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Vinay Kumar MM
HREC, Devihosur, Haveri, Karnataka, India

Anand Nanjappanavar
MHREC, Bagalkot, Karnataka, India

Ravikumar B
HREC, Devihosur, Haveri, Karnataka, India

Ramanagowda H
COH, Bagalkot, Karnataka, India

Venkateshalu
COH, Bagalkot, Karnataka, India

Gopali JB
RHREC, Kumbapur, Karnataka, India

Corresponding Author:
Vinay Kumar MM
HREC, Devihosur, Haveri, Karnataka, India

Evaluation of bio-efficacy and phytotoxicity of Sulfoxaflor 24% SC against grapes mealybug (*Maconellicoccus hirsutus* Green)

Vinay Kumar MM, Anand Nanjappanavar, Ravikumar B, Ramanagowda H, Venkateshalu and Gopali JB

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Abstract
The experiment on evaluation of bio-efficacy and phytotoxicity of Sulfoxaflor 24% SC in grapes was conducted at College of Horticulture, Bagalkot during the year 2019-20. Various formulations of Sulfoxaflor were evaluated in which Sulfoxaflor 24% SC @ 625 ml/ha recorded significantly highest mortality of mealy bug (63.01%) and it was found on par with Buprofezin 25% SC @ 1000 ml/ha (58.90%). Whereas Sulfoxaflor 24% SC @ 750 ml/ha (56.16%) and Clothianidin 50% WDG @ 250 g/ha (52.73%) were found on par which is followed by Imidacloprid 17.8 SL @ 250 ml/ha (45.20%) and Thiamethoxam 25 WG @ 250 g/ha (44.52%). Further, no phytotoxicity symptoms were observed on grape crop by application of the test chemical.

Keywords: Phytotoxicity, sulfoxaflor, bio efficacy, grape

Introduction
Grape is one of the important economic crops growing in especially in southern and northern districts of Karnataka. The important grape growing districts are Kolar, urban parts of Bengaluru, rural parts of Bengaluru, Bijapur, Bagalkot, Belgaum, Koppala and parts of Gulbarga also. Different varieties of grapes are grown by farmers and the high-quality grapes are exported to various countries and also grape is transported to local wine industries also. Use of grapes (*Vitis* species) is known to date back to Neolithic times (McGovern *et al.*, 2017) [5]. Greek philosophers believed in the healing powers of whole grapes and products derived from grapes (Wang *et al.*, 2014) [6].

Grape is a non-climacteric fruit that grows on the perennial and deciduous woody climbing vine. Grape is a cross pollinated vine with simple, lobed, cut or toothed leaves (seldom compound) with racemes of greenish flowers, the fruit consisting of watery or fleshy pulp. The fresh grape berries are good source of sugars, carbohydrates, vitamins, proteins and minerals. Fruits are used for table purpose, wine, juice, raisins and canning. Fresh and dried fruits have various uses in Ayurveda and Umami medicine. The fruits are considered to be laxative, stomachic, diuretic and cooling agents. The juice of unripe berries is used as an astringent in throat infections. Tannins can also be extracted as a by-product from wine industry. It is an important fruit crop, earning foreign exchange. Grapes can be eaten as fresh or used for making jam, juice, jelly, vinegar, wine, grape seed extracts and grape seed oil. Approximately 71 percent of world grape production is used for wine, 27 percent as fresh fruit, and 2 percent as dried fruit.

In Karnataka, grapes are cultivating in an area of 9,700 hectares and the average production is about 1.67 lakh tons. Most of the grapes produced in the state are sold in the local market as fresh fruits and small quantity is sold as raisins. In Karnataka, there are plenty of opportunities for production of wine. The climatic conditions in the state are best suited for the production of grapes suited for wine making. There is a very good demand for wines both in local and international markets. The fresh grapes are spoilt very fast, and therefore, the farmer is liable for economic losses. Similarly, the grape crop is facing many problems includes biotic and abiotic factors like change in climate, pests, and diseases etc.

There are many diseases and pests which are infesting grape and reduce the yield.

