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Management of invasive pest, rugose spiralling whitefly in oil palm and its economic impact

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Abstract
The KVK, Bhadradri Kothagudem conducted front line demonstration during 2019-20, 2020-21 and 2021-22 in KVK operational area of adopted villages on "Demonstration on Management of Rugose spiraling whitefly in Oil palm". Demonstrations were conducted in ten different farmers fields to assess the damage potential and its management strategies. Two treatments *viz.,* technology demonstration i.e Installation of yellow sticky traps. Starch powder @ 10 g/l to remove sooty mold. Azadirachtin 10000 PPM @ 1 ml/l + detergent powder @ 10 g/l two to three sprays at 20 days interval. Release of parasitoids, *Encarsia guadeloupae* and foliar application of *Isaria fumosorosea* @ 1x 10^8 (5 g/l) along with sticker 2 ml/l with intermittent water spray and check (farmers practice) *i.e.,* Spraying of acetamipride @ 0.2 g/l after noticing the infestation of white fly. Significantly higher income was recorded from the technology demonstrated plot over the three years compared to control plot. On an average, the benefit cost ratio was high in treatment *i.e.,* 2.90:1, 3.10:1 and 3.15:1 compared to control plot *i.e.,* 2.66: 1, 2.54:1 and 2.88:1 during 2019-20, 2020-21 and 2021-22 respectively.

Keywords: Oil palm, Rugose Spirallying whitefly, chemical control, economics, gross income, net returns

Introduction
Indian vegetable oil economy is world's fourth largest after USA, China and Brazil which includes oil palm. Oil palm (*Elaeis guineensis* Jacq.) is the only perennial and eco-friendly crop that gives highest oil yield among other edible oil crops giving regular and assured income to the farmers up to 30 yrs. Oil palm, being the cheapest among the edible oils, is widely consumed among the Indian households and contributes to 70% of total vegetable oil import (Department of Horticulture, 2020) [2]. Oil palm is native to West Africa and it is the crop of the present and future vegetable oil economy of the world as well as India (Kalidas *et al*., 2011) [3]. Oil palm accounts to 60% i.e. 8-9 million tons of the total imports worth of Rs. 40,000 crores. Recently, its productivity is getting reduced due to the incidence of pests and diseases. RSW is one among them. Rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin, an invasive whitefly species belonging to the family Aleyrodidae, originally called as gumbo limbo spiralling whitefly, was first reported in coconut (*Cocos nucifera* L.) during 2004 in Belize, Central America (Martin, 2004) [5]. In India, the dangerous invasive pest was reported for the first time on the same coconut crop at Pollachi, Tamil Nadu in India during August 2016 (Sundararaj and Selvaraj, 2017) [9]. Subsequently, the pest was reported to feed on many horticultural plants such as banana, sapota, mango, guava, custard apple, water apple (Selvaraj *et al*., 2017) [7]. The RSW was reported to feed on more than 30 host plants in India and about 120 plant species including several economically important horticultural and ornamental crops globally. It was a serious threat to several arecaceae plant species in Florida (Stocks and Hodges, 2012) [8].
Rugose spiraling whitefly (RSW) is a feeding pest that can cause serious infestation in oil palm. RSW nymphs and adults feed on the sap from the under surface of leaves and leaflets. Its feeding causes stress to the host plant by removing water and nutrients. They have a concentric waxy spiralling appearance and can also be found on other ornamentals such as cocoa, guava and papaya.

Production of honeydew, which covers the surface of leaves results in the growth of sooty mold, its presence on the upper surface of the leaf can potentially reduce photosynthesis of the plant.

Indiscriminate and unwise use of chemical insecticides can result in control failure, besides polluting the environment and upsetting the ecological balance. To minimize the harmful effects of chemical pesticides, integrated pest management involving various eco-friendly tactics and sensible use of pesticides is needed to reduce the losses caused by pests to tolerable levels. The districts Khammam, Bhadradri Kothagudem, Nalgonda and Suryapet grows oil palm. In Bhadradri Kothagudem district oil palm crop occupied nearly 63,000 acres accordingly, high incidence of RSW has been reported from this district. The farmers are unable to diagnose the pest and assess the damage potential caused by it. Hence the FLD was planned to demonstrate the damage potential caused by RSW in oil palm and its management strategies.

Materials and Methods

The present study was undertaken at ten different farmers' fields of Bhadradri Kothagudem district of Telangana with two treatments *viz.*, technology demonstration and check (farmers practice) (Table 1). The experiment was conducted consecutively for three years i.e. during *Kharif* seasons of 2019-20, 2020-21 and 2021-22. The experimental design, site and farmer selection, the layout of demonstration, farmer's participation, etc., were followed as suggested by Choudhary (1999) [1]. The crops were grown by following all the agronomic practices. The following observations were made during the crop period. Observations on RSW incidence made before the spray on palm infestation. Percentage of leaves infested/palm (no. of leaves infested by RSW /total leaf per palm) was done before and after the treatment. (Table 1).

