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RESEARCH **P**APER

Bio-efficacy of dinotefuran 20 per cent SG against sucking insect pests of okra

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Evaluation of dinotefuran 20 per cent SG against sucking pests of okra was undertaken in an experimental block at Agricultural Research Station, Bheemarayanagudi during *Rabi* 2012-13. The test chemical, dinotefuran 20% SG @ 30 g *a.i.* per ha is most effective dosage for the management of sucking pests like leafhopper, *A. biguttula*, aphids, *A. gossypii*, thrips, *T. tabaci* and whiteflies, *B. tabaci* and also recorded higher okra fruit yield of 93.01 q per ha. Apart from this, dinotefuran 20 per cent SG at varied dosages is quite safer to natural enemies. So, dinotefuran 20% SG @ 30 g *a.i.* per ha can be used for the effective management of sucking pests and for realizing higher okra fruit yield.

Key words : Bioefficay, Dinotefuran, Sucking insect pests, Okra

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INTRODUCTION

Okra [*Abelmoschus esculentus* (L.) Monch] commonly known as "bhendi" belongs to family Malvaceae. The crop can be grown throughout the year, but it is commonly cultivated in *Kharif* and summer seasons. It is very popular due to its high nutritional and medicinal values. It is being cultivated all over India with major share in the states of Uttar Pradesh, Madhya Pradesh, Karnataka, Gujarat and Maharashtra. In India, it occupies about 5.32 lakh hectares area accounting to 63.46 lakh tones of annual production with an average productivity of 11. 9 MT per ha (Anonymous, 2014). As many as 72 species of insects have been recorded on okra (Rao and Rajendran, 2003) of which the sucking pests comprising of aphids (*Aphis gossypii* Glover), leafhopper (*Amrasca biguttula biguttula* Ishida), whitefly (*Bemisia tabaci* Gennadius) and thrips (*Thrips tabaci* Linderman) cause significant damage to the crop.

Aphids and leafhoppers are important pests in the early stage of the crop which desap the plants, make them weak and reduce the yield. Failure to control them in the initial stages cause yield loss to the tune of 54.04 per cent (Chaudhary and Dadeech, 1989). Whitefly, besides causing direct damage, acts as a vector of yellow vein mosaic virus (YVMV), which is a major constraint for okra cultivation (Neeraja *et al.*, 2004).

Dinotefuran is a novel insecticide belonging to third generation neonicotinoids and acts as an agonists of nicotinic acetylcholine receptors and labeled as "Reduced-Risk" by the EPA, generally safer to humans and the environment (Anonymous, 2011). So, the present study was taken-up to assess its bioefficacy against sucking pests of okra.

RESEARCH METHODOLOGY

Evaluation of dinotefuran 20 per cent SG against

sucking pests of okra was undertaken in an experimental block at Agricultural Research Station, Bheemarayanagudi during *Rabi* 2012-13. The experiment was laid out in a Randomized Block Design (RBD) with seven treatments and three replications. The test molecule, dinotefuran 20 per cent SG (M/s. PI Industries, Haryana) was tested at three different dosages *viz*., 20, 25, 30 g *a.i.* per hectare for its efficacy against sucking pests. These were compared with three standard checks *viz.*, imidacloprid 17.8% SL @ 22.25 g *a.i.*, acetamiprid 20% SP @ 20 g *a.i.* and thiamethoxam 25% WG @ 25 g *a.i.* per hectare along with an untreated control against sucking pests. Treatments were imposed thrice based on sucking pest population build-up (above ETL). All the agronomic packages were followed as per the recommendation and fruit borers and powdery mildew were managed in all the treatments uniformly. Observations were recorded on number of leafhoppers, thrips, aphids and whiteflies from top three leaves of randomly selected and tagged five plants in each plot. The observations were taken one day prior to treatment imposition and 3, 7 and 10 days after treatment imposition. The data collected from three sprays were averaged and expressed on per leaf basis. The natural enemy population per plant was recorded after each spray. The yield data collected from each plot was extrapolated on hectare basis. The treatments were subjected to statistical analysis by single factor ANOVA and were compared by following Duncan's multiple range test.