Diseases are downy mildew, powdery mildew etc and the important pests like thrips, flea beetle and mealy bug. Among all the pest's mealybug is one the important pest infesting grape crop by hiding in the cracks and crevices of loose bark. The infestation leads to reduction in the quality of grapefruit and vigour of the plant will be reduced. More than 85 species of insects have been reported on grapevine in India. A total of 22 insect pests are found to attack grapevine in northern Karnataka. A total of 40 vertebrates (Birds-27, bat-2, snails, and slugs -5, rodents-6) were recorded as pests of grapes in different countries (Suitha N D, 2017) [3].

Economic losses resulting from vineyard mealybug infestations have increased dramatically during the past decade. In response, there has been a cosmopolitan effort to improve control strategies and better understand mealybug biology and ecology, as well as their role as vectors of plant pathogens. Mealybugs are named for the powdery secretions covering their bodies. The most important vineyard mealybugs belong to the subfamily Pseudococcinae (Hardie *et al.* 1996) [4].

Material and Methods

The experiment on evaluation of bio-efficacy and phytotoxicity of Sulfoxaflor 24% SC in grapes was conducted at College of Horticulture, Bagalkot during the year 2019-20. Bagalkot is situated in northern dry zone of Karnataka state at 16.18°N latitude, 75.7°E longitude and at an altitude of 533 m above mean sea level; The climatic condition of the Bagalkot is slightly tropical as compared some other regions of Karnataka. The average rainfall of this area is about 683 mm, distributed over a period of 4 months from June to September with 25 rainy days. Sometimes the temperature may rise to 34 but the average annual temperature of this area is 25.8 ºC. The observations on phytotoxicity symptoms at 1,3,7,10 and 14 Days after application of test chemical and the number of mealybug colonies per vine were recorded in different intervals (1DAS, 1DAS, 3 DAS, 5 DAS and 7 DAS) in grape vine (Manik Chaman). The experiment was designed in Randomized Block Design. Mealybug population was recorded on five randomly selected vines. Observations of mealybug were compiled and subjected to statistical analysis. Phytotoxicity symptoms like leaf injury on tips and leaf surface, wilting, vein clearing, necrosis, epinasty and hyponasty observations were recorded on 1,3,7,10 and 14 days after application of test chemical.

Results and Discussions

During both the spray, the mealy bug infestation differed significantly with respect to all the treatments. Sulfoxaflor 24% SC @ 625 ml/ha recorded significantly highest mortality of mealy bug (63.01%) and it was found on par with Buprofezin 25% SC @ 1000 ml/ha (58.90%). Whereas Sulfoxaflor 24% SC @ 750 ml/ha (56.16%) and Clothianidin 50% WDG @ 250 g/ha (52.73%) were found on par which is followed by Imidacloprid 17.8 SL @ 250 ml/ha (45.20%) and Thiamethoxam 25 WG @ 250 g/ha (44.52%). The least mortality of mealy bug found in Sulfoxaflor 24% SC @ 500 ml/ha (41.78%). The untreated check recorded significantly highest infestation of mealy bug as presented in the Table 1 and similarly in second spray the mealy bug colonies range was recorded 6.90 to 7.50 colonies/vine. The lowest number of mealy bug colonies were recorded 1.00/vine in sulfoxaflor 24% SC @ 625ml/ha followed by sulfoxaflor 24% SC @ 750 ml/ha and sulfoxaflor 24% SC @ 1000 ml as compared to control and other treatments. Similarly highest percent reduction over control 60.27% was recorded in sulfoxaflor 24% SC @ 625 ml/ha followed by Buprofezin 25% SC @ 1000ml/ha, whereas, least percent reduction 42% was recorded in Thiamethoxam 25WG@250g/ha. Further, these findings are in conformity also reported that the application of Buprofezin 25% SC achieved around 78.65% reduction over control. Mohamed *et al.* (2021) [1] opined the same that, spraying of Buprofezin 25% SC 1.25ml/l was found effective against adult mealybug up to four weeks after the spraying. Similarly, Richard *et al.* (2020) [7] reports also in conformity with the present findings.

