Synergistic Effects of Insecticides and Wetting Agents on Mango Mealybug (*Drosicha mangiferae* Green) Management

ABSTRACT

The experiment was conducted at Entomology laboratory of Sher-e-Bangla Agricultural University with the following treatments to understand the efficacy of different insecticidal combination with wetting agents against nymph and adult of devastating mango mealybug. The treatments consist of T_1 = Nitro 505 EC + Petroleum oil, T_2 = Nitro 505 EC + Ethyl alcohol, T_3 = Nitro 505 EC + Detergent, T_4 = Capture 75 WG + Petroleum oil, T_5 = Capture 75 WG + Ethyl alcohol, T_6 = Capture 75 WG + Detergent, T_7 = Imitaf 20 SL + Petroleum oil, T_8 = Imitaf 20 SL + Ethyl alcohol, T_9 = Imitaf 20 SL + Detergent. The study examined the mortality rate of mealybugs by treating those combinations. Treatment T_8 consistently showed the highest nymphal mortality rates across different application times, significantly outperforming other treatments. Conversely, T_6 exhibited the lowest control of first instar nymphs, with notably fewer nymphs controlled after 48 hours compared to other treatments. T_3 and T_9 also showed significant results in nymphal mortality, gradually increasing over time. While T_2 initially showed high nymphal mortality, it revealed statistically similar results to T_1, T_5, T_4, T_7, and T_8. T_9 performed the poorest, with the lowest control of second instar nymphs after 48 hours, while T_3 and T_6 also demonstrated lower efficacy. Regarding adult mealybugs, mortality rates were lower compared to nymphs, attributed to the development of a protective waxy layer. Treatment T_5 showed the highest control of adult mealybugs, followed by T_2, with statistically significant differences observed. T_6 exhibited the lowest control, significantly different from T_5. Despite slight increases over time, all treatments resulted in significantly lower numbers of adult mealybugs compared to the initial 12-hour application period. Overall, the study highlights the differential efficacy of treatments in controlling mealybug nymphs and adults, with T_8 showing consistent effectiveness against nymphs and T_5 being most effective against adult mealybugs.

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1. INTRODUCTION

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Mealybugs (Hemiptera: Pseudococcidae) are important pests worldwide causing economic damage to several agri-horticultural crops. Mango (*Mangifera indica* L.), the king of fruits is a member of family Anacardiaceae and is known for its strong aroma, delicious taste, and high nutritive value (Sahoo et al.2009). Mango is cultivated in about 7,50,000 hectares of land in the Indian subcontinent. In Bangladesh, mango ranks first in terms of area and third in terms of production. Insect pests are the

major threat to the mango production, accounting for huge seasonal loss (Ishaq et al. 2004). Several insects attack the mango from the nursery stage to fruit maturity. Grossly, 400 insects and non-insect pests have been recorded from the Indian subcontinent as pests. However, thirty are obnoxious and serious pests to the mango orchard (Kapadia 2003). Among all of the mango insect pests, mealybug (*Drosicha mangiferae)* is one of the notorious and destructive pests, rendering a huge scale of fruit loss (Karar et al. 2006). Bhagat (2004) had mentioned that though this insect is mainly a pest of the mango tree. However, in the areas of heavy populations, it has the tendency to attack a variety of other fruit trees like peach (*Prunus persica*), plum (*P. domestica*), papaya (*Carica papaya*), and all citrus species. Karar (2010) had opined that mealybug preferred mango varieties differentially. Mango mealybug became a serious pest of mango and citrus in West Africa, which reduced mango fruit by 50-90%, and the pest caused a serious nuisance (Moore 2004). *D. mangiferae* is considered to be the prime destructive mealybug species of mangoes in the subcontinent of South East Asia. *D. mangiferae* is a serious, devastating, polyphagous, dimorphic, and notorious pest of mango orchards in the Indian sub-continent (Rao et al. 2006). Mealybug is a polyphagous pest that was reported to cause serious damage on various fruit trees, particularly mango (Akinlosotu et al. 1994). The major host plants are mango (*Mangifera indica*), jackfruit (*Artocarpus heterophyllus*), citrus (*Citrus spp*.), frangipani (*Plumeria rubra*), and fig (*Ficus spp*.) (Ivbijaro et al. 1992). Mealybugs are sucking insects, soft bodied, oval shape and cottony in appearance found to attack on leaves, stems, roots and fruits which are covered like whitish powder. They suck a large amount of sap from all parts of the tree. They are found in moist, warm climates and also act as a vector for several plant diseases. They attach themselves to the plant and secrete a powdery wax layer used for protection while they suck the plant juices. Some species of mealybug lay their eggs in the same waxy layer used for protection; in quantities of 50-100, other species are born directly from the female (Vogele et al. 1991). Juvenile mealybug can crawl from an infested plant to a non-infested plant. The other mode of transfer is that small 'crawlers' are transferred by wind, rain, birds, ants, clothing, and vehicles and settle on new plants. The female mealybug is unable to fly and not active. In fact, humans are great friends, helping in the transport of the mealy bug. Ants attracted by the honeydew have been seen carrying mealybug from plant to plant. Both the quality and the quantity of the food are greatly affected due to this infestation (Herren 1981). The nymphs and females of this bug suck sap from inflorescence, tender leaves, shoots and fruit peduncles. Affected panicles shrivel and die. Infested plants are affected by the sooty mould (Tandon et al. 1978). Severe infestation often leads to fruit drops or makes the fruit unfit for marketing (Karar et al. 2013). In general, *D. mangiferae* is found to infest almost all mango cultivars, resulting in severe fruit necrosis. Due to the growth of sooty mould on the leaves, photosynthetic activity is affected (Pruthi et al. 1960). Further, the sooty mould of *D. mangiferae* provides an effective medium for rapid growth of black and sooty fungi which decolorize the fruit and make it unacceptable to consumers (CABI 2005). All over the world, scientists are working to find out the chemical control strategies to overcome the yield losses in crop plants due to mealybug attack. To tackle this notorious insect pest of mango, the appropriate chemical insecticides need to be applied in the

