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Evaluation of neem and pongamia formulations for the management of leafhopper, *Idioscopus nitidulus* (Walker) (Hemiptera: Cicadellidae) in mango

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ABSTRACT: Mango leafhopper, *Idioscopus nitidulus* (Walker) is one of the major sucking pests of mango. Botanicals such as neem and pongamia are of greater importance in managing the pest population. A field experiment was carried out during 2016 and 2017 to evaluate four herbal formulations at different concentrations along with a positive (imidacloprid) and a negative (water) control. The results suggested that among the different concentrations, neem soap or pongamia soap sprayed at 5 g/l or neem herbal formulation or pongamia herbal formulation sprayed at 5 ml/l reduced the hopper population in both the study years. The research highlights the use of different botanicals in the management of leafhoppers in mango.

Keywords: Mango, leafhopper, *Idioscopus nitidulus*, botanicals

INTRODUCTION

Mango leafhopper, *Idioscopus nitidulus* Walker is a major sucking pest that attacks the inflorescence and young shoots of mango (Verghese and Jayanthi, 2001). The adults and nymphs suck the sap from the inflorescence and young shoots, resulting in their drying and poor fruit set (Nachiappan and Bhaskaran, 1983). As a result of feeding, leafhoppers excrete honey dew on to the flowers and leaves leading to development of the sooty mould fungus *Meliola mangiferae* and *Capnodium mangiferae* (Verghese, 2001) which affects the photosynthetic activity of the trees. Among the mango hoppers, so far 22 species (Dalvi *et al*., 1992) have been reported, of which *Idioscopus nitidulus* is more destructive causing (20-100%) loss (Sohi and Sohi, 1990). The hopper breeds on both shoots and inflorescence unlike *I. clype*alis and *I. nagpurensis*, which breeds only on inflorescence (Verghese and Devi, 2011). In mango, the hopper activity coincides with maximum emergence of inflorescence and new shoots.

Current management practices include use of chemical insecticides like imidacloprid and cypermethrin. But non judicious application of highly toxic and persistent insecticides is causing several problems such as disrupting natural enemy complexes, development of insecticide resistance, secondary pest outbreak, pest resurgence and environmental pollution (Fishwick, 1988). The beneficial insects like predators and pollinators are diminished by use of these pesticides. Since pollinators play a major role in mango fruit setting, as mango is cross pollinated by insects, the use of these chemical insecticides will severely affect the pollinators. Imidacloprid is a banned chemical on European Union and USA since the traces of insecticides kills the beneficial insects like pollinators, but in India it is still under review.

Botanical insecticides have long been touted as an alternative to synthetic chemical insecticides for pest management (Isman *et al*., 2006; Echereobia *et al*., 2010). Since they are eco-friendly, economic, target-specific and biodegradable. Entomopathogens offer effective substitute for the control of many insect pests.

Many workers have isolated and identified several chemical compounds from leaves and seeds of many plant species and screened out many insect feeding deterrent and growth inhibitors (Jacobson *et al*., 1975). Among them neem and pongamia based products have extensively been used and have proved their pest control efficacy against several insect pests both in field and storage. However, exploration on the use of botanicals against mango hoppers is sparse. Hence, considering the importance of eco-friendly approaches to manage the pests, the present study was intended to evaluate different concentrations of neem soap, pongamia soap (commercialized products of ICAR-IIHR), neem herbal formulation and pongamia herbal formulation (new

products developed at ICAR-IIHR) for the management of mango hopper, *I .nitidulus* under organic farming.