With regards to the phytotoxicity study, no phytotoxicity symptoms were observed on grape crop by application of the test chemical Sulfoxaflor 24% SC even at the dose of 1500 ml/ha at 1, 3, 7, 10 and 14 days after application as presented in the Table 3.

Table 1: Bio-efficacy of Sulfoxaflor 24% SC on Mealy bug of grape during the First spray of year 2019-20.

Sl. No.	Treatments	No of mealy bug colonies per vine					Reduction over control (%)	Control due to treatments (%)
		Pretreatment count	1DAS	3 DAS	7 DAS	10 DAS		
1.	Sulfoxaflor 24% SC @ 500 ml/ha	15.00 (4.37)	14.50 (4.30)	12.00 (3.96)	09.00 (3.50)	07.00 (3.14)	41.78	53.33
2.	Sulfoxaflor 24% SC @ 625 ml/ha	12.50 (4.03)	11.50 (3.89)	08.00 (3.32)	05.00 (2.73)	02.50 (2.08)	63.01	80.00
3.	Sulfoxaflor 24% SC @ 750 ml/ha	13.50 (4.17)	12.50 (4.03)	09.50 (3.58)	06.50 (3.04)	03.50 (2.37)	56.16	74.07
4.	Buprofezin25% SC @ 1000 ml/ha	13.00 (4.10)	12.00 (3.96)	09.00 (3.50)	06.00 (2.94)	03.00 (2.23)	58.90	76.92
5.	Imidacloprid 17.8 SL @ 250 ml/ha	14.50 (4.30)	14.00 (4.24)	11.50 (3.89)	08.50 3.41)	06.00 (2.94)	45.20	58.62
6.	Thiamethoxam 25 WG @ 250 g/ha	15.00 (4.37)	14.50 (4.30)	11.50 (3.89)	08.00 (3.32)	06.50 (3.04)	44.52	56.66
7.	Clothianidin 50% WDG @ 250 g/ha	13.00 (4.10)	12.50 (4.03)	10.50 (3.74)	07.00 (3.14)	04.50 (2.62)	52.73	65.38
8.	Untreated control	16.00 (4.50)	16.00 (4.50)	17.50 (4.68)	19.00 (4.85)	20.50 (5.02)	-	-
S.Em.±		NS	0.36	0.35	0.31	0.25	-	-
C.D. (5%)			NS	1.05	0.92	0.75	-	-
C.V. (%)			14.17	16.42	18.73	19.65	-	-

Figures in parenthesis are square root transformed values

Table 2: Bio-efficacy of Sulfoxaflor 24% SC on Mealy bug of grape during the Second spray of year 2019-20.

Sl. No.	Treatments	No of mealy bug colonies per vine					Reduction over control (%)	Control due to treatments (%)
		Pretreatment count	1DAS	3 DAS	7 DAS	10 DAS		
1.	Sulfoxaflor 24% SC @ 500 ml/ha	07.00 (3.14)	06.50 (3.04)	05.50 (2.84)	04.50 (2.62)	04.00 (2.50)	43.83	42.85
2.	Sulfoxaflor 24% SC @ 625 ml/ha	07.50 (3.23)	07.00 (3.14)	04.00 (2.50)	02.50 (2.08)	01.00 (1.5)	60.27	86.66
3.	Sulfoxaflor 24% SC @ 750 ml/ha	07.00 (3.14)	06.00 (2.94)	04.50 (2.62)	03.00 (2.23)	01.50 (1.72)	57.53	78.57
4.	Buprofezin25% SC @ 1000 ml/ha	07.50 (3.23)	07.00 (3.14)	04.00 (2.50)	02.50 (2.08)	01.50 (1.72)	58.90	80.00
5.	Imidacloprid 17.8 SL @ 250 ml/ha	07.50 (3.23)	07.00 (3.14)	05.50 (2.84)	04.00 (2.50)	03.50 (2.37)	45.20	53.33
6.	Thiamethoxam 25 WG @ 250 g/ha	07.50 (3.23)	07.00 (3.14)	05.50 (2.84)	04.50 (2.62)	04.00 (2.50)	42.46	46.66
7.	Clothianidin 50% WDG @ 250 g/ha	07.00 (3.14)	6.00 (2.94)	04.50 (2.62)	03.50 (2.37)	02.50 (2.08)	54.79	64.28
8.	Untreated control	06.90 (3.12)	7.50 (3.23)	08.50 (3.41)	10.00 (3.66)	11.50 (3.89)	-	-
S.Em.±		NS	0.28	0.22	0.22	0.18	-	-
C.D. (5%)			NS	0.67	0.67	0.54	-	-
C.V. (%)			22.37	22.58	27.23	25.88	-	-

