1986, 1990) studied the activity of flavonoids against nymphs of *Triatoma infestans* (Hemiptera: Reduviidae). Sosa *et al.* (2000) investigated 20 flavonoids isolated from Argentina native plants and others, commercially purchased on *T. molitor* larvae growth, results indicated that quercetin, was the most effective growth inhibitor for *T. molitor* larvae.

Flavonoids from leaves of *Annona squamosa* (Kotkar *et al.,* 2002) and *Ricinus communis* (Upasani *et al.,* 2003) were found to arrest the population growth of pulse beetle, *Callosobruchus chinensis* L in green gram (*Vigna radiate* L.) during storage. Flavonoids also showed an ovicidal effect on bruchid eggs as well as affecting the number and weight of the emerging adults as a function of

concentration (Salnuke *et al.*, 2005). Salnuke *et al.*, (2005) suggest that flavonoids can act as potential grain protectants via contact, oviposition deterrent and ovicidal action. Different flavonoids are found to alter moulting in insects, causing death (Stamp & Yang, 1996). Most of the studied flavonoids either act as anti-estrogens or inhibit cytochrome P450 isozyme expression and activity (Tsyrlov *et al.*, 1994).

Increasing the concentration of the flavonoids resulted in a remarkable increase in nymphs mortality. This result agree with finding of Salnuke *et al.*, (2005), who found that flavonoids were toxic to adults and eggs of *Callosobruchus chinensis* (L.). Rathikannu (2005) reported that the highest percent reduction of defoliator population was noticed after second spray in NSKE 5% (53.34) followed by NEEMAZAL T/S 1% 900 ml ha^{-1} (49.09) treated plots at 5 DAT. Ramprasad *et al*. (1998) reported that NSKE 5% was found to be effective as fenvalerate (0.01%) against *S. litura*. and Neem oil 3 % and NSKE 5 % bring about suppression of *S. litura* on greengram (Estoy *et al*., 1992) and on soybean (Soejinto, 1992).

Hence, it is concluded that biopesticides, flavonoids are highly comparable with chemical pesticides in the management of *S. litura* infesting *G. superba*. 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 for the management of *S. litura* infesting *G. superba.*

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