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Field Evaluation of Botanicals on Pest Complex of *Solanum nigrum* Linn.

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Field experiments were carried out in farmer's holdings at Coimbatore and Tirupur districts of Tamil Nadu during June, 2012 to September, 2012 to assess the efficacy of botanical pesticides against sucking pests and defoliators infesting *Solanum nigrum*. Foliar application of profenophos @ 2 ml per litre was effective against sucking pests as well as defoliators with maximum leaf yield of 22.40 kg/12m$_2$ harvest as against 11.45 kg/12m$_2$ harvest in untreated control. Azadirachtin one per cent and aqueous leaf extract of *Andrographis paniculata* 2% recorded maximum reduction in pest population and also conserved more number of predatory coccinellids.

Key words: *Solanum nigrum, botanicals,* sucking pests, defoliators, predatory coccinellids

Among the medicinal plant species, black night shade, *Solanum nigrum* L., (Family Solanaceae)is an important medicinal cum green leafy vegetable, It has great demand in the Indian system of medicine. This herb is gaining importance in pharmaceutical industry due to its amazing therapeutic potential. The plant contains the alkaloids, solamargine, solanigrine and solasonine (Ridout *et al.,* 1989). The whole plant is useful for rheumatalgia, swellings, cough, asthma, bronchitis, wounds, ulcer, nausea, skin diseases, fever, dropsy and general debility. The plant is bitter, acrid, emollient, antiseptic, anti-inflammatory, expectorant, diuretic, diaphoretic, rejuvenating and sedative. *S. nigrum* is affected by a group of sucking pests and defoliators. Major pest complex includes aphids, *Aphis gossypii* Glover, thrips, *Thrips tabaci* (Lind.), leaf miner, *Liriomyza trifolii* (Burgess), defoliators including *Spodoptera litura* Fab., *Henosepilachna vigintioctopunctata* (Fab.) and *Plusia peponis* Fab. Nymphs and adults of *A. gossypii* suck the sap from lower surface of the leaves, flowers and flower buds,causing wrinkling and drying

Insect pests, diseases and weeds are important biotic constraints inflicting 20 to 25 per cent loss in agriculture production. Synthetic pesticides have of course, played very significant role in restricting many pest problems. However, indiscriminate use of chemicals has resulted in pesticide resistance, resurgence of target organism or emergence of secondary pests because of destruction of parasitoids and predators, impact on non-target organisms, including humans, environmental pollution through accumulation of pesticides in soil, water and air and residues in agricultural and animal products. Increasing awareness about the deleterious effects of insecticides paved the way for integrated and eco-friendly pest management. One such method is the use of botanical pesticides, that are safe and eco- friendly, can overcome problems associated with chemical insecticides especially in the medicinal plants eco-system. Botanical were the earliest recorded insecticides in agriculture. The efficacy of neem products was observed by several workers (Karmarkar and Bhole, 2000). As there is a growing demand for organically grown produce in national and international markets, the present study was undertaken to test the field efficacy of selected botanicals against pest complex of *S. nigrum viz.,* aphids, thrips, leaf miners and defoliators and predatory coccinellids.

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Materials and Methods

Field trials were laid out in the farmer's holdings at two locations *Viz.,* Kallipalayam, Coimbatore and Pappampatti, Tirupur districts during June, 2012 to September, 2012 to assess the field efficacy of selected botanical insecticides against aphids, thrips, leaf miners and defoliators (*Spodoptera litura*, *Henosepilachna vigintioctopunctata* and *Plusia peponis*) infesting *S. nigrum*. Field experiments were laid out in randomized block design (RBD) with eight treatments with three replications (Table 1). Recommended package of practices were followed to raise a good crop.

Pre-treatment count on pest population was made before spraying. Post-treatment counts were made at 1, 3, 5, 7 and 14 days after spraying. Ten plants were selected at random from each plot (4x3 m$_2$) and the population of sucking pests, defoliators *viz., Spodoptera litura, Henosepilachna vigintioctopunctata, Plusia peponis* and natural enemies were recorded and expressed as number per plant. Leaf yield from each plot was recorded. The data from field observations were analyzed following the procedure described by Panse and Sukhatme (1978). Wherever necessary, the pest load in number was transformed into square root of x + 0.5 values before carrying out analysis.

