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Y Rajasekhar
Scientist, Department of Entomology, Agricultural Research Station, Amadalavalasa, Acharya N.G. Ranga Agricultural University, Lam, Guntur, Andhra Pradesh, India

B Swathi
Scientist, Department of Entomology, Agricultural Research Station, Amadalavalasa, Acharya N.G. Ranga Agricultural University, Lam, Guntur, Andhra Pradesh, India

T Srelatha
Principal Scientist (SSAC), Agricultural Research Station, Amadalavalasa Acharya N.G. Ranga Agricultural University, Lam, Guntur, Andhra Pradesh, India

Corresponding Author:
Y Rajasekhar
Scientist, Department of Entomology, Agricultural Research Station, Amadalavalasa, Acharya N.G. Ranga Agricultural University, Lam, Guntur, Andhra Pradesh State, India

Evaluation of eco-friendly insecticides against sucking pest on Mesta

Y Rajasekhar, B Swathi and T Srelatha

Abstract
Field trials were conducted at Agricultural Research Station, Amadalavalasa for three consecutive years during *Kharif* 2015-16, 2016-17 and 2017-18 to evaluate the eco-friendly insecticides against sucking insect pests *viz*., Aphids, *Aphis gossypii* (Glover); leafhoppers, *Amrasca biguttula biguttula* (Ishida); whiteflies, *Bemisia tabaci* Genn. and mealybug, *Phenacoccus solenopsis* Tinsley in mesta, *Hibiscus sabdariffa* L (Roselle). Imidacloprid 600 FS@5ml per kg seed (1part chemical + 1part water) was effective against sucking pests up to 40 days after sowing. Among the treatments, profenophos 50EC@2ml/l (standard check) was most effective against Mesta pests with higher fibre yield. Among the botanical and microbial insecticides, azadiractin (neem oil) (1500 ppm) @5 ml/l was found effective against sucking pests and recorded higher fibre yield.

Keywords: Sucking pests, Roselle, botanicals, microbials

1. Introduction
There are more than 300 tropical and sub-tropical Hibiscus species. Roselle or Jamaica sorrel (*Hibiscus sabdariffae*) is a unique species cultivated in many tropical regions for its leaves, seeds, stem and calyces which, the dried calyces are used to prepare tea, syrup, jams and jellies as beverages (Ansari *et al.*, 2013) [1]. Roselle is an annual plant which takes about six months to mature. Roselle has drawn the attention of food, beverage and pharmaceutical manufacturers because of its commercial potential as a natural food and colouring agent that can replace some synthetic products. Roselle is locally known as 'Mesta' or 'Meshta' on the Indian Subcontinent (Halimatul *et al.*, 2007) [6].

The warm and humid tropical climate is suitable for roselle plants as it is exceptionally susceptible to frost and mist. The temperature range within which roselle thrives is between 18 and 35 ºC, with an optimum of 25 ºC. Roselle is a short-day plant that is very sensitive to the photoperiod. Roselle plants prefer well drained humus and rich fertile soils with a pH of 4.5 to 8.0.

In Andhra Pradesh, it is mainly concentrated in Vizianagaram and Srikakulam Districts, accounts for 98.7 per cent of the total area in the state (Sreelatha and Raju, 2004) [16]. However, there are certain abiotic and biotic constraints, significantly limiting the production. Insect pests are important biotic factors contributing towards low yield and economical management of these would certainly contribute to higher yields. Cultivation of Roselle is subjected to a number of pest outbreaks; some of the common insect pests of Roselle reported were Aphids, *Aphis gossypii* (Glover); leafhoppers, *Amrasca biguttula biguttula* (Ishida); whiteflies, *Bemisia tabaci* Genn. and mealybug, *Phenacoccus solenopsis* Tinsley. Among them, mealybug is the major pest occurring throughout the crop growth period which is causing an accountable damage and has direct impact on the fibre yield loss of up to 40 per cent (Raju *et al*., 1988) [14]. Therefore, appropriate management practices should be adopted for managing these sucking pests in mesta. The present study mainly focuses on finding out the efficacies of different botanicals, microbials and chemicals against sucking pest complex of mesta, keeping in mind the cost and eco-friendliness of the management practices.

