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Research Article

Bioefficacy and Phytotoxicity of Clothianindin 50 WDG against Thrips and Mealybugs in Grapevine

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Abstract

Two separate experiments were conducted in the field to examine the effectiveness of clothianidin 50 WDG against thrips and mealybugs that were infesting grapevines. The findings highlighted that applying clothianidin 50 WDG @ 1000 g ha^{-1} proved highly efficient in curbing the population of the sucking pests, outperforming lower doses of the compound. Following two rounds of soil drenching spaced 14 days apart, there was an average reduction of 76.63% for thrips and 78.09% for mealybugs. Other concentrations of clothianidin 50 WDG (600, 500 and 400 g ha^{-1}) demonstrated significant reductions in the populations of thrips and mealybugs, exhibiting a similar level of efficacy as the standard check (Methomyl 40 SP and Buprofezin 25 SC) in all field experiments. Notably, no signs of harm to the grapevine were observed at any of the tested doses. Clothianidin 50 WDG @ 1000 g ha^{-1} resulted in the highest grape yield, producing 14.25 and 8.94 kg $vine^{-1}$ at Madhampatti and Kalampalayam, respectively. Throughout the clothianidin 50 WDG treatment plots, the presence of natural enemies was noted and their activity remained unaffected, indicating no adverse impact on the natural enemy population.

Keywords: Bioefficacy, Clothianidin, Mealybug, Phytotoxicity, Thrips

Introduction

Grapes (*Vitis vinifera* L.), commonly referred to as grapevines, are members of the Vitaceae family and are believed to have originated in Western Asia and Europe (Jawahar reddy *et al.*, 2021). According to Butani (1979) and Atwal and Dhaliwal (2005), as many as 85 species of insect pests have been documented in the context of grapes in India. Tandon and Verghese (1994) reported approximately 94 insect pests associated with grapevines; while in northern Karnataka, Balikai and Kotikal (2003) advocated the presence of 26 pests that were infesting grapevines. Among these insect pests thrips and mealybugs are economically important. Thrips and mealybugs, as sucking insect pests, significantly contribute to the loss of both quality and quantity in grape production (Kulkarni *et al.*, 2006). Thrips are the most destructive insects which damage foliage, blossoms as well as berries. Three species of thrips namely *Rhipiphorothrips cruentatus* Hood, *Scirtothrips dorsalis* Hood and *Thrips hawaiiensis* (Morgan) are found infesting grapevine in India. *R. cruentatus* thrips, in both their adult and nymph stages, inflict harm by scraping the underside of the leaf with their stylets, leading to the extraction of cell sap (Kulkarni *et al.*, 2006; Ramakrishna Ayyar, 1932). The berry thrips like *S. dorsalis* is the most important pest causing damage to berries and 10^{th} to 12^{th} leaves in the vine, which host more thrips population compared to other leaves (Ranga Reddy and Murthy, 2006). *S. dorsalis*, through the process of laceration and sap-sucking, causes the development of black corky scab formation in all stages of grape berries (FIP, 1982; Reddy, 1957), which adversely affects marketability and export potential, as the visual appeal is a basic requirement in the marketing of table grapes (Patil *et al.*, 2017).

In various grape-growing regions of India, especially in the regions of Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu, the pink mealybug *Maconellicoccus hirsutus* (Green) and the citrus mealybug *Planococcus citri* Risso are recognized as important species leading to substantial losses (Mani *et al.*, 2007). Mealybug, *M. hirsutus* is the important

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and most destructive sucking pest. The grapevine mealybug alone has the potential to cause yield losses ranging from 50% to 100% in the field (Azam, 1983; Kulkarni, 2010). These pests have been reported to inflict significant and widespread damage across all the major grape-growing regions in India (Kulkarni, 2010; Mani *et al*., 1987; Manjunath, 1985). The grapevine mealybug exhibits the ability to feed on various parts of the vine, including the trunk, leaves and fruits (Flaherty *et al*., 1992; Mani *et al.*, 2014). Both the nymphs and adults of mealybugs extract sap from the vine, including canes, leaves and fruit bunches and reduces crop vigour. Furthermore, their excretion of honeydew encourages the growth of sooty mold, rendering the fruits being unsuitable for consumption and the production of raisin. The presence of sooty mold on leaves hinders their photosynthetic ability, consequently obstructing the development of grape bunches (Kulkarni, 2010). This pest is observed year-round, with its severity escalating notably between the months of October and March (Balikai, 1999).

These problems with sucking pests and mealybugs are spurring the search for effective quick control measures. Generally, grapes are able to cope with insect infestation, but the damage is severe, it is necessary to take action. In recent times, the effectiveness of registered insecticides for controlling grapevine insect pests has relied on direct contact toxicity. These products consist of a range of broad-spectrum organophosphates and carbamates (such as prothiofos, chlorpyriphos and methomyl), along with the selective insect growth regulator buprofezin (Lo and Walker, 2011). Nonetheless, attaining complete coverage of the pest habitat proves to be challenging. Furthermore, sucking insects are often concealed within different parts of the plants or may emerge on newly developing shoots even after the uses of insecticides (Brück *et al.*, 2009).