Results and Discussion

Bio-efficacy of botanicals against aphids, Aphis craccivora

Experimental results revealed that pre-treatment count on aphid population ranged from 30.6 to 37.0 aphids per plant (Table 1). One day after treatment (DAT), significant reduction in aphid population was observed in all the treatments, while it was 34.8 aphids per plant in untreated control. Minimum aphid population was observed in standard chemical check profenophos, (0.2 per plant) followed by azadirachtin (19.2 per plant) and neem seed kernel extract (22.9 per plant). At three days after treatment, cent per cent aphid mortality was observed in standard chemical check profenophos. Among other treatments, minimum population of aphids was observed in azadirachtin (11.3 per plant) followed by NSKE (16.1 per plant) and *A. paniculata* (18.8 per plant). Similar trend was observed at five and seven days after treatment. At 14 DAT, increase in aphid population was observed in all treatments. At 14 DAT, minimum population was observed in standard chemical check (0.5 aphids /plant) followed by azadirachtin (5.0 aphids /plant), *A. paniculata* (5.6 aphids/plant) and NSKE (9.7 aphids/plant). Mean population was minimum in the standard chemical check (0.14 aphids/plant) followed by azadirachtin (8.50 aphids/plant) and *A. paniculata* (12.44 aphids/ plant). Similar findings were reported by Mariappan and Duleepkumar (1993) and Mallikarjuna Rao *et al.* (1999a) in chillies. Plant extract of *Artimesia vulgaris* Linn., showed the highest mortality of aphids (70.65 per cent) on brinjal (Monita Devi *et al.,* 2003).

Bio-efficacy of botanicals against thrips, Thrips tabaci

Pre-treatment count of thrips ranged from 6.8 to 7.9 /plant (Table 2). One DAT, significant population reduction was observed in all the treatments. Minimum thrips population was observed in the standard chemical check profenophos (0.1 thrips per plant) followed by azadirachtin, *A. paniculata* and NSKE with a population of 1.8, 2.2 and 2.4 thrips/plant, respectively. Three days after treatment, cent per cent population reduction was observed in profenophos sprayed plots. Similar findings were reported by Chandrasekaran and Veeravel (1998). Among the other treatments, minimum thrips population was observed in azadirachtin (1.0/ plant) followed by *A. paniculata* (1.3/plant) and *V. negundo* (1.9/plant). At 5 DAT, minimum population was observed in azadirachtin and *A. paniculata* (0.5/ plant) followed by NSKE and pungam oil (0.9 and 1.0 per plant, respectively). Seven days after treatment, *A. paniculata* recorded maximum reduction (0.2 thrips/plant) followed by azadirachtin (0.3 thrips/ plant), NSKE (0.6 thrips/plant) and pungam oil (0.7 thrips/plant). 14 DAT, thrips population increased in all the treatments. Minimum thrips population was observed in standard chemical check (0.4 thrips/ plant) followed by *A. paniculata* (0.9 thrips/plant) and azadirachtin (1.1 thrips/plant). Mean thrips population was minimum in standard chemical check (0.10 thrips/plant) followed by azadirachtin (0.94 thrips/ plant), *A. paniculata* (1.02 thrips/plant) and NSKE (1.44 thrips/plant).

These results are in line with findings of Varghese (2003) who reported that nimbecidine five per cent spray was highly effective in reducing thrips on chillies. Neem cake application @ 500 kg/ha and seedling root dip with 1 per cent neem oil followed by neem oil spray at weekly intervals reduced the thrips population to lower levels in chilli (Mallikarjuna Rao *et al.,* 1999). Similarly, GCKE 5 per cent (garlic chilli kerosene extract) along with half dose of nimbecidine (2.5 ml/l) registered the lowest incidence of thrips in chilli (Lingappa *et al.,* 2002).