The yield data were collected from both technologies demonstrated plot and farmers practiced plot. Yield parameters of both technology assessment plot and farmers practiced plot were recorded. Using the yield parameters extension gap, technology gap, yield gap, technology index was calculated as procedure suggested by Rajashekhar *et al*., (2022) [6], Samui *et al*., (2000) [11] and Lakshmi Narayanamma, 2023 [4]. To find out the economic impact of treatments effected due to RSW incidence and yield the benefit cost ratio was calculated.

Extension gap (Kg/ha) = Demonstrations yield –Yield under existing farmer's practice

Technology gap (Kg/ha) = Potential Yield – Demo Yield

Additional return = Demonstration return – farmer's practice return

$$\text{Yield gap (\%)} = \frac{\text{Extension gap}}{\text{Yield under farmers practice}} \times 100$$

$$\text{Technology gap (\%)} = \frac{\text{Technology gap}}{\text{Potential yield}} \times 100$$

$$\text{Technology index (\%)} = \frac{\text{Potential yield - Demonstration yield}}{\text{Potential yield}} \times 100$$

Results and Discussion

According to the current results and subsequent analysis of the data in all the three consecutive years, the infestation of RSW was lower in the technology demonstrated plot compared to farmers practice. The reason behind this is regular monitoring of the pest incidence and timely application of starch powder @ 10 g/l to remove sooty mold. Also included spraying of azadirachtin 10,000 PPM @ 1 ml/l + detergent powder @ 10 g/l and use of biological control agents like release of parasitoids, *Encarsia guadeloupae* and foliar application of *Isaria fumosorosea* along with sticker (2 ml/lit) with intermittent water spray, which further reduced the infestation up from 9.47 -11.44 percent in technology demonstrated plot compared to farmer practice (18.42 to 14.26) (Table 1, 2 and 3).

Table 1: Details of the treatment's technological intervention and farmer's practice

Technology intervention	Farmers practice	Gap
Installation of yellow sticky traps.	Not Followed	Full Gap
Starch powder @ 10 g/l to remove sooty mold. Azadirachtin 10000 PPM @ 1 ml/l + detergent powder @ 10 g/l two to three sprays at 20 days interval.	Not Followed	Full Gap
Release of parasitoids, *Encarsia guadeloupae* and Foliar application of *Isaria fumosorosea* @ 1x 10^8 (5 g/l) along with sticker (2 ml/lit) with intermittent water spray	Not Followed	Full Gap
Need based spray	Indiscriminate use of insecticides	Partial Gap

Table 2: Percent of RSW incidence at different locations of farmer's fields before treatment

		Percent RSW incidence/ locations										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
2019-20	Farmers Practice	23.2	25.2	19.1	32.2	25.3	24.7	26.1	21.2	23.3	22.1	24.24
	Demo	24.7	24.2	30.5	31.8	37.7	25.9	22.4	19.6	24.7	20.3	26.18
2020-21	Farmers Practice	21.1	13.3	23.2	24.5	25.6	21.7	14.7	16.8	17.2	22.9	20.10
	Demo	21.0	24.0	21.5	28.4	29.2	21.1	26.5	21.7	25.4	23.6	24.24
2021-22	Farmers Practice	21.7	25.6	21.0	21.7	14.9	14.0	13.0	17	15.4	16.0	18.03
	Demo	17.2	15.3	16.7	14.0	15.0	17.7	18.6	12.0	13.8	16.2	15.65

Table 3: Percent of RSW incidence at different locations of farmers' fields after treatment

		Percent RSW incidence/ locations										
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Mean**
2019-20	Farmers Practice	15.5	21.7	16.8	20.8	19.7	17.5	20.0	16.5	16.5	19.2	18.42
	Demo	12.2	10.7	12.6	11.5	12.7	14.1	12.5	10.3	9.4	8.4	11.44
2020-21	Farmers Practice	18.4	9.7	21.0	16.2	17.8	21.0	15.4	17.7	19.0	21.5	17.77
	Demo	15.1	9.8	8.0	9.9	8.9	10.0	12.0	13.6	12.7	7.1	10.71
2021-22	Farmers Practice	18.1	15.7	17	15.0	12.0	15.8	9.3	12.3	14.2	13.2	14.26
	Demo	8.9	10.2	11.2	12.3	9.2	8.5	7.5	7.2	10.2	9.5	9.47

The highest yield of 285.0, 305.0 and 325.0 (Q/ha) was recorded in the technology demonstrated plot, while lower yield of 269.4, 256.5 and 289.4 (Q/ha) was recorded in the farmers practice plots during 2019-20, 2020-21 and 2021-22, respectively. (Table 4).

