RESEARCH ARTICLE

Assessment of Bioefficacy and Phytotoxicity of Fipronil Against Grapevine Thrips Under Open Field Condition

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ABSTRACT

Evaluation of new insecticide molecules is inevitable in agriculture to overcome insecticide resistance development in agricultural and horticultural crop pests. Experiments for assessment of bioefficacy of fipronil 80 WG against grapes thrips_was conducted in two seasons at Madhampatti village, Thondamuthur, Coimbatore. Fipronil 80 WG at five different doses (30, 40, 50, 80 and 100 g a.i. ha^{-1}), fipronil 5 SC in two different doses (40 and 50 g a.i. ha^{-1}), chlorpyriphos 20 EC @ 200 g a.i. ha^{-1} along with untreated check were taken as treatments for the evaluation. After imposing the treatments twice at fifteen days interval, the highest pest reduction was noticed in plots treated with fipronil 80 WG @ 100, 80, 50 and 40 g a.i.ha^{-1} to the tune of 82.17, 81.67, 81.04 and 80.35 % over untreated check, respectively. Among the various treatments, fipronil 80 WG @ 100 g.a.i.ha^{-1} recorded a significantly higher fruit yield of 8.23 t ha^{-1} which was on par with fipronil 80 WG @ 80 g.a.i.ha^{-1} (8.17 t ha^{-1}) and 50 g.a.i.ha^{-1} (8.00 t ha^{-1}). Grapes sprayed with fipronil 80 WG @ 50, 100 and 200 g.a.i.ha^{-1} doses did not show any phytotoxic effects like epinasty, hyponasty, leaf injury, wilting, vein clearing and necrosis. To conclude, fibronil 80WG @ 50 g a.i. ha^{-1} was recorded on par with other higher doses in reducing the thrips population and increasing the fruit yield. Hence, fibronil 80 WG @ 50 g a.i. ha^{-1} may be recommended for the management of thrips in grapes.

Keywords: *Fipronil, Grapes, Thirps, Bioefficacy, Phytotoxicity.*

INTRODUCTION

Grape (*Vetis vinifera*) is vitamin C rich berry fruit used for table purpose and wine making having good medicinal value antioxidants. Grapes were cultivated over 92 countries in the world with the production of 26.21 million MT per annum during 2021 -2022 (Statistica, 2023). China ranks first in the global grapes production with 11.98 million MT per annum followed by India with 2.9 million MT. In India, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh, Punjab, Madhya Pradesh and Haryana are the major grape growing states. In Tamilnadu, grapes were cultivated in an area of 2.16 lakh ha with an annual production of 58.93 MT tones (Horticultural Statistics at a Glance, 2018). Insect pests are the imperative production constraints in grape cultivation with recorded 85 species of insect pests (Atwal and Dhaliwal, 2005) and 94 insect pests (Tandon and Verghese, 1994) off which thrips (*Rhipiphorothirps cruentatus* Hood and *Scirtothrips dorsalis* Hood) are the utmost disparaging sucking insects of grapevine which damage berries, blossoms as well as foliage. Foliar thrips *R. cruentatus* scrap the leaf tissue vigorously for feeding results, foliate become silvery white, emaciated, turn bronzing, upward curled leaves and premature fruit drop. The infestation of berry thrips, *S. dorsalis*, causes black corky surface and scab formation in the berries due to laceration and sucking the sap from the berries (Reddy, 1957; Rangareddy and Murthy, 2006) which ultimately reduce the quality and marketability of the table berries.

Insecticides are the primary defense for the management of notorious pests in most of the horticultural crops. Grapes one of the most pesticide consuming crop in India. The use of conventional and older chemistry molecules, leads to food safety and environmental issues apart from resistance development in insect pests in host crop. Discovery of new insecticide molecules with different mode of action and target sites in insects is the solution for the above issues. Novel molecules are effective at low dosages and have less exposure in the environment. Fipronil a promising phenyl pyrrozole insecticide and

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are inhibitors of GABA (gamma-aminobutyric acid) in insects. They act as an antagonist and bind to the GABA receptors in the post synaptic sites and prevent opening of chloride ion channels. This causes neurotoxicity, overstimulation, hyperexcitation and ultimately death to the insect. The effectiveness of this molecule against thrips were reported earlier (Prema *et al*., 2016 and Patil *et al*., 2017). Fipronil 5 SC is already available in the market and the new and improved formulation of fipronil 80 WG was evaluated for its bioefficacy and phytotoxicity for the management of grapevine thrips under open field condition.

