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Efficacy of different insecticides against grape mealybug (*Pseudococcus maritimus* Ehrhorn)

Muhammad Tariq Reki[1], Ghulam Ali Bugti[*2], Jan Muhammad Mari[3], Syed Ahmed Shah[1], Gaji Bux Bugti[1], Naseer Ahmed Marri[1], Muhammad Afzal Roonjha[2]

[1]*Agriculture Research Institute Quetta, Balochistan, Pakistan*

[2]*Department of Entomology, Lasbela University of Agriculture, Water & Marine Sciences, Uthal, Balochistan, Pakistan*

[3]*Sindh Agriculture University, Tando Jam, Sindh, Pakistan*

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Abstract

The efficacy of synthetic pesticides (Buprofezin 25 SC 1.25ml/L, Methomyl 40 SP 1g/L, Dichlorvos 76EC 2ml/L and Chlorpyriphos 20 EC 2ml/L) were tested against grape mealy bug, *Planococcus maritimus*. The results showed that all the pesticides were reduced the mealy bug infestation on grape vines and fruit bunches. The maximum control efficiency was obtained by pesticide Buprofezin 25SC after 1st, 2nd and 3rd spray that was 70.37, 73.64 and 78.65 percent, while Dichlorvos 76EC resulted 60.17, 64.58 and 71.21 percent and Chlorpyriphos 20EC showed s 54.01, 59.06 and 66.84 percent after 1st, 2nd and 3rd spray, whereas Methomyl 40SP reduced 54.03, 59.09 and 66.87 percent infestation respectively. Thus the results indicates that the Buprofezin 25 SC showed a remarkable control on the mealybug colonies on grape vines and fruit bunches.

***Corresponding Author:** Ghulam Ali Bugti ✉ gabugti@outlook.com

Introduction

Grape (*Vitis vinifera* L.) is one of the most remunerative summer fruit crop, grown in mountainous and sub-mountainous areas up to 6,000 feet or more are suitable for its cultivation. In Pakistan, grapes are grown on 13,000 hectares with the total production of about 49,000 tons (GoP, 2011). Extensive and intensive cultivation of grapes tend to attract various kinds of pests to the vineyards; and there are 132 insects that are known to attack grape vine in the world. Some 85 species of insects are known to occur on grapes in the sub-continent.

The grape mealybug, *Pseudococcus maritimus* Ehrhorn (Homoptera: Pseudococcidae) is a serious insect pest infesting vineyards. It has a flattened, oval pink body covered in a mealy white wax coating. It is somewhat segmented in appearance, but the divisions between head, thorax and abdomen are not distinct. Mature wingless females are about 5 mm long. They have long waxy filaments along the edge of the body that are longest at the rear and become progressively shorter toward the front end. Mealybug has recently become one of the key pests affecting cotton crop. Although damage is only caused by the female mealybug. which suck plant sap and nutrients, and promote the honeydew which leads various disease in the crop(Rothwangl *et al.* 2004; Hashmi, 1994; Daane and Bentley, 2007). Nearly 26 pests infesting grape vines, which also included mealybug, and has been recorded as major pests on grapes. A total of 20 species of mealy bugs have been reported on grape vine in the world, but only six species have been reported from different states in India (Babu and Azam, 1999).

Among them the most devastating species is grape mealy bug, *M. hirsutus*. Severe out break of mealy bugs was reported during 1974 in Andhra Pradesh by Tejkumar *et al.* (1977). Babu and Azam (1989) reported that the grape vine mealy bug, *M. hirsutus* is a serious vineyard pest in India.. When vines are pruned the mealy bug attacks such tender developing sprouts causing stunted growth. Malformation of growing shoots and leaves occurs due its feeding and sticky honeydew excreted by mealy bug predisposes to mould growth. Gautam and Cooper (2003) reported the efficacy of pirimiphos methyl (Actellic 50 EC at 10 ml/litre), deltamethin (Decis 2.8 EC at 5.0 ml/litre) and chlorpyriphos + dimethoate (Salut at 5.0 ml/litre) against mealy bug *M. hirsutus* and revealed 100 percent kill of all stages of the pest within six hours.

