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# *Mealybug management in elephant foot yam corms during storage*

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## Abstract

In India, mealybug (*Rhizoecus amorphophalli* Betrem) is big menace during storage of elephant foot yam corms and threatening elephant foot yam cultivation. A storage study was conducted to find out the effects of various treatments on mealybug infestation on elephant foot yam corms during 2022 and 2023 at the Regional Centre of ICAR-Central Tuber Crops Research Institute, Bhubaneswar, Odisha under AICRPTC. The treatment consists of : Imidacloprid 17.8 SL (0.6 ml $l^{-1}$) ($T_1$), Thiamethoxam 25 WG (0.6 g $l^{-1}$) ($T_2$), Salt (NaCl) solution @ 1000 ppm ($T_3$), Neem oil:soap mixture @ (10:4) ml $l^{-1}$ followed by Neem oil @ 15 ml $L^{-1}$ after one week ($T_4$), 1:1 combination of neem oil:soap mixture @ (10:4) ml $l^{-1}$: Imidacloprid 17.8 SL (0.6 ml $l^{-1}$) ($T_5$), Cowdung slurry (2 kg $l^{-1}$) ($T_6$) and Control ($T_7$). The experiment was conducted in a randomized block design with three replications. During the year 2022, mealybug field infested corms were used for the study, whereas, during the year 2023, mealybug field infestation was not found, hence, uninfested corms were used. The results revealed that during the year 2022 at 3 months after storage, the treatment cowdung slurry ($T_6$) was found very effective in minimizing the mealybug numbers on the corms followed by the application of 1:1 combination of neem oil : soap mixture @ (10:4) ml $l^{-1}$: Imidacloprid 17.8 SL (0.6 ml $l^{-1}$) ($T_5$). Maximum number of mealybug was found in the corms of control treatment ($T_7$). During the year 2023, no mealybug infestation was found in any of the treatments up to 2 months storage. However, at 3 months ofter storage, mealybug infestation was noticed in control ($T_7$) and application of salt (NaCl) solution @ 1000 ppm ($T_3$) treatments. Sprouting percentage 3 months after storage revealed that during the year 2022, the highest sprouting (96%) was noticed in cowdung slurry ($T_6$) treatment followed by the application of 1:1 combination of neem oil : soap mixture @ (10:4) ml $l^{-1}$: Imidacloprid 17.8 SL (0.6 ml $l^{-1}$) ($T_5$) (92%). In control treatment ($T_7$) only 10% sprouting was observed. During the year 2023, 100% sprouting was registered in all the treatments. Thus, mealybugs appearance and infestation are depending upon the prevailing climate and its damaging effect is depends on duration of the infestation.

**Keywords:** Cowdung slurry, Elephant foot yam, Mealybug, Sprouting

## Introduction

Elephant foot yam (*Amorphophallus paeoniifolius* (Dennst.) Nicolson) is an important tropical tuber crop in India. It is grown in Andhra Pradesh, Bihar, Chattishgarh, Gujarat, Karnataka, Kerala, Maharastra, Odisha, Uttar Pradesh, Tamil Nadu West Bengal and Northeastern states (Nedunchezhiyan and Byju, 2005). Its modified stem 'corm' is consumed as vegetable after boiling, baking and frying. Pickle, a delicacy, is also prepared

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from elephant foot yam corm (Nedunchezhiyan and Misra, 2008). Corms are rich in minerals and vitamins (Nedunchezhiyan et al., 2008). Corms are also used to prepare many indigenous medicines for piles, asthma, dysentery and other abdominal disorders. It is a 'food medicine'. Usually, the plant produces single corm with few cormels. Both corm and cormels are used as planting material. The variety 'Gajendra' which is very popular in India has low calcium oxalate content (Nedunchezhiyan and Misra, 2008) and does not produce any cormels. However, small size one or two cormels per plant in 'Gajendra' variety are reported when grown in clay rich heavy soils (Sankaran et al., 2008). After harvest of the corm, farmers keep uniform 400-500 g weight corms for seed purpose for subsequent planting season.

