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# Management of Oil Palm Bunch Failure in High Sex Ratio Palms

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*Bunch failure due to insufficient pollen is a serious problem in all the oil palm growing countries. It is observed that the main problem is due to lack of pollinating weevils as a result of inadequate male flowers in the plantations. The establishment of pollinating weevils in high sex ratio palms is a critical requirement for oil palm productivity.*

*Bunch failure due to lack of pollination in high sex ratio palms was found to cause more than 90 per cent yield loss. The problem was severe, particularly, in isolated young oil palm plantations. Presence of limited number of male flowers led to fewer pollinating weevils even after inundating releases leading to poor yield. Intercropping with crops like banana and sugarcane which require great amount of water encouraged the emergence of more female than male flowers. Assisted pollination by sprinkling pollen grains on female inflorescences proved effective to a certain extent. Various treatments like severe pruning of fronds and application of gibberellic acid in high doses proved effective in mitigating the problem. These allowed natural pollination with the emergence of more male flowers and establishment of pollinating weevils.*

***Keywords****: Bunch failure, thrips, pollinating weevils, inundating releases, gibberellic acid.*

Oil palm, *Elaeis guineensis* Jacq. is a monoecious crop where both male and female inflorescences emerge on a single palm but at different times. Hence, the female flowers require pollen grains from other palms in the vicinity (Corley, 1976). Pollination occurs by means of wind and insects and among the insects, thrips and curculionid weevils are predominant. Of the various weevils of the Curculionidae family, *Elaeidobius kamerunicus* (*Figure 1*) is found to be most effective with high searching ability compared to other species of the same genus. The weevil population often fluctuates over different months with low numbers during summer months i.e. May to July and high during December to February as the latter months are ideal for its development. High temperatures coupled with low humidity could be the reason for poor population of the weevil during summer months leading to poor fruit set. In India there have been concerns regarding periodic occurrence of poor


*Figure 1 Pollinating weevil,* Elaeidobius kamerunicus *on male inflorescence*

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pollination that leads to bunch failure (*Figure 2*) and thereby resulting in yield losses in certain locations. The prime reason for this problem seems to be inadequate weevil population due to lack of male inflorescence. Although satisfactory levels of fruit set are being achieved in states like Andhra Pradesh, Tamil

*Figure 2 Bunch failure due to paucity of pollination*

Nadu and Kerala states, poor fruit set and insufficient pollination problems are reported in many states particularly from North Eastern parts of India. It is observed that immature palms are more prone to bunch failure problems during summer months compared to mature palms. However, it was observed that the weevils replenish quickly and develop on young palms with the onset of the monsoon. Although adult weevils are found up to 20 days of emergence of male inflorescences, peak activity is noticed during 3-5 days of anthesis. Existence of high humidity and low temperatures in the irrigated oil palm plantations may lead to enhanced pest problems resulting in usage of chemical control measures. This ultimately causes negative impact on the growth and development of weevil populations. All the pesticides (both insecticides and fungicides) are found to be detrimental to weevil activity as they cause mortality within one hour after application. Presence of spider webs on and above the inflorescences is also one of the reasons for poor pollination in summer months as each web traps more than fifty adults on an average. Variation in percent fruit set is observed with low fruit set in July-September compared to April-June. Sterile fruit production (%) is linked with pollination which was highest in summer anthesised flowers followed by those in rainy season and the least is observed during March-April pollinated flowers (15%) (Anon, 2014).

Adverse weather conditions like high rainfall and very hot and dry weather have significant effect on the population and aggressiveness of the pollinating weevil, *Elaeidobius kamerunicus* (Prasetyo *et al*., 2014; Syed, 1982; Dhileepan, 1992 & 1994). Sugih *et al.* (1996) reported that *E. kamerunicus* activity was practically absent during very low rainfall period in Riau, Sumatra. Basri *et al.* (1987) opined that male inflorescences had a great influence on weevil population, as it is correlated with the occurrence of anthesis.