At present, no effective chemicals are available for the control of these insect pests, while biological methods are having their own constraints. However, the systemic insecticides deliver immediate and significant control initially and chemical control methods continue to be widely employed by grape farmers (Muthukrishnan *et al*., 1994; Muthukrishnan *et al*., 2001; Vinothkumar *et al.*, 2017). Against this backdrop, the current study was carried out to assess the effectiveness and potential phytotoxicity of clothianidin 50 WDG against thrips and mealybugs of grapes.

Materials and Methods

Bioefficacy of Clothianidin 50 WDG

Field Experiments

During the period of 2011-2012, a field trial was initiated in the farmer's fields within the Coimbatore district to assess the effectiveness of clothianidin 50 WDG in controlling thrips and mealybugs on grapevines. The grape variety chosen for the study was Paneer grape. Specifically selected gardens were ensured to be completely unprotected post fruit pruning. The trial was structured in a Randomized Block Design (RBD), encompassing seven treatments that were replicated three times, each treatment consisting of four vines. Application of the treatments was executed between 50 to 75 days after fruit pruning. The field experiment took place in Madhampatti village, located within the Coimbatore district of Tamil Nadu.

Treatment Details

The details of treatments conducted during the field experiment are presented in table 1.

Table 1: Experimental treatment information in the field study

Sl. No.	Treatment	Dose (g a.i. ha^{-1})	Product ha^{-1}	Method of application
1	Clothianidin 50 WDG	200	400 g	Soil drenching
2	Clothianidin 50 WDG	250	500 g	
3	Clothianidin 50 WDG	300	600 g	
4	Clothianidin 50WDG	500	1000 g	
5	Buprofezin 25 SC	250	1000 ml	Foliar spray
6	Methomyl 40 SP	500	1250 g	
7	Untreated control	-	-	-

Time and Method of Insecticide Application

The application of insecticide treatments began between 50 and 75 days after the fruit pruning stage, corresponding to the point when the infestation of sucking pests on leaves and the resulting damage reached the Economic Threshold Level (ETL). The amount of chemical required for soil drenching was calculated by using the following formula,

$$\text{Product needed for a single vine} = \frac{\text{Product recommended ha}^{-1}}{\text{Total number of vines ha}^{-1}}$$

The necessary amount of chemical was dissolved in water and administered using a knapsack sprayer, either with the nozzle removed or an Aspee jet nozzle used. The insecticide was carefully directed around the grapevine stem's base during drenching and 500 litres of solution ha^{-1} were used.

Pre- and Post-Treatment Observations

Prior to the commencement of the experiment, a count of thrips and mealybugs was conducted. Throughout the experimental duration, two applications of insecticide were administered using a knapsack sprayer. First soil drenching was given between 50 to 75 days after the fruit pruning and second drenching was given 15 days after the first soil drenching. Observations on thrips and mealybugs were made on 1st, 3rd, 5th, 7th, 10th and 14th days after soil drenching. To evaluate the insecticidal efficacy, the total count of thrips adults and mealybug colonies present on both the vines and bunches was recorded across four vines within each treatment (Jawahar reddy *et al.*, 2021).

Thrips Population Assessment

The presence of thrips was documented on selected shoots and the results were expressed as the number of thrips shoot^{-1} vine^{-1} (Kulkarni *et al.*, 2006).

Mealybug Population Assessment

The mealybug population was evaluated by counting the overall number of mealybug colonies on each vine and the results were expressed as the total number of mealybug colonies vine^{-1} (Balikai, 1999).

Phytotoxicity of Clothianidin 50 WDG

The observation on phytotoxicity was made on 1st, 3rd, 5th, 7th, 10th and 14th days after soil drenching of clothianidin 50 WDG on grape leaves and berries at harvest for the phytotoxic symptoms, such as leaf chlorosis, leaf tip burning, leaf necrosis, leaf epinasty, leaf hyponasty, vein clearing, wilting, rosetting, *etc*.

The percentage of leaf injury was computed using the following formula,

$$\text{Percent leaf injury} = \frac{\text{Total grade points}}{\text{Maximum grade} \times \text{No. of leaves observed}} \times 100$$

Any observed phytotoxicity symptoms were graded according to the following scale:

Grade	Phytotoxicity symptoms (%)
0	No phytotoxicity
1	1-10
2	11-20
3	21-30
4	31-40
5	41-50
6	51-60
7	61-70
8	71-80
9	81-90
10	91-100

(Source: Vinothkumar *et al.*, 2017)

Results and Discussion

Bioefficacy of Clothianidin 50 WDG against Thrips (Scirtothrips dorsalis Hood)