2. Material and Methods
The present experiment was carried out during three consecutive seasons of *Kharif* 2016-17, 2017-18 and 2018-19 at Agricultural Research Station under Acharya N.G. Ranga Agricultural University, Amadalavalasa, Srikakulam district of Andhra Pradesh. The experiment was laid out in randomized block design using AMV-5 variety consisting of three replications and seven treatments including untreated control.

Individual plot size of 6.0m x 4.5m was maintained. All the recommended agronomical package of practices (*viz*., field preparation, sowing, thinning, weeding, fertilizer application etc.,) were adopted for raising the crop. The seed was treated with imidacloprid 600FS@5ml per kg seed in 1:1 ratio and then shade dried and sown in T1 plots and remaining treatments were imposed at 35, 50 and 60 days after sowing (DAS). Population of aphids and whiteflies (no./top 3 leaves/plant), leafhoppers (number/6 leaves from 3 different strata *i.e.*, top, middle and bottom strata) and mealybug (number of plants effected and expressed in %) was recorded at 3, 9 and14 days after each spray on 10 randomly selected and tagged plants in each plot to know the efficacy of the insecticides. At harvest, plant height, basal diameter of the stem at base and fibre yield were recorded as part of yield attributing parameters. The details of the insecticides are as follows

T_1 - Seed treatment with imidacloprid600 FS @5 ml / kg seed (1part chemical +1 part water)
T_2 - NSKE 5% at 35, 50 and 65(DAS)
T_3 - Azadirachtin (1500ppm)@5ml/l at 35, 50 and 65 DAS
T_4-*Lecanicilliumlecani*@6g/l at 35, 50 and 65 DAS
T_5 - NSKE 5% at 35DAS+Azadirachtin (1500ppm) @5ml/l at 50 DAS + *Lecanicillium lecani* @ 6g/l at 65 DAS;
T_6 - Profenophos@ 2ml/l at 35, 50 and 65 DAS (standard check) and
T_7 - Untreated check.

Preparation and application of spray solution

Commercial formulations of microbials *viz*., neem oil (1500 ppm) and *Lecanicillium lecani* were purchased directly from local market. Neem Seed Kernel Extract was prepared one day prior to imposition of the treatment by using the following method.

Neem Seed Kernel Extract preparation

Neem Seed Kernels obtained from the neem seed and dried under shade. The shade dried kernels were powdered using mixy. Fifty grams of kernel powder was soaked overnight in double quantity of water. Later, the mixture was squeezed thoroughly using muslin cloth and the volume was made up to one litre so as to obtain 5 per cent solution an 2g/l of soap powder was added to solution and stirred well which acts as a surfactant.

Results and Discussions

The present experiment was carried out during three consecutive seasons of *Kharif* 2016-17, 2017-18 and 2018-19 and mean data of the three years is presented in the table 1 and 2. The findings of the present research study as well as relevant discussion have been conferred under following points.

Efficacy of imidacloprid 600 FS as seed treatment against sucking pests

Seed treatment is a highly progressive and demandable technology for management of various crop pests (Taylor *et al*., 2001; Magalhaes *et al*., 2009) [19, 9]. The mean data of the three years on the efficacy of seed treatment on the incidence of sucking pests presented in the table 1. Imidacloprid 600 FS@5ml per kg seed (1 part chemical + 1part water) was effective against sucking pest complex up to 40 days after sowing (DAS) and recorded significantly low population of aphids (3.16 no./plant), whiteflies (0.29 no./plant), leafhoppers (0.17no./plant) and 3.17 in seed treated plots after first spray as against high population of 6.71, 0.60, 0.37 and 4.59, respectively in untreated check. the present findings are supported from the results of Dhandapani *et* and Dhivhar Palanisamy (2002) [3] who reported that imidacloprid 600FS was effectively controlled the aphids (aphis gossypii) and leaf hoppers (*Amrasca biguttula biguttula*) in cotton up to 8 weeks after sowing. Similarly, Harish Kumar *et al*. (2013) [8] who also reported that imidacloprid 600 FS @0.75ga.i. per kg seed when applied as seed treatment was most effective against sucking pets up to four weeks of seed germination.