In India, inundating release of weevils into newly cultivated oil palm areas is a regular practice to make them settle on the male inflorescences. However, in recent years high sex ratio palms have been facing the problem of bunch failure due to lack of pollen grains, which needs to be rectified. Since these palms produce more female inflorescences, it leads to low or no male flowers resulting in scarcity of pollen grains. Lack of male flowers leads to poor survival of pollinating weevils as the latter live and feed on spent male flowers only. This ultimately leads to bunch failure and bunch abortion affecting the yield levels. This problem is mostly observed during the immature period. To overcome this issue the present study was carried out using growth

regulators and other physical and cultural practices to enhance the fruit setting and solve the sex ratio difficulty.

## MATERIALS AND METHODS

Investigations were carried out in the problematic areas of Mandya and Mysore districts of Karnataka state of India during 1997-2019. Observations on the identification of the problem, likely causes of the problem, remedial measures taken and results obtained in the problematic plantations are mentioned in detail.

### Investigation I

***Mandya district, Karnataka state***

In this district bunch failure was observed in some of the oil palm plantations located in the Cauvery river basin villages. Paddy and sugarcane are the traditional crops in these areas using river water for irrigation. The present experimental plantation is located in Chandagalu village (12.539101, 76.830110) just adjacent to paddy and sugarcane fields whose seepage water run to the oil palm plantation. Drainage channels are made to drain the excess water. As the water is plenty and the said crops are continuously grown in the river belt, the soil in the oil palm plantation is found to be always wet which leads to initiation of female flowers only. Due to lack of male flowers, bunch failure was observed to be more than 90 per cent. Although assisted pollination (*Figure 3*) was carried out by collecting the pollen grains from other plantations, it is not a feasible method and a permanent solution although it helped to obtain nearly 70 per cent success (*Figure 4*). Due to lack of male flowers, the weevils did not survive and hence it was required to release more weevils or

*Figure 3 Assisted pollination on female flowers*

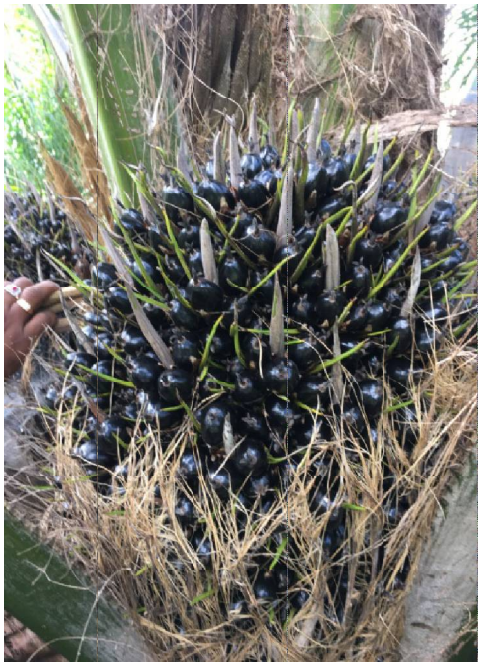

*Figure 4 FFBs development due to assisted pollination*

practice assisted pollination every time for every female inflorescence. The palms had good girth with more than fifty leaves on each palm. Every palm had nearly twenty to twenty-five aborted female inflorescences. Very few

palms had one or two developing fresh fruit bunches (FFB). Since the plantation is an isolated one, far away from the other oil palm plantations, no movements of pollinating weevils were noticed. Even though the plant growth was good, due to paucity of pollen, continuous bunch failure was observed.

***Technological intervention***

The farmer was asked to prune the roots of a few palms in the existing plantation and also to raise six to seven young palms of 2-3 years old or more in big cement pots (without any contact with the ground soil of the plantation) with only life saving irrigation (i.e. minimum water for the survival of the palms so as to get only male flowers). This technique worked well with the emergence of male flowers followed by establishment of pollinating weevils. This was because of the artificial stress created. Thus bunch failure problem stopped within a period of 2 years of the investigation. Natural pollination was observed due to the male flower initiation and establishment of pollinating weevils. This became a successful technology for implementation in the problematic plantings during 1998 to 2010.