MATERIAL AND METHODS

Two field experiments were conducted at Madhampatti to test the efficacy of fipronil 80 WG against grapes foliar thrips. The experiments were conducted in Randomized Block Design (RBD) with nine treatments replicated thrice with the plot size of 5 x 6 m (5 x 6 veins) using the variety Muscat. The treatments were, T_1 - fipronil 80 WG @ 30 g a.i.ha^{-1}, T_2 - fipronil 80 WG @ 40 g a.i. ha^{-1}, T_3 - fipronil 80 WG @ 50 g a.i.ha^{-1}, T_4 - fipronil 80 WG @ 80 g a.i.ha^{-1}, T_5 - fipronil 80 WG @ 100 g a.i.ha^{-1}, T_6 - fipronil 5 SC @ 40 g a.i.ha^{-1}, T_7 - fipronil 5 SC @ 50 g a.i.ha^{-1}, T_8 - chlorpyriphos 20 EC @ 200 g a.i.ha^{-1} and T_9 - untreated control. The vines were pruned during March and November months every year. Insecticide applications were given twice at 15 days interval in the month of January for both the trial with the help of knapsack sprayer using spray volume of 500 litres per hectare. The average temperature in the open field during the study period ranged between 27-31 °C with relative humidity ranging between 70 and 80% and there was no rainfall during the periods of observation. Number of berries with corky symptoms was counted on five randomly selected shoots on one day before and 3, 5, 7, 10 and 15 days after each spray and per cent damage was calculated. Mean of two season data were taken based on replication and days after application wise for each spray before analysis. Per cent reduction over untreated control was calculated for each spray. Yield also recorded from each picking from each treatment and were pooled and represented in tonnes ha^{-1}.

To evaluate the phytotoxicity (if any) caused by fipronil 80 WG on grapes, experiments were conducted simultaneously along with bioefficacy trial with three treatments viz., fipronil 80 WG @ 50, 100 and 200 g a.i.ha^{-1} along with untreated control and replicated five times. Five shoots were selected at random in each plot and the plants were examined for phytotoxic symptoms like, leaf tip drying, wilting, necrosis, vein clearing, epinasty and hyponasty. To know the crop tolerance, the plants were observed on 1, 3, 7 ,10 and 14 days after spraying as per the protocol of Central Insecticide Board Registration Committee (CIB and RC) for the phytotoxic symptoms. The Per cent leaf injury was calculated using the CIB &RC grade scale *viz.,* no phytotoxicity symptom – grade 0; 1-10 % leaf injury - grade 1; 11-20 % leaf injury - grade 2; 21-30 % leaf injury -grade 3; 31-40 % leaf injury - grade 4; 41-50 % leaf injury - grade 5; 51-60 % leaf injury - grade 6; 61-70 % leaf injury - grade 7; 71-80 % leaf injury - grade 8; 81-90 % leaf injury - grade 9 and 91-100 % leaf injury - grade 10. Based on the grades recorded from replication per cent leaf injury was calculated using the formula,

$$\text{Percent leaf injury} = \frac{\text{Total grade points}}{\text{Maximum grade x Number of leaves observed}} \text{ X } 100$$