Bio-efficacy of botanicals against defoliation

Table 1. Field efficacy of botanicals against *Aphis craccivora* on *Solanum nigrum*

Treatment	Number of aphids per three leaves per plant*						
	PTC	1 DAT	3 DAT	5 DAT	7 DAT	14 DAT	Mean
NSKE 5 % w/v	36.2	22.9 (4.83)$_{c}$	16.1 (4.07)^{c}	11.2 (3.41)$_{d}$	5.2 (2.36)^{c}	9.7 (3.18)$_{c}$	13.02
Andrographis paniculata 2 % w/v	30.6	25.2 (5.06)^{cd}	18.8 (4.38)$_{cd}$	9.1 (3.09)$_{c}$	3.5 (1.98)$_{b}$	5.6 (2.43)^{b}	12.44
Vitex negundo 2 % w/v	34.4	29.0 (5.41)^{d}	22.2 (4.74)^{e}	16.4 (4.10)$_{e}$	9.4 (3.13)$_{d}$	13.3 (3.68)$_{d}$	18.06
Azadirachtin1% v/v	37.0	19.2 (4.42)^{b}	11.3 (3.43)$_{b}$	4.3 (2.17)^{b}	2.7 (1.77)^{b}	5.0 (2.30)^{b}	8.50
Mineral oil 3 ml/litre	33.6	28.7 (5.39)^{d}	24.1 (4.95)^{e}	20.6 (4.57)^{f}	18.4 (4.34)$_{e}$	24.2 (4.96)$_{e}$	23.20
Pungam oil 3ml/litre	34.8	27.1 (5.23)^{d}	21.6 (4.68)$_{d}$	19.7 (4.49)$_{f}$	16.1 (4.05)^{e}	21.4 (4.66)$_{e}$	21.18
Profenophos 2ml/litre	36.2	0.2 (0.81)$_{a}$	0.0 (0.71)^{a}	0.0 (0.71)^{a}	0.0 (0.71)^{a}	0.5 (0.95)^{a}	0.14
Untreated control	32.6	34.8 (5.93)^{e}	40.5 (6.39)$_{ef}$	43.2 (6.60)$_{g}$	45.7 (6.79)^{f}	57.8 (7.63)^{f}	44.40
CD (0.05)	-	0.369	0.322	0.288	0.298	0.383	-

*Pooled mean of two locations and three replications.

In each column, means followed by a common letter were not significantly different by LSD at 5 per cent

Table 2. Field efficacy of botanicals against *Thrips tabaci* on *Solanum nigrum*

Treatment	Number of thrips per plant*						
	PTC	1 DAT	3 DAT	5 DAT	7 DAT	14 DAT	Mean
NSKE 5 % w/v	7.8	2.4 (1.68)bc	2.0 (1.57)c	0.9 (1.17)c	0.6 (1.02)bc	1.3 (1.33)bc	1.44
Andrographis paniculata 2 % w/v	7.5	2.2 (1.62)b	1.3 (1.33)b	0.5 (0.97)b	0.2 (0.81)a	0.9 (1.17)b	1.02
Vitex negundo 2 % w/v	7.1	3.4 (1.96)d	1.9 (1.53)c	1.2 (1.30)cd	1.5 (1.40)d	2.3 (1.67)de	2.06
Azadirachtin1% v/v	7.7	1.8 (1.49)b	1.0 (1.22)b	0.5 (0.97)b	0.3 (0.86)ab	1.1 (1.26)b	0.94
Mineral oil 3 ml/litre	6.8	3.1 (1.88)cd	2.6 (1.75)d	1.5 (1.40)d	1.9 (1.54)d	2.8 (1.81)e	2.38
Pungam oil 3ml/litre	7.2	3.2 (1.91)cd	2.1 (1.59)cd	1.0 (1.22)cd	0.7 (1.07)c	1.8 (1.49)cd	1.76
Profenophos 2ml/litre	7.9	0.1 (0.76)a	0.0 (0.71)a	0.0 (0.71)a	0.0 (0.71)a	0.4 (0.91)a	0.1
Untreated control	7.6	8.9 (3.04)e	10.3 (3.28)e	9.6 (3.17)e	11.2 (3.40)e	14.9 (3.92)f	10.98
CD (0.05)	-	0.284	0.204	0.266	0.315	0.232	-

* Pooled mean of two locations and three replications.

In each column, means followed by a common letter were not significantly by LSD different at 5 per cent.