RESEARCH FINDINGS AND ANALYSIS

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Sucking pests population :

Leafhopper: *Amrasca biguttula biguttula* :

Among the different sucking pests, leafhoppers were important sucking pests and predominant during the crop season. The leafhopper population at 3 days after first spray (DAS) was significantly lowest in dinotefuran 20% SG @ 30 g *a.i.*/ha (0.63 hoppers/ leaf) which was statistically at par with its lower dose @ 25 g *a.i.* (0.95 hoppers/ leaf), but was significantly superior compared to its lower dose @ 20 g *a.i.* (1.23 hoppers/ leaf) (Table 1). The new molecule, dinotefuran 20% G @ 30g *a.i.* per ha was significantly superior compared to all standard checks, imidacloprid 17.8% SL @ 22.25 g *a.i.* per ha (1.62 hoppers/leaf), acetamiprid 20% SP @ 20 g *a.i.* per ha (1.48 hoppers/ leaf) and thiamethoxam 25% WG @ 25 g *a.i.* per ha (1.88 hoppers/leaf) at 3 DAS. The leafhopper population in untreated control was significantly highest compared to all other treatments at 3 DAS (4.79 hoppers/ leaf). Leafhopper population at seven and 10 DAS was lowest in dinotefuran 20% SG @ 30 g *a.i.* per ha (0.53 and 0.91 hoppers/ leaf, respectively) was statistically at par with its lower dose @ 25 g *a.i.* per ha (0.87 and 1.05 hoppers/ leaf,

Table 1 : Efficacy of dinotefuran 20 per cent SG against leafhoppers on okra during the year 2012-13

Sr. No.	Treatments	Dose g *a.i.*/ ha	No. of leafhoppers/ leaf									
			1st spray				2nd spray			3rd spray		
			DBS	3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS	3 DAS	7 DAS	10 DAS
1.	Dinotefuran 20%SG	20	4.11(2.02)	1.23 (1.09)	1.27(1.12)	1.86(1.36)	0.87(0.93)	1.21(1.09)	2.28(1.50)	1.19(1.08)	0.93(0.95)	1.11(1.05)
2.	Dinotefuran 20%SG	25	3.68(1.91)	0.95(0.96)	0.87(0.91)	1.05(1.03)	0.65(0.76)	0.64(0.79)	1.71(1.30)	0.59(0.79)	0.35(0.58)	0.48(0.67)
3.	Dinotefuran 20%SG	30	4.38(2.09)	0.63(0.78)	0.53(0.73)	0.91(0.95)	0.33(0.57)	0.38(0.60)	1.35(1.15)	0.47(0.67)	0.34(0.57)	0.21(0.44)
4.	Imidacloprid 17.8 % SL	22.25	4.79(2.18)	1.62(1.27)	2.02(1.41)	3.05(1.74)	2.26(1.50)	3.49(1.87)	4.46(2.10)	1.22(1.09)	1.79(1.33)	1.77(1.32)
5.	Acetamiprid 20% SP	20	3.80(1.95)	1.48(1.20)	1.36(1.16)	1.97(1.40)	1.45(1.21)	2.53(1.58)	3.80(1.95)	1.18(1.06)	1.64(1.27)	1.51(1.23)
6.	Thiamethoxam 25% WG	25	4.37(2.08)	1.88(1.37)	2.00(1.40)	2.70(1.65)	1.78(1.32)	4.65(2.15)	4.73(2.17)	1.62(1.26)	1.49(1.22)	2.16(1.47)
7.	Untreated control	-	4.30(2.06)	4.79(2.18)	4.91(2.20)	5.30(2.31)	4.05(2.01)	5.26(2.30)	6.30(2.50)	2.22(1.48)	2.23(1.49)	2.84(1.68)
	C.D. (P=0.05)		NS	0.263	0.206	0.157	0.221	0.264	0.177	0.262	0.278	0.261
	S.E.±			0.089	0.068	0.055	0.074	0.089	0.056	0.085	0.091	0.086
	CV (%)			12.68	9.72	6.36	11.88	10.88	5.67	16.00	16.25	14.64

DBS: Day before spray; DAS: Days after spray Figures in the parenthesis are $\sqrt{x+0.5}$ transformed values NS= Non-significant

respectively) but significantly superior compared to its lower dose and also all standard checks, *viz.*, imidacloprid 17.8% SL @ 22.25 g *a.i.* acetamiprid 20% SP @ 20 g *a.i.* and thiamethoxam 25% WG @ 25 g *a.i.* per ha.