The percent increase in yield in technology assessment plot when compared with the farmers practiced plot was 5.8, 18.9 and 15.6, respectively (Table 4). Subsequently, higher net returns were recorded in the technology demonstrated plots with Rs 1,67,900/-, Rs.1,72,800/- and Rs.1,88,500/ha and lower net returns of Rs.1,51,433/-, Rs.1,50,450/- and Rs. 1,62,064/-, respectively were recorded in the farmers practice plots during 2019-20, 2020-21 and 2021-22, respectively. On an average, the benefit cost ratio was high in treatment compared to control plot during three years of experimentation. The results clearly indicated that the technology provided was proved effective for the farmers, as it recorded the least incidence of RSW and reaped higher yields, accordingly, highest benefit cost ratio.

Table 4: Economic impact of experiment during 2019-20, 2020-21 and 2021-22

Year	**Yield (Q/ha)**		**% Increase in yield**	**Net returns Rs. /ha**		**B:C Ratio**	
	Demo	**Farmers Practice**		**Demo**	**Farmers Practice**	**Demo**	**Farmers Practice**
2019-20	285.0	269.4	5.8	1,67,900	1,51,433	2.90:1	2.66:1
2020-21	305.0	256.5	18.9	1,72,800	1,50,450	3.10:1	2.54:1
2021-22	325.0	289.4	15.6	1,88,500	1,62,064	3.15:1	2.88:1

Table 5: Grain yield and gap analysis

Year	**Yield gap (%)**	**Extension gap (Q/ha)**	**Technology gap (Q/ha)**	**Technology index (%)**	**Additional returns (Rs.)**
2019-20	5.8	15.6	65	18.57	16467
2020-21	18.9	48.5	45	14.75	22350
2021-22	15.6	35.6	25	7.14	26436

The results are in concurrence with that of previous publication where biological control of rugose spiralling whitefly, *Isaria fumosorosea* spraying with *Encarsia guadeloupae* proved effective in managing RSW and accepted by coconut farmers of north coastal districts of Andhra Pradesh (Visalakshi *et al*., 2021) [12] and in Mandya, Mysuru, East and West Godavari by Selvaraj *et al*., 2019 [10].

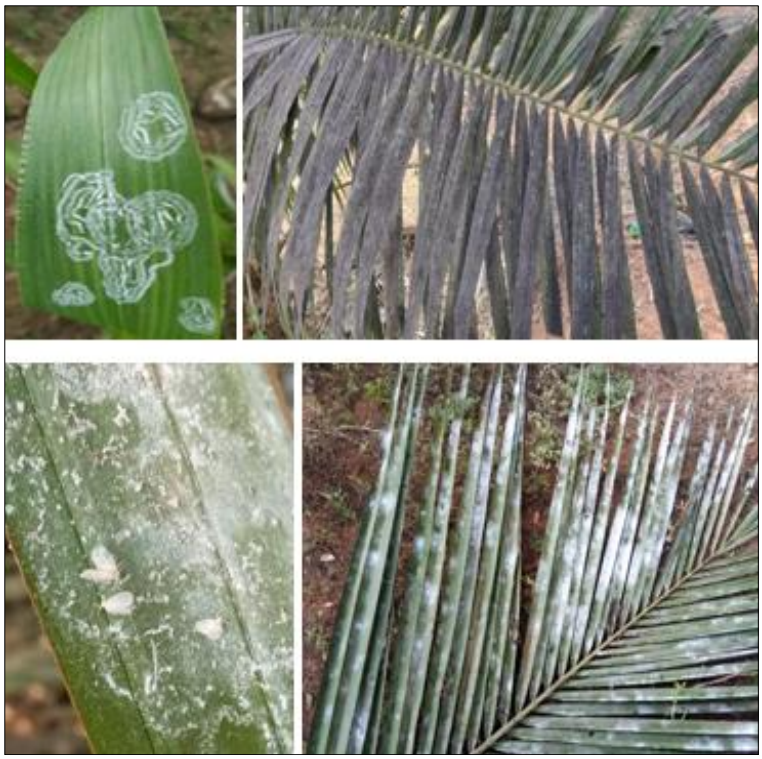

Fig 1: Rugose spiraling whitefly (RSW) is causing serious infestation in oil palms.

Conclusion

On the basis of the result obtained in present study it can be concluded that location specific IPM modules have gained significance due to the changing pest scenario in different seasons and agroecosystems. The yield gap between farmer practices and technology demo plot was perceptibly higher, there is urgent need to make stronger extension services for educating the cultivators in the implementation of improved technology. However, the yield level under local practice was lower which could be further improved by adopting recommended integrated pest management technologies. The FLD intervention is highly effective among farmers with increased net returns. With the results obtained in technology demonstrated plot it is recommended to take further into wide scale in Bhadradri Kothagudem district.

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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