RESULTS AND DISCUSSION

Mean percent damage before initiating the trial was ranged from 11.97 to 12.24 per cent (Table 1). There was a significant reduction in thrips damage after first round of application on 5 days after spraying (DAS). The lowest damage was recorded in fipronil 80 WG at 100, 80, 50 and 40 g a.i. ha^{-1} (7.72, 7.78, 7.92 and 8.05 %, respectively) followed by fipronil 5 SC @ 50 and 40 g a.i. ha^{-1} (8.03 and 8.19 %, respectively). After first round of application, the highest reduction was recorded in plots treated with fipronil 80 WG @ 100, 80, 50 and 40 g a.i. ha^{-1} recorded 54.80, 54.50, 53.60 and 52.90 per cent over untreated check, respectively followed by fipronil 5 SC @ 50 and 40 g a.i. ha^{-1} (53.00 and 52.00 %), whereas chlorpyriphos 20 EC @ 200 g a.i. ha^{-1} recorded the least reduction of thrips damage over untreated control (39.00 %) (Table 1). After second round of application, on 3 DAS, all the fipronil treated plots except fipronil 80 WG @ 30 g a.i. ha^{-1} observed on par in reducing the thrips damage same trend was recorded on 5 DAS also. On 15 DAS, fipronil 80 WG @ 100 g a.i. ha^{-1} registered the least per cent thrips damage of 4.69 per cent whish is followed by fipronil 80 WG @ 80 g a.i. ha^{-1} (4.80 %), fipronil 80 WG @ 50 g a.i. ha^{-1} (4.93 %), fipronil 80 WG @ 40 g a.i. ha^{-1} (5.02 %) and fipronil 5 SC @ 50 g a.i. ha^{-1} (5.10 %) and found on par with each other. Based on percent reduction of thrips damage over untreated control the relative efficacy of the treatments were, fipronil 80 WG @ 100 g a.i. ha^{-1} (82.17 %) = fipronil 80 WG @ 80 g a.i. ha^{-1} (81.67 %) = fipronil 80 WG @ 50 g a.i. ha^{-1} (81.04 %) > fipronil 80 WG @ 40 g a.i. ha^{-1} (80.35 %) = fipronil 5 SC @ 50 g a.i. ha^{-1} (80.20 %) = fipronil 5 SC @ 40 g a.i. ha^{-1} (79.49 %) > fipronil 80 WG @ 30 g a.i. ha^{-1} (69.43 %) > chlorpyriphos 20 EC @ 200 g a.i. ha^{-1} (62.15 %) (Table 2).

Among the various treatments, fipronil 80 WG @ 100 g.a.i.ha^{-1} recorded significantly higher fruit yield of 8.23 t ha^{-1} which was on par with fipronil 80 WG @ 80 g.a.i.ha^{-1} (8.17 t ha^{-1}) and 50 g.a.i.ha^{-1} (8.00 t ha^{-1}) when compared to fipronil 5 SC @ 50 g.a.i.ha^{-1} (7.83 t ha^{-1}) and untreated check (6.00 t ha^{-1}) (Table 2). The phytotoxic effect of fipronil 80 WG on grapes variety Muscat revealed that grapes sprayed with fipronil 80 WG @ 50, 100 and 200 g.a.i.ha^{-1} doses did not show any phytotoxic effects like epinasty, hyponasty, leaf injury, wilting, vein clearing and necrosis (Table 3). Present results are in accordance with the findings of Prema *et al*. (2016) who reported that fipronil 80 WG at 100, 80, 60, 50 and 40 g a.i./ha reduced more than 80 per cent thrips damage to grape berries, thus recorded significantly minimum fruit damage. The results of Patil *et al*. (2017) revealed that fipronil 5% SC was most effective against grape thrips. Similar results with fipronil 80 WG was found superior in controlling onion thrips (Hosamani *et al.,* 2012). Niranjana (2008) who reported that fipronil 80 WG (50 g a.i./ha) followed by spinosad 2.5 SC (84.375 g a.i./ha) and imidacloprid 17.8 EC (45 g a.i./ha) proved effective for the management of of thrips in grapes. Zameeroddin *et al*. (2019) revealed that fipronil 80 WG @ 50 g.a.i./ha and fipronil 80 WG @ 60 g.a.i./ha along with imidacloprid 17.8 SL @ 25 g.a.i./ha were on par with each other and recorded highest mortality of thrips in grapes followed by fipronil 80 WG @ 40 g.a.i./ha and thiamethoxam 25 WG @ 25 g.a.i./ha.