Pre-treatment count on per cent defoliation ranged from 11.1 to 12.7 per cent (Table 3). One day after treatment, there was no significant difference in the defoliation percentage. Three days after treatment, significant reduction in defoliation was observed in treatments. Minimum per cent defoliation was observed in standard chemical check profenophos sprayed plots (4.4%), followed by *A. paniculata* (5.2%) and azadirachtin (6.4%). Five days after treatment, lowest defoliation percentage was observed in standard check profenophos (0.5%) followed by *A. paniculata* (1.2%), azadirachtin (3.2%) and NSKE (3.6%). Seven days after treatment, cent per cent reduction in defoliation was observed in standard chemical check profenophos. Per cent defoliation was low in azadirachtin (0.6%) and *A. paniculata* (0.7%). 14 DAT, minimum defoliation was observed in the standard check (nil damage) followed by azadirachtin (1.1%) and *A. paniculata* (1.3%). Mean defoliation was minimum in profenophos (3.20%) followed by *A. paniculata* (4.00%) and azadirachtin (4.56%). The antifeedant property of neem seed kernel was first described against desert locust, *Schistocerca gregaria* Forsk (Pradhan *et al.,* 1962). Similarly, NSKE 7 per cent resulted in cent per cent mortality of *S. litura* and prolonged the pupal period (Badge *et al.,* 1999).

Table 3. Bio-efficacy of botanicals on defoliation in *Solanum nigrum*

Treatment	Defoliation* (%)						
	PTC	1 DAT	3 DAT	5 DAT	7 DAT	14 DAT	Mean
NSKE 5 % w/v	12.8	12.6 (3.60)c	9.4 (3.12)d	3.6 (1.99)c	1.4 (1.35)c	2.1 (1.60)c	5.82
Andrographis paniculata 2 % w/v	12.2	11.6 (3.45)a	5.2 (2.38)b	1.2 (1.30)b	0.7 (1.07)b	1.3 (1.33)b	4.00
Vitex negundo 2 % w/v	12.9	12.7 (3.61)c	9.9 (3.21)d	6.7 (2.68)d	3.1 (1.89)d	4.6 (2.25)de	7.40
Azadirachtin1% v/v	11.8	11.5 (3.43)a	6.4 (2.62)c	3.2 (1.89)c	0.6 (1.02)b	1.1 (1.26)b	4.56
Mineral oil 3 ml/litre	11.3	11.2 (3.40)a	10.3 (3.28)d	7.9 (2.89)d	4.6 (2.25)e	5.4 (2.42)e	7.88
Pungam oil 3ml/litre	11.5	11.3 (3.42)a	10.1 (3.24)d	6.8 (2.69)d	3.4 (1.96)d	4.1 (2.13)d	7.14
Profenophos 2ml/litre	12.6	11.1 (3.39)a	4.4 (2.20)a	0.5 (0.97)a	0.0 (0.71)a	0.0 (0.71)a	3.20
Untreated control	11.2	12.0 (3.53)b	13.6 (3.75)e	13.9 (3.79)e	14.5 (3.87)f	19.3 (4.44)f	14.66
CD (0.05)	-	0.347	0.274	0.276	0.262	0.201	-

*Defoliation by *Spodoptera litura, Henosepilachna vigintioctopunctata Plusia peponis*;

*Pooled mean of two locations and three replications.

In each column, means followed by a common letter were not significantly different by LSD at 5 per cent

Bio-efficacy of botanicals against leaf miner, *Liriomyza trifolii*

The results revealed that pre-treatment count on leaf damage by leaf miner in treatments ranged from 6.9 to 8.5 per cent (Table 4). There was no significant difference in per cent leaf damage one day after treatment. Leaf damage was reduced three days after treatment with a per cent damage in standard check profenophos of 5.3% followed by azadirachtin (6.6%). Three days after treatment, minimum leaf damage was observed in standard check profenophos (2.4%) followed by *A. paniculata* (3.8%) and azadirachtin (4.5%). At five days after treatment, minimum per

Table 4. Field efficacy of botanicals against leaf miner damage on *Solanum nigrum*