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appropriate destructive stage of the insect, especially at the nymphal stage. So, this research aimed to screen the insecticides from different groups for their efficacy against *D. mangiferae* and to find a possible combination of wetting agents with insecticides which would be effective against the mango mealybug.

2. MATERIALS AND METHODS

This research was conducted in the laboratory of the Dept. of Entomology of Sher-e-Bangla Agricultural University, Dhaka. The following treatments are applied during the experiment viz.,T_1 = Nitro 505 EC (chlorpyrifos + cypermethrin) @ 1ml/L of water + Organic solvent 2% in water, T_2 = Nitro 505 EC (chlorpyrifos + cypermethrin) @ 1ml/L of water + Ethyl alcohol 2% in water, T_3 = Nitro 505 EC (chlorpyrifos + cypermethrin) @ 1ml/L of water + Detergent 2% in water, T_4 = Capture 75 WG (imidacloprid 70%+emamectin benzoate 5%) @ 0.5g/L of water + Petroleum oil 2% in water, T_5 = Capture 75 WG (imidacloprid 70%+emamectin benzoate 5%) @ 0.5g/L of water + Ethyl alcohol 2% in water, T_6 = Capture 75 WG (imidacloprid 70%+emamectin benzoate 5%) @ 0.5g/L of water + Detergent 2% in water, T_7 = Imitaf 20 SL (imidacloprid) @ 0.5ml/L of water + Petroleum oil 2% in water, T_8 = Imitaf 20 SL (imidacloprid) @ 0.5ml/L of water + Ethyl alcohol 2% in water, T_9 = Imitaf 20 SL (imidacloprid) @ 0.5ml/L of water + Detergent 2% in water. The adult mealybugs were collected from different mango plants which are not been sprayed with any insecticide for the last month. The mango plants were approximately twelve years old and situated in the area of Sher-e-Bangla Agricultural University. These insects were brought to the Entomology laboratory and kept in the transparent plastic jars covered with porous white cloth for aeration. Inside the jars, leaves of mango with soft branches were given to the insects for feeding. During the laboratory experiment total hundred number of individuals of mango mealybugs were set in each petri-dish. After treatment application, the dead individuals were removed and counted at different hours of intervals (12, 24, 36, 48). Finally, the mortality rate was calculated from the rest survivors using the following formula-

$$\text{Mortality rate} = \frac{\text{Initial no. of individual} - \text{Survived no. of individual}}{\text{Total no. of individual}}$$

The selected chemical insecticides combined with wetting agents were used against 1st, 2nd, 3rd instar nymphs and adult mealybugs to count the mortality rate. The mortality data have been analyzed by Statistic 10 version software using the split plot design under Completely Randomized Design (CRD). The significance of the treatment means has been determined by the LSD test at α = 0.05.