Before the commencement of the experiment, a pre-count of the thrips population was conducted, revealing that the population was uniformly distributed across all the treatments (Kulkarni, 2010; Table 1). A notable difference was observed among the treatments after 3rd, 7th and 10th days of soil drenching. The thrips population varied from 8.75 to 9.33 numbers shoot^{-1} with no significant differences observed among the various treatments at one day before imposition of treatments. At three days after second soil drenching, the maximum reduction of thrips was observed in the treatments, clothianidin 50 WDG @ 1000 g ha^{-1} (5.17 numbers shoot^{-1}) and clothianidin 50 WDG @ 600 g ha^{-1} (5.33 numbers shoot^{-1}), which were demonstrating superiority over all other treatments and on par with each other. At seven days after first soil drenching, clothianidin 50 WDG @ 1000 g ha^{-1} (0.50 number shoot^{-1}) and clothianidin 50 WDG @ 600 g ha^{-1} (0.92 number shoot^{-1}) were equally effective in bringing down the population of thrips and were superior over all other treatments. All the treatments in ten days after first soil drenching were found to be effective. At ten days after first soil drenching, the lowest population of thrips was observed in the treatments, clothianidin 50 WDG @ 1000 g ha^{-1} (1.08 numbers shoot^{-1}) and clothianidin 50 WDG @ 600 g ha^{-1} (1.33 numbers shoot^{-1}) compared to all other treatments, which were on par with each other. The standard, methomyl 40 SP @ 1250 g ha^{-1} (4.50 numbers shoot^{-1}) was found to be equally effective as clothianidin 50 WDG @ 500 g ha^{-1} (4.67 numbers shoot^{-1}) and were superior over the lower dose of clothianidin 50 WDG @ 400 g ha^{-1} (5.75 numbers shoot^{-1}).

Second Soil Drenching

At three days after second soil drenching, clothianidin 50 WDG @ 1000 g ha^{-1} (0.08 numbers shoot^{-1}) was highly effective against thrips population and was demonstrating superiority over all other treatments. The subsequent best treatment was clothianidin 50 WDG @ 600 g ha^{-1} (0.50 numbers shoot^{-1}). At seven days after second soil drenching, among the treatments, clothianidin 50 WDG @ 1000 g ha^{-1} (0.20 number shoot^{-1}) and clothianidin 50 WDG @ 600 g ha^{-1} (0.33 numbers shoot^{-1}) were the best treatments which recorded lowest thrips population and were on par with each other. At ten days after second soil drenching, maximum reduction of thrips was observed in clothianidin 50 WDG @ 1000 g ha^{-1} (0.30 numbers shoot^{-1}). Clothianidin 50 WDG @ 600 g ha^{-1} (0.58 numbers shoot^{-1}) was the next best treatment and was on par with the standard, methomyl 40 SP @ 1250 g ha^{-1} (1.00 numbers shoot^{-1}). The other standard, buprofezin 25SC @ 1000 ml ha^{-1} (1.83 numbers shoot^{-1}) was equally effective as clothianidin 50 WDG @ 500 g ha^{-1} (1.92 numbers shoot^{-1}) and clothianidin 50 WDG @ 400 g ha^{-1} (2.00 numbers shoot^{-1}) (Table 2).

Bioefficacy of Clothianidin 50 WDG against Mealybug (Maconellicoccus hirsutus Green)

The distribution of mealybug population across all plots was uniform before the initiation of treatments. There was a notable distinctions in treatments after 3rd, 7th and 10th days of soil drenching.

First Soil Drenching

Mealybug population varied from 9.17 to 10.75 colonies vine^{-1}

Table 1: Bioefficacy of clothianidin 50 WDG against thrips on grapevine

Treatment	Pre count	Population of thrips (No. $shoot^{-1}$ $vine^{-1}$) days after first soil drenching						
		1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	14 DAT	Mean
Clothianidin 50 WDG @ 400 g ha^{-1}	9.17 (3.01)	8.83 $(2.97)^{d}$	7.92 $(2.81)^{d}$	6.50 $(2.55)^{d}$	5.92 $(2.43)^{bc}$	5.75 $(2.50)^{c}$	6.42 $(2.53)^{d}$	6.89
Clothianidin 50 WDG @ 500 g ha^{-1}	8.75 (2.96)	7.83 $(2.80)^{c}$	6.58 $(2.57)^{b}$	5.50 $(2.34)^{bc}$	4.25 $(2.06)^{b}$	4.67 $(2.16)^{b}$	4.92 $(2.22)^{bc}$	5.63
Clothianidin 50 WDG @ 600 g ha^{-1}	8.92 (2.97)	7.33 $(2.71)^{ab}$	5.33 $(2.31)^{a}$	2.67 $(1.63)^{a}$	0.92 $(0.78)^{a}$	1.33 $(1.15)^{a}$	1.67 $(1.29)^{a}$	3.21
Clothianidin 50 WDG @ 1000 g ha^{-1}	9.00 (2.98)	7.08 $(2.70)^{a}$	5.17 $(2.28)^{a}$	2.33 $(1.52)^{a}$	0.50 $(0.41)^{a}$	1.08 $(1.04)^{a}$	1.42 $(1.19)^{a}$	2.93
Buprofezin 25 SC @ 1000 ml ha^{-1}	9.08 (3.01)	8.10 $(2.84)^{c}$	7.25 $(2.70)^{c}$	6.00 $(2.45)^{cd}$	5.08 $(2.26)^{b}$	5.50 $(2.35)^{c}$	5.42 $(2.33)^{c}$	6.23
Methomyl 40 SP @ 1250 g ha^{-1}	8.83 (2.97)	7.67 $(2.77)^{bc}$	6.33 $(2.52)^{b}$	5.17 $(2.28)^{b}$	4.17 $(2.05)^{b}$	4.50 $(2.18)^{b}$	4.75 $(2.18)^{b}$	5.43
Untreated check	9.33 (3.05)	9.67 $(3.11)^{e}$	9.50 $(3.08)^{e}$	8.83 $(2.97)^{e}$	8.91 $(2.99)^{c}$	8.58 $(2.93)^{d}$	7.50 $(2.74)^{e}$	8.83