Niranjana (2008) reported that the highest table grapes yield in the plots treated with fipronil 80 WG (50 g a.i. /ha) followed by spinosad 2.5 SC (84.375 g a.i./ha), fipronil 80 WG (40 g a.i./ha) and imidacloprid 17.8 EC (45 g a.i./ha). The results of present investigation are in line with Prema *et al.* (2016) with respect to fipronil 80 WG treatments in grapes. Prema *et al*. (2016) observed no symptoms of phytotoxicity in the plots treated with Fipronil 80 WG at 100, 80, 60, 50 and 40 g a.i./ha. Similarly, Prema *et al.* (2017) did not observe any phytotoxicity symptoms in rice plots treated with Fipronil 80 WG at 40 and 50 g a.i./ha. This finding gets support from the reports of Kulkarni and Adsule (2006), who reported the increased fruit yield in fipronil treated plots when compared to the untreated check. The present investigation was in agreement with the findings of Patel *et al.* (2010) who reported the highest yield of cotton from fipronil 100 and fipronil 50 g a.i. ha^{-1}. Similarly, Venkat and Sreehari (2009) also reported that fipronil 80 WG at 50 g a.i. ha^{-1} recorded the highest yield of 16.35 q ac^{-1} in chillies. Venkateshalu *et al.* (2009) also registered higher yields and net profits in chilli ecosystem with fipronil 5 SC. Durga *et al*. (2009) also recorded increased bulb yield of onion. From the present study, it is concluded that fipronil 80 WG @ 50 g a.i. ha^{-1} was more effective against grapes thrips and registered on par with its higher doses and grapes sprayed with fipronil 80 WG @ 50, 100 and 200 g.a.i.ha^{-1} doses did not show any phytotoxic effects like epinasty, hyponasty, leaf injury, wilting, vein clearing and necrosis. Thus, these chemicals can be the potent component in development of IPM module for grapes.

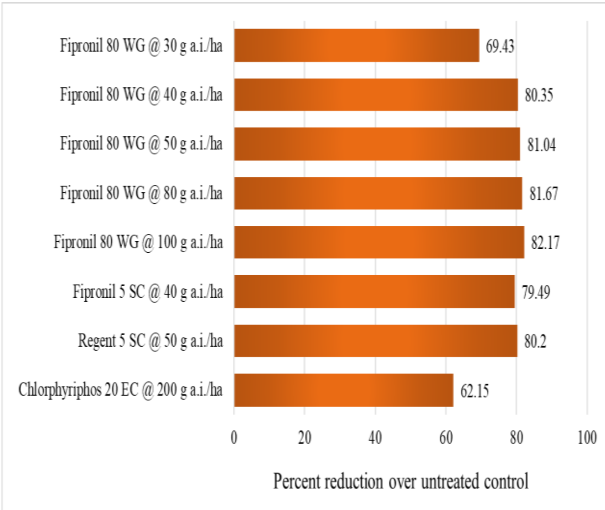

Fig.1. Effect of fipronil 80 WG against grapes thrips

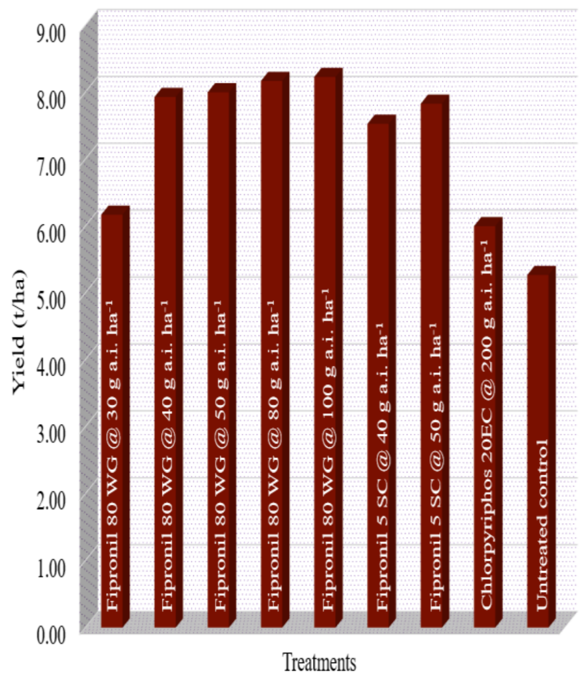

Fig 2. Impact of Insecticides on yield of grapes

Table 1. Bioefficacy of fipronil 80 WG against thrips damage on grapes - First spray (Pooled mean of two season)