Treatment	Leaf damage (%)*						
	PTC	1 DAT	3 DAT	5 DAT	7 DAT	14 DAT	Mean
NSKE 5 % w/v	8.5	8.1 (2.91)^{b}	6.5 (2.63)^{d}	3.0 (1.84)$_{cd}$	1.4 (1.37)^{c}	1.9 (1.53)^{c}	4.18
Andrographis paniculata 2 % w/v	7.9	7.3 (2.78)^{b}	3.8 (2.04)^{b}	1.6 (1.43)$_{b}$	0.8 (1.12)^{b}	1.2 (1.30)$_{b}$	2.94
Vitex negundo 2 % w/v	8.0	7.9 (2.88)^{b}	5.4 (2.40)^{cd}	3.9 (2.08)^{d}	1.8 (1.51)^{cd}	2.3 (1.67)^{cd}	4.26
Azadirachtin1% v/v	6.9	6.6 (2.63)^{a}	4.5 (2.21)^{bc}	2.4 (1.65)^{bc}	0.9 (1.17)^{b}	1.3 (1.32)^{b}	3.14
Mineral oil 3 ml/litre	7.4	7.3 (2.78)^{b}	6.1 (2.56)^{d}	4.3 (2.14)^{d}	3.1 (1.86)$_{e}$	3.7 (2.04)^{e}	4.90
Pungam oil 3ml/litre	8.3	8.0 (2.89)^{b}	5.7 (2.47)^{cd}	3.8 (2.01)^{cd}	2.2 (1.64)$_{de}$	2.8 (1.79)^{d}	4.50
Profenophos 2ml/litre	7.1	5.3 (2.39)^{a}	2.4 (1.66)$_{a}$	0.2 (0.81)$_{a}$	0.0 (0.71)^{a}	0.0 (0.71)^{a}	1.58
Untreated control	7.0	6.9 (2.70)^{b}	9.2 (3.10)$_{e}$	11.4 (3.43)$_{e}$	12.7 (3.62)^{f}	17.3 (4.20)^{f}	11.50
CD (0.05)	-	0.338	0.326	0.396	0.246	0.201	-

* Pooled mean of two locations and three replications.

In each column, means followed by a common letter were not significantly different by LSD at 5 per cent

cent leaf damage was observed in standard check profenophos (0.2%) followed by *A. paniculata* (1.6%), azadirachtin (2.4%) and NSKE (3.0%). Similar trend was observed at 7 DAT. At 14 DAT, minimum leaf damage was observed in profenophos (nil damage) followed by *A. paniculata* (1.2%), azadirachtin (1.3%) and NSKE (1.9%). Mean leaf damage was minimum in standard check (1.58%) followed by *A. paniculata* (2.94%) and azadirachtin (3.14%). Neem seed kernel extract (5 %) was the most effective treatment against larval instars, resulting in mean larval mortality of 53.4% and minimum damage of 25.5% in cowpea (Ganapathy *et al.*, 2010). Efficacy of neem seed kernel extract, neem oil, karanj oil was studied by Stein and Parrella (1985), Azam (1991), Jagannatha (1994) and Jeyakumar (1995).

Bio-efficacy of botanicals against predatory coccinellids

Cheilomenes sexmaculata (Fabricius)*, Harmonia octomaculata* (Fabricius) and *Chilocorus* sp were the important predatory coccinellids recorded in *S. nigrum* ecosystem. Pre-treatment count on predatory coccinellid ranged from 1.2 to 1.7/plant (Table 5). One day after treatment, minimum predatory coccinellid population was observed in profenophos treated plots (0.0/plant) followed by azadirachtin (0.4/plant), *V. negundo* and NSKE (0.5/plant). Similar trend was

Table 5. Bio-efficacy of botanicals on predatory coccinellids in *Solanum nigrum*