Table 1: Continue...

Treatment	Population of thrips (No. $shoot^{-1}$ $vine^{-1}$) days after second soil drenching							Pooled mean
	1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	14 DAT	Mean	
Clothianidin 50 WDG @ 400 g ha^{-1}	4.50 $(2.12)^{e}$	2.42 $(1.55)^{d}$	2.10 $(1.44)^{c}$	1.83 $(1.35)^{c}$	2.00 $(1.41)^{d}$	2.91 $(1.71)^{c}$	2.63	4.76
Clothianidin 50 WDG @ 500 g ha^{-1}	2.83 $(1.68)^{c}$	1.67 $(1.29)^{c}$	1.60 $(1.25)^{bc}$	1.25 $(1.11)^{bc}$	1.92 $(1.38)^{d}$	2.50 $(1.58)^{bc}$	1.96	3.79
Clothianidin 50 WDG @ 600 g ha^{-1}	1.20 $(1.07)^{b}$	0.50 $(0.70)^{b}$	0.17 $(0.24)^{a}$	0.33 $(0.33)^{a}$	0.58 $(0.76)^{b}$	1.42 $(1.19)^{a}$	0.70	1.95
Clothianidin 50 WDG @ 1000 g ha^{-1}	0.58 $(0.76)^{a}$	0.08 $(0.17)^{a}$	0.25 $(0.40)^{a}$	0.20 $(0.24)^{a}$	0.30 $(0.29)^{a}$	1.20 $(1.08)^{a}$	0.44	1.68
Buprofezin 25 SC @ 1000 ml ha^{-1}	4.67 $(2.16)^{e}$	2.60 $(1.61)^{d}$	1.42 $(1.18)^{bc}$	0.75 $(1.08)^{bc}$	1.83 $(1.35)^{cd}$	2.16 $(1.47)^{b}$	2.14	4.18
Methomyl 40 SP @ 1250 g ha^{-1}	3.33 $(1.82)^{d}$	1.50 $(1.25)^{c}$	0.83 $(0.91)^{b}$	0.17 $(0.86)^{b}$	1.00 $(0.99)^{bc}$	1.29 $(1.11)^{a}$	1.45	3.44
Untreated check	6.08 $(2.47)^{f}$	5.92 $(2.43)^{e}$	6.00 $(2.45)^{d}$	5.50 $(2.35)^{d}$	5.00 $(2.24)^{e}$	4.83 $(2.20)^{d}$	5.56	7.19

DAT- Days after treatment; Figures in parentheses are $\sqrt{x + 0.5}$ transformed values; In a column means followed by a common letter are not significantly different by LSD (P=0.05)

with no significant differences observed among the various treatments at one day before imposition of treatments (Table 2). Three days after the initial soil drenching, a substantial decrease in the number of mealybug colonies was noted in specific treatments. Notably, the clothianidin 50 WDG @ 1000 g ha^{-1} treatment exhibited 7.33 colonies $vine^{-1}$, while the clothianidin 50 WDG @ 600 g ha^{-1} treatment displayed 7.58 colonies $vine^{-1}$; which were on par and superior over any other treatments. The lower dose of clothianidin 50 WDG @ 400 g ha^{-1} (9.33 colonies $vine^{-1}$) was on par with the other standard methomyl 40 SP @ 1250 g ha^{-1} (9.17 colonies $vine^{-1}$). All the treatments in three days after first soil drenching were found to be superior over untreated control (10.83 colonies $vine^{-1}$). At seven days after first soil drenching, clothianidin 50 WDG @ 1000 g ha^{-1} (0.33 colonies $vine^{-1}$) and clothianidin 50 WDG @ 600 g ha^{-1} (0.58 colonies $vine^{-1}$) were equally and highly effective against mealybug colonies and were demonstrating superiority over all other treatments. The subsequent best treatments, clothianidin 50 WDG @ 500 g ha^{-1} (4.00 colonies $vine^{-1}$), buprofezin 25 SC @ 1000 ml ha^{-1} (4.75 colonies $vine^{-1}$) and methomyl 40 SP @ 1250 g ha^{-1} (6.17 colonies $vine^{-1}$) were on par with each other. The lower dose of clothianidin 50 WDG @ 400 g ha^{-1} (6.75 colonies vine^{-1}) was found to be equally effective as standards.