In India, mealybug (*Rhizoecus amorphophalli* Betrem) is big menace during storage of elephant foot yam corms and threatening elephant foot yam cultivation (Nedunchezhiyan et al., 2011). Mealybugs declared as economically important insect pests world-wide (Baliadi et al., 2023). These pests are polyphagous, may attack many crops that cause the host growth and the tuber storage problems (Baliadi et al., 2023). Williams (1985) reported the presence of this mealybug in some root crops in India. It is a very noxious insect, and the soft body of this insect can easily be identified by the presence of white powder waxy substances all over its body. They are seen in cluster on the stem, petiole and leaf, particularly on ventral side; infestation is very high during warm and dry period. It infests on the corms both in the field as well as in storage (Misra et al., 2005). The field infestation ranged from 6 to 45% (Palaniswami and Peter, 2008). Usually, elephant foot yam seed crop is harvested during dry season after attaining full matutity. During this period, through soil cracks and holes formed after pseudostem drying, it enters into corms and infests. The infestation became severe when the corms are left for longer period in the soil during the dry season. Mealybug is a warm and humid condition loving pest. When the temperature is more than 30°C, its infestation is severe and increases with rising temperature and humidity. During storage the temperature and humidity are high; it infests entire lot of corms. The crawler and adults suck and de-sap the cell content of corms (Palaniswami, 1999). They cover the corm surface along with dirty white powdery mealy substances. Severely infested corms shrivel; adversely affecting the quality and marketability of the corms. It is also directly affecting the sprouting and indirectly both production and productivity.

Several attempts have been made to control mealybug. Rubbing of infested corms with dry cloth and washing the corms with water forcefully are some of the management practices which are recommended (Misra et al., 2003; Ray, 2015). However, re-infestation after some time is very common in the above techniques. Misra et al., (2002) reported that dipping of elephant foot yam corms in monocrotophos (35% WP) 0.05% solution for 10 min was found effective in controlling the mealybugs. But it is not advised to use insecticides on vegetables. Indian farmers traditionally use cow dung, red earth, copper sulphate and salt to treat seeds/tubers either to prevent pests and diseases or to improve germination. Cow dung slurry was used for tuber treatment, when cut tubers of yam and elephant foot yam are used as seed material as because it arrests evaporation and prevents pests and diseases (Misra et al., 2003; Nedunchezhiyan, 2008; ICAR-CTCRI, 2021). Pigeonpea seeds are treated with red earth, clay and fly ash to prevent storage pests (Singal and Chauhan, 1997).

As the mealybug problem reached alarming level in various parts of India, the present investigation was carried out under All India Cooperative Research Project on Tuber Crops (AICRPTC) to develop eco-friendly and sustainable technology for managing mealybug.

## Materials and Methods

A storage study was conducted to find out the effects of chemicals and organic methods of management of mealybug infestation on elephant foot yam corms during 2022 and 2023 at the Regional Centre of ICAR-Central Tuber Crops Research Institute, Bhubaneswar, Odisha under AICRPTC. The treatment consists of : Imidacloprid 17.8 SL (0.6 ml $l^{-1}$) ($T_1$), Thiamethoxam 25 WG (0.6 g $l^{-1}$) ($T_2$), Salt (NaCl) solution @ 1000 ppm ($T_3$), Neem oil:soap mixture @ (10:4) ml $l^{-1}$ followed by Neem oil @ 15 ml $l^{-1}$ after one week ($T_4$), 1:1 combination of neem oil:soap mixture @ (10:4) ml $l^{-1}$: Imidacloprid 17.8 SL (0.6 ml $l^{-1}$) ($T_5$), Cowdung slurry (2 kg $l^{-1}$) ($T_6$) and Control ($T_7$). The experiment was conducted in a randomized block design with three replications. Each treatment comprised 24 corms of relatively uniform size and 450-550 g fresh weight. The treatments were imposed immediately after harvest of the corms. Each treatment was kept in 1 m x 1m cubical raised to 60 cm height with 25 mm thickness ply in the storage shed. The treatments were kept 5 m away from each other in a well-ventilated storage shed. The corms were spread in single layer.