Similar trend of superiority of dinotefuran 20 per cent SG against leaf hopper was recorded @ 30 g *a.i.* after second and third spray over rest of the treatments including standard checks.

Ghosh *et al.* (2014) reported dinotefuran @ 25 g.*a.i.* per ha showing very good spectrum of action throughout the seasons against BPH population than the conventional acephate and imidacloprid a commonly used neo-nicotenoid.

Aphids : *Aphis gossypii* :

Incidence of the aphids was moderate and appeared at later part of the crop growth. Therefore, observation on aphids was recorded only at second and third spray. Among the different treatments, dinotefuran 20% SG @ 30 g *a.i.* per ha at 3 DAS recorded significantly lowest aphid population of 0.93 per leaf, which was statistically at par with its lower dose @ 25 g *a.i.* per ha (1.06 aphids/ leaf) and imidacloprid 17.8% SL @ 22.25 g *a.i.*/ha (1.40 aphids /leaf), but was significantly superior compared to its lower dose @ 20 g *a.i.* (2.44 aphids/ leaf) and standard checks, acetamiprid 20% SP @ 20 g *a.i.* per ha (2.22 aphids / leaf) and thiamethoxam 25% WG @ 25 g *a.i.* per ha (1.79 aphids/ leaf) (Table 2). Aphid population in untreated control was 3.99 per leaf which was significantly highest compared to all other treatments at three DAS. Similar trend of effectiveness of dinotefuran 20% SG @ 30 g *a.i.* per ha was recorded at seven and 10 DAS (0.42 and 0.31 aphids/ leaf, respectively) which was statistically at par with its lower dose @ 25 g *a.i.* per ha (0.31 and 0.49 aphids/ leaf, respectively) but significantly superior compared to all other treatments.

Higher incidence of aphids was recorded during third spray, even then, similar trend of effectiveness of dinotefuran @ 30 g *a.i.* was observed at 3, 7 and 10 days after third spray.

Thrips : *Thrips tabaci* :

Moderate population of thrips was noticed during initial stages of crop growth and was declined at later stages. Dinotefuran 20% SG @ 30 g *a.i.* per ha recorded 0.80 thrips per leaf which was significantly lowest compared to its lower doses @ 25 and 20 g *a.i.* per ha (2.13 and 3.80 thrips/ leaf, respectively) (Table 3). However, dinotefuran 20% SG @ 25 g *a.i.* per ha recorded thrips population of 1.20 and 2.60 per leaf at 7 and 10 DAS, respectively and was statistically at par with its higher dose @ 30 g *a.i.* per ha (0.67 and 2.13 thrips/ leaf, respectively). The standard checks, imidacloprid 17.8% SL @ 22.25 g *a.i.*, acetamiprid 20% SP @ 20 g *a.i.* and thiamethoxam 25% WG @ 25 g *a.i.* per ha proved inferior to test chemical at seven DAS (4.10, 4.23 and 5.00 thrips/ leaf, respectively). On the other hand, thrips population in untreated control was 7.40 to 10.33 per leaf during the observation period. So, test chemical, dinotefuran 20% SG @ 30 g *a.i.*/ha was found effective against thrips upto 10 DAS and was significantly superior compared to all standard check chemicals.