All the treatments in ten days after first soil drenching were found to be superior over untreated control (10.92 colonies vine^{-1}). At ten days after first soil drenching, among the treatments, maximum reduction of mealybug colonies was observed in clothianidin 50 WDG @ 1000 g ha^{-1} (0.67 colonies vine^{-1}) and clothianidin 50 WDG @ 600 g ha^{-1} (1.25 colonies vine^{-1}), which were on par and superior over any other treatments. The standard, buprofezin 25 SC @ 1000 ml ha^{-1} (3.58 colonies vine^{-1}) and clothianidin 50 WDG @ 500 g ha^{-1} (4.08 colonies vine^{-1}) were the next best treatments and which were equally effective against mealybug colonies. The lower dose of clothianidin 50 WDG @ 400 g ha^{-1} (6.50 colonies vine^{-1}) was on par with the other standard methomyl 40 SP @ 1250 g ha^{-1} (5.83 colonies vine^{-1}).

Second Soil Drenching

At three days after second soil drenching, among the treatments clothianidin 50 WDG @ 1000 g ha^{-1} (0.50 colony vine^{-1}) alone was highly effective against mealybugs and was superior over all other treatments. Clothianidin 50 WDG @ 600 g ha^{-1} was the next best treatments which recorded

Table 2: Bioefficacy of clothianidin 50 WDG against mealybugs on grapevine

Treatment	Pre count	Population of mealybugs (No. of colonies vine^{-1}) days after first soil drenching						
		1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	14 DAT	Mean
Clothianidin 50 WDG @ 400 g ha^{-1}	10.50 (3.24)	10.17 (3.19)^{c}	9.33 (3.04)^{c}	8.17 (2.86)^{d}	6.75 (2.60)^{c}	6.50 (2.55)^{c}	6.92 (2.63)^{d}	7.97
Clothianidin 50 WDG @ 500 g ha^{-1}	9.83 (3.13)	9.25 (3.04)^{b}	8.58 (2.93)^{b}	6.58 (2.57)^{b}	4.00 (2.00)^{b}	4.08 (2.01)^{b}	4.83 (2.20)^{b}	6.22
Clothianidin 50 WDG @ 600 g ha^{-1}	10.00 (3.16)	8.83 (3.00)^{a}	7.58 (2.74)^{a}	4.33 (2.08)^{a}	0.58 (0.44)^{a}	1.25 (1.11)^{a}	1.83 (1.35)^{a}	4.07
Clothianidin 50 WDG @ 1000 g ha^{-1}	9.17 (3.03)	8.75 (2.96)^{a}	7.33 (2.71)^{a}	4.08 (2.02)^{a}	0.33 (0.33)^{a}	0.67 (0.81)^{a}	1.75 (1.32)^{a}	3.82
Buprofezin 25 SC @ 1000 ml ha^{-1}	9.92 (3.15)	9.25 (3.04)^{b}	8.25 (2.90)^{b}	6.67 (2.58)^{b}	4.75 (2.18)^{bc}	3.58 (1.88)^{b}	5.00 (2.24)^{b}	6.25
Methomyl 40 SP @ 1250 g ha^{-1}	9.42 (3.07)	9.33 (3.10)^{b}	9.17 (3.03)^{c}	7.25 (2.70)^{c}	6.17 (2.50)^{bc}	5.83 (2.42)^{c}	6.33 (2.52)^{c}	7.35
Untreated check	10.75 (3.28)	10.83 (3.30)^{d}	11.25 (3.40)^{d}	11.08 (3.33)^{e}	10.75 (3.28)^{d}	10.92 (3.31)^{d}	10.83 (3.30)^{e}	10.94

Table 2: Continue...

Treatment	Population of mealybugs (No. of colonies vine^{-1}) days after second soil drenching							Pooled mean
	1 DAT	3 DAT	5 DAT	7 DAT	10 DAT	14 DAT	Mean	
Clothianidin 50 WDG @ 400 g ha^{-1}	6.25 (2.50)^{c}	5.83 (2.41)^{f}	3.00 (1.78)^{d}	2.75 (1.66)^{e}	2.92 (1.71)^{e}	2.83 (1.68)^{e}	3.93	5.95
Clothianidin 50 WDG @ 500 g ha^{-1}	4.00 (2.00)^{b}	2.92 (1.71)^{d}	1.33 (1.15)^{c}	1.17 (1.08)^{c}	1.25 (1.12)^{c}	1.58 (1.25)^{c}	2.04	4.13
Clothianidin 50 WDG @ 600 g ha^{-1}	1.67 (1.29)^{a}	1.00 (1.00)^{b}	0.75 (0.86)^{b}	0.50 (0.71)^{b}	0.60 (0.76)^{b}	0.75 (0.87)^{b}	0.88	2.47
Clothianidin 50 WDG @ 1000 g ha^{-1}	1.58 (1.25)^{a}	0.50 (0.69)^{a}	0.25 (0.40)^{a}	0.10 (0.17)^{a}	0.10 (0.17)^{a}	0.42 (0.64)^{a}	0.49	2.16
Buprofezin 25 SC @ 1000 ml ha^{-1}	4.08 (2.02)^{b}	2.17 (1.47)^{c}	1.08 (1.04)^{bc}	1.00 (1.00)^{c}	1.50 (1.22)^{cd}	1.67 (1.29)^{c}	1.92	4.08
Methomyl 40 SP @ 1250 g ha^{-1}	6.00 (2.45)^{c}	5.00 (2.24)^{e}	2.42 (1.55)^{d}	1.83 (1.35)^{d}	1.92 (1.38)^{d}	2.00 (1.41)^{d}	3.20	5.27
Untreated check	9.75 (3.12)^{d}	9.00 (3.00)^{g}	8.92 (2.99)^{e}	8.42 (2.90)^{f}	8.42 (2.90)^{f}	8.17 (2.86)^{f}	8.78	9.86

