

## Program Based Research Grant (PBRG)

# Sub-project Completion Report

on

## Development of integrated crop management technologies for higher production of coconut in Bangladesh

### Sub-project Duration

June 2018 to March 2022

### Coordinating Organization

Pomology Division, Horticulture Research Centre  
Bangladesh Agricultural Research Institute  
Joydebpur, Gazipur-1701

### Project Implementation Unit

National Agricultural Technology Program-Phase II Project  
Bangladesh Agricultural Research Council  
Farmgate, Dhaka-1215



March 2022

# Program Based Research Grant (PBRG)

## Sub-project Completion Report

on

**Development of integrated crop management technologies for higher production of coconut in Bangladesh**



### **Implementing Organization**

Pomology Division, HRC, BARI

Entomology Division, BARI

Plant Pathology Division, BARI

and

Society for Sustainable Development for the Rural and Urban Area  
(SSURDA)



**Project Implementation Unit**  
**National Agricultural Technology Program-Phase II Project**  
**Bangladesh Agricultural Research Council**  
**Farmgate, Dhaka-1215**

March 2022

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**Edited by:**

Project Implementation Unit  
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Bangladesh

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The execution of PBRG sub-project has successfully been completed by 3 divisions of BARI (Pomology Division, HRC, Entomology Division and Plant Pathology Division) and an NGO (SSURDA) using the research fund of WB, IFAD and GoB through Ministry of Agriculture. We would like to acknowledge to the World Bank for arranging the research fund and supervising the PBRGs by BARC. It is worthwhile to mention the cooperation and quick responses of PIU-BARC, NATP-2 in respect of field implementation of the sub-project in multiple sites. Preparing the sub-project completion report required to contact a number of persons for collection of information and processing of research data. Without the help of those persons, the preparation of this document could not be made possible. All of them, who have made it possible, deserve appreciation. Our thanks are due to the Director PIU-BARC, NATP-2 and his team who given their whole hearted support to prepare this document. We hope this publication would be helpful to the agricultural scientists of the country for designing their future research projects in order to technology generation as well as increasing production and productivity for sustainable food and nutrition security in Bangladesh. It would also assist the policy makers of the agricultural sub-sectors for setting their future research directions.

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## Abbreviation and Acronyms

BARI	Bangladesh Agricultural Research Institute
BARC	Bangladesh Agricultural Research Council
CEM	Coconut Eriophyid Mite
HRC	Horticulture Research Centre
ICM	Integrated Crop Management
IDM	Integrated Disease Management
IPM	Integrated Pest Management
NATP	National Agricultural Technology Program
PIU	Project Implementation Unit
RARS	Regional Agriculture Research Station
RPW	Red Palm Weevil
RWD	Root Wilt Disease
SSURDA	Society for Sustainable Development for the Rural and Urban Area

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## Executive Summary

NATP Phase 2 has funded the subproject “Development of Integrated Crop Management Technologies for Higher Production of Coconut in Bangladesh”. The sub-project was started in June 2018 and implemented by four components (Pomology Division, Horticulture Research Center, BARI conducted research on fertilizer and irrigation; Entomology Division, BARI conducted research on insect management; Plant Pathology Division, BARI conducted research on management of major diseases; and SSURDA validated technologies developed by different components.)

Prior to start the experiments, base line survey on the management practices like application of fertilizer, irrigation and growth regulators; insect and mite pest problems and the management options followed by farmers and major diseases of coconut had been done in all the target locations viz. Barishal, Patuakhali, Jashore, Satkhira, Chuadanga, Kushtia, Meherpur and Gazipur in 2018-19. From the surveyed report, it was observed that minimum respondent farmers (24.3%) in Patuakhali and Satkhira and maximum respondent farmers (44.3%) in Gazipur applied fertilizers for their coconut trees. Farmers were reported to apply generally fertilizer per plant per year amounting Urea-500 g, MoP-500 g and Cowdung 20.0 Kg. Application of irrigation differed from 7.6 to 32.4%. Use of growth regulators was negligible.

Coconut eriophyid mite, Rhinoceros beetle and Red palm weevil were found to attack coconut tree in the studied locations. It was revealed that coconut eriophyid mite was predominant pest followed by Rhinoceros beetle and Red palm weevil. From the efficacy study of pheromone traps against red palm weevil, it was observed that pheromone trapping could be an effective tool in IPM program against this pest.

During the survey program at Gazipur, Jashore, Shatkhira, Barishal, Chuadanga and Meherpur districts, four diseases (grey leaf spot, bud rot, root wilt and stem bleeding) were identified. Among the four diseases, incidence of grey leaf spot caused by *Pestalotia palmarum* and bud rot disease caused by *Phytophthora palmivora* were high in all the surveyed areas. The highest incidence of grey leaf spot was observed in Barishal (75%). The incidences of bud rot, stem bleeding and root wilt were recorded to be 5%, 1% and 1.67%, respectively at Jashore.

Experiments on fertilizer and irrigation were conducted by Pomology Division of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur and RARS, Rahmatpur, Barishal during June 2019 to May 2020. The number of female flower, number of fruit set, fruit weight, fruit yield and amount of green coconut water increased significantly when fertilizers were applied at the rate of N: 675 g/plant (Urea-1465 g/plant) , P: 150 g/plant (TSP-750 g/plant), K: 1500 g/plant (MoP-3000 g/plant), S: 93 g/plant (Gypsum-581 g/plant), Zn: 32 g/plant (ZnSo<sub>4</sub>-90 g/plant), B:7.5 g/plant (Boric acid-44 g/plant) and cowdung: 20 kg/plant). The highest water content in green coconut was found in above mentioned treatment (1004 ml) and the lowest water content was recorded in native soil (580 ml). Irrigation 4-6 times after bud break or primordium initiation in dry season was found suitable for coconut production. Number of fruit per plant from integrated technology and farmer’s practices were 135.3 and 54.7, respectively. Net profit was recorded 3609/- in integrated technology and 1108/- in farmers practice. Integrated management technology has been selected for field validation by On Farm Research Division (OFRD), BARI.

Field day on application of fertilizer and irrigation was held at RARS, Rahmatpur, Barishal and Field days on Integrated Management of coconut were held at RARS, Rahmatpur, Barishal and Fruit Research Farm Joydebpur, Gazipur.

A technology was generated on “Application of fertilizer in coconut by Pomology Division. At the same time, Technology Fact Sheet on “Application of Fertilizer in Coconut” was prepared by Pomology Component.

The results revealed that management package comprising sanitation, applying recommended doses of fertilizers and alternate spraying of Vertimec 018 EC and Intrepid 10SC offered the highest reduction (87.39%) of mite infestation over control. Through the project activities, invasive insect roguse spiraling whitefly was first recorded in Bangladesh. Population dynamics and management approaches of rugose spiraling whitefly (RSW) infesting coconut was studied at RARS, Barishal and RARS, Jashore. Population of rugose spiraling whitefly was quite high during September and it peaked during mid November, then it started to decline upto January. From the several studies on management options against RSW, a technology for managing the pest was developed. It was recommended that sanitation along with rotation spraying of chemical insecticide acetamiprid (Tundra 20SP) @ 1g/l of water and bio-pesticide Bioclean or Fizimite @ 1ml/l of water at 15 days interval revealed satisfactory control of RSW in coconut.

Field experiments were conducted to find out the effective disease management package against grey leaf spot and bud rot. During two years of experimentation, several cultural, biological, chemical and integrated approaches were applied to control the diseases. The lowest grey leaf spot incidence was recorded in plants treated with Autostin (Carbendazim) followed by sanitation (two times). Though coconut is a tree plant and it takes long time to get the response of treatments, we generated a technology for the management of grey leaf spot and bud rot diseases. Shortly, the integrated management package developed by Plant Pathology Component is: Sanitation (two times, one at May and another at October) + two times spraying of Autostin (Carbendazim) @ 2 g/l water at the plant canopy at 15 days interval to control grey leaf spot + spraying of Secure (Fenamidon + Mancozeb) @ 2 g/l water at the crown of tree 2 times at 15 days interval to control bud rot disease. Fungicides should be sprayed after sanitation as a preventive measure. The developed technology is selected for field validation and will be validated by On-Farm Research Division (OFRD), BARI. We believe that if the technology could be used accurately and timely at the farmers’ field, the incidence and severity of coconut grey leaf spot and bud rot disease will be reduced, production will be increased and farmers will be benefited.

Integrated management practices with best treatments of Pomology, Entomology and Plant Pathology components on coconut were tested at Joydebpur and Rahmatpur. Field day on Fertilizer and Irrigation Management and Integrated Management Practices on coconut was held at Fruit Research Farm, Joydebpur, Gazipur and Rahmatpur, Barishal.

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Under component SSURDA, eight field days on coconut management technologies were also arranged in the project areas (three in Jashore, four in Barishal and one in Gazipur), where around 360 farmers participated. Two field validation studies were done in the farmers’ field of Kestopara, Jashore and Rahmatpur, Barishal. Different project activities were published in local and national newspapers.

**Key words:** Fertilizer, Coconut mite, rugose spiraling white fly, Bud rot, Grey leaf spot, ICM

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## PBRG Sub-project Completion Report (PCR)

### A. Sub-project Description

- 1. Title of the PBRG sub-project: Development of Integrated Crop Management Technologies for Higher Production of Coconut in Bangladesh**
- 2. Implementing organization (s):** Bangladesh Agricultural Research Institute and Society for Sustainable Development for the Rural and Urban Area (SSURDA)
- 3. Name and full address with phone, cell and E-mail of Coordinator, Associate Coordinator, PI/Co-PI (s):**

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#### **4. Sub-project budget (Tk.):**

4.1 Total: 1,30,00,000.00 (Tk. One crore thirty lacs only)

4.2 Latest Revised (if any): N/A

#### **5. Duration of the sub-project:**

5.1 **Start date (based on LoA signed):** 10<sup>th</sup> June 2018

5.2 **End date: April 2022**

**6. Background of the sub-project:** In Bangladesh coconut is considered as a crop of high economic value for its diversified uses. However, the yield is about 21 nuts per year per tree which is very low, compared to other coconut-growing countries. Among the coconut growing countries of the world, Bangladesh ranked 19 in the case of areas, while production status ranked 30 and yield 77 (FAOSTAT 2012). So, it is clear that the production and yield of coconut in Bangladesh is very low. This poor yield is due to lack of high-yielding varieties, inadequate nourishment and lack of technology for pests and diseases management. Coconut

responds very well to judicious application of fertilizer and irrigation. With appropriate management, coconut can be grown even in the poorest soils with soil drainage and aeration in sub-soil (Malhotra et al., 2017). Nitrogen is important in promoting leaf growth and development. Deficiencies in phosphorus retard palm growth and delay flowering. In potassium deficient soils, potassium fertilizers have a positive effect on the number of inflorescences, bunches, nuts per bunch and total nut production. Application of organic material enhances the utilization of nutrients by plants and water retention ability of soil (Guar, 1994). Judicious application of fertilizers increases nut and copra yield by as much as 230% and a coconut farmer can realize a net income of about 180% compared to without fertilization (<https://pca.gov.ph/pdf/cocoTech/fertilization/fertilizationGuideForCoconuts.pdf>). In India, supplementary irrigation during summer gives an increased yield of 31 nuts/palm in sandy loam soils (Bhaskaran and Leela, 1978). Therefore, appropriate nutrient management technology is needed for the higher production of coconut. Recently coconut is seriously suffered by coconut eriophyid mite, along with other insect pests, viz. red palm weevil and rhinoceros beetle. Bud rot, grey leaf spot etc. are prevailing major disease problems, while root wilt and leaf rot diseases may be the serious threats for its future production. In spite of the importance of coconut in the national economy, due importance has not been paid for the improvement of this crop. Recently steps has been taken to import high yielding varieties from different countries like Vietnam and India but very few works have so far been done on integrated nutrient, water and pest management. Southern and south-west part of Bangladesh are suitable for coconut production. Due to shallow water level and favorable weather condition, huge land area is under coconut cultivation. However, the production is not satisfactory. Growers are not using recommended doses of fertilizers, and do not take any control measures against major pests and diseases. Many countries of the world export coconut. Though Bangladesh has potential to produce coconut, but due to lack of appropriate ICM technologies and awareness of growers we are far behind from exporting coconut. The aim of the project was to develop ICM technologies to increase productivity and create awareness among the growers to use ICM technologies.

#### **7. Sub-project general objective (s):**

- 7.1 Development of integrated crop management packages on production and protection aspects of coconut;
- 7.2 On-farm validation and up scaling of the developed ICM packages;
- 7.3 Awareness building of coconut growers and extension personnel on the developed technologies.

#### **8. Sub-project specific objectives (component wise):**

- 8.1 Pomology: Development and expansion of integrated crop management packages on production aspects of coconut.
- 8.2 Entomology: Development and expansion of integrated pest management packages to manage insect and mite pests of coconut.
- 8.3 Plant Pathology: Development and expansion of integrated disease management packages to manage different disease of coconut.
- 8.4 SSURDA: Field validation and awareness building of coconut growers and extension personnel on the developed technologies.

#### **9. Implementing location (s):** Gazipur; RARS, Jashore; Patuakhali; Shatkhira; Chuadanga; Kushtia and Meherpur

## 10. Methodology in brief

**Coordinating Component: Pomology Division, HRC, BARI**

**Experiment 1. Base line survey on management practices of coconut**

Base line survey on the management practices like fertilizer, irrigation and growth regulator application on coconut had been done in all the target locations of Barishal, Patuakhali, Jashore, Satkhira, Chuadanga, Kushtia, Meherpur and Gazipur during 2018-19 using a questionnaire (Annexure-1).



**Fig 1. Survey team at Barishal**



**Fig 2. Unfruitfulness found at Barishal, Survey, 2018**

Two experiments on fertilizer and irrigation were conducted on BARI Narikel-2 at Pomology Division of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur and Regional Agricultural Research Station, Rahmatpur, Barishal during 2019-2020. BARI Narikel-2 is a high yielding variety. Fruit size is large and oval shaped. It is cultivated throughout the country. Matured fruits are harvested after 11-12 months of flowering and green coconut is harvested after 5-6 months.