However, on the 7th day after treatments medium phytotoxicity was observed on flowers dipped in deltamethrin and chlorphyriphos + dimethoate. Balikai (2005) concluded that looking to the efficacy of insecticides on vine and bunches the lower dosage of Buprofezin 25 SC @ 1125 ml/ha is recommended for the management of mealy bugs on grapes. Biradar *et al* (2006) found that Diafenthiuron 50SC @ 800 and 1600 g a.i./ha gave better control of mealy bugs on grapes and recorded higher fruit yields of 24.7 and 25.0 t/vine with higher C:B ratio of 11.1 and 11.4, respectively, Cloyd *et al.* (2012). Keeping in view the above facts of chemical control of grape mealy bug, the present study was carried out to evaluate the efficacy of different insecticides against grape mealy bug and to identify the most effective insecticide for the control of grape mealy bug.

Materials and methods

Site selection and experimental layout

The ten year old grape vineyard located at the Agriculture Research Institute, Quetta, Balochistan was selected in this study in the year 2015. The efficacy of different insecticides was studied on locally known Thompson seedless variety planted at a spacing of 10 x 3 ft.

Treatments

The following insecticides were used to evaluate their efficacy against target pest on grape.

1. Buprofezin 25 SC 1.25mL/L
2. Methomyl 40 SP 1g/L
3. Dichlorvos 76 EC 2mL/L
4. Chlorpyriphos 20 EC 2mL/L
5. Control (untreated)

The crop was pruned in April and all other recommended cultural practices were followed. The insecticides were applied at their recommended

doses. The mealy bug population was counted before application of the insecticides and after 3 days, 7 days and 14 days of application. Ten grape vines in each treatment were selected for collection of the data and the average population was worked out. The amount of spray solution required was estimated at each time by spraying water on control treatments. The amount of insecticide required for preparing spray solution was calculated by using the formula Q x A.I = C x V (where Q= Quantity of insecticide required, A.I= Active ingredient in product, C= Required concentration and V=Volume of spray required). The known quantity of insecticide was mixed with little quantity of water and then the solution was poured in the bucket containing the desired quantity of water. It was thoroughly stirred with the help of wooden stick.

Data analysis

The level of efficacy of insecticides was evaluated using ANOVA followed by least significant difference test using statistical software SPSS 21.0 (IBM, 2012).

Results

The efficacy of various pesticides against grape mealy bug, *Planococcus maritimus* was tested. The four insecticides (Buprofezin 25SC 1.25ml/L, Methomyl 40SP 1 g/L, Dichlorvos 76EC 2ml/L and Chlorpyriphos 20 EC 2ml/L) were used and their efficacy was compared with control (untreated). The data on *Planococcus maritimus* colonies on vines and fruit bunches were recorded and the results were analysed.

Planococcus maritimus colonies on grape vines

1st spray

The pre-treatment and post treatment count of *Planococcus maritimus* colonies on grape vines showed that pest infestation decreased significantly after 3-days of pesticidal spray ($F=34.97$; $DF=14$; $P<0.05$), 7-days after first spray ($F=245.72$; $DF=14$, $P<0.05$) and 14-days after first spray ($F=2161.78$; $DF=14$, $P<0.05$); while non-significant results were observed for pre-treatment between pesticides ($F=1.03$; $DF=14$; $P>0.05$). Spraying grape vines with Buprofezin 25 SC significantly decreased the *Planococcus maritimus* colonies i.e. 23.95, 15.57 and 9.34/vine after 3, 7 and 14 days of spray, respectively as compared to pre-treatment count of 31.52/vine; while grape vines sprayed with Methomyl 40 SP and Chlorpyriphos 20 EC remained higher i.e. 15.01 and 15.20/vine after 14 days of spray as compared to 32.63 and 33.05/vine, respectively. In untreated (control) grape vines, the count of mealy bug colonies was in the range of 33.63 to 38.21/vine during 14 days after spray. All the pesticides were effective to reduce the mealy bug infestation on grape vines; however Buprofezin 25SC showed its remarkable efficacy by reducing the mealy bug colonies on grape vines maximally (Fig.1).

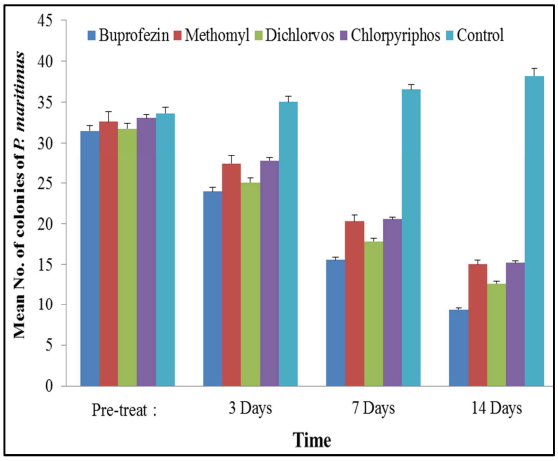

Fig. 1. Effect of various synthetic pesticides after their first spray against grape mealybug *Planococcus maritimus* (number of colonies per vine).