DAT- Days after treatment; Figures in parentheses are $\sqrt{x + 0.5}$ transformed values; In a column means followed by a common letter are not significantly different by LSD (P=0.05) one mealybug colony vine^{-1}. The standard, buprofezin 25 SC @ 1000 ml ha^{-1} (2.17 colonies vine^{-1}) was found to be superior over clothianidin 50 WDG @ 500 g ha^{-1} (2.92 colonies vine^{-1}), methomyl 40 SP @ 1250 g ha^{-1} (5.00 colonies vine^{-1}) and clothianidin 50 WDG @ 400 g ha^{-1} (5.83 colonies vine^{-1}). After the second soil drenching, all treatments exhibited superiority compared to the untreated control (9.00 colonies vine^{-1}), within a three-day timeframe.

At seven days after second soil drenching, the lowest mealybug colonies were observed in the vine treated with clothianidin 50 WDG @ 1000 g ha^{-1} (0.10 colony vine^{-1}). Clothianidin 50 WDG @ 600 g ha^{-1} was the next best treatment which recorded 0.50 mealybug colony vine^{-1}. The standard, buprofezin 25 SC @ 1000 ml ha^{-1} (1.00 colony vine^{-1}) was found to be equally effective as clothianidin 50 WDG @ 500 g ha^{-1} (1.17 colonies vine^{-1}). The other standard, methomyl 40 SP @ 1250 g ha^{-1} (1.83 colonies vine^{-1}) was superior over lower dose of clothianidin 50 WDG @ 500 g ha^{-1} (2.75 colonies vine^{-1}).

Phytotoxicity

No signs of phytotoxicity were observed on the grape vines at the tested dosages of any of the insecticidal treatments, namely clothianidin 50 WDG @ 400 g ha^{-1}, clothianidin 50 WDG @ 500 g ha^{-1}, clothianidin 50 WDG @ 600 g ha^{-1}, clothianidin 50 WDG @ 1000 g ha^{-1}, as well as the standard check (Buprofezin 25 SC @ 1000 ml ha^{-1} and Methomyl @ 1250 g ha^{-1}).

The present findings on the effectiveness of clothianidin 50 WDG on thrips are in agreement with the findings of Sunitha and Jagginavar (2010) who studied the effect of different neonicotinoids (imidacloprid, acetamaprid and thiamethoxam) for the management of thrips. From their results, neonicotinoids demonstrated a notably higher efficacy against thrips in comparison to other categories of insecticides.

The percent reduction of thrips ranged from 33.80 to 76.63 (first trial) and 52.09 to 69.05 (second trial) in clothianidin 50 WDG treated plots. The higher dose of clothianidin 50 WDG @ 1000 g ha^{-1} was recorded as 76.63% and 69.05% reduction over control in the first and second trials, respectively. The efficacy of clothianidin 50 WDG against thrips was higher than buprofezin 25 SC and methomyl 40 SP (Figure 1). Mealybug population was reduced to 78.09 and 61.68 in the first and second trials, respectively. In both the field experiments, the higher dose of clothianidin 50 WDG @ 1000 g ha^{-1} was recorded as 60% to 70% reduction of mealybugs after two soil drenching (Figure 2).

Throughout the study period, clothianidin 50 WDG @ 600 g ha^{-1} was found equally effective as that of clothianidin 50 WDG @ 1000 g ha^{-1} and were on par with each other in their bioefficacy against all the sucking pests. The results reflected in the current study are in accordance with the findings and research of Patil *et al.* (2007), who found that clothianidin 50 WDG was effective against cotton sucking pest complex in all the doses evaluated. They reported that higher dose of clothianidin 50 WDG (25 g a.i. ha^{-1}) was found to be the most effective insecticide in bringing down the sucking pest