S. No.	Treatments	Per cent thrips damage*						Mean	PRC
		PTC	3 DAS	5 DAS	7 DAS	10 DAS	15 DAS		
1.	Fipronil 80 WG @ 30 g a.i. ha^{-1}	12.18	10.10^{d} (18.5)	8.55^{d} (16.10)	8.10^{d} (16.53)	8.59^{c} (17.00)	9.56^{c} (18.01)	9.51	44.3
2.	Fipronil 80 WG @ 40 g a.i. ha^{-1}	12.02	9.03^{a} (17.48)	7.42^{bc} (15.81)	5.91^{abc} (14.06)	6.46^{a} (14.73)	7.45^{ab} (15.81)	8.05	52.9
3.	Fipronil 80 WG @ 50 g a.i. ha^{-1}	12.05	8.93^{abc} (17.47)	7.31^{abc} (15.68)	5.88^{abc} (14.03)	6.22^{a} (14.44)	7.13^{a} (15.49)	7.92	53.6
4.	Fipronil 80 WG @ 80 g a.i. ha^{-1}	12.04	8.74^{ab} (17.19)	7.19^{ab} (15.55)	5.67^{ab} (13.77)	6.03^{a} (14.20)	7.01^{a} (15.33)	7.78	54.5
5.	Fipronil 80 WG @ 100 g a.i. ha^{-1}	12.11	8.63^{a} (17.08)	7.07^{a} (15.42)	5.60^{a} (13.69)	5.91^{a} (14.07)	6.99^{a} (15.31)	7.72	54.8
6.	Fipronil 5 SC @ 40 g a.i. ha^{-1}	12.24	9.28^{c} (17.56)	7.54^{c} (15.92)	6.07^{c} (14.26)	6.52^{a} (14.79)	7.52^{b} (15.91)	8.19	52.0
7.	Regent 5 SC @ 50 g a.i. ha^{-1}	12.17	9.11^{bc} (17.57)	7.27^{abc} (15.64)	5.94^{bc} (14.11)	6.37^{a} (14.62)	7.30^{b} (15.67)	8.03	53.0
8.	Chlorphyriphos 20 EC @ 200 g a.i. ha^{-1}	12.15	11.13^{e} (19.49)	10.06^{e} (18.49)	9.09^{e} (17.55)	9.50^{d} (17.95)	10.62^{d} (19.00)	10.43	39.0
9.	Untreated check	11.97	14.78^{f} (22.60)	16.60^{f} (24.02)	18.06^{f} (25.48)	19.62^{e} (26.28)	21.50^{e} (27.62)	17.09	-

Table 2. Bioefficacy of fipronil 80 WG against thrips damage on grapes – Second spray (Pooled mean of two season)