**Fig 3. BARI Narikel-2 from the treated plot**

### **Experiment 2. Effect of fertilizer on flowering, fruit drop and yield of coconut**

The experiment was carried out at the Fruit Research Farm, Pomology Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur and Regional Agriculture Research Station, Rahmatpur, Barishal during 2019-2020. There were 5 fertilizer treatments per plant viz., T<sub>1</sub> (RD): N<sub>450</sub>P<sub>100</sub>K<sub>1000</sub>S<sub>63</sub>Zn<sub>21</sub>B<sub>5</sub>, T<sub>2</sub> (RD + 25% more): N<sub>562</sub> P<sub>125</sub> K<sub>1250</sub> S<sub>79</sub> Zn<sub>26</sub> B<sub>6.25</sub>, T<sub>3</sub> (RD+ 50% more): N<sub>675</sub> P<sub>150</sub> K<sub>1500</sub> S<sub>93</sub> Zn<sub>32</sub> B<sub>7.5</sub>, T<sub>4</sub> (FP): 20 kg cowdung and T<sub>5</sub>: Control (Native soil). Fertilizers were mixed with soil of about 0.8 m area around the palm after 1.0 m and light irrigation was dispensed. The experiment was laid out in Randomized Complete Block Design (RCBD) with four replications. Age of tree at Joydebpur was 12-15 years and at Rahmatpur the age was 30-35 years. Data on plant height, base girth, number of bunch, number of fruits per bunch, total number of fruit set and green coconut water were recorded. Data were analyzed statistically as per the standard method using R software and mean separation was done by DMRT.



**Fig 4. Fertilizer application method (A), experimental field view of fertilizer at Joydebpur (B) and Rahmatpur (C)**

### **Experiment 3. Effect of irrigation on flowering and fruit drop in coconut**

The experiment on “Effect of irrigation on flowering and fruit drop in coconut” was conducted at Pomology Division, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur and Regional Agriculture Research Station, Rahmatpur, Barishal during 2019-20. Irrigation was applied at a rate of equivalent to about 2 mm/day or 100 l/day following the basin method. Data on plant height, base girth, number of bunch, number of fruits per bunch and total number of fruit set were recorded. Data were analyzed statistically as per the standard method using R software and mean separation was done by DMRT.



**Fig 5. Experimental field view of irrigation at Joydebpur**



**Fig 6. Experimental field view of irrigation at Rahmatpur**

#### **Experiment 4. Integrated management practices of best treatments of three components**

Experiment on integrated management practices of best treatments of three components was carried out at the Fruit Research Farm, Joydebpur, Gazipur and Regional Agriculture Research Station, Rahmatpur, Barishal. Integrated management practices were

1. Sanitation (Cleaning 2 times at April/May and September/October, Removal of all the dead palms, cleaning the crowns of the palm and any debris) +  $N_{675} P_{150} K_{1500} S_{93} Zn_{32} B_{7.5}$  + Cowdung @ 20 Kg/plant. NPK were applied in two installments, 50% at September/October and the rest 50% at April/May. Gypsum, boron, Zn and cowdung were applied as blanket dose at September/October. Irrigation was applied at 10 days interval after bud break in the dry season.
2. Sanitation two times + Alternate spraying of Vertimec 18 EC @ 2 ml/l of water and Intrepid 10 EC @ 1.5 ml/litre of water. Three sprays were done in 2-6 months old nuts at 2 months interval. Severely infested coconut leaves along with adults and nymphs of whitefly were cut, removed and burned. Rotation spraying of chemical insecticide Acetamiprid (e.g. Tundra 20SP, Platinum 20SP etc.) @ 1g/l of water and biopesticide Fizimite or Bioclean @ 1ml/l of water was done at 15 days interval and 2-3 sprays were required to obtain good results.
3. Sanitation two times + Spraying of Autostin (Canbendazim) @ 2 g/l water two times at 15 days interval to control gray leaf spot + Secure @ 2 g/l water 2 times at 15 days interval to control bud rot disease.

Integrated management practices were compared with the farmer's practices. At Fruit Research Farm, Joydebpur and Regional Agriculture Research Station, Rahmatpur, Barishal number of coconut trees were 30 (15+15) for integrated management and 30 (15+15) for farmer's practices.



**Fig 7. Experimental field view of integrated management practices at Joydebpur (A) and Rahmatpur (B)**

## ***Implementing Component-1: Entomology Division, BARI***

### **Experiment 01: Baseline survey on the insect pest and mite problems in coconut in different regions of Bangladesh**

Field surveys were performed on the coconut growers in 8 locations viz. Barishal, Patuakhali, Jashore, Satkhira, Chuadanga, Kushtia, Meherpur and Gazipur during 2018-2019 to document insect and mite pest problems of coconut and the management options followed by farmers. Three villages were randomly selected from each location. From each village 20 farmers having 3 or more coconut trees were selected randomly. Those selected farmers were interviewed with a pre-fixed questionnaire. In this study, farmers' management options were surveyed under three responses viz. sanitation or cleaning the crown, use of insecticides and no control option. Farmers usually practice sanitation or clean the crown for good growth and productivity of coconut, they don't consider it as mean for controlling pests. But in this study, sanitation or cleaning the crown practiced by farmers at least once a year was considered as a management option against insect and mite pests of coconut.

Parameters assessed through questionnaires were expressed in percentages of responses obtained. The farmers were acquainted with the purpose of the study and assurances of confidentiality and anonymity were given to them.



**Fig 1. Field survey at Gazipur**



**Fig 2. Field survey at Barishal**

### **Experiment 02. Efficacy of aggregation pheromone in trapping red palm weevil (*Rhynchophorus ferrugineus* Olivier) infesting coconut palms**

The study was conducted in the research field of BARI, Gazipur. Three sites were chosen to be the field of study; each site had at least from 10 to 12 coconut trees with 5-20 m in height and approximately 10-30 years old. In each site 3 traps were installed maintaining 25 m distance for a trapping period from March 2019 till June 2019. Pheromone was not changed during the study period. Each site was considered as one replication. Sevin (Carbaryl) @ 1 tea spoon /trap mixed in cut pieces of tender coconut leaves were placed in the trap for the killing of attracted weevils. The traps were placed in the soil near to the base of a coconut tree to protect the traps from extreme heat for their continuous and long-term efficacy against the weevils. Captured weevils were collected from each trap once a week and transferred to the laboratory where they were counted. Sum of the numbers of caught weevils was gathered monthly for each trap and cumulatively throughout the experimental period. Monthly variations of the red palm weevil abundance were recorded during the experimental period.



**Fig 3. Field view of the experiment**



**Fig 4. Red palm weevil attracted to pheromone traps**

### **Experiment 03. Bio-rational based management of coconut eriophyid mite**

Three field trials were conducted during 2019 and 2020 to develop bio-rational based management options against coconut eriophyid mite (CEM). The first trial was conducted at BARI, Gazipur during January – September 2019. Experiment was conducted in a randomized block design with three replicates consisting of single palm each. The respective treatments were applied on 2-6 months old nuts.

The treatments were assigned as follows:

- T<sub>1</sub>: Sanitation + four sprays of microbial pesticide *Beauveria bassiana* at 5g/liter of water
- T<sub>2</sub>: Sanitation + four sprays of bio-pesticide Azadirachtin 1% (Biomax) @ 2 ml/liter of water.
- T<sub>3</sub>: Sanitation + four sprays of Abamectin 1.8 EC (Vertimec) at 1.2 ml/liter of water.
- T<sub>4</sub>: Sanitation + four sprays of chemical miticide Chlorphenapyr 10SC (Intrepid) @ 1.0 ml/liter of water
- T<sub>5</sub>: Untreated control

Based on the findings of the above study two further field trials for developing management package against coconut eriophyid mite was conducted in BARI, Gazipur (Trial 02) and RARS, Jashore (Trial 3) during February 2020 - October 2020. The trials were laid out in RCBD with three replicates consisting of single palm each.

The treatments of the two trials were assigned as follows:

- T<sub>1</sub>: Sanitation (Cleaning the crown and removal of infested nuts) + Recommended doses of fertilizers (RDF) + alternate spraying of Bio-acaricide K-mite (0.5% Matrine and plant oil) @ 2 ml/ litre of water and Intrepid 10SC (Chlorphenapyr) @ 1.5 ml/ litre of water
- T<sub>2</sub>: Sanitation + RDF + alternate spraying of Bio-acaricide Fizimite (10% Sodium lauryl ether sulphate) @ 2 ml/ litre of water and Intrepid 10SC (Chlorphenapyr) @ 1.5 ml/ litre of water
- T<sub>3</sub>: Sanitation + RDF + alternate spraying of Bio-acaricide Vertimec 018 EC (Abamectin) @ 2 ml/ litre of water and Intrepid 10SC (Chlorphenapyr) @ 1.5 ml/ litre of water
- T<sub>4</sub>: Sanitation + RDF + alternate spraying of Bio-acaricide K- mite (0.5% Matrine and plant oil) @ 2 ml/ litre of water and Vertimec 018 EC (Abamectin) @ 2 ml/ litre of water
- T<sub>5</sub>: Untreated control.



**Fig 5. Field Trial 01 at BARI, Gazipur**



**Fig 6. Treatment application in Trial 01**



Fig 7. Field Trial 02 at BARI, Gazipur



Fig 8. Field Trial 03 at RARS, Jashore

#### **Experiment 04. First record of the invasive rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) in Bangladesh and its status as coconut pest**

The infestation of rugose spiraling whitefly (RSW) was firstly observed on May, 2019 in the RARS Farm, BARI, Jashore, on coconut trees. Subsequently, the whitefly population increased greatly and spreads across the neighboring districts. Up to November 2019, RSW infestation was observed infesting coconut trees in six more districts viz., Magura, Jhenaidah, Kushtia, Pabna, Gopalganj and Faridpur. Probably by this time the pest has spread to more districts of the country. As the occurrence of RSW was confirmed from different locations, the samples were collected from infested coconut trees and brought to the IPM Laboratory, Division of Entomology, BARI for further observations. Coconut leaves infested with immature stages and puparium were collected in the polythene bags and adults were kept in 70% alcohol. Part of the collection of host plant leaves/parts infested with immature stages and puparium were placed in rearing jar for the possible emergence of parasitoids.

The pest status and population density of *A. rugioperculatus* on coconut trees was assessed from September to November 2019 in four upazilas of four districts viz, Jashore sadar, Jashore; Magura sadar, Magura; Boalmari, Faridpur and Ishurdi, Pabna. To document the pest status, 60 plants were randomly selected in each location. Then total number of infested plants were counted and % plant infestation was calculated. Again, for documenting the population density of RSW, 5 infested coconut trees were selected in each location. From, each infested coconut tree, 5 leaflets were selected randomly and number of RSW puparium and nymphal population was recorded. The pest population density has been presented as mean puparium or nymph population per leaflet per infested plant.

#### **Experiment 05. Management of rugose spiraling whitefly, *Aleurodicus rugioperculatus* infesting coconut**

The present investigation was carried out in two locations viz. Regional Agricultural Research Station (RARS), BARI, Jashore and RARS, Rahmatpur, Barishal during December 2019-February 2020 and to develop a suitable management option against newly introduced invasive pest rugose spiraling whitefly (RSW). Same methodology was followed in both the locations. Three chemical insecticides and two bio-pesticides were tested in this study. Experiment was conducted in a randomized block design with three replicates consisting of single palm each. There were six treatments including control. Treatments were assigned as follows:

- T<sub>1</sub>: Spraying of Pegasus 500 SC (Diafenthiuron) @ 1 ml/litre of water
- T<sub>2</sub>: Spraying of Fytoclean (Potassium salt of fatty acid) @ 5 ml/litre of water
- T<sub>3</sub>: Spraying of Bioclean (D- lemonene) @ 1ml/litre of water
- T<sub>4</sub>: Spraying of Tundra 50 SP (Acetamiprid) @ 1 g /litre of water
- T<sub>5</sub>: Spraying of Admire 200 SL (Imidacloprid) @ 0.5 /litre of water
- T<sub>6</sub>: Untreated control.

Two sprays of each insecticide were done using high volume foot pump sprayer. Nymph and adult whitefly population on coconut leaflets were counted at 1 day before spraying and 7 days after spraying. Recorded data subjected to proper analysis and means were separated by DMRT and Tukey test for Jashore and Barishal, respectively.



Fig 9. Field view of experiment at RARS, Jashore

Fig 10. Field view of experiment at RARS, Jashore

### Experiment 06. Population dynamics and management of rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin infesting coconut

**Population abundance:** To know the seasonal abundance of rugose spiraling whitefly (RSW) population, coconut leaflet were collected on randomly 10 coconut palm at weekly interval during September/2020 to June/2021 at RARS, Rahmatpur Barishal.

**Management study:** The present studies were carried out at the Regional Agricultural Research Station, Rahmatpur, Barishal (90°17' E, 22°78" N) during September 2020 to June 2021 to develop a suitable management option against newly introduced invasive pest rugose spiraling whitefly (RSW). The selected coconut trees were in the age group of 6 years reaching 8-12 feet height (dwarf variety). Experiment was conducted in a randomized block design with three replicates consisting of single palm each. There were six treatments including control. Treatments were assigned as follows:

T<sub>1</sub>: Spraying of Tundra 50 SP (Acetamiprid) @ 1 g /litre of water

T<sub>2</sub>: Spraying of Bio-clean (D- Limonene 5% SL) @ 1 ml/L of water

T<sub>3</sub>: Spraying of Biotrin (Matrine 0.5%) @ 1.5 ml/L of water

T<sub>4</sub>: Rotation spraying of Tundra 50 SP (Acetamiprid) @ 1 g /litre of water and Bioclean (D-limonene) @ 1ml/litre of water

T<sub>5</sub>: Rotation spraying of Tundra 50 SP (Acetamiprid) @ 1 g /litre of water and Biotrin (Matrine 0.5%) @ 1.5 ml/litre of water

T<sub>6</sub>= Untreated control.