Effect of different treatments on aphid population

Impact of various eco-friendly insecticides (botanicals and microbials) along with profenophos 50EC@2ml/l taken as a standard check against sucking pests of Mesta is presented in table 1. All the treatments were significantly superior over untreated check in all the three sprays. Among the treatments, profenophos 50 EC@2ml/l (standard check) at 35, 50 and 65 DAS was the most effective in reducing population of aphids with 0.22, 1.89 and 0.17number per plant after 1st, 2nd and 3rd spray, respectively as against high population of 6.71, 1.89 and 0.17 in untreated check. *Lecanicilium lecani* @6g/l at 35, 50 and 65 days after sowing (DAS) was the next best treatment by recording of mean population 0.88 aphids per plant as against 2.92 aphids per plant in untreated check. Which is followed by NSKE 5% at 35 DAS+Azadirachtin (1500ppm) at 50 DAS+ *Lecanicilium lecani* @6g/l at 65DAS (0.91 aphids/plant), azadirachtin (1500ppm) at 35, 50 and 65 DAS (0.95 aphids/plant) and NSKE 5% at 35, 50 and 65DAS (1.14 aphids/plant) and were on par with each other. The biopesticides (botanicals and microbial) were less effective over the profenophos 50EC@2ml/l (Standard check). Results of the present experiment are drawn support with findings of Ghelani *et al*. (2006) [4] who reported that more than 70 per cent reduction of cotton aphids with treatment of *Lecanicilium lecani*@5g/l. Nirmala *et al*. (2006) [13] who also reported that fungal isolates of *Verticilium lecani* @ 1x107 spores/ml effective against *Aphis gossypii*. Ghelani *et al*. (2014) [5] recorded that 31.8, 33.2 and 48.2 per cent mortality of aphis on *Bt* cotton at 15 days after spray with NSKE 5%, azadirachtinn (1500 ppm) @0.0009%) and *Verticilium lecani* @ 2.5kgs/ha.

Effect of different treatments on whitefly population

The data on the effect of ecofriendly insecticides on whiteflies presented in table 1 revealed that all the treatments (except seed treatment with imidacloprid 600FS@5kg/seed) were significantly superior over untreated check in reducing the whitefly population at all the three sprays with low population ranging from 0.12 to 0.80 whiteflies per plant in the treatments compared to 0.60 to 1.42 in untreated check. Among the treatments, profenophos 50EC@2ml/l (standard check) at 35, 50 and 65 DAS was effective in reducing population of whiteflies with 0.12, 0.44 and 0.41 number per plant after 1st, 2nd and 3rd spray, respectively as against high population of 0.60, 1.42 and 1.23 in untreated check which is followed by the azadirachtin (1500ppm)@5ml/l at 35, 50 and 65 DAS was next best treatment with mean whitefly population of 0.45 whiteflies per plant compared to higher incidence of 1.08 whiteflies per plant in untreated check and were on par with each other. The next best treatments in the descending order of efficacy are *Lecanicilium lecani* @6 g/l at 35, 50 and 65 DAS (0.49 whiteflies/plant), NSKE 5% at 35

DAS+Azadirachtin (1500ppm) at 50 DAS+ *Lecanicilium lecani* @6g/l at 65DAS (0.50 aphids/plant) and NSKE 5% at 35, 50 and 65DAS (0.60 whiteflies/plant) and were on par with each other. The present findings are in line with the reports of Suraj *et al*. (2016) [17] who reported aadirachtin1% EC@2ml/l and *Verticilium lecani*@5g/l were efficacious in reducing jassid pooulation by recording of 12.49 and 10.91 jassids per 15 leafs after first spray as against 21.33 in control in okra. Ghelani *et al*. (2014) [5] reported that per cent mortality of aphids was 42.46, 40.79 and 40.79 on *Bt* cotton at 15 days after spray with NSKE 5%, azadirachtinn (1500 ppm) @0.0009%) and *Verticilium lecani* @2.5kgs/ha. The findings of the Hanumantharaya *et al*. (2008) [7] support the present study who stated that two sprays of NSKE on cotton at 38 and 60 DAS reduced the jassied population.