Table 2 : Efficacy of dinotefuran 20 per cent SG against aphids on okra during the year 2012-13

Sr. No.	Treatments	Dosage (g *a. i.*/ha)	No. of aphids/ leaf						
			2nd spray				3rd spray		
			DBS	3DAS	7DAS	10DAS	3DAS	7DAS	10DAS
1.	Dinotefuran 20% SG	20	3.92 (1.97)	2.44 (1.55)	1.15 (1.07)	0.46(0.67)	5.44(2.33)	3.58(1.88)	7.17 (2.67)
2.	Dinotefuran 20% SG	25	3.39 (1.84)	1.06 (1.02)	0.31 (0.53)	0.49 (0.63)	2.06 (1.42)	1.51 (1.21)	4.06 (2.02)
3.	Dinotefuran 20% SG	30	3.42 (1.85)	0.93 (0.95)	0.42 (0.63)	0.31 (0.55)	1.57 (1.25)	1.13 (1.07)	3.77 (1.93)
4.	Imidacloprid 17.8 % SL	22.25	3.51 (1.88)	1.40 (1.19)	0.91 (0.94)	0.84 (0.91)	2.55 (1.59)	2.92 (1.69)	4.93 (2.22)
5.	Acetamiprid 20% SP	20	3.63 (1.90)	2.22 (1.48)	0.97 (0.98)	0.60 (0.74)	3.07 (1.74)	3.51 (1.87)	6.37 (2.52)
6.	Thiamethoxam 25% WG	25	3.60 (1.90)	1.79 (1.33)	1.47 (1.21)	0.80 (0.87)	4.46 (2.11)	3.72 (1.93)	6.19 (2.48)
7.	Untreated control	-	4.28 (2.06)	3.99 (1.99)	1.95 (1.40)	1.55 (1.24)	8.65 (2.94)	9.15 (3.02)	10.71 (3.28)
	C.D. (P=0.05)		NS	0.241	0.310	0.267	0.286	0.317	0.231
	S.E.±			0.080	0.102	0.088	0.095	0.104	0.076
	CV (%)			11.09	19.74	20.11	9.10	10.50	5.70

DBS: Day before spray; DAS: Days after spray Figures in the parenthesis are $\sqrt{x+0.5}$ transformed values NS= Non-significant

Whiteflies : *Bemisia tabaci* :

Whitefly population was moderate to low and was noticed at later stages of the crop growth and the observations indicated that, dinotefuran 20% SG @ 30 g *a.i.* was significantly superior and recorded lower whitefly population (0.52 whiteflies/ leaf) which was statistically at par with dinotefuran 20% SG @ 25 g *a.i.* (0.69 whiteflies/ leaf) and was significantly superior compared to its lower dose @ 20 g *a.i.* (1.28 whiteflies/ leaf) and standard checks, imidacloprid 17.8% SL @ 22.25 g *a.i.* acetamiprid 20% SP @ 20 g *a.i.* and thiamethoxam 25% WG @ 25 g *a.i.* (2.18, 1.69 and 1.49 whiteflies/ leaf, respectively) (Table 4). The chemical dinotefuran 20% SG @ 25 g *a.i.* has performed as effectively at its dose @ 30 g *a.i.* till 10 days after third spray. However, the population of whiteflies in untreated control ranged from 4.22 to 6.68 per leaf during the observation period and was significantly highest compared to all other treatments.

Overall results indicated that, dinotefuran 20% SG @ 30 g *a.i.* per ha is most effective dose for the management of sucking pests *viz.*, leafhopper, aphids, thrips and whiteflies upto 10 DAS and is statistically superior compared to all standard checks.

Natural enemy population :

Natural enemy population comprising coccinellids and spiders ranged from 1.79 to 2.29 per plant a day before spray (Table 5). The natural enemy population reduced slightly at 3 days after spray of dinotefuran 20 per cent SG but the population rebuild up was observed after 10 days of spray which was even greater than the initial population thereby showing that the test chemicals

Table 3 : Efficacy of dinotefuran 20 per cent SG against thrips on okra during the year 2012-13