Two sprays of each pesticide were done in each month at 7 days interval using high volume power sprayer. Nymph, pupa and adult whitefly population on coconut leaflets were counted at 1 day before spraying and 7 days after spraying in each month. Three month average data were made into population per leaflet. The experimental data were analyzed by SAS software. The mean number of whitefly/leaflet data were subjected to square root transformation before the analysis of variance (ANOVA) and means were separated by tukey's HSD Post Hoc tests (SAS Institute, 2012).



Fig 11. Field view of the experiment

### **Implementing Component-2: Plant Pathology Division, BARI**

To know the current status of coconut disease, a pre-designed questionnaire (Annexure-1) was prepared. There are many diseases of coconut recorded in Bangladesh earlier. However, during the survey program conducted in major coconut growing areas (Barishal, Jashore, Patuakhali, Shatkharia, Kushtia, Chuadanga and Meherpur), it was revealed that grey leaf spot and bud rot disease are the most severe diseases in coconut. The survey program was conducted at two villages from each district and 30 growers from each village.

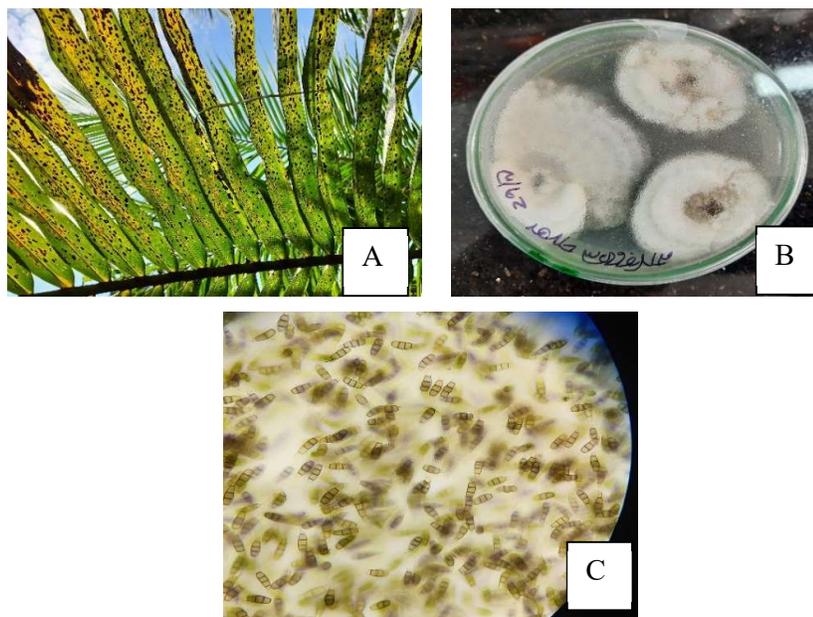


**Fig 1. Survey at Jashore**



**Fig 2. Survey at Barishal**

During the survey program it was identified that two diseases of coconut viz. grey leaf spot caused by *Pestalotia palmarum* and bud rot caused by *Phytophthora palmivora* were prominent at all the surveyed areas (Figure 7).



**Fig 3. Coconut grey leaf spot disease. A. Disease symptom on leaf. B. *Pestalotia palmarum* on Potato Dextrose Agar medium. C. Conidia of *P. palmarum***

To control these diseases (grey leaf spot and bud rot), experiments were set (2<sup>nd</sup> year) at Joydebpur, Gazipur and RARS Rahmatpur, Barishal applying the following treatments:

- T<sub>1</sub>: Sanitation at May and October (removal of all the dead palms, cleaning the crowns of the palm and any debris, provide adequate drainage)
- T<sub>2</sub>: Application of biocontrol agents @ 200 g/plant at 2 months interval (first dose in the soil and later doses on leaf axil)
- T<sub>3</sub>: Application of nutrients {Urea-1kg, TSP -2.5 kg/plant, MP -1 kg/plant (Half during monsoon and half during December), Cupric sulphate -300 g/plant, Manganese Sulphate -300 g/plant, Zinc Sulphate -300 g/plant, Sodium Borate -300 g/plant, Ferrous Sulphate -200 g/plant, Sodium Chloride -1kg/plant, Lime -1kg/plant, Ammonium Molibdata 50 g/plant). (1/2 in soil, 1/4 during monsoon, and 1/4 at November)}. Preparation of nutrients paste: 150 g Cupric Sulphate, 105 g Zinc Sulphate, 1 kg lime, 1 kg Sodium Chloride were mixed together with water to form a paste. The paste was kept overnight at 30<sup>o</sup> C and was applied at root zone. The remaining nutrients was added and mixed thoroughly in the soil. Soil around the palm was removed upto root zone in a radius of 1.2 m. All externally visible rotten roots were cut and removed.
- T<sub>4</sub>: Application of phenolic compounds (Gallic Acid - 200 ppm/plant, Coumarin -200 ppm/plant, Caffeic acid -200 ppm/plant, Ascorbic acid -400 ppm/plant). Spraying and inject at 2 months interval
- T<sub>5</sub>: Chemical fungicides (Autostin 2g/L water at 15 days interval and Secure @ 2g/L water at 15 days interval)
- T<sub>6</sub>: Untreated control

Sanitation at May and October (removal of all the dead palms, cleaning the crowns of the palm and any debris, provide adequate drainage) along with spraying of Autostin (carbendazim) @ 2 g/L at 15 days interval and Secure (Fenamidon + Mancozeb) @ 2 g/L 2 times at 15 days interval was applied along with other intercultural operations (irrigation and balanced fertilizers).

At the end of 2<sup>nd</sup> year, the best treatments (sanitation + fungicide spray) were combined and experiments were set at Joydebpur and RARS, Rahmatpur. Pair plot technique was used where T<sub>1</sub>: Sanitation at May and October (removal of all the dead palms, cleaning the crowns of the palm and any debris, provide adequate drainage) along with spraying of Autostin (carbendazim) @ 2 g/l at 15 days interval and Secure (Fenamidon + Mancozeb) @ 2 g/l 2-3 times at 15 days interval was applied along with other intercultural operations; T<sub>2</sub>: No treatment (Farmers practice).



Fig 4. Experimental field at BARI, Gazipur



**Fig 5. Experimental field at Gazipur Gazipur**



**Fig 6. Experiment Field at RARS Rahmatpur Barishal**

Disease incidence was calculated using percent data. Three coconut plants were treated in each treatment. Three replications of each treatment were maintained. Disease severity was recorded using 0-5 scale described by Fagan and Goes (1999, where 0: No visible symptoms, 1: 1-5% leaf area diseased, 2: 5.1-12% leaf area diseased, 3: 12.1-25% leaf area diseased, 4: 25.1-50% leaf area diseased and 5: >50% leaf area diseased.

### ***Implementing Component-3 : SSURDA***

**Methodology in brief (with appropriate pictures):** The main objective and responsibilities of SSURDA component of the project are to validation and demonstration of crop management technologies developed by Pomology Component for balance nutrient management, Entomology Component for the management of invasive insect and Pathology Component for the management of major diseases. Best treatment of each component was incorporated in validated demonstrations at farmers fields (four locations). Hence, this project was undertaken owing to develop and validate integrated crop management technologies. The crop management packages applied in the demonstration plots are:

- a) Sanitation: Severely infested coconut leaves along with adults and nymphs of white fly should be cut, removed and burned.
- b) Fertilizer should be applied at the rate of N: 562-675 g/plant (urea-1220-1465 g/plant) P: 125-150 g/plant (TSP-625-750 g/plant), K: 1250-1500 g/plant (MoP-2500-3000 g/plant), S: 79-93 g/plant (gypsum-494-581 g/plant), Zn: 26-32 g/plant (ZnSo<sub>4</sub>-74-90 g/plant), B: 6.25-7.5 g/plant (boric acid-36-44 g/plant) and cowdung-20 kg/plant in the plants of 15 years old and above. Fifty per cent of NPK has to be applied in the month of September/October and rest 50% of NPK should be applied in April/May. Gypsum, boron, zinc and cowdung are to be applied as blanket dose in September/October. Before using fertilizer, sanitation i.e., cleaning 2 times at April/May and September/October has to be performed.
- c) Rotation spraying of chemical insecticide Acetamiprid (e.g. Tundra 20SP, Platinum 20SP etc.) @ 1g/l of water and biopesticide Fizimite or Bioclean @ of 1ml/l of water at 15 days interval. Usually, 2-3 sprays are required to obtain good results.
- d) Spraying of Autostin (canbendazim) @ 2 g/l water two times at 15 days interval to control gray leaf spot + Secure (Fenamidon + Mancozeb) @ 2 g/l water 2 times at 15 days interval to control bud rot disease



**Fig 1. Farmers field in Jashore**



**Fig 2. Coconut disease at farmers field of Satkhira**



**Fig 3. Farmers field at Satkhira**

## 11. Results and Discussion

*Coordinating Component : Pomology Division, HRC, BARI*

### *Experiment 1. Base line survey on management practices of coconut*

Base line survey on the management practices like application of fertilizer, irrigation and growth regulators on coconut was carried out in all the target locations viz. Barishal, Patuakhali, Jashore, Satkhira, Chuadanga, Kushtia, Meherpur and Gazipur during 2018-19. From the surveyed report, it was observed that minimum respondent farmers (24.3%) in Patuakhali and Satkhira and maximum respondent farmers (44.3%) in Gazipur applied fertilizers for their coconut trees (Table 1). Farmers were reported to apply generally fertilizer per plant per year amounting urea-500 g, MoP-500 g and cowdung 20.0 kg. Application of irrigation in respondent farmers differed from 7.6 to 32.4%. Use of growth regulators was negligible.

**Table 1. Per cent respondent on management practices in different locations (Base line survey)**

Locations	Per cent respondent on management practices		
	Fertilizer	Irrigation	Growth regulator
Barishal	26.4	8.0	1.2
Patuakhali	24.3	7.8	1.2
Jashore	31.4	11.7	2.2
Chuadanga	26.5	8.2	1.8
Shatkhira	24.3	7.6	1.4
Meherpur	29.0	10.2	2.0
Kushtia	31.5	11.2	2.5
Gazipur	44.3	32.4	11.2

### *Experiment 2. Effect of fertilizer on flowering, fruit drop and yield of coconut*

**At Joydebpur :** Effect of fertilizer on plant height, base girth, number of bunch, number of female flower per bunch and average number of fruit set been presented in Table 2 and Plate 8. Plant height differed significantly among the treatments. The highest plant height was observed in T<sub>3</sub> (6.86 m) followed by T<sub>2</sub> (6.48 m) and T<sub>1</sub> (6.35 m). The lowest plant height was recorded in control treatment (6.04 m). Initial number of female flower per bunch and finally fruit set were recorded. The highest number of initial female flower was observed in T<sub>3</sub> (18.4) and the lowest number of female flowers was obtained from T<sub>5</sub> (10.3). Fruit set differed significantly among the different treatments. The highest number of fruits per bunch was noticed in T<sub>3</sub> (12.4) followed by T<sub>2</sub> (11.8) and T<sub>1</sub> (10.2). The lowest number of fruit set per bunch was recorded in T<sub>1</sub> i.e., control (7.3).

The number of female flower, number of fruit set, fruit weight, fruit yield and green coconut water increased when fertilizers were applied at the rate of N: 675 g/plant (Urea-1465 g/plant) , P: 150 g/plant (TSP-750 g/plant), K: 1500 g/plant (MoP-3000 g/plant), S: 93 g/plant (Gypsum-581 g/plant), Zn: 32 g/plant (ZnSo<sub>4</sub>-90 g/plant), B:7.5 g/plant (Boric acid-44 g/plant) and cowdung: 20 kg/plant (Table 3). Number of fruits per plant differed significantly among the treatments. The highest number of fruits was observed in T<sub>3</sub> (156.2) and the lowest in T<sub>5</sub> (56.9). Fruit weight and water content in green coconut have been presented in Table 3. The highest water content was found in T<sub>3</sub> (1004 ml) followed by T<sub>2</sub> (950 ml) and T<sub>1</sub> (880 ml). The lowest water content in green coconut was observed in T<sub>5</sub> (580 ml).