MATERIALS AND METHODS

Field trials were conducted in 2016 and 2017 at ICAR-Indian Institute of Horticultural Research (12^0 58`N; $77^0$35`E) Hesaraghatta, Bangalore, Karnataka in an organic mango orchard of *cv* Totapuri comprising of 28 trees in an area of one acre with spacing 10x10 aged 15 years. The experiment was laid out in a Randomized Complete Block Design (RCBD) consisting of 14 treatments including a control with four replications each. The treatments were neem soap (5 g/l, 10 g/l and 15 g/l), pongamia soap (5 g/l, 10 g/l and 15 g/l), Neem herbal formulation (5 g/l, 10 g/l and 15 g/l), Pongamia herbal formulation (5 g/l, 10 g/l and 15 g/l), imidacloprid 0.3 ml/l and a control (water) were sprayed once in a experimental period using a knap sack sprayer. Treatments consisted of 12 botanicals/herbal formulations and a positive control (chemical insecticide) along with a negative control (water). Fourteen random trees were selected where each treatment was sprayed to a single tree and five random shoots were considered as single replication. Hence each treatment consisted of 20 random shoots/ tree. Insecticide spray (imidacloprid) was done in the adjacent conventional mango orchard as chemical insecticides are prohibited in organic mango orchard. Spraying was done during the morning hours and observations were recorded before 10 am as winged insects remain sluggish during morning hours. Visual counts on number of leafhoppers per shoot or inflorescence were recorded before spray and after spray of botanicals. A day before spraying the pre count of leafhoppers per shoot was recorded and the subsequent observations were made at regular intervals viz., 24 h, 48 h, 72 h, one week, two weeks and 3 weeks of post treatment and compared with pre-treatment. The same trial was conducted during the month of March of 2017. Data were subjected to statistical analysis ANOVA (p=0.05).

RESULTS AND DISCUSSION

The current management practices for the leafhoppers include the use of insecticides which have paved a way to various ill-effects to the flora and fauna. In recent years the major drawback of the use of these pesticides includes insecticide- resistance, pest resurgence and also the cost of these insecticides. There is an urgent need for alternative methods which are eco-friendly that include sustainable management practices. The results of the present study suggested that during the first year of the study, there was a significant difference between control and all other treatments i.e. different concentration of botanicals and a chemical spray (Table 1).

The mean number of *I. nitidulus* per shoot or panicle in pre count ranged from 3.57 to 7.57 compared to 6 in negative control and 8.29 in positive control respectively (Table 1). After 24 h of treatment, there was no significant difference among the treatments. The mean number of *I. nitidulus* per shoot ranged from 2.57 to 5.14 compared to 7.86 in negative control. After 72 h of treatment, all the treatments were significantly superior to control. There was no significant difference among the treatments. The mean number of *I. nitidulus* per panicle ranged from 0.71 to 2.14 compared to 13 in negative control.

One week of post treatment, the same trend was observed there was no significant difference among the different concentrations of botanicals as all the treatments were on par. However, all the treatments were significantly superior compared to control. The mean number of *I. nitidulus* per shoot ranged from 0.43 to 1.14 compared to 13.43 in negative control. Two weeks of post treatment, all the treatments were significantly superior to control. There was no significant difference among the different concentrations of botanicals. Neem herbal formulation (10 ml/l) and pongamia herbal formulation (15 ml/l) were found to be more effective as it resulted in 100% control of *I. nitidulus*. Three weeks of post treatment, all the treatments were significantly superior to control in controlling the *I. nitidulus* population. Among the different concentrations of botanicals all the treatments were on par with each other.

The chemical spray, imidacloprid (0.3 ml/l) was significantly superior to other treatments. Hence, botanicals like neem soap and pongamia (5 g/l) or neem herbal formulation or pongamia herbal formulation (5 ml/l) can replace with insecticide spray (imidacloprid) in management of hoppers. Among the commercial formulations of IIHR, neem and pongamia soap or herbal formulations sprayed at 5 g/l or 5 ml/l found significantly effective in repelling the hoppers 100% (Table 1).

Table 1. Bio-efficacy of neem and pongamia formulations against mango leafhoppers in organic mango orchard in 2016