**Investigation II**

***Mysore district, Karnataka state***

This investigation was conducted from 2016-19 in one of the isolated plantations of Kolagala village (12.106064, 76.408447), HD Kote Taluk of Mysore district where bunch failure (*Figures 5 & 6*) was a serious problem. Here the problem identified was high sex ratio planting material. Very low number of male inflorescences emerged from these palms which ultimately led to lack of pollinating weevils and thereby bunch failure. Sugarcane and banana were cultivated as intercrops by providing flood irrigation. Since banana needs

*Figure 5 Bunch failure in high sex ratio palms*

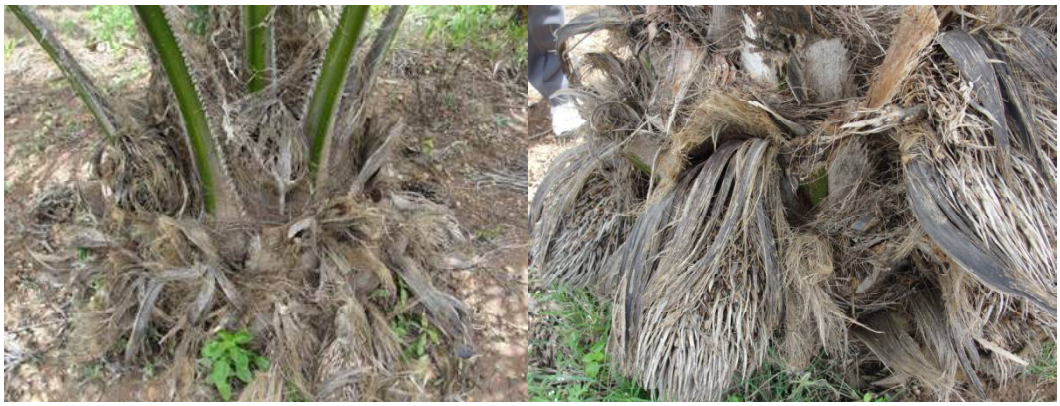

*Figure 6 Bunch failure in juvenile oil palm plants*

regular watering, the oil palm also benefitted from it by producing mainly female inflorescences. Male inflorescences were visible on few palms that were on the raised bunds in the plot with sugarcane. This could be due to reduced irrigation water on the raised bund planting. Partial activity of pollinating weevils was observed on the male inflorescence. However male flower emergence was not a continuous occurrence and the pollinating weevils were not establishing in the plantation. Even where male inflorescences were found, the problem was that pollination was not observed. Except for planting materials, other aspects like soil, water and inter cultivation practices were found to be good and did not have any adverse effect on the growth and emergence of male inflorescences.

***Technological interventions***

The following technologies were implemented to rectify the problem:

i. Recommended to implement already proven technology i.e. stopping irrigation and giving only adequate irrigation,
ii. Raised aged oil palm plants (5%) in big cement pots with life saving irrigation and keeping them at different places in the plantation so as to raise only male inflorescence,
iii. After ascertaining continuous emergence of male inflorescences, inundating releases of pollinating weevils were carried out for their establishment,
iv. Flood irrigation to the plot (sugarcane intercropped) where male flowers could be seen, was stopped so that male inflorescences could be further produced,
v. Heavy pruning of leaves (*Figure 7*) in one palm in each row (5%), keeping only the spindle and one whorl of leaves below the spindle,
vi. Application of gibberellic acid (0.001%) at high concentrations of 1 ppm (100 ml in 10 litres of water) on two palms in each row of palms (7%) as it enhances male flower initiation at high concentrations. This was recommended to be carried out at fortnightly intervals for 2 months continuously, and
vii. Carried out assisted pollination to make the existing female flowers into good pollinated bunches by collecting the pollen from nearby plantations.