**Table 2. Effect of fertilizer on plant growth, number of bunch, number of female flower and number of fruit set at Joydebpur**

Treatment	Plant height (m)	Base girth (m)	Number of bunch Per plant	Average number of initial female flower per bunch	Average number of fruit set per bunch
T <sub>1</sub> (RD) : N <sub>450</sub> P <sub>100</sub> K <sub>1000</sub> S <sub>63</sub> Zn <sub>21</sub> B <sub>5</sub>	6.35c	1.22a	9.5c	16.3b	10.2b
T <sub>2</sub> (RD + 25% more) : N <sub>562</sub> P <sub>125</sub> K <sub>1250</sub> S <sub>79</sub> Zn <sub>26</sub> B <sub>6.25</sub>	6.48b	1.24a	10.4b	17.6ab	11.8ab
T <sub>3</sub> (RD+ 50% more) : N <sub>675</sub> P <sub>150</sub> K <sub>1500</sub> S <sub>93</sub> Zn <sub>32</sub> B <sub>7.5</sub>	6.86a	1.26a	12.6a	18.4a	12.4a
T <sub>4</sub> (FP): 20 kg cowdung	6.23cd	1.18b	8.4d	12.7c	7.6c
T <sub>5</sub> : Control (Native soil)	6.04d	1.14b	7.8d	10.3d	7.3c
CV (%)	8.4	9.2	10.7	12.6	11.8

Similar letter (s) in a column do not differ significantly at 0.05 level

**Table 3. Effect of fertilizer on number of fruits per plant, fruit weight and fruit yield at Joydebpur**

Treatment	Number of nuts/ plant	Fruit weight (Kg)	Fruit yield per plant (Kg)	Green coconut water (ml)
T <sub>1</sub> (RD) : N <sub>450</sub> P <sub>100</sub> K <sub>1000</sub> S <sub>63</sub> Zn <sub>21</sub> B <sub>5</sub>	96.9c	4.20c	406.9c	880c
T <sub>2</sub> (RD + 25% more) : N <sub>562</sub> P <sub>125</sub> K <sub>1250</sub> S <sub>79</sub> Zn <sub>26</sub> B <sub>6.25</sub>	122.7b	4.80b	589.0b	950b
T <sub>3</sub> (RD+ 50% more) : N <sub>675</sub> P <sub>150</sub> K <sub>1500</sub> S <sub>93</sub> Zn <sub>32</sub> B <sub>7.5</sub>	136.2a	5.40a	843.4a	1004a
T <sub>4</sub> (FP): 20 kg cowdung	63.8d	3.80d	242.4d	700d
T <sub>5</sub> : Control (Native soil)	56.9e	3.20e	182.0e	580e
CV (%)	10.3	9.2	13.4	11.5

Similar letter (s) in a column do not differ significantly at 0.05 level

### At Rahmatpur

Data on plant height, base girth, number of leaves/plant, number of fruits/bunch and number of nuts /plant have been presented in Table 4. There were no significant differences in the plant height and base girth of the experimental coconut tree. Significant difference was observed in the number of leaves per plant. The highest number of leaves per plant was found in treatment T<sub>2</sub> (30.3) and the lowest number of leaves in T<sub>5</sub> (23.6). Number of bunch per plant differed significantly. The highest number of bunch per plant was reported in the treatment T<sub>3</sub> (9.93) and the lowest number of bunch recorded was in T<sub>4</sub> (7.31). The length of spadix differed significantly among the treatments. The highest spadix length was exhibited in T<sub>3</sub> (95.9 cm) and the lowest spadix length was noted in T<sub>5</sub> (70.9cm). The highest number of fruit per bunch was observed in T<sub>3</sub> (10.8) followed by T<sub>2</sub> (10.5) and the lowest number of fruit per bunch was observed in T<sub>5</sub> (6.7). There was a significant difference in the number of nuts per plant. The highest number of nuts per plant was noticed in T<sub>3</sub>

(107.3) followed by T<sub>2</sub> (99.0), but they were statistically at par. The lowest number of nuts per plant was recorded in T<sub>5</sub>.

**Table 4. Effect of fertilizer on plant growth and yield contributing characters of coconut at RARS, Rahmatpur, Barishal**

Treatment	Plant height (m)	Base girth (m)	No. of leaves	No. of bunch/plant	Length of spadix (cm)	Number of fruit/bunch	Number of nuts/plant
T <sub>1</sub>	19.8	1.57	24.6 bc	9.35a	78.6	8.1 b	75.8 b
T <sub>2</sub>	19.4	1.61	30.3 a	9.42	80.1	10.5 a	99.0 a
T <sub>3</sub>	19.9	1.55	27.6 ab	9.93a	95.9	10.8 a	107.3 a
T <sub>4</sub>	20.2	1.42	25.6bc	7.35 b	76.8	7.08 b	52.1 c
T <sub>5</sub>	18.4	1.55	23.6 c	7.31a	70.9	6.7 c	49.0 c
CV (%)	8.68	7.68	6.12	13.21	13.63	14.37	10.2

Similar letter (s) in a column do not differ significantly at 0.05 level



**Fig 8. Female flower, fruits per bunch, individual fruit and inner part of green coconut in the treatment N<sub>675</sub>P<sub>150</sub>K<sub>1500</sub>S<sub>93</sub>Zn<sub>32</sub>B<sub>7.5</sub> + Cowdung @ 20 kg/plant**



**Fig 9. Fruits in farmer's practices**

### **Experiment 3. Effect of irrigation on flowering and fruit drop in coconut**

**At Joydebpur:** Effect of irrigation on plant height, number of bunch, number of female flower and number of fruit set at Joydebpur has been presented in Table 4. Average number of fruit set per bunch was affected by irrigation. The highest number of bunch per tree was found in T<sub>3</sub> (10.8) followed by T<sub>2</sub> (10.7), but they were statistically at par. At the same time, the number of female flower differed significantly among the treatments. The highest number of female flower was recorded in T<sub>3</sub> (17.6) followed by T<sub>2</sub> (17.0). But T<sub>3</sub> did not have significant difference with T<sub>2</sub>.

Total number of fruit set showed significant differences among the treatments. The highest number of fruit set was exhibited in T<sub>3</sub> (142.1) and the lowest number of fruit (63.0) set was exhibited in T<sub>4</sub> i.e. untreated control.

**Table 5. Effect of irrigation on plant growth, number of bunch, number of female flower and number of fruit set at Joydebpur**

Treatment	Plant height (m)	Base girth (m)	Number of bunch Per plant	Number of initial female flower per bunch	Number of fruit set per bunch	Number of fruit set per plant
T <sub>1</sub> : Two irrigations at an interval of 10 days starting from bud break or primordium initiation	10.1b	1.28a	10.2b	15.5b	11.3b	115.3c
T <sub>2</sub> : Four irrigations at an interval of 10 days starting from bud break or primordium initiation	10.5a	1.31a	10.7a	17.0ab	12.4ab	133.0b
T <sub>3</sub> : Six irrigations at an interval of 10 days starting from bud break or primordium initiation	10.4a	1.32a	10.8a	17.6a	13.2a	142.1a
T <sub>4</sub> : Untreated (Control)	10.0b	1.20b	7.5c	11.8c	8.4c	63.0d
CV (%)	10.3	9.8	12.4	10.2	11.3	13.3

Similar letter (s) in a column do not differ significantly at 0.05 level

**At Rahmatpur :** Effect of irrigation on plant height, base girth, number of bunch per plant, number of initial female flower, number of fruit set per bunch and per plant at Rahmatpur was presented in Table 4. Average number of fruit set per bunch was affected by irrigation. The highest number of bunch per tree was found in T<sub>3</sub> (14.8) followed by T<sub>2</sub> (14.2). But they were statistically at par. At the same time, the number of female flower differed significantly among the treatments. The highest number of female flower per bunch was recorded in T<sub>3</sub> (15.7) followed by T<sub>2</sub> (15.0). But T<sub>3</sub> failed to produce significant difference with T<sub>2</sub>. The total number of fruit set showed significant difference among the treatments. The highest number of fruit set was exhibited in T<sub>3</sub> (155.4) and the lowest number of fruit set was exhibited in T<sub>4</sub> i.e. untreated control (92.4).

**Table 6. Effect of irrigation on plant growth, number of bunch, number of female flower and number of fruit set at Rahmatpur**

Treatment	Plant height (m)	Base girth (m)	Number of bunch per plant	Number of initial female flower per bunch	Number of fruit set per bunch	Number of fruit set per plant
T <sub>1</sub> : Two irrigations at an interval of 10 days starting from bud break or primordium initiation	19.3	1.48	13.4b	12.2b	8.4b	112.6c
T <sub>2</sub> : Four irrigations at an interval of 10 days starting from bud break or primordium initiation	20.6	1.51	14.2a	15.0ab	9.6ab	136.3b
T <sub>3</sub> : Six irrigations at an interval of 10 days starting from bud break or primordium initiation	20.7	1.52	14.8a	15.7a	10.5a	155.4a

T <sub>4</sub> : Untreated (Control)	20.3	1.45	10.5c	10.4c	8.8c	92.4d
CV (%)	11.5	10.2	14.6	12.0	14.8	10.2

Similar letter (s) in a column do not differ significantly at 0.05 level

**Experiment 4.** Integrated crop management package on production and protection of coconut  
Number of fruits per plant and profit analysis were presented in Table 6. Number of fruits per plant were obtained from integrated technology (Plate-10) and farmer's practices were 135.3 and 54.7, respectively. Net profit was recorded to be 3609/- in integrated technology and 1108/- in farmer's practice.



**Fig 10. Fruits in integrated treatment, at Joydebpur (A) and Rahmatpur (B)**

**Table 7. Profit analysis of integrated technology in 2021**

Integrated technology	Number of fruits/plant	Price of green coconut	Total price	Total cost	Net profit	BCR
T <sub>3</sub> : Urea-1465 g, TSP-750 g, MoP-3000 g, Gypsum-581 g, ZnSo <sub>4</sub> -90 g, Boric acid-44 g, Cowdung-20 kg + treatments for insect and diseases	135.3	40/-	5412/-	1803/-	3609/-	2.00
FP ( Cowdung 20 kg/plant)	54.7	40/-	2188/-	1080/-	1108/-	1.02

#### **Implementing Component-1: Entomology Division, BARI**

#### **Experiment 01. Benchmark survey on the insect pest and mite problems in coconut in different regions of Bangladesh**

As indicated in Table 1, coconut eriophyid mite, Rhinoceros beetle and Red palm weevil were found to attack coconut tree in the studied locations. It was revealed that coconut eriophyid mite was predominant pest followed by Rhinoceros beetle and Red palm weevil.

The highest mite infested tree (98.33%) was observed in Patuakhali and Jashore which followed Barishal (96.67%) and Chuadanga (88.33%). The mite infestation was the lowest in Meherpur (60.00%). The highest Rhinoceros beetle infested tree (68.33%) was observed in Jashore which followed Meherpur (65.00%) and patuakhali (36.67). The Rhinoceros beetle infestation was the lowest in Kushtia (5.00%). On the other hand, the highest red palm weevil infested tree (8.33%)

was observed in Barishal which was followed by those of Patuakhali (6.67%) and Meherpur (6.33%). The red palm weevil infestation was noted the lowest in Chuadanga (1.33%).

As indicated in Table 2, in all the surveyed locations, more than 50% coconut grower didn't adopt any control measures against insect and mite pest. Use of insecticides was practiced by only 1.67-8.33 coconut growers. It was observed that, 30.00-48.33% farmers cleaned the crown at least once a year, this practice no doubt was helpful in reducing pest attack, but most of the farmers adopted this practice considering growth and productivity of the coconut tree.

**Table 1. Location wise incidence of insect and mite pests of coconut**

Location	Percent tree infestation±SE		
	Mite	Rhinoceros beetle	Red palm weevil
Barishal	96.67±1.51	30.00±3.80	8.33±1.82
Patuakhali	98.33±1.06	36.67±3.01	6.67±0.56
Jashore	98.33±1.41	68.33±1.62	2.67±0.25
Chuadanga	88.33±3.43	35.00±2.31	1.33±0.12
Shatkhiria	73.33±3.21	11.67±1.34	2.33±0.68
Meherpur	60.00±2.72	65.00±2.00	6.33±0.58
Kushtia	75.00±6.70	5.00±1.16	5.00±0.53
Gazipur	69.67±4.43	5.33±0.54	7.67±1.27

**Table 2. Farmers' management options on insect and mite pests of coconut**

Location	Respondent (%)		
	Sanitation (cleaning the crown at least once a year)	Use of insecticide	No control option
Barishal	35.00	3.33	65.00
Patuakhali	30.00	5.00	66.67
Jashore	46.67	8.33	51.67
Chuadanga	43.33	3.33	56.67
Shatkhiria	48.33	5.00	50.00
Meherpur	41.67	1.67	58.33
Kushtia	48.33	3.33	51.67
Gazipur	43.33	1.67	56.67

Results clearly indicated that in all the surveyed locations nut infesting eriophyid mite emerged as the most damaging pest of coconut. Rhinoceros beetle and red palm weevil were found as the potential threat in all the surveyed locations. It was evident from the investigations, that the farmers experienced enormous economic loss due insect and mite pests. Most of them found it difficult to spray insecticides to mitigate insect pests. Given the wide array of human health effects from pesticide exposure, cultural control measures and application of bio-pesticides should be encouraged, to avoid a build-up of insect and mite pests.

**Experiment 02. Efficacy of aggregation pheromone in trapping red palm weevil (*Rhynchophorus ferrugineus* Olivier) infesting coconut palms.**

The results of the present study are shown in Fig. 1. It was revealed trap catch of adult Red Palm Weevil (RPW) was the highest (6.89/ week) after one week of installation, which showed gradual declining trend with the progress of time. After 4 weeks (23 March) trap catch was 4.67 per week, while after 8 weeks the trap catch was 3.00 per week. After 11 weeks, trap catch was zero.

From the study, it could be concluded that for good results, the pheromone lures need to be changed after 8 weeks of installation in the field. Abdallah and AlKhatri, (2003), observed that RPW adults emerged continually throughout the year. No trap catch after 11 weeks in this study could be attributed to the reduction of trapping capacity of pheromone lures and also to the decline of RPW population due to trapping. El- BoKl *et al.*, (2015) Observed that trap catch of RPW per month on date palms could be as high as 42.33. Pheromone trapping of red palm weevil an ecologically safe and environmentally friendly tool in the IPM strategy currently adopted worldwide for red palm weevil management in coconut palm plantations and one that can be implemented on large scale by farmers on a collective basis.

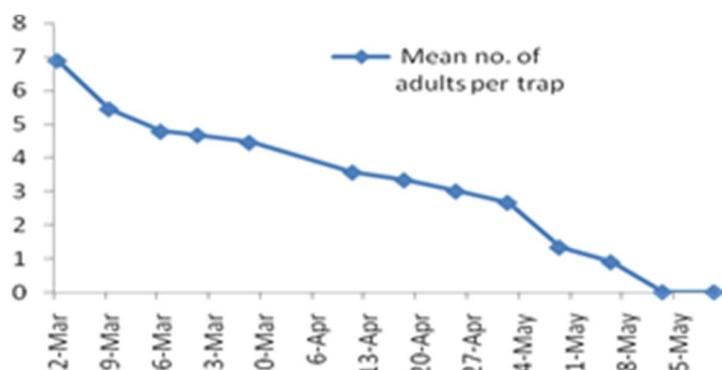


Fig. 1 Weekly catch of Adult RPW per trap in coconut during March -May 2019

### Experiment 03. Bio-rational based management of Coconut Eriophyid Mite

The results of the trial 01 revealed that management package comprising of Sanitation +four sprays of chemical miticide Chlorphenapyr 10SC (Intrepid) @ 1.0 ml/liter of water offered highest reduction (86.66%) of mite infestation over control which was followed by Sanitation +four sprays of Abamectin 1.8 EC (Vertimec) at 1.2 ml/liter of water (Table 01). Performance of *Beauveria bassiana* and Azadirachtin 1% was not satisfactory.