2nd spray

The results suggested that the effect of insecticidal spray of various synthetic pesticides on grape vines against *Planococcus maritimus* was significant ($P<0.05$) in decreasing mealy bug colonies after 3-days of second spray ($F=76.65$; $DF=14$; $P<0.05$), 7-days after second spray ($F=335.34$; $DF=14$, $P<0.05$) and 14-days after second spray ($F=2032.54$; $DF=14$, $P<0.05$).

The recorded data showed that the count of *Planococcus maritimus* colonies on grape vines after 3,7 and 14 days of Buprofezin 25SC spray was 21.32, 13.86 and 8.31/vine as compared to pre-treatment count of 31.52/vine; while the count of mealy bug colonies after 3,7 and 14 days of Dichlorvos 76EC spray was 22.33, 15.85 and 11.25/vine, respectively as

compared to pre-treatment count of 31.76/vine. However, Methomyl 40SP and Chlorpyriphos 20EC showed relatively weak action against mealy bug and after 14 days of their spray the insect count was 13.36 and 13.53/vine as compared to pre-treatment count of 32.63 and 33.05/vine, respectively. In control (untreated) vines, the count of mealy bug colonies was in the range of 33.63 to 35.34/vine during 14 days observation period after spray second. It was observed that Buprofezin 25SC remained the most effective against the mealy bug as compared to rest of the treatments. However, Dichlorvos 76EC ranked second in suppressing the mealy bug infestation on grape vines (Fig.2).

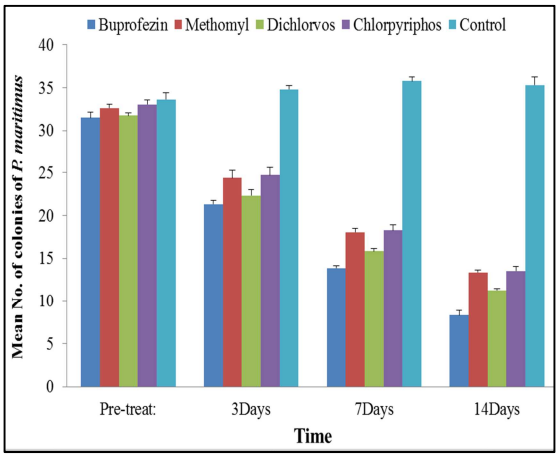

Fig. 2. Effect of various synthetic pesticides after their second spray against grape mealybug *Planococcus maritimus* (number of colonies per vine).

3rd spray

The statistical analysis indicated that spraying grape vines with various pesticides against *Planococcus maritimus* resulted significant (P<0.05) effect on the count of mealy bug colonies after 3-days of third spray (F=111.87; DF=14; P<0.05), 7-days after third spray (F=642.09; DF=14, P<0.05) and 14-days after third spray (F=6905.56; DF=14, P<0.05).

The data indicated that the count of *Planococcus maritimus* colonies on grape vines after 3,7 and 14 days of Buprofezin 25SC spray was 17.91, 11.22 and 6.73/vine as compared to pre-treatment count of 31.52/vine; while the count of mealy bug colonies after 3,7 and 14 days of Dichlorvos 76EC spray was 18.75, 12.84 and 9.12/vine, respectively as compared to pre-treatment count of 31.76/vine. Methomyl 40SP and Chlorpyriphos 20EC showed least effects in suppressing mealy bug as compared to above two pesticide products and after 14 days of Methomyl 40SP and Chlorpyriphos 20EC spray, the count of mealy bug colonies was 10.82 and 10.96/vine as compared to pre-treatment count of 32.63 and 33.05/vine, respectively. In control (untreated) vines, the count of mealy bug colonies was in the range of 33.63 to 36.67/vine during 14 days observation period after third spray; and noted a continuous increase in the number of mealy bug colonies. The results of the present study clearly suggested that Buprofezin 25SC was most effective pesticide to combat mealy bug on grapes; followed by Dichlorvos 76EC; while Methomyl 40SP and Chlorpyriphos 20EC remained least effective against mealy bug infestation on grape vines when compared with Buprofezin 25SC (Fig. 3).