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3. RESULTS AND DISCUSSION

3.1 Effect of chemical insecticides in combination with suitable wetting agents on 1st instar nymph of mango mealybug in laboratory

The data pertaining to the mortality percentage of first instar nymphs of mango mealybug at different hours of post-treatment interval are shown in Table 1. The results reveal significant differences among the treatments. Table 1 illustrates that treatment T_8 consistently exhibited the highest overall mortality rate across various application hours. T_8 resulted in the highest number of nymphal mortalities, approximately 97.33, followed by T_2 and T_4 with 96.67 and 96.67, respectively. Conversely, treatment T_6 showed the lowest efficacy in controlling first instar nymphs, with only 77.00 nymphs controlled after 48 hours, significantly different from the most effective treatment, T_8. Additionally, treatments T_3 and T_9 demonstrated significant results, showing a gradual increase in nymphal mortality due to insecticidal application. The result supports the findings of Karar *et al.* (2009) and Syed *et al*. (2012) found that profenofos showed maximum percent mortality (93.3% and 86.67%, respectively) of the 1st and 2nd instar mango mealybug.

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Table 1. Mortality rate of first instar nymph of mealybug at different hours of insecticide application at different combinations

Mortality rate of first instar nymph (%)				
Treatments	**12h**	**24h**	**36h**	**48h**
T_1 (Nitro 505 EC + Petroleum oil)	91.67 b	95.00 a	95.67 a	96.67 ab
T_2 (Nitro 505 EC + Ethyl alcohol)	93.33 a	94.67 a	95.67 a	96.00 ab
T_3 (Nitro 505 EC + Detergent)	42.33 d	51.67 c	64.00 c	89.67 bc
T_4 (Capture 75 WG + Petroleum oil)	90.33 b	96.33 a	96.67 a	96.67 ab
T_5 (Capture 75 WG + Ethyl alcohol)	93.67 a	95.33 a	95.33	96.33 abc
T_6 (Capture 75 WG + Detergent)	49.33 c	60.67 b	66.00 a	77.00 d
T_7 (Imitaf 20 SL + Petroleum oil)	90.67 ab	92.33 a	95.33 bc	96.00 ab
T_8 (Imitaf 20 SL + Ethyl alcohol)	91.00 a	95.33 a	96.00 a	97.33 a
T_9 (Imitaf 20 SL + Detergent)	45.67 cd	61.67 b	70.67 b	88.00 c
CV	**3.31**	**4.22**	**3.84**	**4.57**
LSD (0.05)	**4.45**	**6.05**	**5.71**	**7.24**

[In a column the lettering indicates the statistical difference between the treatments at 5% level of significance; where LSD= Least Significant Difference, CV= coefficient of variation]

3.2 Effect of chemical insecticides in combination with suitable wetting agents on 2nd instar nymphs of mango mealybug in the laboratory

The data pertaining to the mortality percentage of the second instar of the mango mealy bug at different hours of post-treatment interval are shown in Table 2. The results reveal significant differences among treatments. Table 2 reveals that although treatment T_2 showed the highest overall mortality rate across different application hours, it yielded statistically similar results to treatments T_1, T_5, T_4, T_7, and T_8. Conversely, these treatments showed statistically different results compared to T_9, which exhibited the lowest control of second instar nymphs, followed by T_3 and T_6 with 71.00 and 80.67 mealybug nymphs after 48 hours of application. Initially, T_8 controlled the maximum number of nymphs at 89.33, while T_9, T_3, and T_6 showed the lowest mortality after 12 hours of application. Subsequently, these treatments resulted in satisfactory numbers of nymphal mortality at 24 and 36 hours of insecticide application. The result supports the findings of Karar *et al.* (2009), Abbas *et al.* (2009), and Syed *et al*. (2012) found that profenofos showed maximum percent mortality of the 2nd instar mango mealybug.