Treatment	Pre-count	After 24 h	After 48 h	After 72 h	After 1 week	After 2 weeks	After 3 weeks
Neem soap (5 g/l)	6.71	5.14	3.14	1.71	0.86	0.43	0.29
Neem soap (10 g/l)	5.71	4.86	2.71	1.57	1.14	0.57	0.14
Neem soap (15 g/l)	5.14	3.57	3.14	1.29	0.57	0.43	0.00
Pongamia soap (5 g/l)	5.29	4.14	3.71	2.14	1.14	1.00	0.43
Pongamia soap (10 g/l)	7.57	5.14	1.43	0.71	0.57	0.43	0.29
Pongamia soap (15 g/l)	6.43	4.86	3.14	1.43	0.43	0.29	0.00
Neem herbal formulation (5 ml/l)	5.57	4.43	2.29	2.14	1.14	0.57	0.43
Neem herbal formulation (10 ml/l)	3.57	2.57	1.14	0.86	0.71	0.00	0.00
Neem herbal formulation (15 ml/l)	4.14	3.14	1.71	1.14	0.86	0.71	0.57
Pongamia herbal formulation (5 ml/l)	5.14	4.14	2.71	0.86	0.43	0.29	0.14
Neem herbal formulation (10 ml/l)	4.43	3.57	2.29	1.29	0.71	0.14	0.00
Pongamia herbal formulation (15 ml/l)	3.86	3.14	1.43	1.14	0.86	0.00	0.00
Chemical control (positive)	8.29	3.29	0.86	0.29	0.00	0.00	0.00
Control (negative)	6.00	7.86	8.71	13.00	13.43	11.57	13.57
LSD p=0.05	NS	3.50	3.09	2.28	1.67	1.58	1.51

Similar results were obtained during the second year of the study (2017), where all the treatments were significantly effective in repelling the hoppers compared to absolute control (Table 2).

There was a significant difference between all the treatments and chemical control from 24 h to three weeks of post treatment. The mean number of *I. nitidulus* per shoot ranged from 1.86 to 6.29 (Table 2).

After 24 h of treatment, all the treatments were significantly superior to negative and positive control. Treatments consisting of pongamia soap (5, 10 and 15 g/l), neem herbal formulation (5, 10 and 15 g/l) were significantly superior to neem soap (5 g/l). All other treatments were on par. The mean number of *I. nitidulus* per panicle or shoot ranged from 1.57 to 4.86 compared to 5.86 in negative and 1.28 in positive control. After 48 h of treatment, all the treatments were found effective in controlling *I. nitidulus* compared to control. Among the botanicals, pongamia soap (10 and 15 g/l) was found to be significantly superior to pongamia soap (5 g/l) while all other treatments were on par. Neem soap 5 g/l was found to be less effective compared to pongamia soap (15 g/l). All other treatments were on par with each other. After 72 h of treatment, all the treatments were significantly superior to control in controlling the *I. nitidulus*. All other treatments were on par. The mean number of *I. nitidulus* per shoot ranged from 0.57 to 2.86 compared to 9.29 in negative control.

After 72 h, the chemical control was found 100 % effective in controlling the *I. nitidulus* after 48 h of post treatment where the population of *I. nitidulus* was found to be 0 (Table 2). One week of post treatment, among the different concentrations of botanicals all the treatments were on par. However, all the treatments were significantly superior to control. The mean number of *I. nitidulus* ranged from 0.14

to 0.86 compared to 9.29 in negative control. Two weeks of post treatment, all the treatments were on par compared to control. Among the botanicals all the treatments were on par. Treatment consisting of neem soap (15 g/l), pongamia soap (15 g/l), neem herbal formulation (15 ml/l), and pongamia herbal formulation (10 ml/l) showed 100% efficacy in controlling *I. nitidulus* (Table 2). Three weeks of post treatment, all the treatments were significantly effective in controlling *I. nitidulus* compared to control. All other treatments were on par. Pongamia soap (15 g/l), neem herbal formulation (5 ml/l and 15 ml/l), pongamia herbal formulation (10 and 15 ml/l) resulted in 100% efficacy in controlling the *I. nitidulus*.

Table 2. Bio-efficacy of neem and pongamia formulations against mango leafhoppers in organic mango orchard in 2017