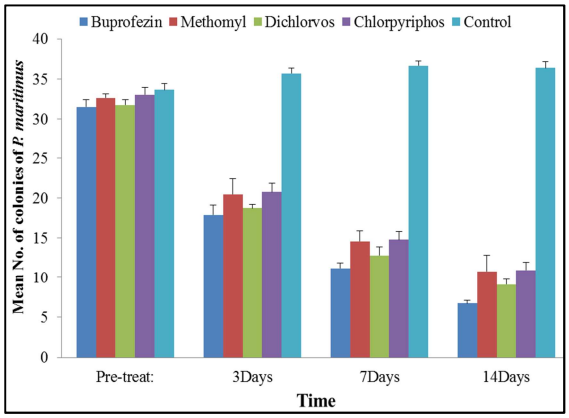

Fig. 3. Effect of various synthetic pesticides after their third spray against grape mealybug *Planococcus maritimus* (number of colonies per vine).

Planococcus maritimus colonies on fruit bunches

1st spray

The pre-treatment and post treatment count of *Planococcus maritimus* colonies on fruit bunches of grapes showed that pest infestation decreased significantly after 3-days of pesticidal spray (F=10.09; DF=14; P<0.05), 7-days after first spray (F=54.45; DF=14, P<0.05) and 14-days after first spray (F=674.41; DF=14, P<0.05); while non-significant for pre-treatment count between pesticides (F=1.92; DF=14; P=0.2009).

The collected results showed that spraying grapes with Buprofezin 25 SC significantly suppressed the count of *Planococcus maritimus* colonies i.e. 6.25, 4.06 and 2.44/bunch after 3,7 and 14 days of first spray, respectively as compared to pre-treatment count of 8.22/bunch; while the count of mealy bug colonies on grapes was 6.76, 4.80 and 3.41/bunch after 3,7 and 14 days of first Dichlorvos 76EC spray, respectively as compared to pre-treatment count of 8.56/bunch. The count of mealy bug colonies on fruit bunches was higher i.e. 3.61 and 3.89/bunch, 14 days after first spray of Methomyl 40SP and Chlorpyriphos 20EC as compared to 7.86 and 8.45/bunch, respectively. In untreated (control) grape vines, the count of mealy bug colonies was in the range of 8.12 to 8.91/bunch during 14 days after spray. Although, the pesticides evaluated were highly effective to check the pest infestation; but Buprofezin 25SC showed its superiority by decreasing mealy bug colonies on grape bunches at lowest level (Fig.4).

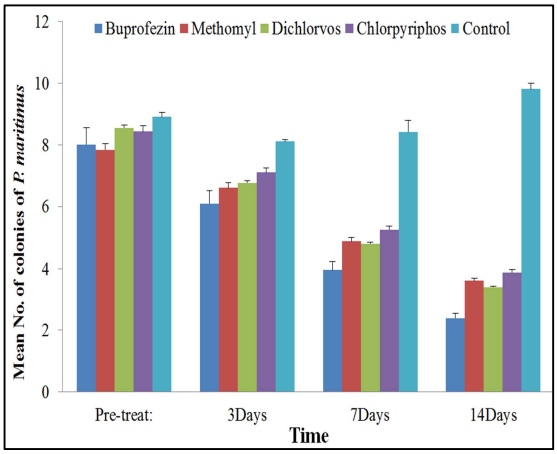

Fig. 4. Effect of various synthetic pesticides after first spray against grape mealybug *Planococcus maritimus* (number of colonies per bunch).

2nd spray

The results indicate that the effect of insecticidal spray of various synthetic pesticides on grape vines against *Planococcus maritimus* was significant (P<0.05) in decreasing mealy bug colonies on fruit bunches after 3-days of second spray (F=20.16; DF=14; P<0.05), 7-days after second spray (F=77.58; DF=14, P<0.05) and 14-days after second spray (F=1136.12; DF=14, P<0.05).

The results were indicate that the number of *Planococcus maritimus* colonies on grape vines after 3,7 and 14 days of Buprofezin 25SC spray was 5.88, 3.82 and 2.29/bunch as compared to pre-treatment count of 8.02/bunch; while the count of mealy bug colonies after 3,7 and 14 days of Dichlorvos 76EC spray was 6.56, 4.66 and 3.31/bunch, respectively, as compared to pre-treatment count of 8.56/bunch. However, Methomyl 40SP and Chlorpyriphos 20EC were relatively less effective against mealy bug and after 14 days of their spray the insect count was 3.52 and 3.79/bunch as compared to pre-treatment count of 7.86 and 8.45/bunch, respectively. In control (untreated) vines, the count of mealy bug colonies on fruit bunches was in the range of 8.75 to 8.91/bunch during 14 days observation period after spray second. It was observed that Buprofezin 25SC remained the most effective pesticide against the mealy bug, followed by Dichlorvos 76EC that ranked second in decreasing the pest infestation on grapes plantation (Fig.5).