Effect of different treatments on leaf hopper population

The mean data on impact of botanicals and microbials along with profenophos 50EC@2ml/l taken as a standard check against leaf hopper population is presented in the table 1 and results revealed that all the treatments were significantly superior over untreated check in the three sprays. Efficacy of the botanicals and mirobials in reducing the leaf hopper population was lower compared to profenophos 50EC@2ml/l. The leaf hopper population in the treatments is low and ranging from 0.06 to 0.35 leafhoppers per plant compared to higher population of 0.37 to 0.65 per plant in untreated check. Among the treatments, mean leaf hopper population was low (0.11 no./plant) in profenophos 50EC@2ml/l at 35, 50 and 65 DAS which is followed by azadirachtin (1500ppm)@5ml/l at 35, 50 and 65 DAS was the next best treatment in reducing the leaf hopper population by recording of 0.20 no. per plant. The treatments *Lecanicilium lecani* @6g/l at 35, 50 and 65 DAS (0.23 no./plant), NSKE 5% at 35 DAS+Azadirachtin (1500ppm) at 50 DAS+ *Lecanicilium lecani* @6g/l at 65DAS (0.23 no./plant) and NSKE 5% at 35, 50 and 65DAS (0.24 no./plant) and were on par with each other. The findings of the present study can supported with the results of the Suraj *et al*. (2016) [17] who reported that azadirachtin 1% EC @2ml/l gave 40.38 per cent reduction of jassid population in okra. Baladaniya *et al*. (2010) [2] revealed that *V. lecanii* at 7g/l gave significantly higher mortality of okra jassid which is in conformity with the present findings. The present findings matched more or less with the reports of Ghelani *et al*. (2014) [5] who stated that per cent mortality of jassids was 41.6, 40.4 and 50.3 on *Bt* cotton at 15 days after spray with NSKE 5%, azadirachtinn (1500 ppm) @0.0009%) and *Verticilium lecani* @2.5kgs/ha.

Table 1: Eco-friendly management of sucking insects in Mesta (Mean of 2016, 2017 and 2018)