S. No.	Treatments	Per cent thrips damage*						Mean	PRC	Fruit Yield*
		PTC	3 DAS	5DAS	7 DAS	10DAS	15DAS			
1.	Fipronil 80 WG @ 30 g a.i. ha^{-1}	9.56	7.81^{b} (16.22)	6.81^{b} (15.12)	5.92^{c} (15.25)	6.92^{d} (14.08)	8.00^{c} (16.43)	7.50	69.43	6.17
2.	Fipronil 80 WG @ 40 g a.i. ha^{-1}	7.45	5.54^{a} (13.61)	4.23^{a} (11.87)	2.99^{abc} (11.11)	3.71^{abc} (9.96)	5.02^{ab} (12.94)	4.82	80.35	7.93
3.	Fipronil 80 WG @ 50 g a.i. ha^{-1}	7.13	5.34^{a} (13.36)	4.06^{a} (11.62)	2.86^{abc} (10.95)	3.61^{ab} (9.72)	4.93^{ab} (12.82)	4.65	81.04	8.00
4.	Fipronil 80 WG @ 80 g a.i. ha^{-1}	7.01	5.04^{a} (12.96)	3.90^{a} (11.36)	2.70^{ab} (10.84)	3.54^{ab} (9.46)	4.80a^{b} (12.66)	4.50	81.67	8.17
5.	Fipronil 80 WG @ 100 g a.i. ha^{-1}	6.99	4.84^{a} (12.68)	3.76^{a} (11.04)	2.55^{a} (10.67)	3.43^{a} (9.19)	4.69^{a} (12.51)	4.38	82.17	8.23
6.	Fipronil 5 SC @ 40 g a.i. ha^{-1}	7.52	5.53^{a} (13.60)	4.44^{a} (12.16)	3.24^{c} (11.68)	4.10^{c} (10.37)	5.38^{b} (13.40)	5.03	79.49	7.53
7.	Regent 5 SC @ 50 g a.i. ha^{-1}	7.30	5.40^{a} (13.44)	4.27^{a} (11.93)	3.16b^{c} (11.44)	3.93^{bc} (10.21)	5.10^{ab} (13.04)	4.86	80.20	7.83
8.	Chlorphyriphos 20 EC @ 200 g a.i. ha^{-1}	10.62	9.75^{c} (18.18)	8.55^{c} (17.00)	8.06^{e} (17.28)	8.82^{e} (16.50)	9.94^{d} (18.38)	9.29	62.15	6.00
9.	Untreated check	21.50	22.47^{d} (28.30)	23.60^{d} (29.06)	24.96^{f} (30.92)	26.40^{f} (29.97)	28.37^{e} (32.17)	24.55	-	5.27

*Mean of three replications; PTC – Pretreatment count; DAS- Days after spraying; PRC - Percent Reduction over control; Figures in parentheses are arc sine transformed values; In a column, means followed by a common letter(s) are not significantly different by DMRT (P=0.05)

Table 3. Phytotoxic effect of fipronil 80 WG on grapes (Pooled mean of two season)

S. No.	Phytotoxic effects	Phytotoxicity rating *											
		Fipronil 80 WG @ 50 g a.i. ha^{-1}			Fipronil 80 WG @ 100 g a.i. ha^{-1}			Fipronil 80 WG @ 200 g a.i. ha^{-1}			Untreated check		
		R1	R2	R3	R1	R2	R3	R1	R2	R3	R1	R2	R3
1.	Leaf tip injury	0	0	0	0	0	0	0	0	0	0	0	0
2.	Wilting	0	0	0	0	0	0	0	0	0	0	0	0
3.	Vein clearing	0	0	0	0	0	0	0	0	0	0	0	0
4.	Necrosis	0	0	0	0	0	0	0	0	0	0	0	0
5.	Epinasty	0	0	0	0	0	0	0	0	0	0	0	0
6.	Hyponasty	0	0	0	0	0	0	0	0	0	0	0	0

* Observed at 1, 3, 5, 7, 10 and 14 days after each spraying

CONCLUSION

Fipronil 80 WG @ 50 g a.i. ha^{-1} was more effective against grapes thrips and registered on par with its higher doses and grapes sprayed with fipronil 80 WG @ 50, 100 and 200 g.a.i.ha^{-1} doses did not show any phytotoxic effects like epinasty, hyponasty, leaf injury, wilting, vein clearing and necrosis. Thus, these chemicals can be the potent component in development of IPM module for grapes.

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Ethics statement

No specific permits were required for the described field studies because no human or animal subjects were involved in this research.

Originality and plagiarism

The authors assure that the contents were written by us and were not plagiarized.

Consent for publication

All the authors agreed to publish the content.

Competing interests

There were no conflict of interest in the publication of this content

Data availability

All the data of this manuscript are included in the MS. No separate external data source is required. If anything is required from the MS, certainly, this will be extended by communicating with the corresponding author through corresponding official mail.

Author contributions

Idea conceptualization – BVK; Experiments – PK,VM, PT; Guidance - BVK, Writing original draft - PK,VM, PT; Writing - reviewing & editing – BVK, PK.

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