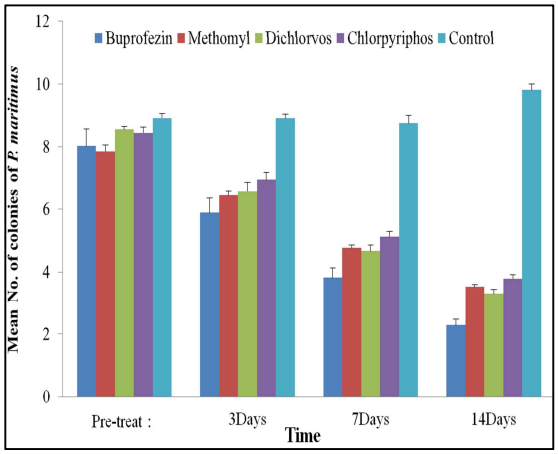

Fig. 5. Effect of various synthetic pesticides after second spray against grape mealy bug *Planococcus maritimus* (number of colonies per bunch).

3rd spray

The evident from the statistical analysis of the data showed that spraying grape vines with various pesticides against *Planococcus maritimus* showed significant (P<0.05) effect on the count of mealy bug colonies on fruit bunches after 3-days of third spray (F=92.85; DF=14; P<0.05), 7-days after third spray (F=136.60; DF=14, P<0.05) and 14-days after third spray (F=1017.94; DF=14, P<0.05).

The number of *Planococcus maritimus* colonies observed on fruit bunches of grapes after 3,7 and 14 days of Buprofezin 25SC spray was 3.80, 2.47 and 1.48/bunch as compared to pre-treatment count of 8.02/bunch; while the count of mealy bug colonies after 3,7 and 14 days of Dichlorvos 76EC spray was 3.82, 2.71 and 1.92/bunch, respectively as compared to pre-treatment count of 8.56/bunch. Methomyl 40SP and Chlorpyriphos 20EC showed least effects in suppressing mealy bug as compared to above two pesticide products and after 14 days of Methomyl 40SP and Chlorpyriphos 20EC spray, the count of mealy bug colonies was 2.91 and 2.76/bunch as compared to pre-treatment count of 7.86 and 8.45/bunch, respectively.

In untreated vines, the count of mealy bug colonies was in the range of 8.51 to 9.49/bunch during 14 days observation period after third spray; and noted a continuous increase in the number of mealy bug colonies when left without insecticidal treatment. The results of the present study clearly suggested that Buprofezin 25SC showed better results to decrease pest infestation than Dichlorvos 76EC, Methomyl 40SP and Chlorpyriphos 20EC (Fig.6).

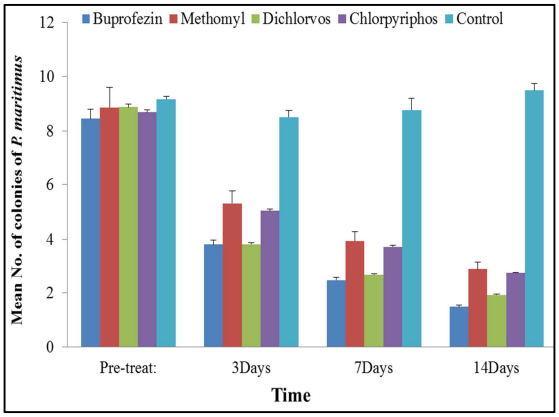

Fig. 6. Effect of various synthetic pesticides after third spray against grape mealybug *Planococcus maritimus* (number of colonies per bunch).