Treatments	*Number per plant												*Per cent incidence			
	Aphids				Whiteflies				Leafhoppers				Mealybug			
	1st Spray	2nd Spray	3rd Spray	Mean	1st Spray	2nd Spray	3rd Spray	Mean	1st Spray	2nd Spray	3rd Spray	Mean	1st Spray	2nd Spray	3rd Spray	Mean
T_1 - Seed treatment with imidacloprid 600 FS @5 ml/ kg seed (1:1 ratio)	3.16 (1.90)	1.73 (1.49)	0.12 (0.79)	1.67 (1.47)^{c}	0.29 (0.89)	1.19 (1.30)	1.15 (1.28)	0.88 (1.17)^{d}	0.17 (0.82)	0.60 (1.05)	0.60 (1.05)	0.46 (0.98)^{d}	3.17 [10.26]	6.07 [14.18]	6.13 [14.32]	5.12 [13.06]^{d}
T_2 - NSKE 5% at 35, 50 and 65 DAS	3.03 (1.88)	0.39 (0.94)	0.00 (0.71)	1.14 (1.28)^{b}	0.31 (0.90)	0.80 (1.14)	0.68 (1.09)	0.60 (1.05)^{c}	0.11 (0.78)	0.26 (0.87)	0.35 (0.92)	0.24 (0.86)^{c}	2.49 [9.08]	3.05 [10.06]	2.73 [9.52]	2.76 [9.56]^{c}
T_3 - Azadirachtin (1500ppm)@5ml/l at 35, 50 and 65 DAS	2.54 (1.74)	0.30 (0.90)	0.00 (0.71)	0.95 (1.20)^{b}	0.21 (0.84)	0.59 (1.04)	0.56 (1.03)	0.45 (0.97)^{ab}	0.11 (0.78)	0.25 (0.86)	0.25 (0.86)	0.20 (0.84)^{b}	1.75 [7.60]	2.84 [9.69]	2.71 [9.48]	2.43 [8.97]^{bc}
T_4 - *Lecanicillium lecani* @6 g/l at 35, 50 and 65 DAS	2.12 (1.62)	0.50 (1.00)	0.01 (0.71)	0.88 (1.17)^{b}	0.23 (0.86)	0.62 (1.06)	0.62 (1.06)	0.49 (1.00)^{bc}	0.12 (0.79)	0.30 (0.90)	0.26 (0.87)	0.23 (0.85)^{bc}	2.40 [8.91]	2.71 [9.48]	1.96 [8.05]	2.36 [8.83]^{bc}
T_5 - NSKE 5% at 35DAS+ Azadirachtin (1500 ppm) @5ml/l at 50 DAS + *Lecanicillium lecani* @6g/l at 65 DAS	2.41 (1.70)	0.32 (0.91)	0.00 (0.71)	0.91 (1.19)^{b}	0.24 (0.86)	0.70 (1.09)	0.56 (1.03)	0.50 (1.00)^{bc}	0.11 (0.78)	0.29 (0.89)	0.29 (0.89)	0.23 (0.85)^{bc}	1.85 [7.81]	2.15 [8.38]	1.90 [7.91]	1.97 [8.04]^{b}
T_6 - Profenophos@ 2ml/l at 35, 50 and 65 DAS (standard check)	0.22 (0.85)	0.06 (0.74)	0.00 (0.71)	0.09 (0.77)^{a}	0.12 (0.79)	0.44 (0.97)	0.41 (0.96)	0.33 (0.91)^{a}	0.06 (0.75)	0.13 (0.79)	0.16 (0.81)	0.11 (0.78)^{a}	0.49 [4.00]	0.61 [4.43]	0.60 [4.39]	0.57 [4.29]^{a}
T_7 - Untreated check	6.71 (2.68)	1.89 (1.54)	0.17 (0.82)	2.92 (1.85)^{d}	0.60 (1.05)	1.42 (1.38)	1.23 (1.31)	1.08 (1.26)^{e}	0.37 (0.93)	0.65 (1.07)	0.62 (1.06)	0.55 (1.02)^{e}	4.59 [12.38]	6.15 [14.35]	6.67 [14.95]	5.81 [13.94]^{d}
F-test	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
CD (P=0.05)	0.18	0.12	0.02	0.11	0.07	0.05	0.11	0.06	0.03	0.03	0.04	0.02	0.66	1.70	0.95	0.94
CV (%)	5.71	6.62	1.90	5.03	4.45	2.37	5.43	3.17	2.15	2.00	2.37	1.60	4.44	9.70	5.56	5.70

Note: Values in parenthesis ( ) and [ ]are square root and arc sine transformed values, respectively.

Effect of different treatments on mealybug

It is evident from the table 1 that pooled data of three consecutive sprays revealed that efficacy of the botanicals and microbials in reducing the mealybug population was lower compared to profenophos 50EC@2ml/l (standard check). The per cent mealybug infestation among different treatments was ranged from 0.57 to 5.81. Among the treatments, Profenophos 50EC@2ml at 35, 50 and 60DAS had registered significantly lower mealybug infestation (0.57%) compared to botanicals and microbial pesticides. Among the botanicals and microbials, NSKE 5% at 35 DAS+Azadirachtin (1500ppm) at 50 DAS+ *Lecanicilium lecani* @6g/l at 65DAS registered lower mealybug infestation of 1.97 per cent. The descending order of remaining treatments in efficacy against mealybug were *Lecanicilium lecani* @6g/l at 35, 50 and 60 DAS (2.36%), Azadirachtin (1500ppm)@5ml/l at 35, 50 and 60 DAS (2.43%) and NSKE 5% at 35, 50 and 60 DAS (2.76%). The findings of the present study are drawn support from the results of the Rashid *et al*., (2011) [15] who reported that application of neem oil @2.0 and 1.5% registered 70.69 and 20.64 per cent reduction of mealybug, *Phenacoccus solenopsis* on cotton. Surilivelu *et al*. (2012) [18] who reported