Table 2. Mortality rate of second instar nymph of mealybug at different hour of insecticide application at different combination

Mortality rate of Second instar nymph (%)				
Treatments	**12h**	**24h**	**36h**	**48h**
T_1 (Nitro 505 EC + Petroleum oil)	81.00 bc	87.67 b	92.66 a	95.00 a
T_2 (Nitro 505 EC + Ethyl alcohol)	85.67 ab	94.00 a	95.00 a	96.67 a
T_3 (Nitro 505 EC + Detergent)	42.67 d	50.67 c	49.67 c	71.00 c
T_4 (Capture 75 WG + Petroleum oil)	79.00 c	93.00 a	94.00 a	96.33 a
T_5 (Capture 75 WG + Ethyl alcohol)	77.67 c	95.67 a	95.87 a	96.00 a
T_6 (Capture 75 WG + Detergent)	42.00 d	51.67 c	53.00 c	80.67 b
T_7 (Imitaf 20 SL + Petroleum oil)	85.00 ab	91.33 ab	94.33 a	95.33 a
T_8 (Imitaf 20 SL + Ethyl alcohol)	89.33 a	93.00 a	95.33 a	96.33 a
T_9 (Imitaf 20 SL + Detergent)	37.67 d	41.00 d	60.33 b	61.00 d
CV	**4.9**	**3.87**	**4.51**	**4.66**
LSD (0.05)	**5.79**	**5.16**	**6.28**	**6.98**

[In a column, the lettering indicates the statistical difference between the treatments at 5% level of significance; where LSD= Least significant difference, CV= coefficient of variation]

3.3 Effect of chemical insecticides in combination with suitable wetting agents on 3rd instar nymphs of mango mealybug in the laboratory

The data regarding the percent mortality of third instar nymphs of mango mealybug at different hours after spray are given in Table 3. Table 3 indicates that treatment T_8 resulted in the highest nymphal mortality after 48 hours of application, while treatment T_5 experienced the highest mortality at 87.33% after 12

hours. T_8 showed statistically similar results to T_2 and T_5 but differed significantly from T_9, which had the lowest number of nymphal mortalities. After 24 and 36 hours of treatment application, T_5 controlled the highest number of third instar nymphs, whereas T_9 yielded the lowest numbers, with only 41.33 and 45.00 after 24 and 36 hours of insecticidal application, respectively. According to Agricola *et al*. (1989), chlorpyriphos and methomyl manifested good control against the Comstock mealy bug, *Pseudococcus comstocki* (Kuwana), in both laboratory and field conditions.

Table 3. Mortality rate of third instar nymphs of the mealybug at different hours of insecticide application at different combinations

Mortality rate of third instar nymph (%)				
Treatments	**12h**	**24h**	**36h**	**48h**
T_1 (Nitro 505 EC + Petroleum oil)	63.00 c	74.33 c	81.00 b	87.00 bc
T_2 (Nitro 505 EC + Ethyl alcohol)	75.67 b	82.00 b	90.67 a	97.33 a
T_3 (Nitro 505 EC + Detergent)	40.67 d	48.67 d	50.67 d	55.33 e
T_4 (Capture 75 WG + Petroleum oil)	71.33 b	74.67 c	81.00 b	88.67 b
T_5 (Capture 75 WG + Ethyl alcohol)	87.33 a	91.33 a	94.67 c	96.67 a
T_6 (Capture 75 WG + Detergent)	40.00 d	42.00 e	50.33 d	65.00 d
T_7 (Imitaf 20 SL + Petroleum oil)	65.33 c	71.00 c	77.67 b	83.33 c
T_8 (Imitaf 20 SL + Ethyl alcohol)	73.00 b	81.67 b	92.00 a	97.67 a
T_9 (Imitaf 20 SL + Detergent)	40.00 d	41.33 e	45.00 e	61.33 d
CV	**4.47**	**3.95**	**3.92**	**3.65**
LSD (0.05)	**4.74**	**4.57**	**4.67**	**5.09**

[In a column, the lettering indicates the statistical difference between the treatments at 5% level of significance; where LSD= Least Significant Difference, CV= coefficient of variation]

3.4 Effect of chemical insecticides in combination with suitable wetting agents on adult mango mealybug in laboratory

The mortality percentage of adult mango mealy bugs at different hours of treatment interval is shown in Table 4. The results reveal highly significant differences among treatments. From Table 4, it is evident that the mortality rate is drastically reduced compared to nymphal mortality. This is due to the development of a waxy layer on their body surface. After 48 hrs, the highest number of adult mealybugs was controlled by T_5 treatment, which was recorded as 72.00, followed by T_2 with 64.00. But these were statistically different. the treatment T_5 controlled 15.12 adult mealybugs after 12 hours, but it gave a tremendous result after 72 hrs of this combination application. The lowest adult mealybug was controlled by T_6 with only 33.00, that was statistically different from the best treatment T_5. After 24 hours and 36

hours of dose application, all the treatments resulted in significantly lower numbers of adult mealybugs with a slide increase compared to 12 hrs of insecticidal application. Karar *et al.* (2009) and Abbas *et al. (*2009) documented that supracide was the most effective insecticide for the control of adults. Syed *et al*. (2012) found that triazophos proved to be an effective insecticide for the control of the adult by showing 64.0 and 100% mortality in the leaf dip method and foliar application. He also found that profenofos, methomyl and triazophos application provided effective control of the mango mealybug.