Discussion

The province of Balochistan is well known for production of high quality grapes. However, new insect pests are emerging as a threat for the vineyards. Due to lack of plant protection efficiency in grapes, the marketable fruit yield is reduced. Mealybug has recently become one of the key pests affecting a number of field crops, vegetables and fruit trees (Vaughn, 2000). Mealy bug is hardy in nature and show resistance to various protection measures. in our research we observed that the pesticides were effective to reduce the mealy bug infestation on grape vines and fruit bunches. of the maximum control parentage was obtained by spraying pesticide Buprofezin 25SC after 1st, 2nd and 3rd spray was (av.74.22%); Dichlorvos 76EC after 1st, 2nd and 3rd spray was (av. 66.36%), respectively. The efficacy of Chlorpyriphos 20EC after 1st, 2nd and 3rd (av. 59.97%) was recorded and Methomyl 40SP showed (av. 60.00%) to reduce the colonies of target insect. the results were supported by researchers, Mani (1990) and Beevi *et al.* (1992) that Dichlorvos (0.02%) was most effective to control mealy bug grape vine. Similarly Hatta and Hara (1992) reported that spraying with chlorpyriphos totally eliminated mealy bugs in grape fields. Balikai (1999) reported that, mealy bug population was the lowest (1.17 and 5.90 colonies per vine at 30 and 60 days after treatment, respectively) on grapes where the pest colonies were disturbed with tooth brush and then sprayed with dichlorvos 76EC @ 2 ml/litre of water. Balikai (2002) reported that Buprofezin 25SC @ 1500 ml/ha recorded least number of mealy bug colonies per vine on 15th day after first, second and third sprays (32.5, 20.3 and 10.8, respectively), and was at par with buprofezin 25SC @ 1000 ml/ha (34.6, 22.6 and 13.5, respectively).

The insecticidal efficacy against mealy bug on fruit bunches of grapes showed that Buprofezin 25 SC showed remarkable efficacy by reducing the mealy bug colonies on grape bunches maximally; and its efficacy after 1st, 2nd and 3rd spray was (av.74.82%); Dichlorvos 76EC after 1st, 2nd and 3rd spray was percent (av. 66.36%), respectively. The efficacy of Chlorpyriphos 20EC after 1st, 2nd and 3rd spray was (av. 58.82%) and Methomyl 40SP showed (av. 57.42%) control. Highest average fruit yield of 11505kg ha^{-1} was observed from the vineyard sprayed with Buprofezin 25SC and the lowest fruit yield of 10080kg ha^{-1} was achieved from the vineyard sprayed with Chlorpyriphos 20EC.

Due to mealy bug infestation, the marketable yield in control was severely affected. In the last season, the grapes were marketed at the rate around Rs. 53/- per kilogram; and vineyards sprayed with Buprofezin 25SC, Dichlorvos 76EC, Chlorpyriphos 20EC and Methomyl 40SP produced an additional income of 131970, 63600, 104145 and 56445 rupees per hectare over control. The percentage increase in the income from the vineyards sprayed with Buprofezin 25SC, Dichlorvos 76EC, Chlorpyriphos 20EC and Methomyl 40SP was 27.62, 13.31, 21.80 and 11.81 percent, respectively. It is concluded that Buprofezin 25SC application proved to be highly beneficial to reduce mealy bug infestation maximally, increase yields and improve the net returns. Similar findings have been reported by past researches as well as some recent studies have also supported the present research findings. Looking to the efficacy of insecticides both on vine and bunches, both the treatments of buprofezin 25SC @ 1000 ml/ha and buprofezin 25SC @ 1500 ml/ha along with fish oil rosin soap (Meenark) @ 3125g/ha could be recommended for the management of mealy bugs on grapes, which are equally effective. Balikai (2005) reported that the efficacy of Buprofezin 25SC (Applaud 25SC) resulted least number of mealy bug colonies per vine (27.7, 19.3 and 8.2, respectively) and was at par with Buprofezin 25 SC @ 1500 ml/ha which in turn was at par with Buprofezin 25 SC @ 1125 ml/ha. Biradar *et al.* (2006) found that Diafenthiuron 50SC @ 800 and 1600g a.i./ha gave better control of mealy bugs on grapes and recorded higher fruit yields of 24.7 and 25.0 t/vine with higher C:B ratio of 11.1 and 11.4, respectively. Cloyd *et al.* (2012) have also reported similar results as achieved in the present study.

Conclusions

All the pesticides were effective to reduce the mealy bug infestation on grape vines and fruit bunches; however Buprofezin 25SC showed its remarkable efficacy by reducing the mealybug colonies on grape vines maximally. The Buprofezin 25SC was found to be more effective to control the mealybugs from vineyards than rest of the insecticides tested. So on the basis of results of the present study it is suggested that Buprofezin 25SC may be sprayed on vineyards that suppressed the mealybug colonies on grape vines and fruit bunches for better yield production.

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