Figures in parenthesis are square root transformed values.

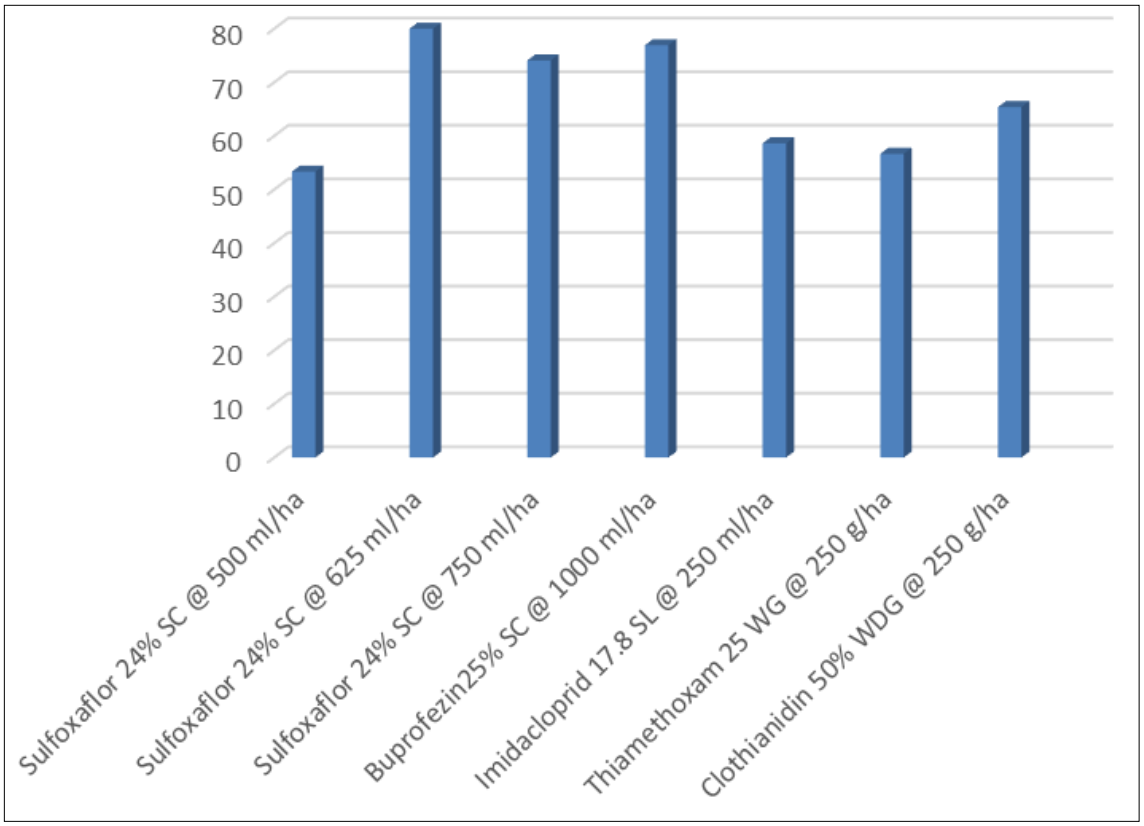

Fig 1: % Reduction over control during First Spray

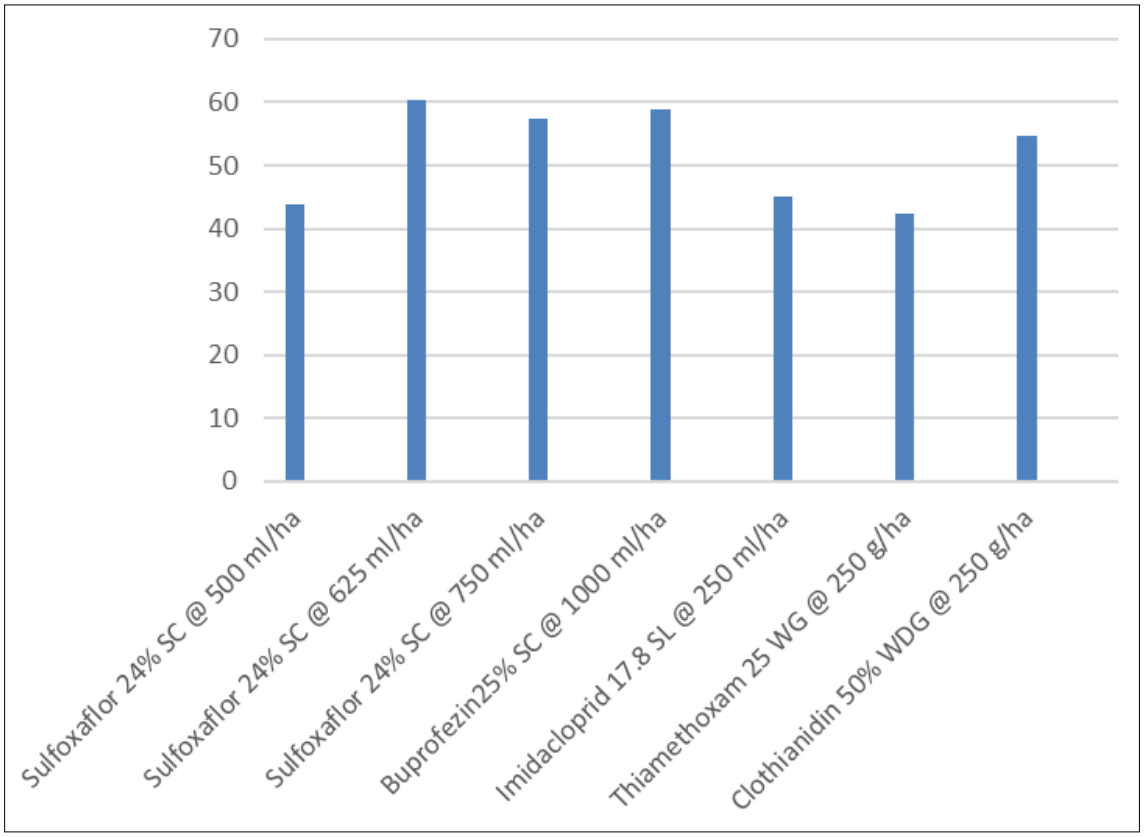

Fig 2: % Reduction over control during Second Spray

Table 3: Phytotoxicity of Sulfoxaflor 24% SC on grape during year 2019-20.

Sl. No.	Treatments	Phytotoxicity symptoms at 1,3,7,10 and 14 Days after application of test chemical																									
		Leaf injury on Tips and leaf surface.					Wilting					Vein Clearing					Necrosis					Epinasty					Hyponasty				
		1	3	7	10	14	1	3	7	10	14	1	3	7	10	14	1	3	7	10	14	1	3	7	10	13	1	3	7	10	14
1	Sulfoxaflor 24% SC @ 750 ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	Sulfoxaflor 24% SC @ 1500 ml/ha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Conclusion

The insecticides Sulfoxaflor 24% SC @ 625 ml/ha and Buprofezin 25% SC 1.25 were effective to reduce the mealy bug infestation on grape vines and fruit bunches; with respect to the efficacy we recorded on par results, even in phytotoxic observations both the chemicals don't cause any phytotoxic effect on plants. Further, these chemicals also safer to the natural enemies.

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