*Figure 7 Heavy pruning of leaves (defoliation)*

## RESULTS AND DISCUSSIONS

Assisted pollination that was carried out for one year by collecting pollen from nearby plantations yielded 70 per cent results but complete pollination of bunches was not

observed (*Figure 8*). However, it was found to be a better treatment in the present condition as there were no male flowers and no pollinating weevils and there was no possibility of getting the pollinating weevils from other plantations due to the isolated location of the plantation. Though the weevils were rated as having good searching ability of nearly 10 km as observed earlier (Babu, 1997 - pers. comm.) in the same taluk (a revenue divisional area used for administrative purpose), due to lack of male flowers, this did not happen. The mimicking effect from female inflorescences did not prove to be effective in attracting weevil population.

*Figure 8 Formation of fertilised FFBs due to assisted pollination*

Gibberellic acid (0.001%) was applied at 1 ppm on twenty-five palms out of 350 present in the plot continuously for four times at fortnightly intervals. The last dose was given during the last fortnight of September, 2017. Male inflorescences were visible at 7 to 8 months after the last application i.e. during April - May, 2018. On average fourteen to fifteen male inflorescences (*Figure 9*) were recorded on the treated palms per year. This treatment proved effective in producing more male inflorescences compared to the other treatments like root and leaf pruning and palms in pots. Similar results were also observed by Ajambang *et al*. (2015) with the production of more male inflorescences within a period of one year after the implementation of treatments.

In general, the floral sex initiation in oil palm takes 20-24 months before harvest. In the present scenario, application of gibberellic acid hastened the evocation of male inflorescences in the treated palms by nine months only. The effect of gibberellic acid in

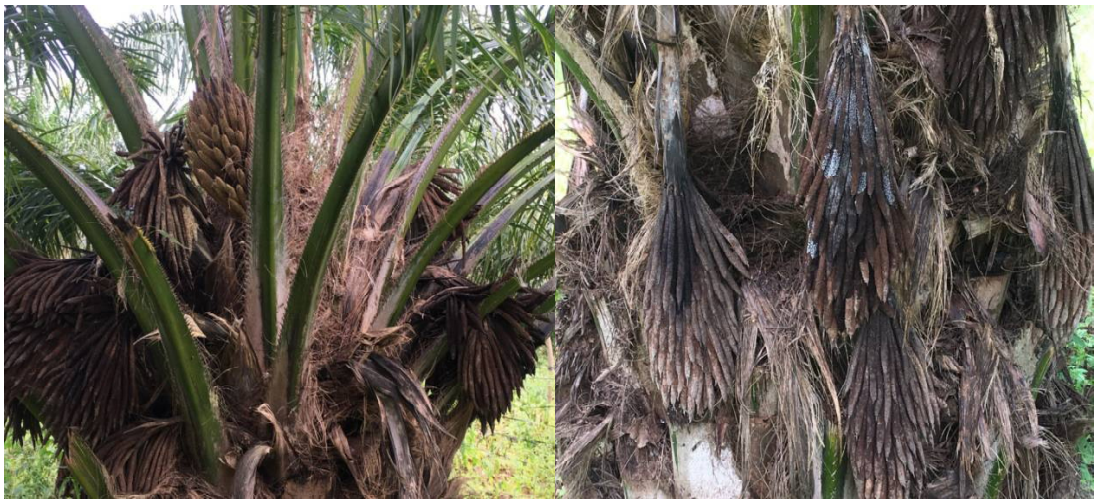

*Figure 9 Heavy emergence of male inflorescences in gibberellic acid treated palms*

oil palm in this case could be mainly on the emergence of male inflorescences from axil of the frond which was earlier suppressed due to unknown factors and not on sex differentiation. This can be attributed to many reasons such as precocious initiation of male flowers or suppression of endogenous ethylene production (which normally increases female inflorescences). Molecular studies might give more leads to this study as gibberellic acid is known to trigger gene expression (like DELLA, etc.) for early evocation of male inflorescences in oil palm.

In the leaf pruned palms, male inflorescences were observed at one to two whorls per palm per year only. Inundating releases (4-5 times) of pollinating weevils by collecting the male inflorescences from other oil palm plantations were found to be successful with good establishment of the weevils in the plantation.