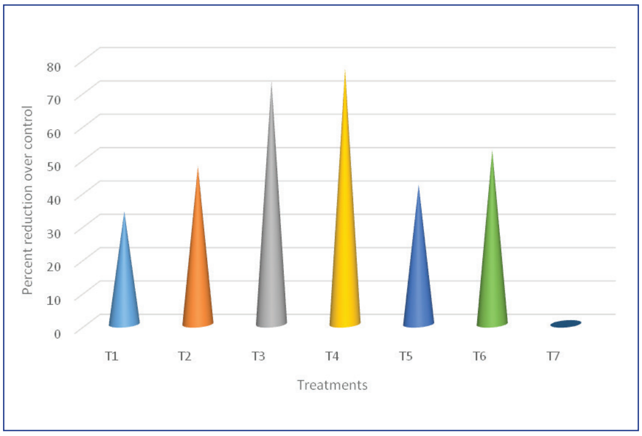

Figure 1: Effect of Clothianidin 50 WDG on Thrips [T_1: Clothianidin @ 400 g ha^{-1}; T_2: Clothianidin @ 500 g ha^{-1}; T_3: Clothianidin @ 600 g ha^{-1}; T_4: Clothianidin @ 1000 g ha^{-1}; T_5: Buprofezin @ 1000 ml ha^{-1}; T_6: Methomyl @ 1250 g ha^{-1}; T_7: Control]

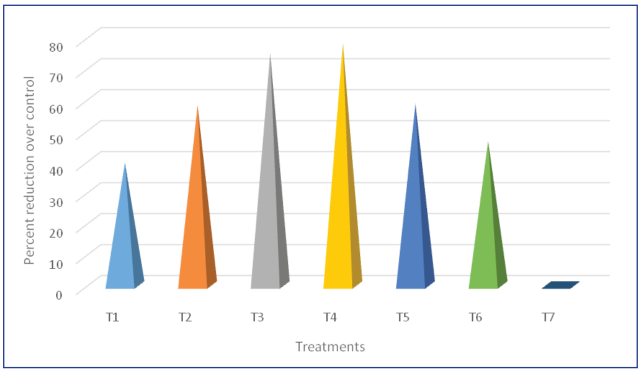

Figure 2: Effect of Clothianidin 50 WDG on Mealybugs [T_1: Clothianidin @ 400 g ha^{-1}; T_2: Clothianidin @ 500 g ha^{-1}; T_3: Clothianidin @ 600 g ha^{-1}; T_4: Clothianidin @ 1000 g ha^{-1}; T_5: Buprofezin @ 1000 ml ha^{-1}; T_6: Methomyl @ 1250 g ha^{-1}; T_7: Control]

complex and clothianidin 50 WDG (20 g a.i. ha^{-1}) was also found to be equally effective at the higher dose. Kulkarni *et al.* (2006) observed that even at a substantial dose of 800 g a.i. ha^{-1}, methomyl 40 SP did not exhibit any phytotoxic symptoms on grapevines.

Conclusion

The study evaluated the efficacy of clothianidin 50 WDG against thrips and mealybugs infesting grapevines. Results showed that applying clothianidin 50 WDG @ 1000 g ha^{-1} effectively reduced thrips and mealybug populations, surpassing lower dosages. Other concentrations of clothianidin 50 WDG also exhibited significant reductions in pest populations without causing harm to the grapevines. Notably, clothianidin 50 WDG @ 1000 g ha^{-1} resulted in the highest grape yield. Additionally, the study confirmed that clothianidin 50 WDG @ 600 g ha^{-1} was as effective @ 1000 g ha^{-1} dose, aligning with prior research. The presence and activity of natural enemies remained unaffected throughout the clothianidin 50 WDG treatment plots, implying no adverse impact on the population of natural enemy. These findings support the potential of clothianidin 50 WDG as an effective and safe option for managing thrips and mealybug infestations in grapevines, warranting further exploration and implementation in agricultural practices.

References

Atwal, A.S., Dhaliwal, G.S., 2005. *Agricultural Pests of South Asia and their Management*. 5th Edition. Kalyani Publishers, New Delhi. pp. 307-308.

Azam, K.M., 1983. Losses due to pests in grapes. *Indian Journal of Entomology* 2, 387-389.

Balikai, R.A., 1999. Seasonal incidence of grapevine mealybug in northern Karnataka. *Insect Environment* 4(4), 148-149.

Balikai, R.A., Kotikal, Y.K., 2003. Pest status of grapevine in northern Karnataka. *Agricultural Science Digest* 23(4), 276-278.

Brück, E., Elbert, A., Fischer, R., Krueger, S., Kühnhold, J., Klueken, A.M., Nauen, R., Niebes, J.F., Reckmann, U., Schnorbach, H.J., Steffens, R., van Waetermeulen, X., 2009. Movento®, an innovative ambimobile insecticide for sucking insect pest control in agriculture: Biological profile and field performance. *Crop Protection* 28(10), 838-844. DOI: 10.1016/j.cropro.2009.06.015.

Butani, D.K., 1979. *Insects and Fruits*. Periodical Export Book Agency, New Delhi. p. 398.

FIP, 1982. Studies on seasonal occurrence of grape pests around Hyderabad. Research Reports, Fruit Improvement Project, Hyderabad. p. 493.