Sr. No.	Treatments	Dosage (g *a. i.*/ha)	No. of thrips/ leaf 1st spray			
			DBS	3DAS	7DAS	10DAS
1.	Dinotefuran 20% SG	20	10.43 (3.22)	3.80 (1.95)	2.97 (1.71)	3.90 (1.97)
2.	Dinotefuran 20% SG	25	10.53 (3.24)	2.13 (1.45)	1.20 (1.09)	2.60 (1.61)
3.	Dinotefuran 20% SG	30	10.13 (3.18)	0.80 (0.88)	0.67 (0.77)	2.13 (1.46)
4.	Imidacloprid 17.8 % SL	22.25	10.43 (3.23)	3.07 (1.76)	4.10 (2.02)	3.73 (1.94)
5.	Acetamiprid 20% SP	20	10.17 (3.19)	4.90 (2.20)	4.23 (2.05)	4.37 (2.09)
6.	Thiamethoxam 25% WG	25	9.90 (3.14)	4.33 (2.08)	5.00 (2.23)	3.70 (1.92)
7.	Untreated control	-	10.33 (3.21)	9.93 (3.15)	9.37 (3.06)	7.40 (2.71)
	C.D. (P=0.05)		NS	0.343	0.340	0.241
	S.E.±			0.114	0.112	0.081
	CV (%)			11.02	11.52	7.31

DBS: Day before spraying DAS: Days after spraying Figures in the parenthesis are $\sqrt{x+0.5}$ transformed values NS= Non-significant

Table 4: Efficacy of dinotefuran 20 per cent SG against whiteflies on okra during the year 2012-13

Sr. No.	Treatments	Dosage (g. *a i.*/ha)	No. of whiteflies/ leaf 3rd spray			
			DBS	3 DAS	7 DAS	10 DAS
1.	Dinotefuran 20% SG	20	2.45 (1.56)	1.28 (1.12)	1.71 (1.31)	1.85 (1.36)
2.	Dinotefuran 20% SG	25	2.61 (1.61)	0.69 (0.83)	0.37 (0.58)	0.95 (0.97)
3.	Dinotefuran 20% SG	30	2.53 (1.58)	0.52 (0.72)	0.11 (0.31)	0.89 (0.94)
4.	Imidacloprid 17.8 % SL	22.25	2.70 (1.64)	2.18 (1.48)	2.58 (1.61)	3.27 (1.80)
5.	Acetamiprid 20% SP	20	2.51 (1.59)	1.69 (1.29)	1.87 (1.35)	2.50 (1.57)
6.	Thiamethoxam 25% WG	25	2.56 (1.60)	1.49 (1.21)	2.75 (1.66)	3.73 (1.92)
7.	Untreated control	-	2.97 (1.72)	4.22 (2.05)	4.85 (2.19)	6.30 (2.51)
	C.D. (P=0.05)		NS	0.264	0.269	0.285
	S.E.±			0.088	0.089	0.095
	CV (%)			12.91	12.93	11.29

DBS: Day before spraying DAS: Days after spraying Figures in the parenthesis are $\sqrt{x+0.5}$ transformed values NS= Non-significant

did not hinder the predatory population during the spray as compared to the standard checks. It clearly indicated that, dinotefuran 20 per cent SG at varied dosages is quite safer to the natural enemies.

Spider population did not exhibit appreciable differences among the treatments in the experiment (Gosh *et al*., 2014), corroborated by Krishnaiah *et al*. (2003) and Vijayaraghavan and Regupathy (2006). Dinotefuran 20 SG at 30 and 40 g *a.i*. per ha was proved to be effective against brown planthopper at 35 locations in India during 2009 (Anonymous, 2010). Halappa and Patil (2014) who reported dinotefuran 20 SG (0.25 g/lit) found to be safe to the natural enemy activity as there was no significant variation among the treatments with respect to the natural enemies population (coccinelids, Chrysopa and spiders).

Okra fruit yield :

Among all the treatments, highest fruit yield of 93.01q per ha was recorded in dinotefuran 20% SG @ 30g *a.i.* per ha which was statistically at par with its lower dose @ 25 g *a.i.* (89.33q/ha), but significantly superior than and its lower dose @ 20 g *a.i.* (84.35 q/ha) (Table 5). New molecule, dinotefuran 20% SG @ 25 *a.i.* per ha was significantly superior compared to standard checks *viz*., imidacloprid 17.8% SL @ 22.25 g *a.i.* acetamiprid 20% SP @ 20 g *a.i.* and thiamethoxam 25% WG @ 25 g *a.i.* per ha (70.25, 79.80 and 75.84 q/ha, respectively). All the treatments recorded significantly higher okra fruit yield compared to untreated control (35.00 q/ha). Overall, dinotefuran 20% SG @ 30 g *a.i.* was highly effective treatment since it has recorded highest okra fruit yield compared to all other treatments.