Table 3. Effect of various treatments on mite infestation in coconut during 2019 at BARI, Gazipur

Treatments	Mean infested nut (%)	Infestation reduction over control (%)
Sanitation + <i>Beauveria bassiana</i>	48.53c	37.67
Sanitation + Azadirachtin 1%	52.18b	32.99
Sanitation + Abamectin 1.8 EC	16.34d	79.02
Sanitation + Chlorphenapyr 10SC	10.39e	86.66
Untreated control	77.87a	-
C.V. (%)	7.42	-

Means having same letter(s) in a column are not significantly different at P> 0.05 followed by LSD.

The results of the trial 02 revealed that management package comprising of Sanitation, applying recommended doses of fertilizer and alternate spraying of Vertimec 018 EC and Intrepid 10SC offered highest reduction (87.39%) of mite infestation over control (Table 02). The management package comprising of Sanitation + RDF+ Fizimite + Intrepid 10SC and Sanitation + RDF+ K- mite + Intrepid 10SC was also found promising which offered 78.32% and 78.19% reduction of mite infested nut over control, respectively.

**Table 4. Effect of various treatments on mite infestation in coconut at BARI, Gazipur during 2020**

Treatments	Mean infested nut (%)	Infestation reduction over control (%)
Sanitation + RDF+ K- mite + Intrepid 10SC	16.85b	78.19
Sanitation + RDF+ Fizimite + Intrepid 10SC	16.75b	78.32
Sanitation + RDF+ Vertimec 18 EC + Intrepid 10SC	9.75c	87.39
Sanitation + RDF+ K- mite + Vertimec 018 EC	17.05b	71.45
Untreated control	72.25a	-
C.V. (%)	9.05	-

The results of the trial 03 revealed that management package comprising of Sanitation, applying recommended doses of fertilizer and alternate spraying of Vertimec 018 EC and Intrepid 10SC offered highest reduction (90.92%) of mite infestation over control (Table 03). The management package comprising of Sanitation + RDF+ Fizimite + Intrepid 10SC and Sanitation + RDF+ K- mite + Intrepid 10SC was also found promising which offered 79.07% and 79.74% reduction of mite infested nut over control.

**Table 5. Effect of various treatments on mite infestation in coconut at RARS, Jashore during 2020**

Treatments	Mean infested nut (%)	Infestation reduction over control (%)
Sanitation + RDF+ K- mite + Intrepid 10SC	14.21c	79.74
Sanitation + RDF+ Fizimite + Intrepid 10SC	14.48c	79.07
Sanitation + RDF+ Vertimec 18 EC + Intrepid 10SC	6.28d	90.92
Sanitation + RDF+ K- mite + Vertimec 018 EC	20.42b	70.49
Untreated control	69.2a	-
C.V. (%)	7.92	-

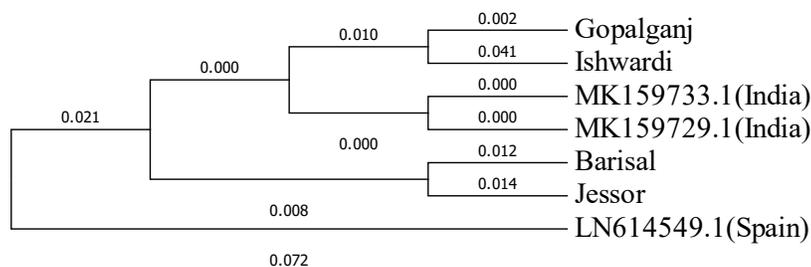
**Experiment 04. First record of the invasive rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) in Bangladesh and its status as coconut pest**

Identification of this pest, damage symptoms, and all the stages of life cycle as observed during the investigation are described below:

**Identification of this pest**

Identity of the pest species was confirmed as *A. rugioperculatus* based on the puparial features following the descriptions given by Martin (2004) and Chandrika *et al.* 2017. Occurrence of reticulated cuticle on dorsum, presence of compound pores in abdominal segments VII and VIII, presence of corrugation on the surface of operculum and acute shape of the apex of lingula were

described as unique features of *A. rugioeperculatus*. The compound pores were distinct with dagger-like process. The pest was further confirmed through DNA barcoding. Phylogenetic analysis comparing with publicly available CO1 sequences from different country revealed that all the four isolates were as *A. rugioeperculatus* (Fig. 1).



**Fig. 2. Phylogenetic tree for CO1 genes of *Aleurodicus* isolates. The bar represents sequence divergence.**

### Symptoms of damage

The typical characteristics like eggs covered with wax were laid by females in a circular or spiral fashion usually on the abaxial surface of leaves. Nymphs and adults were congregated on the leaf surfaces and prolific feeding resulted in profuse honey dew excretion which subsequently get deposited on the upper surface of the leaves which in turn became black due to the development of sooty mold.

### Life stages

All the stages of RSW as observed during the study are outlined below:

#### Egg stage

Eggs are smooth, elliptical, whitish to yellow, translucent and laid by the females on underside of the leaves and fruits in spiral pattern which was covered with the waxy matter (Fig. 2A).

#### Nymphs

Rugose spiraling whitefly has 5 developmental stages. The first instar known as the crawler stage (because it is the only mobile immature stage) hatches out of the egg, and looks for a suitable place to begin feeding with its needle-like mouth parts and sucks plant sap. Crawlers molt into immature stages that are immobile, oval and flat initially but become more convex with the progression of its life cycle. During the survey nymphs were observed and they are light to golden yellow in color in a concentrate manner fully covered with the waxy material and wax filaments are thin which may become denser with progress of time (Fig. 2B).

#### Puparium

Puparia are covered with wooly wax with a group in the colonies under the leaves of the coconut (Fig. 2C). The puparium of this species has a pair of small compound pores on each of seventh and eighth abdominal segments, characteristically rugose/corrugated operculum, reticulated dorsal cuticle and acute lingual apex which are easily distinguishable from related species (Sundararajand Selvaraj 2017).

#### Adults

Adults are congregated covering the whole leaves and found to suck the sap under surface of leaves/leaflets (Fig. 2E-F). They are larger in size, about three times as compared to commonly found whiteflies. Honey dew excretion in large quantity resulted due to their feeding of the pest under the surface of the leaves and premature leaves are dried because of heavy infestation. The lack of photosynthesis process, symptoms like sooty mold are observed. Although taxonomic identification is required for species confirmation, rugose spiraling whitefly adults can be distinguished by their large size and the presence of a pair of irregular light brown bands across the wings (Stocks and Hodges 2012). Males have long pincer-like structures at the end of their abdomen (Fig. 2F).



**A. Eggs**



**B. Nymph**



**C. Puparia**



**D. Parasitized puparia**



**E. Adult Habitus ( Female)**

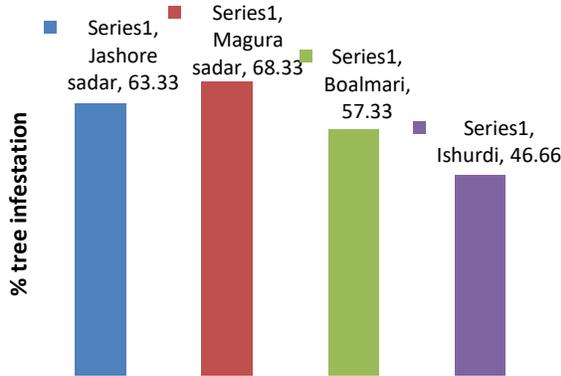


**F. Adult Habitus ( Male)**

**Fig 3 (A-F): Different life stages of Rugose Spiraling Whitefly**

**Pest status on coconut**

Fig. 3 indicated the percent coconut tree infestation by RSW in different locations which ranged from 46.66-68.33%. The highest infestation was recorded from Magura sadar (68.33%) followed by Jashore sadar (63.33%), while the lowest was recorded in Ishurdi, Pabna (46.66%). Elango *et al.* 2019, studied the intensity of damage by *A. rugioperculatus* on coconut in several districts of Tamil Nadu, India. The rugose spiralling whitefly incidence was high in Coimbatore (62.86%) district followed by Tiruppur (56.06%) and Erode (54.43%). The severity of infestation ranged between 40-60 % on coconut in India (Rao *et al.* 2018). Kityo *et al.* 2017 reported up to 100% coconut tree infestation in different districts of Mozambique.



**Fig 3. Percent coconut tree infestation by Rugose Spiraling Whitefly in different locations**

Population density of immature stages of Rugose Spiraling Whitefly in different locations have been presented in Table 1. It was revealed that, nymph population of RSW leaflet<sup>-1</sup> ranged 26.02 -27.72 across different locations, while puparium population of RSW leaflet<sup>-1</sup> ranged 33.12 - 33.64. Kityo *et al.* 2017 observed 25.7-26.8 pupa population of RSW coconut leaflet<sup>-1</sup> in Mozambique.

**Table 6. Population density of immature stages (nymph and puparium) of Rugose Spiraling Whitefly on coconut in different locations**

Locations	RSW population (immature stages) per leaflet per infested plant (Mean±SE)	
	Nymph	Puparium
Jashore sadar	26.08±1.18	33.12±1.56
Magura sadar	26.32±1.88	34.6±0.84
Boalmari, Faridpur	26.24±2.25	33.64±1.40
Ishurdi, Pabna	27.72± 1.43	33.4±2.02

**Experiment 05. Management of rugose spiraling whitefly, *Aleurodicus rugioperculatus* infesting coconut**

As indicated in Table 1, at 7 days after spray (DAS), the lowest mean nymph population /leaflet (4.65) was noticed in Tundra 20 SP treated plots followed by Admire 200 SL treated plots (5.47). The control treatment recorded the highest nymphal population /leaflet (19.30) at 7 DAS. Among the chemical insecticides/ bio-pesticides tested, significantly the highest per cent reduction of whitefly nymphal population over control was recorded in Tundra 50 SP (77.01%), followed by Admire 200 SL (72.55%) and Bio-clean (62.89%).

As indicated in Table 2, at 7 days after spray (DAS), the lowest mean adult whitefly population /leaflet (7.13) was noticed in Tundra 20 SP treated plots followed by Admire 200 SL treated plots (8.13). The control treatment recorded the highest whitefly population /leaflet (25.66) at 7 DAS. Among the chemical insecticides/ bio-pesticides tested, significantly the highest per cent reduction of whitefly adult population over control was recorded in Tundra 50 SP (73.79%), followed by Admire 200 SL (69.85%) and Bio-clean (60.00%). The bio-pesticide bio-clean could be used in a well designed IPM program against Rugose Spiraling Whitefly infesting coconut.

**Table 7. Effect of different treatments on the population reduction of RSW nymphs during December 2019- February 2020 at RARS, Jashore**

Treatments	Mean RSW nymph population/ leaflet		Per cent reduction of RSW nymph population over pretreated at 7 DAS
	1 DBS	7 DAS	
Pegasus 500 SC	20.56	9.09c	55.79
Fyto-clean	20.50	11.51b	43.85
Bioclean	20.40	7.57d	62.89
Tundra 50 SP	20.23	4.65f	77.01
Admire 200 SL	19.93	5.47e	72.55
Untreated control (water spray only)	19.91	19.30a	3.06
CV (%)	2.39	4.38	-

Means having same letter(s) in a column are not significantly different at  $P > 0.01$  followed by DMRT.

**Table 8. Effect of different treatments on the population reduction of RSW adults during December 2019- February 2020 at RARS, Jashore**

Treatments	Mean RSW adult population/ leaflet		Per cent reduction of RSW adult population over pretreated at 7 DAS
	1 DBS	7 DAS	
Pegasus 500 SC	26.80	13.67b	48.99
Fyto-clean	27.00	16.00 b	40.74
Bioclean	26.67	10.67c	60.00
Tundra 50 SP	27.20	7.13d	73.79
Admire 200 SL	26.53	8.13cd	69.85
Untreated control (water spray only)	26.87	25.66a	4.50
CV (%)	4.93	11.65	-

Means having same letter(s) in a column are not significantly different at  $P > 0.01$  followed by DMRT.

As indicated in Table 3, at 7 days after spray (DAS), the lowest mean nymph population /leaflet (4.80) was noticed in Tundra 20 SP treated plots followed by Admire 200 SL treated plots

(6.80). The control treatment recorded the highest nymphal population /leaflet (17.96) at 7 DAS. Among the chemical insecticides/bio-pesticides tested, significantly the highest per cent reduction of whitefly nymphal population over control was recorded in Tundra 50 SP (75.78%), followed by Admire 200 SL (64.94%) and Bio-clean (60.60%).

As indicated in Table 4, at 7 days after spray (DAS), the lowest mean adult whitefly population /leaflet (4.70) was noticed in Tundra 20 SP treated plots followed by Admire 200 SL treated plots (7.23). The control treatment recorded the highest whitefly population /leaflet (18.78) at 7 DAS. Among the chemical insecticides/ bio-pesticides tested, significantly the highest per cent reduction of whitefly adult population over control was recorded in Tundra 50 SP (76.80%), followed by Admire 200 SL (63.00%) and Bio-clean (58.74%).

**Table 9. Effect of different treatments on the population reduction of RSW nymphs during December 2019- February 2020 at RARS, Rahmatpur, Barishal**

Treatments	Mean RSW nymph population/ leaflet		Per cent reduction of RSW nymph population over pretreated at 7 DAS
	1 DBS	7 DAS	
Pegasus 500 SC	19.14	10.46 c	45.21
Fytoclean	19.14	13.21 b	31.02
Bioclean	19.28	7.57 d	60.60
Tundra 50 SP	19.88	4.80 e	75.78
Admire 200 SL	19.40	6.80 d	64.94
Untreated control (water spray only)	19.13	17.96 a	6.08
CV (%)	10.32	9.72	-

All means followed by same letters at each column were not significantly different among the treatments by Tukey test ( $P < 0.05$ ).