Altogether, the investigation that was carried out in this plantation proved effective and successful, showing good response in the form of emergence of male inflorescences, which were meagre or nil prior to starting the investigation; settlement of pollinating weevils in the emerged male inflorescences (*Figure 10*) and finally the increase in FFB yield (*Figure 11*). The series of events that occurred during the experimentation are given below:

- The plantation was established in August, 2012,
- In the present plantation, the FFB yield recorded during August 2015-July 2016 i.e. fourth year of planting (YoP) was 2.23 tonnes per hectare as against 3 tonnes of potential yield. The FFB yield during immature period of 4-8 years should have been 3, 6, 9, 12 and 15 tonnes per year respectively (Corley, 1976),

*Figure 10 Establishment of pollinating weevils on male inflorescences of gibberellic acid treated palm*

*Figure 11 Emergence of fertilised FFBs from the experimental field*

- During 2016-17 i.e. fifth year of planting, no increase in yield was observed. It was only 2.22 tonnes per hectare as against 6 tonnes of potential yield.
- During 2017-18 i.e. sixth year of planting, interventions including application of gibberellic acid and assisted pollination were implemented. This resulted in increase in the FFB yield to 6.41 tonnes. Though it was not upto the potential yield, it gave indications of the success of the inputs. The yield increase could be attributed to assisted pollination.

- During 2018-19 i.e. seventh year of planting, the yield levels increased in a progressive manner compared to the previous year with an FFB output of 9.45 tonnes as against 12 tonnes of potential yield. During this period, plenty of male flowers emerged on the gibberellic acid treated palms. Coupled with this, the release of pollinating weevils and their establishment in the plantation paved way for the transfer of pollen grains from male to female inflorescence. This could be the reason for the high FFB yield.
- The difference between actual productivity and potential yield could reflect the loss due to lack of pollination which in turn was due to inadequate male inflorescences. This was observed as 25.66 per cent, 63 per cent, 28.77 per cent and 21.25 per cent respectively during fourth to seventh year after planting. From the sixth year onwards, the losses reduced gradually which was due to the implementation of interventions for the male flower initiation and thereby the pollinating weevils.
- With the initiation of interventions, the yield increase was observed at 187.44 per cent and 323.76 per cent respectively during the sixth and seventh year after planting i.e. 1 and 2 years after the experimentation.
- It was observed that assisted pollination could result in 187.44 per cent benefit whereas the male inflorescence initiation and thereby settling of pollinating weevil increased the benefit to the extent of 323.76 per cent compared to base year of observation (*Table 1*).

## CONCLUSION

Pollination is a critical factor in oil palm cultivation. Since oil palm is an entomophilous crop, assistance of pollinating weevils is essential to carry the pollen grains from male to female inflorescences. Due to lack of male inflorescences in high sex ratio palms, pollination is becoming a serious problem leading to bunch failure and bunch abortion. Application of 1 ppm gibberellic acid (0.001%) over a few plants at fortnightly interval continuously for 2 months proved effective in initiating male flowers. This ultimately helped the establishment of pollinating weevils thereby enabling natural pollination resulting in

TABLE 1
IMPACT OF DIFFERENT TREATMENTS TO OVERCOME THE BUNCH FAILURE PROBLEM IN KARNATAKA

| | *2014-15* | *2015-16* | *2016-17* | *2017-18* | *2018-19* |
|---|---|---|---|---|---|
| Age of plantation (years) | 3 | 4 | 5 | 6 | 7 |
| Productivity (FFB/ha) | 0 | 2.232 | 2.221 | 6.412 | 9.452 |
| Potential yield (t/ha) | 0 | 3 | 6 | 9 | 12 |
| Loss due to lack of male flowers (%) | 0 | 25.66 | 63.00 | 28.77 | 21.25 |
| Benefit with the experiment (%) | 0 | 0 (zero) | 0 (zero) | 187.44 | 323.76 |

323.76 per cent increased yield. Assisted pollination till the emergence of male flowers and establishment of pollinating weevils in them proved to be a good method to increase the yield.

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If you really want to do something, you will find a way. If you don't, you will find an excuse.

*Anonymous*