Table 4. Mortality rate of adult mealybug at different hours of insecticide application at different combinations

Mortality rate of adult mealybug (%)				
Treatments	**12h**	**24h**	**36h**	**48h**
T_1 (Nitro 505 EC + Petroleum oil)	17.00 b	18.33 d	42.5 a	55.33 c
T_2 (Nitro 505 EC + Ethyl alcohol)	17.5 b	22.4 ab	24.83 c	64.00 b
T_3 (Nitro 505 EC + Detergent)	10.16 e	15.33 e	19.83 d	43.67 e
T_4 (Capture 75 WG + Petroleum oil)	12.17 d	18.33 d	23.07 c	59.67 bc
T_5 (Capture 75 WG + Ethyl alcohol)	15.17 c	21.00 c	24.4 c	72.00 a
T_6 (Capture 75 WG + Detergent)	9.47 e	15.33 e	18.43 d	33.00 f
T_7 (Imitaf 20 SL + Petroleum oil)	13.4 d	21.23 bc	39.00 b	49.67 d
T_8 (Imitaf 20 SL + Ethyl alcohol)	19.17 a	23.33 a	23.67 c	60.00 bc
T_9 (Imitaf 20 SL + Detergent)	12.16 d	17.3 d	19.73 d	39.67 e
CV	**5.66**	**4.22**	**4.89**	**5.65**
LSD (0.05)	**1.36**	**1.38**	**2.19**	**5.13**

[In a column, the lettering indicates the statistical difference between the treatments at 5% level of significance; where LSD= Least Significant Difference, CV= coefficient of variation]

3.5 Nymphal mortality after different hours of treatment application

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From Figure 1, it is clear that treatment T_8 experienced the best result in terms of nymphal instar control. This figure also tells us that the nymphal mortality rate has gone through a fluctuation after different hrs of treatment application. The treatments were considered good in terms of control, although it took time.

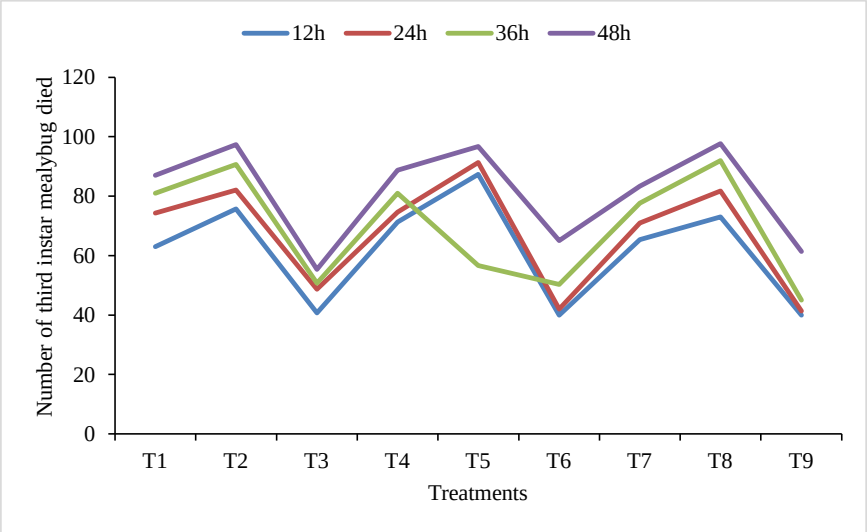

Figure 1. Number of dead third instar nymphs at different hrs of insecticide application

[T_1 = Nitro 505 EC + Petroleum oil, T_2 = Nitro 505 EC + Ethyl alcohol, T_3 = Nitro 505 EC + Detergent, T_4 = Capture 75 WG + Petroleum oil, T_5 = Capture 75 WG + Ethyl alcohol, T_6 = Capture 75 WG + Detergent, T_7 = Imitaf 20 SL + Petroleum oil, T_8 = Imitaf 20 SL + Ethyl alcohol, T_9 = Imitaf 20 SL + Detergent]

3.6 Adult mortality after different hours of treatment application

Figure 2 illustrates a significant reduction in mortality rates compared to nymphal mortality. Within 48 hours, treatment T_5 showed the highest control of adult mealybugs, recording 72.00 individuals, followed by T_2 with 64.00, although these were statistically different. Treatment T_5 notably controlled 15.12 adult mealybugs after 12 hours, with even more impressive results after 72 hours of application. Conversely, the lowest control of adult mealybugs was achieved by T_6, with only 33.00 individuals, which was statistically different from the most effective treatment, T_5. Furthermore, after 24 and 36 hours of dose application, all treatments resulted in significantly lower numbers of adult mealybugs, showing a slight increase compared to the 12-hour insecticidal application.