Treatment	Pre-count	After 24 h	After 48 h	After 72 h	After 1 week	After 2 weeks	After 3 weeks
Neem soap (5 g/l)	6.57	4.86	3.29	2.43	1.29	0.86	0.71
Neem soap (10 g/l)	5.14	3.14	2.43	2.29	1.43	1.14	0.57
Neem soap (15 g/l)	6.29	2.86	1.57	1.29	0.29	0.00	0.00
Pongamia soap (5 g/l)	6.00	2.71	2.57	1.71	1.57	0.71	0.57
Pongamia soap (10 g/l)	5.14	2.14	1.71	1.43	0.43	0.29	0.14
Pongamia soap (15 g/l)	4.71	1.86	1.14	1.00	0.57	0.14	0.00
Neem herbal formulation (5 ml/l)	5.43	2.57	2.43	2.29	1.14	0.86	0.43
Neem herbal formulation (10 ml/l)	3.71	1.71	1.57	1.29	0.43	0.29	0.14
Neem herbal formulation (15 ml/l)	1.86	1.57	1.43	1.14	0.86	0.00	0.00
Pongamia herbal formulation (5 ml/l)	4.86	4.29	2.86	2.71	1.29	1.14	0.86
Pongamia herbal formulation (10 ml/l)	4.14	3.57	2.43	2.29	1.14	0.43	0.29
Pongamia herbal formulation (15 ml/l)	2.43	1.86	1.57	1.29	0.43	0.14	0.00
Chemical control (positive)	3.43	1.28	0.57	0.00	0.00	0.00	0.00
Control (negative)	3.86	5.86	8.00	7.00	7.57	8.86	9.29
LSD p=0.05	NS	3.10	2.71	2.88	1.72	1.60	1.51

The present study is in accordance with Rosaiah (2001) who reported that, neem oil sprayed at 2% was found significantly effective in reducing the leafhopper population. Similarly Anitha (2007) reported that the neem oil was found superior compared to entomopathogens by reducing the leafhopper population to 2.56/3leaves. Chaudhari *et al*., 2017, reported that neem oil 1% recorded higher mean mortality of 79.71% followed by pungam oil at 1% concentration showed the least mean mortality of 40.31%. Similarly Adnan *et al*., (2014) reported that neem oil was found effective against mango leafhopper with a mortality of 48.35, 60.15 and 56.54 % after 24, 72 and 168 hours of spraying respectively.

In the present study among all the treatments, after 24h of post treatment imidacloprid (chemical control) ranked first in reducing the hopper population up to 94%. However, there was 100% control in leafhoppers after 48h of post treatment. This is in agreement with Chaudhari *et al*., (2017) who reported that imidacloprid had a mean mortality of 94.06% of leafhoppers and was on par with thiamethoxam in ultra-high density planting

of mango. The result is also in conformity with Sarode and Mohite (2016) who found imidacloprid to be the most effective in reducing hopper.

Among the botanicals during the first year of the study (2016), neem soap and pongamia soap (5 g/l) were found effective in repelling hoppers. However during the second year of the study (2017), neem soap (5 g/l) was found more effective in controlling the hopper population followed by pongamia soap (10 g/l) probably the abiotic factors such as maximum and minimum temperature, relative humidity, wind speed and density of hopper population significantly contribute to the variation in the efficacy of herbal formulations. However, both years' data suggest that neem soap or pongamia soap sprayed at 5 g/l or neem or pongamia herbal formulation sprayed at 5 ml/l effectively controlled leafhopper population. Verghese (2000) opined that the efficacy of the azadirachtin (3000 and 1000 ppm) seemed to depend on the level of hopper density. At lower densities (<4 per panicle), they were as effective as the synthetic chemicals in mango. This also explains why in most post treatment imidacloprid was found on par with herbals (Table 1 and 2).

Plant products especially of neem were reported to be one of the best alternatives to synthetic insecticides (Pawar and Singh, 1993). These products natural and formulated are cheaper and easily available in local market (Kausalya *et al*., 1997). Vinodhini and Malaikozhundan (2011) reported that neem oil could reduce the leafhopper population up to 43.59 % followed by *Pongamia glabra* oil up to 39.99% in cotton. Similar results are recorded in our trials also for the both the years of study.

CONCLUSION

From the present study it may be concluded that all the botanical formulations of neem and pongamia were found effective in controlling the leafhoppers in mango. Neem soap or pongamia soap sprayed at 5 g/l and neem or pongamia herbal formulation sprayed at 5 ml/l were found significantly superior in reducing the hopper population which was on par with imidacloprid up to three weeks of post treatment during the two years of the study. Hence by incorporating the spray of botanicals in the IPM, sole dependency on pesticides can be reduced. It also possesses the advantage of reducing the ill-effects posed by insecticides and maintains the balance in the ecosystem by protecting the beneficial flora and fauna.

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