Flaherty, D.L., Christensen, L.P., Lanini, W.T., 1992. Mealybugs. In: *Grape Pest Management*. 2nd Edition. (Eds.) Flaherty, D.L., Christensen, L.P., Lanini, W.T., Maoris, J.J., Philips, P.A. and Wilson, L.T. ANR Publication 3343. University of California, Division of Agriculture and Natural Resources, Oakland, California. pp. 159-165.

Jawahar reddy, A., Saindane, Y.S., Datkhile, R.V., Deore, B.V., 2021. Biorational management and mycosis studies of grape thrips [*Rhipiphorothrips cruentatus* H.]. *Pest Management in Horticultural Ecosystems*. DOI: 10.5958/0974-4541.2022.00017.0.

Kulkarni, N.S., 2010. Bio-Efficacy of mineral oil (Servo Agrospray) for the management of thrips and mealy bugs on grapes. *Journal of Eco-friendly Agriculture* 5(2), 146-149.

Kulkarni, N.S., Sawant, I.S., Sawant, S.D., Adsule, P.G., 2006. Bio-efficacy of neem formulations (Azadirachtin 1% and 5%) on important insect pests of grapes and their effect on shelf life. *Acta Horticulturae* 785, 305-312. DOI: 10.17660/ActaHortic.2008.785.38.

Lo, P.L., Walker, J.T.S., 2011. Soil applications of two neonicotinoid insecticides to control mealybugs (Pseudococcidae) in vineyards. *New Zealand Plant Protection* 64, 101-106. DOI: 10.30843/nzpp.2011.64.5969.

Mani, M., Shivaraju, C., Kulkarni, N.S., 2014. Pests. In: *The Grape Entomology*. (Eds.) Mani, M., Shivaraju, C. and Kulkarni, N.S. Springer, New Delhi. pp. 9-166. DOI: 10.1007/978-81-322-1617-9_3.

Mani, M., Kulkarni, N.S., Banerjee, K., 2007. Management of Mealybugs on Grapes. Extension Folder No. 11. National Research Centre for Grapes, Pune, Maharashtra - 412 307, India.

Mani, M., Thontadarya, T.S., Singh, S.P., 1987. Record of natural enemies on the grape mealybug *Maconellicoccus hirsutus* (Green). *Current Science* 54, 624-625.

Manjunath, T.M., 1985. *Maconellicoccus hirsutus* on grapevine. *FAO Plant Protection Bulletin* 33(2), 74.

Muthukrishnan, N., Venugopal, M.S., Janarthanan, R., 1994. Evaluation of new insecticide formulations against rice leaf folder and stem borer. *Pestology* XVII(6), 12-14.

Muthukrishnan, N., Palanisamy, S., Bhuvaneswari, K., Logiswaran, G., Thangaraj, T., 2001. Acid lime pests: Survey, population dynamics, varietal reaction, IPM and evaluation of new chemicals. In: *Proc. of the Second National Symposium on Integrated Pest Management (IPM) in Horticultural Crops: New Molecules, Biopesticides and Environment*. Indian Institute of Horticultural Research, Bangalore, India.

Patil, N.R., Nadaf, A.M., Narabenchi, G.B., Patil, D.R., Sagar, B.S., 2017. Seasonal incidence of thrips, *Scirtothrips dorsalis* Hood on grapes, *Vitis vinifera* L. (cv. Thompson seedless) in Bijapur. *International Journal of Current Microbiology and Applied Sciences* 6(9), 3295-3300. DOI: 10.20546/ijcmas.2017.609.406.

Patil, S.B., Udikeri, S.S., Krishna Naik, L., Rachappa, V., Nimbal, F., Guruprasad, G.S., 2007. Dantop: A promising new molecule for the management of cotton sap feeding insects. *Karnataka Journal of Agricultural Sciences* 20(1), 47-50.

Ramakrishna Ayyar, T.V., 1932. Bionomics of some thrips injurious to cultivated plants in South India. Agriculture and Livestock of India, Delhi. pp. 391-403.

Ranga Reddy, A., Murthy, P.R., 2006. *Proceedings of the International Symposium on Grape Production and Processing*. Baramati (Pune), Maharashtra, India, February 6-11, 2006. International Society for Horticultural Science. p. 127.

Reddy, D.B., 1957. *Proceedings of the 44th Indian Science Congress-III*. Indian Science Congress, Calcutta. p. 102.

Sunitha, N.D., Jagginavar, S.B., 2010. Management of *Scirtothrips dorsalis* in grape. *Indian Journal of Plant Protection* 38(2), 131-133.

Tandon, P.L., Verghese, A., 1994. Present status of insect and mite pests in India. *Draksha Vritta* 14(2), 6-22.

Vinothkumar, B., Shanmugapriya, R., Sangamithra, S., Kuttalam, S., 2017. Evaluation of F9252 (Bifenthrin 8% + Clothianidin 10% SC) against insect pests of sugarcane. *Journal of Sugarcane Research* 7(2), 148-158.