From each treatment 3 corms were randomly selected for counting the number of mealybugs present in each corm and averaged it. Number of mealybugs infested on each corm was counted before imposing treatment, 1 and 3 days after treatment (DAT), and 1, 2 and 3 months after treatment (MAT). The sprouting percentage was calculated at the end of 3 months storage. The data collected were subjected to analysis of variance (ANOVA) in randomized block design using statistical software SAS (SAS 2010). Treatment means were compared for significance at the 0.05 level of probability using the critical differences (CD) as suggested by (Gomez and Gomez, 1984).

## Redults and Discussion

During the year 2022, mealybug field infested corms were used for the study, whereas, during the year 2023, mealybug field infestation was not found, hence, uninfested corms were used. During the year 2022, the pre-treatment counting revealed that the number of mealybugs per corm was ranged from 4.7 to 5.3 (Table 1). The population of mealybug has camedown at 1 and 3 DAT in all the treatments except control ($T_7$) (Table 1). No mealybug was noticed in the treatment cowdung slurry (2 kg $l^{-1}$) ($T_6$) at 1 and 3 DAT. Might haven't seen since the slurry masks the surface. However, mealybug population was found continuously increased in the treatment control ($T_7$) at 1 and 3 DAT (Table 1) (Fig. 1). During the year 2023, no mealybug infestation was found before treatment and 1 and 3 DAT (Table 1).

Table 1. Effect of corm treatment on number of mealybugs present on the corms before and after treatment

| Treatment | Year 2022 | | | Year 2023 | | |
|---|---|---|---|---|---|---|
| | Pre-treatment | 1 DAT | 3 DAT | Pre-treatment | 1 DAT | 3 DAT |
| $T_1$ | 2.35* | 2.35 | 1.95 | 0 | 0 | 0 |
| | (5.0) | (5.0) | (3.3) | | | |
| $T_2$ | 2.28 | 2.28 | 2.05 | 0 | 0 | 0 |
| | (4.7) | (4.7) | (3.7) | | | |
| $T_3$ | 2.28 | 2.28 | 2.12 | 0 | 0 | 0 |
| | (4.7) | (4.7) | (4.0) | | | |
| $T_4$ | 2.35 | 2.35 | 2.12 | 0 | 0 | 0 |
| | (5.0) | (5.0) | (4.0) | | | |
| $T_5$ | 2.28 | 2.28 | 2.05 | 0 | 0 | 0 |
| | (4.7) | (4.7) | (3.7) | | | |
| $T_6$ | 2.28 | 0.71 | 0.71 | 0 | 0 | 0 |
| | (4.7) | (0) | (0) | | | |
| $T_7$ | 2.41 | 2.55 | 2.74 | 0 | 0 | 0 |
| | (5.3) | (6.0) | (7.0) | | | |
| CD (*P*=0.05) | 0.13 | 0.15 | 0.19 | - | - | - |

*X+0.5 square root transformed values
Values in the brackets are original values
DAT- Days after treatment
Treatment details are given in the materials and methods

Fig. 1. Mealybug infestation during storage of elephant foot yam corms

The mealybug population was found increased subsequently with increasing storage period (Table 2). During the year 2022, the treatment control ($T_7$) registered higher mealybug population at 1, 2 and 3 MAT in storage (Table 2). No mealybug infestation was found in the treatment cowdung slurry (2 kg $l^{-1}$) ($T_6$) at 1 MAT in storage. However, 2 MAT the infestation started and progressed slowly up to 3 MAT. The population was significantly very less at 3 MAT in the treatment cowdung slurry (2 kg $l^{-1}$) ($T_6$) (Table 2) (Fig. 2). The same result was reported earlier (Nedunchezhiyan *et al*., 2011). The treatment application of 1:1 combination of neem oil : soap mixture @ (10:4) ml $l^{-1}$: Imidacloprid 17.8 SL (0.6 ml $l^{-1}$) ($T_5$) was the next best with low infestation of mealybug at 1, 2 and 3 MAT (Table 2). Application of *Trichoderma* enriched cowdung could keep mealybug incidence to less than 8%, whereas combined application of fungicide (mangozeb + carbendazim) 0.2% and nanma 0.7% could keep mealybug incidence below 5% (ICAR-CTCRI, 2021). During the year 2023, no mealybug infestation was found in any of the treatments up to 2 months storage. At 3 months after storage, mealybug infestation was found only in control ($T_7$) and application of salt (NaCl) solution @ 1000 ppm ($T_3$) treatments (Table 2). Nedunchezhiyan et al., (2011) reported that salt treatment was effective for short period storage of elephant foot yam corms.

