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Efficacy of different newer insecticides against mango leaf hoppers

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Abstract
A field experiment was conducted on the efficacy of different insecticides against mango leafhoppers during 2014-2015 and 2015-2016 at Doddabbigere of Chennagiri Tq of Davavagere District. The results revealed that among the different insecticidal treatments, dinotefuron 20 SG found to be best the treatment which recorded a significantly lowest number of nymphs and adults, followed by imidacloprid 70 WG and acetamaprid 20 SP found to be more effective against leafhoppers. The next best treatments were, buprofezin 25 SC, thiamethoxam 25 WG, and imdidacloprid 17.8 SL. The plots treated with dinotefuron 20 SG registered the highest (97.50 q/ha) yield which was followed by imidacloprid 70 WG (89.38 q/ha). The treatments of acetamaprid 20 SP, buprofezin 25 SC and thiamethoxam 25 WG produced a satisfactory yield of 85.32 q/ha 86.25 q/ha and 83.50 q/ha respectively. Economics of different treatments showed that Incremental CB ratio were obtained in case of dinotefuron 20 SG (1:4.15), imidacloprid 70 WG (1: 3.93), Acetamiprid 20 SP (1:3.84).

Keywords: Mango, Leafhoppers, Insecticides, Dinotefuron 20 SG

1. Introduction
Mango (*Mangifera indica* Linn.) is the most important commercial fruit of India and is known as King of fruits. Production and quality of mango are mainly hampered by the incidence of about 400 insect pests [1]. Among the mango pests, mango hoppers are most serious and widespread pests throughout the country [2]. *Amritodus atkinsoni* (Lethierry), *Idioscopus clypealis* (Lethierry) *I. niveosparsus* (Lethierry) and *I. nitidulus* (Walker), are serious pests of mango at flowering and fruiting stages and could cause yield loss up to 100% [3, 4]. The hoppers are active during the flowering period and in the remaining period, they remain confined to the under surface of leaves, situated in dark and moist areas of the tree. Large number of nymphs and adults of the hoppers puncture and suck the sap from tender shoots, inflorescence and leaves of mango crop, which cause non-setting of flowers and dropping of immature fruits, thereby reducing the yield. Hoppers also excrete honey dew which encourages the development of sooty mould and this black coating interferes with the normal photosynthetic activity of the plant. Though several natural enemies have been reported on mango hoppers, chemical control remains the widely followed means of hopper management. Insecticides like imidacloprid, lambda cyalothrin or azadiractin have been recommended [2]. The extensive and indiscriminate use of pesticides for hoppers in mango has led to several problems like resurgence of secondary pests, health hazards and pesticide residues on fruit. Hence there is a need to evaluate newer molecules. The objective of the present investigation was to test the efficacy of newer insecticide molecules having different modes of action for the management of hoppers in mango.

2. Material and methods
A field experiment was conducted to evaluate the efficacy of different insecticides against mango leafhoppers during 2014-15 and 2015-16 season at Doddabbigere of Chennagiri Tq of Davanagere District. The experiment was laid out in a 12 year old orchard with cultivar, Alphanso in Randomized Block Design with three replications. The treatments comprising of insecticides are mentioned in Table 1. The control plot was sprayed with water only. The first spray was given at 50 per cent flowering then followed by the second spray 21 days after the first spray. The spray solution of 5 litres per plant was used and sprayed with high volume sprayer. The observations on nymphs and adult hoppers population were taken on four panicles per tree and data were collected on one day before pre-spray and the post treatment counts on absolute population of number of number of nymphs or adults / panicle at 7th and

21st days after each spray. The data obtained from the field experiments were subjected to square root transformation and subjected to ANOVA analysis. The fruit yield per tree was recorded and converted into hectare basis at each harvest and data were subjected to statistical analysis. Significant differences among the means of different treatments were tested using Duncan multiple range test (DMRT).