The present findings are in line with Basavaraj and Kapasi (2016) who evaluated the efficacy of dinitefuran 20 per cent SG at different dosage for the management of sucking pests on okra. Dinitefuran 20% SG @ 30.00 g *a.i*. emerged as best and optimum dose against leafhoppers, aphids, thrips and whiteflies at three days after spray in okra and also highest fruit yield of 74.07 q per ha.

Similar reports of effectiveness of dinotefuran 20 SG against cotton leaf hopper was reported by Kumar and Dhawan (2011) and Mandal *et al.* (2012). Present study also supported by Chaiwong *et al*. (2011) who reported safty of dinotefuran to the spiders. Singh and Kumar (2006) revealed that imidacloprid @ 40 g.a.i. per ha and acetamaprid @ 50 g.a.i. per ha were most effective on leaf hopper and whitefly population.

The results of Abbas *et al*. (2012); Halappa and Patil (2014) and Sreenivas *et al*. (2015) agree with the superiority of dinotefuron 20 % SG @ 30 g.*a.i*. against leaf hoppers, aphids, thrips, and whiteflies in cotton ecosystem. Raghuraman and Gupta (2005) reported that neonicotinoids were cost effective to control the sucking pests' population of cotton efficiently along with simultaneous increase in yield. Dipak *et al.* (2013) also observed highest cotton seed yield in dinotefuron 40 g ha^{-1} treated plot (10.88 q ha^{-1}) followed by at 30 g ha^{-1} (10.08 q ha^{-1}). In addition, Halappa and Patil (2016) reported lowest resistance ratio as compared to imidacloprid against leafhopper.

Table 5 : Safety of dinotefuran 20 per cent SG against natural enemies and yield of okra during the year 2012-13

Sr. No.	Treatments	Dosage (g. *a i*/ha)	No.of predators/ plant			Yield (q/ha)
			DBS	3 DAS	10 DAS	
1.	Dinotefuran 20% SG	20	2.20 (1.47)	1.99 (1.41)	2.30 (1.51)	84.35
2.	Dinotefuran 20% SG	25	2.14 (1.46)	1.88 (1.37)	1.86 (1.36)	89.33
3.	Dinotefuran 20% SG	30	1.90 (1.38)	1.78 (1.34)	1.95 (1.40)	93.01
4.	Imidacloprid 17.8 % SL	22.25	2.00 (1.41)	1.21 (1.10)	1.85 (1.36)	70.25
5.	Acetamiprid 20% SP	20	1.79 (1.33)	1.17 (1.08)	1.46 (1.20)	79.80
6.	Thiamethoxam 25% WG	25	2.29 (1.52)	0.99 (1.00)	1.83 (1.36)	75.84
7.	Untreated control	-	2.20 (1.48)	1.87 (1.36)	2.08 (1.45)	35.00
	C.D. (P=0.05)		NS	0.199	0.147	4.923
	S.E.±			0.064	0.049	1.641
	CV (%)			9.32	5.89	3.605

DBS: Day before spraying DAS: Days after spraying Figures in the parenthesis are $\sqrt{x+0.5}$ transformed values NS=Non-significant

Conclusion :

New molecule, dinotefuran 20% SG @ 30 g *a.i.* is most effective dosage for the management of sucking pests like leafhopper, *A. biguttula*, aphids, *A. gossypii*, thrips, *T. tabaci* and whiteflies, *B. tabaci* and also recorded higher okra fruit yield of 93.01 q per ha. Apart from this, dinotefuran 20 per cent SG at varied dosages is quite safer to natural enemies. So, dinotefuran 20% SG @ 30 g *a.i.* can be used for the effective management of sucking pests and for realizing higher okra fruit yield.

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