that verticillium lecani caused 30.9 per cent reduction of mealybug in cotton crop. The present results were parallel to the reports of Mahalakshmi *et al*. (2010) [10] who observed that *verticillium lecani* was found increasing constantly which caused mortality up to 75.61 per cent. Although bio pesticides provided lower mortality of mealybug as compared to synthetic insecticides but due to rising environmental concerns and ill effects of the synthetic insecticides on the beneficial fauna and environment, the use of synthetic insecticides cannot be preferred (Meyerdirk *et al*., 1982; Mani and Krishnamoorthy, 1997) [12, 11].

Fibre yield and yield attributes

It is evident from the table 2 that plant height (cm), basal diameter (mm) and fibre yield (q/ha) was significantly more in Profenophos 50EC@2ml (standard check) by recording of 330.61, 15.81 and 20.57, respectively. The descending order of treatments with respects fibre yield and its attributes were azadirachtin (1500 ppm)@5ml/l at 35, 50, 65 DAS (313.17, 15.33 and 18.38), NSKE 5% at 35 DAS + azadirachtin (1500 ppm)@5ml/l at 50 DAS + *Lecanicilium lecani* @6g/l at 65 DAS (309.70, 15.16 and 17.95) and NSKE 5% at 35, 50 and 65 DAS (305.78, 15.04 and 17.49) and were on par with each other.

Table 2: Influence of eco-friendly insecticides on Mesta yield parameters (Mean of 2016, 2017 and 2018)

Treatments	Yield parameters		
	Plant height (cm)	Basal diameter (mm)	Yield (q/ha)
T_1 - Seed treatment with imidacloprid 600 FS @5 ml/ kg seed (1:1 ratio)	299.50^{ab}	14.83^{b}	16.88^{bc}
T_2 - NSKE 5% at 35, 50 and 65 DAS	305.78^{ab}	15.04^{ab}	17.49^{b}
T_3 - Azadirachtin (1500 ppm)@5 ml/l at 35, 50 and 65 DAS	313.17^{ab}	15.33^{ab}	18.38^{b}
T_4 - *Lecanicillium lecani* @6 g/l at 35, 50 and 65 DAS	307.56^{ab}	15.05^{ab}	17.13^{bc}
T_5 - NSKE 5% at 35DAS+ Azadirachtin (1500 ppm) @5 ml/l at 50 DAS + *Lecanicillium lecani* @6 g/l at 65 DAS	309.70^{ab}	15.16^{ab}	17.95^{b}
T_6 - Profenophos@ 2ml/l at 35, 50 and 65 DAS (standard check)	330.61^{a}	15.81^{a}	20.57^{a}
T_7 - Untreated check	296.33^{b}	14.93^{b}	15.89^{c}
F-test	Sig.	Sig.	Sig.
CD (P=0.05)	31.26	0.89	1.52
CV (%)	5.82	3.38	4.92

Conclusion

In conclusion, the findings of present research suggest that eco-friendly can be used in swapping to synthetic insecticides to get a better and safer control of sucking pests. Imidacloprid 600 FS@5ml per kg seed (1 part chemical + 1part water) was effective against sucking pest complex up to 40 days after sowing. Among the treatments, profenophos 50EC@2ml/l (standard check), was most effective against mesta pests with higher fibre yield. Botanicals and entomopathogenic fungi evaluated during the course of study exhibited equally more or less efficacies in suppressing the sucking pests of mesta compared to untreated control.

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