3. Results and Discussion

Nymphs and adults population

During 2014-15, the population of *leaf hoppers* before the first spray ranged from 26.00 to 31.00 nymphs and adults per panicle (Table 2). However on 7th day after first spray, dinotefuron 20 SG@ 300 g ha^{-1} recorded significantly the lowest number of nymphs and adults per panicle (0.33) followed by buprofezin 25 SC @ 200 ml ha^{-1} (1.00), thiamethoxam 25 WG 250 g ha^{-1}, acetamiprid 20 SP @ 500g ha^{-1} and imidacloprid 70 WG @ 250 g ha^{-1} recorded 1.00, 1.00, 1.17 and 1.50 nymphs and adults per panicle. The untreated check recorded 52.25 nymphs and adults per panicle. At the 21st day after first spray in all the treatments the population was in increasing trend. However, significantly lowest population of 13.00 nymphs and adults per panicle was recorded in dinotefuron treated plots and this treatment is significantly superior over other treatments. The next best treatments were imidacloprid, thiamethoxam, buprofezin and acetamiprid recorded 19.58, 21.00, 22.00 and 23.00 nymphs and adults per panicle respectively. 7 days after second spray, lowest population was recorded in dinotefuron 20 SG followed by imidacloprid 70 WG and buprofezin 25 SC. The next best treatments were acetamaprid and thiamethoxam. In control plot the highest of 54 nymphs and adults per panicle was recorded. The pre-treatment population during 2015-16 (Table 3) revealed, non-significant variation among different treatments which ranged from 23.45 to 27.31 nymphs and adults per panicle. At 7 days after first spray significantly lowest number of nymphs and adults were recorded in thiamethoxam 25 WG (0.50) followed by dinotefuron 20 SG 300 g ha^{1} recorded 1.00 nymph per panicle but were on par with each other. At 21 days after first spray dinotefuron 20 SG 300 g ha^{1} recorded significant lowest population of 9.93 nymphs and adults per panicle followed by buprofezin 25 SC, imidacloprid 70 WG and thiamethoxam 25 WG 14.50, 16.15 and 15.45 nymphs and adults per panicle. Untreated control recorded 45.50 nymphs and adults per panicle. More or less similar trend was recorded after second spray.

The pooled (Table 4)data on nymphs and adults count of both the years revealed that dinotefuron found to be the best treatment which recorded significantly lower in of 1.00 and 1.75 nymphs and adult population at 7 and 21 days after the first spray. In second spray more or less similar trend was noticed. Earlier studies indicated that dinotefuran 4%+ acephate 50% (54%) SG @ 22+275 g a.i./ha at 15 days interval was effective in reducing the sucking pest population and was followed by dinotefuran 20 SG @ 25g a.i./ha[5]. Further, the different doses of test chemical did not show any deleterious effect on the natural enemy population. Similarly, these results are in line with the earlier findings reported that dinotefuran 20 SG @ 25 and 30 g a.i./ha gave effective control of leafhopper and thrips population on Bt cotton[6 7 8].

Effect on fruit yield and cost economics

During the year 2014-15 maximum marketable fruit yield was recorded in Dinotefuron 20 SG (100.00 q/ha) and was significantly superior over all the other insecticides. This was followed by 90.00, 87.50, 87.00, 85.62 and 81.25 q ha^{-1} in imidacloprid 70 WG, buprofezin 25 SC, thiamethoxam 25 WG, acetamaprid 20 SP and imdidacloprid 17.8 SL respectively. The untreated control plot recorded significantly lowest of 43.75 q ha^{-1}. During 2015-16 the maximum yield was recorded in dinotefuron 20 SG (95.00 q/ha) followed by imidacloprid 70 WG (88.75 q/ha), buprofezin 25 SC (85.00 q/ha), acetamaprid (85.00 q/ha) found to be the next best treatments.

The pooled yield over the years revealed that maximum yield was recorded in dinotefuron 20 SG @ 300 q ha^{-1} and found to be significantly superior over other treatments and also recorded maximum CB ratio of 1: 4.15 (Table 5).

Table 1: Insecticide treatments used in the study

Sl. No.	Treatments	Trade name and company	Dose (mL or g ha^{-1}) (Two time application)
1	Imidacloprid 17.8 SL	Confidor, Bayer Crop Sciences	500
2	Acetamiprid 20 SP	Lift, chemical company	500
3	Thiomethaxam 25 WG	Actra, Syngent India ltd	250
4	Acephate 75 SP	Starthene, Swal Company	1000
5	Dinutefuron 20 SG	Token, Indofil chemical company	300
6	Buprofezin 25 SC	Applaud, Bayer Crop Sciences	2000
7	Imidacloprid 70 WG	Admire, Bayer Crop Sciences	250
8	Untreated control	-	-