**Table 10. Effect of different treatments on the population reduction of RSW adults during December 2019- February 2020 at RARS, Rahmatpur, Barishal**

Treatments	Mean RSW adult population/ leaflet		Per cent reduction of RSW adult population over pretreated at 7 DAS
	1 DBS	7 DAS	
Pegasus 500 SC	19.03	10.36 b	45.54
Fytoclean	18.05	11.76 b	34.92
Bioclean	18.58	7.68 c	58.74
Tundra 50 SP	20.26	4.70 d	76.80
Admire 200 SL	19.53	7.23 c	63.00
Untreated control (water spray only)	19.60	18.78 a	4.16
CV (%)	9.36	13.36	-

All means followed by same letters at each column were not significantly different among the treatments by Tukey test ( $P < 0.05$ ).

### Conclusion

Results of these two locations study clearly indicated that, although the chemical insecticide Tundra 20 SP (acetamiprid) performed best, it is not advisable to spray repeatedly. The best

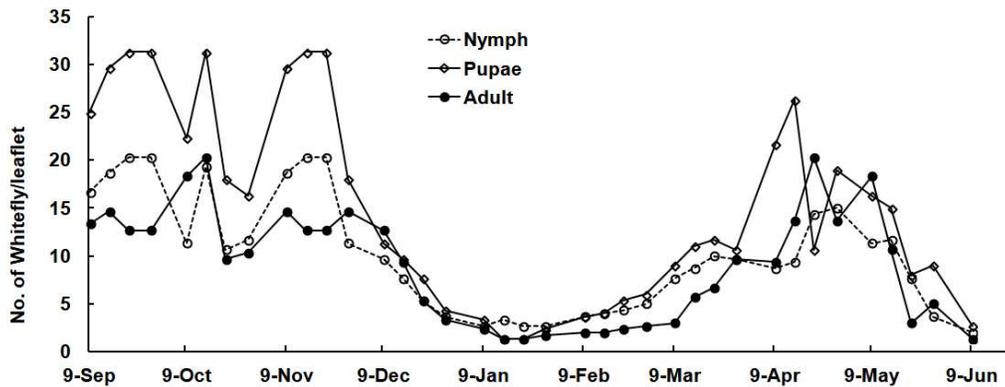
performing bio-pesticide bioclean (D-limonene) can be used in rotation with Tundra 20 SP for sustainable management of this pest.

**Experiment 06. Population dynamics and management of rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin infesting coconut**

**Population abundance:** There was a seasonal variation of rugose spiraling whitefly (RSW) attacking coconut in southern region of Bangladesh. rugose spiraling whitefly (RSW) population was higher during September to November, then the trends were declined up to 1<sup>st</sup> week of March. The population trend again increased from mid March to Mid May then it became lower in June (Fig. 1). It was suggested that with the increasing temperature, pest population becoming higher but in rainy season it became lower.

**Management:** The effect of different treatments on rugose spiraling whitefly (RSW) immature and adult population are presented in Table 1-3. Before spraying there was no significant difference on RSW population among the treatments, but spraying all the treatments reduced RSW population compared to control. A chemical pesticide Tundra 50 SP (Acetamiprid) reduced 85.50% nymph, 83.75% pupae and 84.52% adult reduction over control treated palm. But, rotation spraying of Tundra 50 SP (Acetamiprid) and Bioclean (D-limonene) similiarly reduced 83.21% nymph, 81.25% pupae and 80.95% adult reduction over control. Another biopesticide Biotrin (Matrine 0.5%) did not reduced rugose spiraling whitefly (RSW) population upto the mark.

From the present study it is concluded that a bio-pesticide Bio-clean (D- Limonene 5% SL) and a chemical insecticide Tundra 50 SP (Acetamiprid) effectively reduced Rugose Spiraling Whitefly population. Therefore, rotation spraying of Tundra 50 SP (Acetamiprid) and Bioclean (D-limonene) can sustainable management option against Rugose Spiraling Whitefly infesting coconut.



**Fig. 4. Seasonal population density of rugose spiraling whitefly infesting coconut during 2020-21**

**Table 11. Effect of different treatments on the population reduction of RSW nymphs during September 2020- June 2021 at RARS, Rahmatpur, Barishal**

Treatments	Before spray	After first spray		After second spray (7 days after first spray)	
		Mean RSW nymph/ leaflet	Per cent reduction of RSW nymph population over control	Mean RSW nymph/ leaflet	Per cent reduction of RSW nymph population over control
Acetamiprid (Tundra 50SP)	17.67 a	4.00 c	80.17	3.17 c	85.50
Bioclean (D- Limonene 5% SL)	16.67 a	8.00 b	60.33	4.50 c	79.39
Biotrin (Matrine 0.5%)	16.67 a	9.50 b	52.89	6.83 b	68.70
Acetamiprid + Bioclean	16.50 a	4.17 c	79.34	3.67 c	83.21
Acetamiprid + Biotrin	17.33 a	3.83 c	80.99	4.67 c	78.63
Untreated control	17.33 a	20.17 a	-	21.83 a	-

All means followed by same letters at each column were not significantly different among the treatments by Tukey test ( $P < 0.05$ ).

**Table 12. Effect of different treatments on the population reduction of RSW pupae during September 2020- June 2021 at RARS, Rahmatpur, Barishal**

Treatments	Before spray	After first spray		After second spray (7 days after first spray)	
		Mean RSW pupae / leaflet	Per cent reduction of RSW pupae population over control	Mean RSW pupae / leaflet	Per cent reduction of RSW pupae population over control
Acetamiprid (Tundra 50SP)	23.33 a	5.33 d	80.25	4.33 d	83.75
Bioclean (D- Limonene 5% SL)	21.67 a	9.83 c	63.58	5.33 d	80.00
Biotrin (Matrine 0.5%)	22.00 a	13.17 b	51.23	8.17 b	69.38
Acetamiprid + Bioclean	24.33 a	4.83 d	82.10	5.00 cd	81.25
Acetamiprid + Biotrin	23.67 a	5.33 d	80.25	6.00 c	77.50
Untreated control	25.33 a	27.00 a		26.67 a	

Note: All means followed by same letters at each column were not significantly different among the treatments by Tukey test ( $P < 0.05$ ).

**Table 13. Effect of different treatments on the population reduction of RSW adult during September 2020- June 2021 at RARS, Rahmatpur, Barishal**

Treatments	Before spray	After first spray		After second spray (7 days after first spray)	
		Mean RSW adult / leaflet	Per cent reduction of RSW adult population over control	Mean RSW adult / leaflet	Per cent reduction of RSW adult population over control
Acetamiprid (Tundra 50SP)	12.33 a	3.17 c	81.19	2.17 c	84.52
Bioclean (D- Limonene 5% SL)	10.67 a	5.33 b	68.32	2.83 c	79.76
Biotrin (Matrine 0.5%)	11.67 a	7.67 b	54.46	4.83 b	65.48
Acetamiprid + Bioclean	12.33 a	2.83 c	83.17	2.67 c	80.95
Acetamiprid + Biotrin	14.33 a	3.33 c	80.20	3.33 c	76.19
Untreated control	13.67 a	16.83 a		14.00 a	

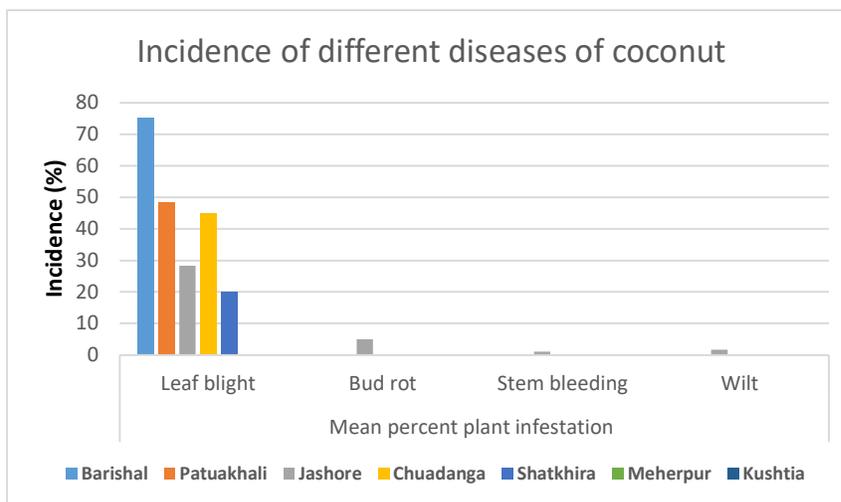
Note: All means followed by same letters at each column were not significantly different among the treatments by Tukey test ( $P < 0.05$ ).

### Conclusion

Rotation spraying of Tundra 50 SP (Acetamiprid) and Bioclean (D- limonene) can be sustainable management option against Rugose Spiraling Whitefly infesting coconut.

### Implementing Component-2: Plant Pathology Division, BARI

- a) **Survey:** During survey, grey leaf spot caused by *Pestalotia palmarum*, bud rot caused by *Phytophthora palmivora*, stem bleeding caused by *Thielaviopsis paradoxa* and root wilt disease caused by phytoplasma were identified in different coconut growing regions. The highest (75%) grey leaf spot incidence was recorded in Barishal (Figure 7). The incidence of bud rot, stem bleeding and wilt disease were very low in all the surveyed areas. In Jashore 5% incidence of bud rot, 1% incidence of stem bleeding and 1.67% incidence of wilt disease were recorded. In all the locations, none of the growers applied recommended doses of fertilizers and follow any standard cultural management practices.



**Fig. 7. Incidence of gray leaf spot, bud rot, stem bleeding and wilt disease of coconut in seven districts of Bangladesh**



**Fig. 8. Management of grey leaf spot and bud rot disease of coconut**

**b) Disease management experiments ( 2<sup>nd</sup> year):** Among the six treatments, the lowest grey leaf spot incidence and severity was recorded in treatment T<sub>5</sub> where plant were sprayed with chemical fungicides followed by T<sub>1</sub> (Sanitation). The highest leaf spot disease was recorded in plants of control plot (Table 1). Three plants of control plots were also infected with bud rot disease. Except the plants of control plots, bud rot disease was not observed in other plants.

**Table 1. Effect of different treatments to control grey leaf spot and bud rot disease of coconut**

Treatments	Grey leaf spot		Bud rot	
	Incidence (%)	Severity	No of Plants	Severity
T <sub>1</sub> : Sanitation at July and December	77.77 a	1.55	0	-
T <sub>2</sub> : Application of biocontrol agents @200g/plant	100.00 a	2.22	0	-
T <sub>3</sub> : Application of nutrients	100.00 a	2.55	0	-
T <sub>4</sub> : Application of phenolic compounds	88.88 a	1.66	0	-
T <sub>5</sub> : Chemical fungicides (Autostin and Secure)	33.33 b	0.44	0	-
T <sub>6</sub> : No treatment (farmers practices)	100.00 a	4.44	3	-

LSD =35.01  $\alpha=0.05$ ; same letter does not differ significantly

**c) Integrated disease management (3<sup>rd</sup> year):** Based on the results of the experiment of the first year, two times sanitation and spraying of fungicides were selected and combined as a technology to control grey leaf spot and bud rot disease of coconut (Table 2). The developed technology against the two major diseases (grey leaf spot and bud rot) was validated Fruit Research Farm, HRC, Gazipur and at RARS, Rahmatpur, Barishal, Bud rot disease was not observed during the experimental time. Data on grey leaf spot were taken. Using the technology (Sanitation 2 times + spray of fungicides), incidence of grey leaf spot disease reduced significantly compared to untreated plots in both locations (Gazipur and RARS, Rahmatpur, Barishal)

**Table 2. Effect of sanitation and fungicide spray on grey leaf spot of coconut**

Locations	Treated (% incidence)	Untreated (% incidence)	95% Confidence Intervals
Joydebpur, Gazipur	10	45	**
RARS, Rahmatpur, Barishal	5	50	**

\*\* Differences among the treated and untreated plots are highly significant. t-test was conducted to compare the mean incidence of treated and untreated plants at 95% confidence intervals. Bud rot disease was not observed in the treated plants, data on grey leaf spot were recorded.

### ***Implementing Component -3: SSURDA***

At Gaidghat, Jashore the developed technologies were applied in the field of seven farmers where about 38 coconut trees were treated. After six months of applying of treatments, the average production of healthy nuts increased 62% in treated 38 plants (Table 1).

**Table 1. Production of coconut at Gaidghat, Jashore using ICM technologies (fertilizer management, insect and disease management) developed by three components**

<b>Plant No.</b>	<b><u>Before Treatment</u> Healthy Nut/Plant/Year</b>	<b><u>After Treatment</u> Healthy Nut/Plant/Year</b>	<b><u>%Increase Healthy</u> Nut/Plant/Year</b>
1.	15	25	50.00
2.	25	35	33.33
3.	35	40	50.00
4.	32	52	30.95
5.	40	58	62.50
6.	20	35	40.00
7.	12	25	100.00
8.	10	22	68.00
9.	15	24	25.00
10.	10	15	57.14
11.	24	32	80.00
12.	30	45	51.21
13.	42	55	33.33
14.	40	65	100.00
15.	25	35	50.00
16.	12	24	56.52
17.	25	42	140.00
18.	24	30	150.00
19.	35	55	400
20.	25	45	300
21.	41	62	166.66
22.	36	48	150.00
23.	10	20	125.00
24.	16	24	125.00
25.	23	36	70.00
26.	5	12	73.07
27.	4	10	150.00
28.	3	15	31.42
29.	5	20	40.00
30.	12	32	50.00
31.	06	15	33.33
32.	8	18	50.00
33.	16	36	30.95
34.	20	34	62.50
35.	26	45	40.00
36.	12	30	100.00
37.	35	46	68.00
38.	25	35	25.00
<b>Total =</b>	<b>799</b>	<b>1297</b>	
<b>Average</b>	<b>21.02</b>	<b>34.13</b>	<b>62%</b>

At Bondobila, Kestopur, Jashore the developed technologies were applied in the field of nine farmers where 80 coconut trees were treated. After six months of applying treatments, the average production of healthy nuts increased 29.28% in treated 80 plants (Table 2).