Table 2. Effect of corm treatment on number of mealybugs present on the corms at 1, 2 and 3 MAT

| Treatment | Year 2022 | | | Year 2023 | | |
|---|---|---|---|---|---|---|
| | 1 MAT | 2 MAT | 3 MAT | 1 MAT | 2 MAT | 3 MAT |
| $T_1$ | 2.35* | 3.58 | 4.53 | 0 | 0 | 0.71 |
| | (5.0) | (12.3) | (20.0) | | | (0) |
| $T_2$ | 2.28 | 3.90 | 4.77 | 0 | 0 | 0.71 |
| | (4.7) | (14.7) | (22.3) | | | (0) |
| $T_3$ | 3.71 | 4.74 | 5.24 | 0 | 0 | 1.87 |
| | (13.3) | (22.0) | (27.0) | | | (3.0) |
| $T_4$ | 3.24 | 3.58 | 4.06 | 0 | 0 | 0.71 |
| | (10.0) | (12.3) | (16.0) | | | (0) |
| $T_5$ | 2.79 | 3.02 | 3.24 | 0 | 0 | 0.71 |
| | (7.3) | (8.6) | (10.0) | | | (0) |
| $T_6$ | 0.71 | 1.79 | 2.07 | 0 | 0 | 0.71 |
| | (0) | (2.7) | (4.3) | | | (0) |
| $T_7$ | 5.27 | 6.31 | 6.89 | 0 | 0 | 2.79 |
| | (27.3) | (39.3) | (47.0) | | | (7.3) |
| CD (*P*=0.05) | 0.28 | 0.32 | 0.35 | - | - | 0.09 |

*X+0.5 square root transformed values
Values in the brackets are original values
MAT- Months after treatment
Treatment details are given in the materials and methods

Sprouting percentage 3 MAT - Months after treatment in storage revealed that in treatment control ($T_7$), 10% sprouting only observed during the year 2022 (Table 3). Baliadi et al., (2023) reported that mealybug infested

Fig. 2. Cowdung treated elephant foot yam corms

tubers, 90% of infested tubers unable to sprout and grow. The sprouting percentage in cowdung slurry (2 kg $l^{-1}$) ($T_6$) treated corms was highest (96%) (Fig. 2) followed by application of 1:1 combination of neem oil : soap mixture @ (10:4) ml $l^{-1}$: Imidacloprid 17.8 SL (0.6 ml $l^{-1}$) ($T_5$) (92%). Nedunchezhiyan et al., (2011) also reported that the cowdung slurry treated corms registered highest percentage sprouting after a long period of storage. During the year 2023, 100% sprouting was registered in all the treatments (Table 3). This is because the infestation of mealybug was nil to very low.

Table 3. Effect of corm treatment on sprouting percentage of corms (3 MAT)

| Treatment* | Sprouting (%) | |
|---|---|---|
| | 2022 | 2023 |
| $T_1$ | 65 | 100 |
| $T_2$ | 72 | 100 |
| $T_3$ | 53 | 100 |
| $T_4$ | 75 | 100 |
| $T_5$ | 92 | 100 |
| $T_6$ | 96 | 100 |
| $T_7$ | 10 | 100 |
| CD ($P$=0.05) | 6 | - |

*Treatment details are given in the materials and methods

## Conclusion

Mealybug appearance and infestation are depending upon the prevailing climate and its damaging effect is depends on duration of the infestation. The cowdung slurry (2 kg $l^{-1}$) treatment is very effective against mealybug and it is organic too. If cowdung is not available for large scale seed corm treatment then one can opt for chemical seed corm treatment of application of 1:1 combination of neem oil : soap mixture @ (10:4) ml $l^{-1}$: Imidacloprid 17.8 SL (0.6 ml $l^{-1}$) before storage.

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