Treatment	Predatory coccinellids* per plant						
	PTC	1 DAT	3 DAT	5 DAT	7 DAT	14 DAT	Mean
NSKE 5 % w/v	1.3	0.5 (0.97)^{c}	0.4 (0.91)$_{c}$	0.8 (1.12)^{c}	1.0 (1.22)^{bc}	1.2 (1.30$_{bcd}$	0.78
Andrographis paniculata 2 % w/v	1.7	0.6 (1.02^{bc}	0.4 (0.91)$_{c}$	0.9 (1.17)^{bc}	1.1 (1.26)^{b}	0.9 (1.17)^{d}	0.78
Vitex negundo 2 % w/v	1.6	0.5 (0.95)^{c}	0.9 (1.17)^{ab}	1.3 (1.33)$_{a}$	1.7 (1.47)^{a}	2.0 (1.57)^{a}	1.28
Azadirachtin1% v/v	1.3	0.4 (0.91)$_{c}$	0.4 (0.91)$_{c}$	0.7 (1.07)^{bc}	0.8 (1.12)^{c}	1.0 (1.22^{cd}	0.66
Mineral oil 3 ml/litre	1.7	0.9 (1.17^{ab}	0.7 (1.07)^{bc}	1.0 (1.22)^{c}	1.1 (1.26)^{b}	1.3 (1.33$_{bc}$	1.00
Pungam oil 3ml/litre	1.4	0.6 (1.02^{bc}	0.4 (0.91)$_{c}$	0.7 (1.07)^{c}	0.9 (1.17)^{bc}	1.1 (1.26) cd	0.74
Profenophos 2ml/litre	1.5	0.0 (0.71)^{d}	0.0 (0.71)^{d}	0.0 (0.71)^{d}	0.0 (0.71)^{d}	0.1 (0.76)^{e}	0.02
Untreated control	1.2	1.0 (1.22)^{a}	1.6 (1.44)$_{a}$	1.4 (1.37)^{a}	1.0 (1.22)^{bc}	1.6 (1.43$_{ab}$	1.32
CD (0.05)	-	0.337	0.345	0.349	0.182	0.189	-

**Menochilus sexmaculatus, Harmonia octomaculata, Chilocorus* spp.; * Pooled mean of two locations and three replications.

In each column, means followed by a common letter were not significantly different by LSD at 5 per cent observed on three and five days after treatment. Predator population increased from seven days after treatment. At 14 DAT, coccinellid population was recorded to be minimum in profenophos (0.1/plant) followed by *A. paniculata* (0.9/plant) and azadirachtin (1.0/plant). Predatory coccinellid population was maximum in untreated control (1.32/plant) followed by *V. negundo* (1.28/plant) as against 0.02 per plant in profenophos treated plots.

Leaf yield

Table 6. Effect of botanicals on leaf yield of *Solanum nigrum*

Treatment	Leaf yield (Kg/12m^2/ harvest)*
NSKE 5 % w/v	16.90^b
Andrographis paniculata 2 % w/v	17.70^b
Vitex negundo 2 % w/v	15.95^b
Azadirachtin1% v/v	17.85^b
Mineral oil @ 3 ml/litre	15.20^b
Pungam oil @ 3ml/litre	15.60^b
Profenophos @ 2ml/litre	22.40^a
Untreated control	11.45^c
CD (0.05)	3.082

* Pooled mean of two locations and three replications.
In each column, means followed by a common letter were not significantly different by LSD at 5 per cent

Leaf yield in different treatments ranged from 11.45 to 22.40 kg per 12m^2 plot per harvest (Table 6). Maximum leaf yield was obtained in profenophos treated plots (22.40 kg/12m^2 plot/harvest) followed by azadirachtin and *A. paniculata* treated plots which recorded the leaf yield of 17.85 and 17.70 kg/12m^2 plot/harvest, respectively. Minimum leaf yield was recorded in untreated control (11.45 kg/12m^2 plot/ harvest) followed by mineral oil and pungam oil treated plots which recorded the leaf yield of 15.20 and 15.60 kg/12m^2 plot/harvest, respectively.

The results of two field experiments, it was evident that profenophos @ 2 ml/ litre was the best treatment for the management of sucking pests as well as defoliators of *S. nigrum*. Among the botanicals, azadirachtin 1 % and *Andrographis paniculata* 2 % were highly effective. Considering the importance of *S. nigrum* as medicinal green leafy vegetable, use of chemical pesticides may be restricted as a last resort, when the pest population exceeds the threshold levels. Hence, foliar application of azadirachtin 1 per cent is recommended not only for the management of sucking pests as well as defoliators but also to conserve the natural enemies in *S. nigrum* ecosystem.

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