**Table 2. Bondobila, Kestopur, Jashore using ICM technologies (fertilizer management, insect and disease management) developed by three components**

<b>Plant No.</b>	<b><u>Before Treatment</u> Healthy Nut/Plant/Year</b>	<b><u>After Treatment</u> Healthy Nut/Plant/Year</b>	<b><u>%Increase Healthy</u> Nut/Plant/Year</b>
1.	46	50	8.69
2.	35	45	28.57
3.	60	70	16.66
4.	45	60	33.33
5.	35	45	28.57
6.	55	70	27.27
7.	34	45	32.35
8.	25	30	20.00
9.	40	45	12.50
10.	50	57	14.00
11.	37	44	18.91
12.	60	62	3.33
13.	55	58	5.45
14.	25	36	44.00
15.	35	47	34.28
16.	25	30	20.00
17.	40	48	20.00
18.	30	35	16.66
19.	26	35	34.61
20.	45	65	44.44
21.	32	40	25.00
22.	58	67	15.51
23.	60	65	8.33
24.	35	45	28.57
25.	45	55	22.22
26.	60	78	30.00
27.	42	53	26.19
28.	31	40	29.03
29.	25	32	28.00
30.	55	65	18.18
31.	20	30	50.00
32.	24	36	50.00
33.	12	18	50.00
34.	2	07	250.00
35.	35	40	14.28
36.	45	55	22.22
37.	57	70	22.80
38.	60	75	25.00
39.	65	68	4.61
40.	13	18	38.46
41.	25	30	20.00
42.	36	42	16.66
43.	34	42	23.52
44.	42	55	30.95

<b>Plant No.</b>	<b><u>Before Treatment</u> Healthy Nut/Plant/Year</b>	<b><u>After Treatment</u> Healthy Nut/Plant/Year</b>	<b><u>%Increase Healthy</u> Nut/Plant/Year</b>
45.	10	15	50.00
46.	10	42	320.00
47.	5	12	140.00
48.	25	32	28.00
49.	20	35	75.00
50.	30	46	53.33
51.	25	36	44.00
52.	40	56	40.00
53.	20	35	75.00
54.	25	30	20.00
55.	55	60	9.09
56.	70	75	7.14
57.	25	36	44.00
58.	50	60	20.00
59.	42	65	54.76
60.	40	40	0.00
61.	10	25	150.00
62.	40	42	5.00
63.	36	36	0.00
64.	15	25	66.66
65.	01	05	400.00
66.	13	20	53.84
67.	24	32	33.33
68.	02	12	500.00
69.	15	25	66.66
70.	12	18	50.00
71.	10	22	120.00
72.	14	24	71.42
73.	12	30	150.00
74.	45	55	22.22
75.	36	45	25.00
76.	21	36	71.42
77.	22	36	63.63
78.	12	20	66.66
79.	08	15	87.50
80.	05	10	100.00
<b>Total =</b>	<b>2561</b>	<b>3311</b>	
<b>Average</b>	<b>32.01</b>	<b>41.38</b>	<b>29.28</b>

At Bakal, Satkhira the developed technologies were applied in the field of four farmers where about 30 coconut trees were treated. After six months of applying treatments, the average production of healthy nuts increased 24.14% in treated 30 plants (Table 3).

**Table 3. Bakal, Satkhira using ICM technologies (fertilizer management, insect and disease management) developed by three components**

<b>Plant No.</b>	<b><u>Before treatment</u> Healthy Nut/Plant/Year</b>	<b><u>After treatment</u> Healthy Nut/Plant/Year</b>	<b><u>%Increase Healthy</u> Nut/Plant/Year</b>
1.	25	35	40.00
2.	22	41	86.36
3.	15	20	33.33
4.	14	20	42.85
5.	08	12	50.00
6.	10	20	100.00
7.	10	15	50.00
8.	13	25	92.30
9.	32	40	25.00
10.	35	54	54.28
11.	15	35	133.33
12.	1	5	400.00
13.	21	25	19.04
14.	45	50	11.11
15.	35	45	28.57
16.	65	72	10.76
17.	55	62	12.72
18.	45	55	22.22
19.	60	75	25.00
20.	55	60	9.09
21.	70	75	7.14
22.	60	78	30.00
23.	55	70	27.27
24.	48	55	14.58
25.	45	60	33.33
26.	55	64	16.36
27.	60	65	8.33
28.	75	85	13.33
29.	60	65	8.33
30.	55	62	12.72
<b>Total =</b>	<b>1164</b>	<b>1445</b>	
<b>Average</b>	<b>38.8</b>	<b>48.16</b>	<b>24.14</b>

At Tulsidanga, Kolaroa, Satkhira the developed technologies were applied in the field of five farmers where about 53 coconut trees were treated. After six months of applying the treatments, the average production of healthy nuts increased 27.02% in treated 53 plants (Table 4).

**Table 4. Tulsidanga, Kolaroa, Satkhira using ICM technologies (fertilizer management, insect and disease management) developed by three components**

<b>Plant No.</b>	<b><u>Before Treatment</u> Healthy Nut/Plant/Year</b>	<b><u>After Treatment</u> Healthy Nut/Plant/Year</b>	<b><u>%Increase Healthy</u> Nut/Plant/Year</b>
1.	12	20	66.66
2.	5	10	100.00
3.	12	25	108.33
4.	22	35	59.09
5.	45	55	22.22
6.	20	35	75.00
7.	35	40	14.28
8.	25	35	40.00
9.	12	14	16.66
10.	09	15	66.66
11.	10	15	50.00
12.	25	35	40.00
13.	40	55	37.50
14.	52	55	5.76
15.	36	42	16.66
16.	60	65	8.33
17.	5	10	100.00
18.	12	18	50.00
19.	5	12	140.00
20.	10	14	40.00
21.	5	10	100.00
22.	16	20	25.00
23.	08	10	25.00
24.	23	25	8.69
25.	60	70	16.66
26.	48	54	12.50
27.	20	25	25.00
28.	10	16	60.00
29.	45	50	11.11
30.	26	35	34.61
31.	20	26	30.00
32.	15	22	46.66
33.	09	14	55.55
34.	10	18	80.00
35.	14	20	42.85
36.	10	15	50.00
37.	18	25	38.88
38.	45	50	11.11
39.	10	16	60.00
40.	45	50	11.11
41.	20	27	35.00
42.	18	25	38.88
43.	10	16	60.00
44.	45	50	11.11
45.	40	45	12.50
46.	36	40	11.11
47.	11	15	36.36
48.	05	10	100.00
49.	08	12	50.00

Plant No.	<u>Before Treatment</u> Healthy Nut/Plant/Year	<u>After Treatment</u> Healthy Nut/Plant/Year	<u>%Increase Healthy</u> Nut/Plant/Year
50.	14	20	42.85
51.	30	35	16.66
52.	42	46	9.52
53.	50	55	10.00
<b>Total =</b>	<b>1238</b>	<b>1572</b>	
<b>Average</b>	<b>23.35</b>	<b>29.66</b>	<b>27.02</b>

**12. Research highlights (Title of the sub-project, background, objectives, methodology, key findings, and key words):**

**Coordinating Component : Pomology Division, HRC, BARI**

**Title of the sub-project:** Development of Integrated Crop Management Technologies for Higher Production of Coconut in Bangladesh.

**Background**

Coconut is considered as a crop of high economic value for its diversified uses. Coconut responds very well to judicious application of fertilizer and irrigation. With appropriate management, coconut can be grown even in the poorest soils with soil drainage and aeration in sub-soil (Malhotra et al., 2017). Nitrogen is important in promoting leaf growth and development. Deficiencies in phosphorus retard palm growth and delay flowering. In potassium deficient soils, potassium fertilizers have a positive effect on the number of inflorescences, bunches, nuts per bunch and total nut production. Application of organic material enhances the utilization of nutrients by plants and water retention ability of soil (Guar, 1994). Judicious application of fertilizers increases nut and copra yield by as much as 230% and a coconut farmer can realize a net income of about 180% compared to without fertilization (<https://pca.gov.ph/pdf/cocoTech/fertilization/fertilizationGuideForCoconuts.pdf>). In India, supplementary irrigation during summer gives an increased yield of 31 nuts/palm in sandy loam soils (Bhaskaran and Leela,1978). Therefore, appropriate nutrient management technology is needed for the higher production of coconut. Though Bangladesh has potential to produce coconut, but due to lack of appropriate ICM technologies and awareness of growers coconut production is far behind from exporting coconut.

**Objectives**

Objectives sub-projects were- Development of integrated crop management packages on production and protection aspects of coconut; on-farm validation and up scaling of the developed ICM packages; awareness building of coconut growers and extension personnel on the developed technologies.

**Methodology**

Prior to start the sub project activities, base line survey on the management practices like application of fertilizer, irrigation and growth regulators on coconut had been done in all the target locations viz. Barishal, Patuakhali, Jashore, Satkhira, Chuadanga, Kushtia, Meherpur and Gazipur during 2018-19.

Experiments on fertilizer and irrigation were conducted on BARI Narikel-2 at Pomology Division of Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur and Regional Agricultural Research Station, Rahmatpur, Barishal during 2019-2020. There were 5 fertilizer treatments per plant viz., T<sub>1</sub> (RD): N<sub>450</sub>P<sub>100</sub>K<sub>1000</sub>S<sub>63</sub>Zn<sub>21</sub>B<sub>5</sub>, T<sub>2</sub> (RD + 25% more): N<sub>562</sub>P<sub>125</sub>K<sub>1250</sub>S<sub>79</sub>Zn<sub>26</sub>B<sub>6.25</sub>, T<sub>3</sub> (RD+ 50% more): N<sub>675</sub>P<sub>150</sub>K<sub>1500</sub>S<sub>93</sub>Zn<sub>32</sub>B<sub>7.5</sub>, T<sub>4</sub> (FP): 20 kg cowdung and T<sub>5</sub>: Control (Native soil). Four irrigation treatments were applied –two times, four times, six

times at 10 days interval starting from bud break or primordium initiation. Irrigation was applied at a rate of equivalent to about 2 mm/day or 100 l/day following the basin method.

At the end of 2<sup>nd</sup> year, trial on integrated management practices of best treatments of three components was carried out at the Fruit Research Farm, Joydebpur, Gazipur and Regional Agriculture Research Station, Rahmatpur, Barishal. Integrated management practices were compared with the farmer's practices. At Fruit Research Farm, Joydebpur and Regional Agriculture Research Station, Rahmatpur, Barishal number of coconut trees were 30 (15+15) for integrated management and 30 (15+15) for farmer's practices.

### **Key findings**

From the surveyed report, it was observed that minimum respondent farmers (24.3%) in Patuakhali and Satkhira and maximum respondent farmers (44.3%) in Gazipur applied fertilizers for their coconut trees. Farmers were reported to apply generally fertilizer per plant per year amounting urea-500 g, MoP-500 g and cowdung 20.0 kg. Application of irrigation in respondent farmers differed from 7.6 to 32.4%. Use of growth regulators was negligible.

The number of female flower, number of fruit set, fruit weight, fruit yield and green coconut water increased when fertilizers were applied at the rate of N: 675 g/plant (Urea-1465 g/plant) , P: 150 g/plant (TSP-750 g/plant), K: 1500 g/plant (MoP-3000 g/plant), S: 93 g/plant (Gypsum-581 g/plant), Zn: 32 g/plant (ZnSo<sub>4</sub>-90 g/plant), B:7.5 g/plant (Boric acid-44 g/plant) and cowdung: 20 kg/plant). The highest water content in green coconut was found in above mentioned treatment (1004 ml). The lowest water content in green coconut was observed in native soil (580 ml). Irrigation 4-6 times in dry season was found suitable for coconut production. Number of fruits per plant was obtained from integrated technology and farmer's practices were 135.3 and 54.7, respectively. Net profit was recorded to be 3609/- in integrated technology and 1108/- in farmers practice. Integrated management technology has been selected for field validation by On Farm Research Division (OFRD), BARI.

**Key words:** Coconut, fertilizer, irrigation, production, increase

### ***Component-1: Entomology Division, HRC, BARI***

**Title of the sub-project:** Development of Integrated Crop Management Technologies for Higher Production of Coconut in Bangladesh.

### **Background**

Coconut is an important fruit crop in Bangladesh. It gives income to the growers continuously and contributes a lot of the total homestead income. It provides livelihood to the farmers through its versatile uses. Prevalence of pests and diseases in majority of the coconut-growing areas has adversely affected the coconut industry to a large extent recently. Coconut palm being a perennial crop, grown mostly under homestead gardens, provides supply of food and shelter for the build-up of various insect pests and diseases which cause extensive damage to the crop during all stages of its growth. In Bangladesh, farmers usually don't apply fertilizer and irrigation in coconut crop, which are also responsible for low yield of coconut in our country. The sub project, therefore, was designed to address the above challenges thorough developing and popularizing ICM technologies at farm level thereby increasing overall productivity of coconut crop in Bangladesh.

### **Objective**

Development and expansion of integrated pest management packages to manage insect pests of coconut.

## Methodology

At the outset of the project activities, field surveys were conducted on the coconut growers in 8 locations viz. Barishal, Patuakhali, Jashore, Satkhira, Chuadanga, Kushtia, Meherpur and Gazipur during 2018-2019 to document insect and mite pest problems of coconut and the management options followed by farmers. Based on the survey results, 5 field experiments were conducted in different locations viz. BARI, Gazipur; RARS, Jashore and RARS, Barishal. Detailed methodology of the individual experiments have been furnished in section 10 of the report. Moreover, two field validation studies were done in the farmers' field of Kestopara, Jashore and Rahmatpur, Barishal.

Eight field days on coconut pest management were also arranged during in project areas (three in Jashore and four in Barishal and one in Gazipur) where around 360 farmers participated.