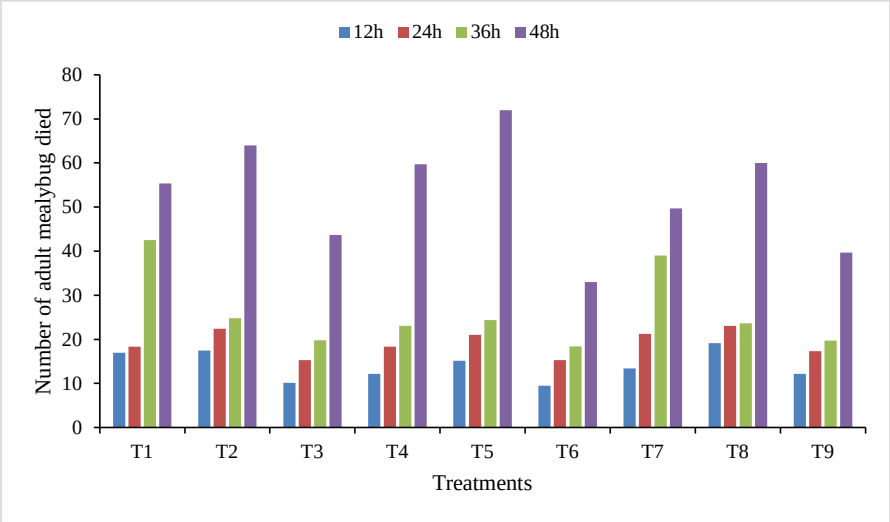

Fig. 2. Number of dead adult mealybug at different hrs of insecticide application

[T_1 = Nitro 505 EC + Petroleum oil, T_2 = Nitro 505 EC + Ethyl alcohol, T_3 = Nitro 505 EC + Detergent, T_4 = Capture 75 WG + Petroleum oil, T_5 = Capture 75 WG + Ethyl alcohol, T_6 = Capture 75 WG + Detergent, T_7 = Imitaf 20 SL + Petroleum oil, T_8 = Imitaf 20 SL + Ethyl alcohol, T_9 = Imitaf 20 SL + Detergent]

4. CONCLUSION

In laboratory experiment, different spray was given in the 1st, 2nd, and 3rd instars of nymphs and adults of mango mealybugs. In 1st instars of the nymph, data were taken after 12,24,36 and 48 hours interval respectively. The highest mortality of 1st instar nymph of mango mealybugs was observed in imitaf 20 SL + ethyl alcohol with 97.33%. In 2nd instar nymph, the highest mortality was observed in nitro 505 EC + ethyl alcohol (96.67%). In 3rd instars of nymph, the highest mortality percentage (91.00) of 3rd instar nymphs after 24 hours of spray of mango mealybugs was observed in the capture 75 WG + ethyl alcohol. The highest mortality percentage (94.00) of 3rd instar nymphs after 36 hours of spray of mango mealybugs was observed in capture 75 WG + ethyl alcohol, but the highest mortality percentage (97.67) of 3rd instar nymph after 48 hours of spray of mango mealybugs was observed in imitaf 20 SL + ethyl alcohol. The highest mortality percentage (72.00) of adult mealybug was observed in capture 75 WG + ethyl alcohol.

From the above results, it could be concluded that the 1st instar nymph was more vulnerable to insecticides with ethyl alcohol and less effective against adult mealybug. The order of susceptibility of the different stages of the mealybug was 1st instar nymph> 2nd instar nymph> 3rd instar nymph> adult. Imitaf

20 SL + ethyl alcohol was the most effective against 1st instar nymph, nitro 505 EC + ethyl alcohol was the most effective against 2nd instar nymph and in 3rd instar nymph, maximum mortality was found in capture 75 WG + ethyl alcohol and this were also the most effective chemical insecticides in combination with suitable wetting agents against adult.

5. REFERENCES

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