Table 2: Evaluation of insecticides against Mango leaf hoppers during 2014 -2015

Sl. No.	Treatments	Dose (mL or g ha^{-1})	Mean number of nymphs or adults/panicle					Yield (q/ha)
			First spray			Second spray		
			1DBFS	7DAFS	21DAFS	7DASS	21DASS	
1.	Imidacloprid 17.8 SL	500	28.25 (5.36)^{a}	3.83 (2.08)^{c}	28.33 (5.36)^{b}	4.75 (2.29)^{d}	1.00 (1.22)^{b}	81.25^{bc}
2	Acetamiprid 20 SP	500	31.00 (5.61) ^{a}	1.17 (1.29)^{d}	23.00 (4.84)^{c}	4.50 (2.24)^{d}	0.50 (0.99)^{c}	85.62^{bc}
3	Thiamethoxam 25 WG	250	29.73 (5.50) ^{a}	1.00 (1.22)^{d}	21.00 (4.63)^{c}	5.00 (2.35)^{d}	1.00 (1.22)^{b}	87.00^{bc}
4	Acephate 75 SP	1000	27.50 (5.29) ^{a}	18.50 (4.35)^{b}	28.25 (5.36)^{b}	6.00 (2.55)^{c}	1.00 (1.22)^{b}	80.00^{c}
5	Dinutefuron 20 SG	300	28.25 (5.36) ^{a}	0.33 (0.88)^{e}	13.00 (3.67)^{d}	1.00 (1.22)^{f}	0.50 (1.97)^{c}	100.00^{a}
6	Buprofezin 25 SC	2000	26.00 (5.13) ^{a}	1.00 (1.22)^{d}	22.00 (4.76)^{c}	2.00 (1.58)^{e}	0.50 (0.99)^{c}	87.50^{bc}
7	Imidacloprid 70 WG	250	29.25 (5.45) ^{a}	1.50 (1.41)^{d}	19.58 (4.46)^{c}	1.81 (1.44)^{e}	1.00 (1.21)^{b}	90.00^{b}
8	Untreated control	-	26.58 (5.20) ^{a}	52.25 (7.26)^{a}	78.50 (8.89)^{a}	54.00 (7.38)a	13.00 (3.67)^{a}	43.75^{d}
	SEm±	-	0.12	0.09	0.14	0.06	0.06	1.19
	CD (p=0.05)	-	0.36	0.29	0.43	0.18	0.18	3.63

DBFS: Day Before First Spray; **DAFS:** Days After First Spray; values in the parentheses are $\sqrt{x+1}$ transformed value; Means followed by same letters do not differ significantly by DMRT (P=0.05)

Table 3: Evaluation of insecticides against Mango leaf hoppers during 2015 – 2016

Sl. No.	Treatments	Dose (mL or g ha^{-1})	Mean number of nymphs or adults/panicle					Yield (q/ha)
			First spray			Second spray		
			1DBFS	7DAFS	21DAFS	7DASS	21DASS	
1.	Imidacloprid 17.8 SL	500	23.73 (4.92)	3.00 (1.87)^{c}	24.00 (4.95)^{b}	3.25 (1.94)^{e}	0.56 (1.03)^{b}	75.00^{c}
2	Acetamiprid 20 SP	500	25.25 (5.07)	1.50 (1.41)^{de}	21.00 (4.64)^{b}	4.00 (2.12)^{cd}	0.25 (0.87)^{cde}	85.00^{b}
3	Thiamethoxam 25 WG	250	26.00 (5.15)	0.50 (1.00)^{f}	15.45 (3.99)^{c}	3.45 (1.99)^{de}	0.20 (0.84)^{e}	80.00^{c}
4	Acephate 75 SP	1000	24.00 (4.95)	12.45 (3.60)^{b}	22.12 (4.76)^{b}	4.56 (2.25)^{c}	0.45 (0.97)^{bc}	77.50^{c}
5	Dinutefuron 20 SG	300	26.00 (5.14)	1.00 (1.22)^{ef}	9.93 (2.71)^{d}	1.47 (1.40)^{f}	0.12 (0.79)^{e}	95.00^{a}
6	Buprofezin 25 SC	2000	27.31 (5.27)	3.24 (1.93)^{c}	14.50 (3.87)^{c}	1.56 (1.44)^{f}	0.41 (0.95)^{bcd}	85.00^{b}
7	Imidacloprid 70 WG	250	23.45 (4.89)	2.00 (1.56)^{d}	16.15 (4.08)^{c}	1.00 (1.22)^{g}	0.23 (0.85)^{de}	88.75^{b}
8	Untreated control	-	24.45 (4.98)	32.00 (5.69)^{a}	45.50 (6.76)^{a}	51.00 (7.17)^{a}	6.80 (2.70)^{a}	40.00^{d}
	SEm±	-	0.11	0.10	0.15	0.05	0.03	1.33
	CD (p=0.05)	-	0.35	0.30	0.45	0.17	0.11	4.03

DBFS: Day Before First Spray; **DAFS:** Days After First Spray; values in the parentheses are $\sqrt{x+1}$ transformed value; Means followed by same letters do not differ significantly by DMRT (P=0.05)

Table 4: Evaluation of insecticides against Mango leaf hoppers during 2015-2016 (Pooled data)

Sl. No.	Treatments	Dose (mL or g ha^{-1})	Mean number of nymphs or adults/panicle					Yield (q/ha)
			First spray			Second spray		
			1DBFS	7DAFS	21DAFS	7DASS	21DASS	
1.	Imidacloprid 17.8 SL	500	25.99 (5.15)	3.00 (1.87)^{c}	26.17 (5.16)^{b}	4.00 (2.12)^{d}	0.78 (1.13)^{b}	78.12^{d}
2	Acetamiprid 20 SP	500	28.13 (5.35)	1.50 (1.41)^{de}	22.00 (4.74)^{c}	4.25 (2.18)^{d}	0.38 (0.93)^{c}	85.32^{bc}
3	Thiamethoxam 25 WG	250	27.87 (5.33)	0.50 (1.00)^{f}	18.23 (4.32)^{d}	4.23 (2.17)^{d}	0.60 (1.05)^{bc}	83.50^{bcd}
4	Acephate 75 SP	1000	25.75 (5.12)	12.45 (3.6)^{b}	25.19 (5.07)^{b}	5.28 (2.40)^{c}	0.48 (0.99)^{c}	78.75^{cd}
5	Dinutefuron 20 SG	300	27.13 (5.25)	1.00 (1.22)^{ef}	13.75 (3.77)^{e}	1.64 (1.46)^{e}	0.56 (1.03)^{bc}	97.50^{a}
6	Buprofezin 25 SC	2000	26.65 (5.20)	3.24 (1.93)^{c}	18.25 (4.32)^{d}	1.78 (1.51)^{e}	0.46 (0.98)^{c}	86.25^{b}
7	Imidacloprid 70 WG	250	26.35 (5.18)	2.00 (1.56)^{d}	17.87 (4.28)^{d}	1.00 (1.22)^{f}	0.62 (1.05)^{bc}	89.38^{b}
8	Untreated control	-	25.52 (5.09)	32.00 (5.69)^{a}	62.00 (7.90)^{a}	52.50 (7.28)^{a}	9.90 (3.22)^{a}	41.88^{e}
	SEm±	-	0.08	0.10	0.09	0.05	0.04	0.93
	CD (p=0.05)	-	0.24	0.30	0.30	0.17	0.14	2.82

DBFS: Day Before First Spray; **DAFS:** Days After First Spray; values in the parentheses are $\sqrt{x+1}$ transformed value; Means followed by same letters do not differ significantly by DMRT (P=0.05)

Table 5: Cost economics of insecticide molecules against Mango leaf hoppers during 2015 and 2016

Sl. No	Treatments	Dose (mL or g ha^{-1})	Yield (q/ha)	% increase in yield over control	Cost of Production (Rs/ha)	Cost of protection (Rs/ha)	Total cost of production (Rs/ha)	Gross returns (Rs/ha)	Net returns (Rs/ha)	C:B ratio
1	Imidacloprid 17.8 SL	500	78.12^{d}	46.40	25000	2500	27500	93744	68744	1: 3.41
2	Acetamiprid 20 SP	500	85.32^{bc}	50.92	25000	1638	26638	102384	77384	1: 3.84
3	Thiamethoxam 25 WG	250	83.50^{bcd}	49.85	25000	1875	26875	100200	75200	1: 3.73
4	Acephate 75 SP	1000	78.75^{cd}	46.82	25000	2875	27875	94500	69500	1: 3.39
5	Dinutefuron 20 SG	300	97.50^{a}	57.05	25000	3190	28190	117000	92000	1: 4.15
6	Buprofezin 25SC	2000	86.25^{b}	51.44	25000	3750	28750	103500	78500	1: 3.60
7	Imidacloprid 70WG	250	89.38^{b}	53.14	25000	2283	27283	107256	82256	1: 3.93
8	Untreated control	-	41.88^{e}	-	25000	0	25000	50256	25256	1: 2.01

(Price of Mango = Rs.1200/q)
Imidacloprid 17.8 SL= Rs. 3000/lit Dinutefuron 20 SG = Rs. 7600/kg
Acetamiprid 20 SP = Rs. 1700/kg Buprofezin 25SC = Rs. 1100/lit
Thiamethoxam 25WG = Rs. 3600/kg Imidacloprid 70WG = Rs. 6000/kg
Acephate 75 SP = Rs. 500/kg

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