## Key findings

- Coconut eriophyid mite, Rhinoceros beetle and Red palm weevil were found to attack coconut tree in the studied locations. It was revealed that coconut eriophyid mite was predominant pest followed by Rhinoceros beetle and Red palm weevil.
- Mass trapping with pheromone could be one the important component of Red palm weevil IPM program.
- Management package comprising of sanitation, applying recommended doses of fertilizers and alternate spraying of Vertimec 018 EC and Intrepid 10SC offered highest reduction of mite infestation over control.
- Through the project activities, invasive roguse spiraling whitefly (RSW) was first recorded in Bangladesh.
- Population of rugose spiraling whitefly was quite high during September and it peaked during mid November, then it started decline up to January.
- From several studies on management options against RSW, a technology for managing the pest was developed. It was recommended that sanitation along with rotation spraying of chemical insecticide acetamiprid (Tundra 20SP) @ 1g/l of water and biopesticide Bioclean @ of 1ml/l of water at 15 days interval would satisfactorily control RSW in coconut.

**Key words:** Coconut mite, Roguse spiraling whitefly, IPM

## ***Implementing Component-2: Plant Pathology Division, BARI***

### **Title of the sub-project: Development of Integrated Crop Management Technologies for Higher Production of Coconut in Bangladesh.**

**Background:** Coconut, *Cocos nucifera* L. belongs to the family palmaceae is an important plantation crop mainly in tropical and subtropical parts of the world. Many people depending upon this coconut tree directly or indirectly, it provides food for millions and it is considered as the one of the top ten most useful trees in the world. Because of this multiple uses, this tree is popularly called as “Kalpavriksha”, “Tree of Life”, “Tree of Heaven” or “Tree of abundance”. More than 93 countries growing coconut in the world in an area of 12 million hectares with an annual production of 59.98 million tons of nuts. Coconut is a versatile product; it is called as a complete food because it is rich in calories, vitamins and minerals. It is mainly consumed as fresh nuts, tender coconuts, coconut oil and copra meal. The kernel of coconut is an excellent source of minerals; it has copper, calcium, iron, manganese, magnesium and zinc. It is also a very good source of B-complex vitamins such as folates, riboflavin, niacin, thiamin and pyridoxine (Abhishek *et al.*, 2021). However, disease pest are the major constraints of coconut production worldwide. In Bangladesh

very little information is available on disease status of coconut. Moreover, coconut growers are not aware of applying balanced fertilizers, pesticides and using cultural management practices properly to increase crop yield. Focusing the hindrances of higher production of coconut in Bangladesh, the sub-project was design to develop ICM package for applying balanced nutrient, insect pest and disease management and also to create awareness among the growers to use ICM packages.

**Objectives:** To develop disease management technology

**Methodology:** Disease survey was conducted to identify major disease of coconut and their current status. Experiment was conducted at Gazipur to find out effective management practices against two major diseases (grey leaf spot and bud rot). In the third year, two best treatments (two times sanitation and spraying of Autostin @ 2 g/L at 15 days interval and Secure @ 2 g/L 2 times at 15 days interval was applied along with other intercultural operations) were combined and applied to control grey leaf spot and bud rot disease.

**Key findings:** During the survey, grey leaf spot, bud rot, root wilt and stem bleeding were identified. Among the four diseases, incidence of grey leaf spot caused by *Pestalotia palmarum* and bud rot disease caused by *Phytophthora palmivora* were high in all the surveyed areas. The highest 75% incidence of grey leaf spot at Barishal, 5% incidence of bud rot, 1% incidence of stem bleeding and 1.67% incidence of root wilt disease were recorded at Jashore region. After two years experimentation, a disease management package: Sanitation (two times, one at May and another at October) + two times spraying of Autostin (canbendazim) @ 2 g/l water at the plant canopy at 15 days interval to control grey leaf spot + Secure (Fenamidon + Mancozeb) @ 2 g/l water at the crown of tree 2 times at 15 days interval to control bud rot disease) was developed. If the package could be disseminated among the coconut growers, coconut production will be increased in Bangladesh.

**Key words:** Disease Incidence, grey leaf spot, bud rot

### ***Implementing Component-3: SSURDA***

#### **Title: Validation of developed coconut ICM technologies at farmers' field**

Background: In Bangladesh, coconut is considered as a crop of high economic value for its diversified uses. However, the yield is about 21 nuts per year per tree which is very low, compared to other coconut-growing countries. Among the coconut growing countries of the world, Bangladesh ranked 19 in case of areas, while production status ranked 30 and yield 77 (FAOSTAT 2012). So, it is clear that the production and yield of coconut in Bangladesh are very low. This poor yield is due to lack of high-yielding varieties, lack of management practices, inadequate nourishment and pests and diseases control. Recently, coconuts are seriously suffered by coconut eriophyid mite, rugose spiraling white fly along with other insect pests, viz. red palm weevil and rhinoceros beetle. *Bud rot, grey leaf spot etc. are the prevailing major disease problems, while root wilt and leaf rot diseases may be the serious threats for its future production.* Unfortunately, in spite of the importance of coconut in the national economy, due importance has not been paid for the improvement of this crop. Recently steps has been taken to import high yielding varieties from different countries like Vietnam and India but very few works have so far been done on the integrated nutrient, water and pest management. Three technologies on Coconut nutrient management, insect management and disease management were developed and these technologies should be validated in the farmers field.

**Objectives:** To increase crop yield and create awareness of the growers to use advanced technologies.

**Methodology:** Technologies developed by Pomology Division, HRC, BARI; Entomology Division, BARI and Plant Pathology Division, BARI on nutrient management, insect management and disease management were applied in the framers field at Jashore and Shatkhira.

**Key findings:** Production increased 62% at Gaidghat, Jeshore, 30% at Bondobila, Kestopur, Jashore, 24% at Bakal, Satkhira and 27% at Tulsidanga, Kolaroa, Satkhira. Growers were happy with their production and they were motivated to use the developed technology.

Key words: Coconut, ICM, Validation, Production

## B. Implementation Status

### 1. Procurement (component wise): Not applicable for all components

Description of equipment and capital items	PP Target		Achievement		Remarks
	Physical (No.)	Financial (Tk.)	Physical (No.)	Financial (Tk.)	
(a) Office equipment					
(b) Lab & field equipment					
(c) Other capital items					

### 2. Establishment/renovation facilities: Not applicable for all components

Description of facilities	Newly established		Upgraded/refurbished		Remarks
	PP Target	Achievement	PP Target	Achievement	

### 3. Training/study tour/ seminar/workshop/conference organized:

Coordinating Component: Pomology

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training	-	-	-	-	-
(b) Workshop	-	-	-	-	-
(c) Others (Field day)	147	63	210	One day/batch	Seven field days were conducted at Rahmatpur and Joydebpur

### Training/study tour/ seminar/workshop/conference organized: Entomology

Description	Number of participant			Duration (Days/weeks/ months)	Remarks
	Male	Female	Total		
(a) Training					
(b) Workshop					
(c) Field day	299	61		01 day for each field day	

**Training/study tour/ seminar/workshop/conference organized: Plant Pathology**

N/A

Description	Number of participant			Duration (Days/weeks/) months	Remarks
	Male	Female	Total		
(a) Training					
(b) Workshop					
(c) Field day					

**Training/study tour/ seminar/workshop/conference organized: SSURDA**

Description	Number of participant			Duration (Days/weeks/months)	Remarks
	Male	Female	Total		
(a) Training					
(b) Workshop					
(c) Field day	405	75	480	1 (day)	8 field days in 4 locations, Gaidghat, Kestopur in Jashore and Bakal, Kolaroa in Satkhira.

**C. Financial and Physical Progress (combined & component wise)**

(Fig in Tk)

Components	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
Coordinating component	4700000	3750000	3743124		99.82	
Component-1	3850000	2500000	2492135		99.68	
Component- 2	1450000	1300000	1300000		100.00	
Component -3	3000000	2750000	2750000		100.00	
Total	13000000	10300000	10285259		99.87	

**Financial and Physical Progress**

*Coordinating component : Pomology Division, HRC, BARI*

(Fig in Tk)

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	673604	500000	498056	1944	99.61	
b. Field research/lab expenses and supplies	2486858	2278000	2370850	-92850	104.08	
c. Operating expenses	460003	400000	281790	118210	70.45	
d. Vehicle hire and fuel, oil & maintenance	457715	260000	282013	-22013	108.47	
e. Training/workshop/seminar etc.	120000	120000	120000	0	100.00	
f. Publications and printing	300000	0	0	0	0.00	
g. Miscellaneous	201820	192000	191820	180	99.91	
h. Capital expenses	0	0	0	0	0.00	
<b>Total</b>	<b>4700000</b>	<b>3750000</b>	<b>3744529</b>	<b>5471</b>	<b>99.85</b>	

**Implementing Component-1: Entomology Division, BARI**

(Fig in Tk)

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	493285	329161	356066	-26906.2	108.17	
b. Field research/lab expenses and supplies	1956715	1357839	1262331	59423	92.96	
c. Operating expenses	550000	332000	337462	-15220.4	101.65	
d. Vehicle hire and fuel, oil & maintenance	500000	282000	199986	86859	70.92	
e. Training/workshop/seminar etc.	200000	116000	200000	-34000	172.41	
f. Publications and printing	0	0	0	0	0	
g. Miscellaneous	150000	83000	136290	-62290	164.20	
h. Capital expenses	0	0	0	0	0	
<b>Total</b>	<b>3850000</b>	<b>2500000</b>	<b>2492135</b>	<b>7865.4</b>	<b>99.69</b>	

**Implementing Component-2: Pathology Division, BARI**

(Fig in Tk)

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	357390	356180	356180	0	100.00	
b. Field research/lab expenses and supplies	750505	694005	694005	0	100.00	
c. Operating expenses	192230	125000	124943.5	56.5	99.95	
d. Vehicle hire and fuel, oil & maintenance	99000	74815	73000	1815	97.57	
e. Training/workshop/seminar etc.	0	0	0	0	0.00	
f. Publications and printing	0	0	0	0	0.00	
g. Miscellaneous	50875	50000	49780	220	99.56	
h. Capital expenses	0	0	0	0	0.00	
<b>Total</b>	<b>1450000</b>	<b>1300000</b>	<b>1297909</b>	<b>2091.5</b>	<b>99.42</b>	

**Implementing Component-3: SSURDA**

(Fig in Tk)

Items of expenditure/activities	Total approved budget	Fund received	Actual expenditure	Balance/ unspent	Physical progress (%)	Reasons for deviation
a. Contractual staff salary	1028875	943135	1008875	-65740		
b. Field research/lab expenses and supplies	1246125	1142282	1148220	-5938		
c. Operating expenses	250000	229167	217905	11262		
d. Vehicle hire and fuel, oil & maintenance	200000	183333	200000	-16667		
e. Training/workshop/seminar etc.	200000	183333	100000	83333		
f. f. Publications and printing	0	0	0	0		
g. Miscellaneous	75000	68750	75000	-6250		
h. Capital expenses	0	0	0	0		
<b>Total</b>	<b>3000000</b>	<b>2750000</b>	<b>2750000</b>	<b>0</b>		

**D. Achievement of Sub-project by Objectives (Tangible form): Technology generated/ developed**

*Coordinating Component: Pomology Division, HRC, BARI*

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i. e. product obtained, visible, measurable)	Outcome (short term effect of the research)
Development and expansion of integrated crop management packages on production aspects of coconut.	Base line survey on the management practices. Experiments on fertilizer and irrigation were conducted. Sanitation/cleaning done.	Optimum fertilizer dose and irrigation schedule were identified.	Fertilizer, irrigation, sanitation management technology to increase coconut yields

**Achievement of Sub-project by objectives (Tangible form): Technology generated/developed**  
*Implementing Component : Entomology Division, BARI*

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
Development and expansion of integrated pest management packages to manage insect pests of coconut	<ul style="list-style-type: none"> <li>- Survey program conducted to identify major insect pests of coconut</li> <li>- Conducted extensive field and lab research to develop sustainable management options against coconut eriophyid and rugose spiraling whitefly</li> </ul>	<ul style="list-style-type: none"> <li>- Invasive Roguse Spiraling Whitefly (RSW) was first recorded in Bangladesh.</li> <li>- Population dynamics of RSW documented and its sustainable management package developed</li> <li>- Sustainable management options against coconut eriophyid and rugose spiraling whitefly developed</li> </ul>	Insect pest management technologies for higher productivity of coconut

**Achievement of Sub-project by Objectives (Tangible form): Technology generated/developed**  
*Implementing Component : Plant Pathology Division, BARI*

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output (i.e. product obtained, visible, measurable)	Outcome (short term effect of the research)
Development and expansion of integrated disease management packages to manage different diseases of coconut	<ul style="list-style-type: none"> <li>- Survey program conducted to identify the major diseases of coconut</li> <li>- Different cultural, biological and chemical approaches were applied to find out the effective control measures and develop technology</li> </ul>	<ul style="list-style-type: none"> <li>- Grey leaf spot and bud rot disease were identified as major disease problem of coconut</li> <li>- Sanitation (two times) and fungicides (Autostin and Secure)</li> </ul>	Disease management technology to increase crop yield and income generation

**Implementing Component : SSURDA**

<b>General/specific objectives of the sub-project</b>	<b>Major technical activities performed in respect of the set objectives</b>	<b>Output (i.e. product obtained, visible, measurable)</b>	<b>Outcome (short term effect of the research)</b>
Field validation and awareness building of coconut growers and extension personnel on the developed technologies.	Application of fertilizer, irrigation, insecticides and fungicides; sanitation of the selected coconut plants of farmer's field.	Number of coconut increased 62% at Gaidghat, Jeshore, 30% at Bondobila, Kestopur, Jashore, 24% at Bakal, Satkhira and 27% at Tulsidanga, Kolaroa, Satkhira. Growers were happy with their production and they were motivated to use the developed technology.	Production of coconut as well as income of the farmers will be increased.

**E: Information/Knowledge generated/Policy generated**

**Coordinating Component : Pomology Division, HRC, BARI**

<b>General/specific objectives of the sub-project</b>	<b>Major technical activities performed in respect of the set objectives</b>	<b>Output</b>	<b>Outcome (short term effect of the research)</b>
Development and expansion of integrated crop management packages on production aspects of coconut.	Sanitation, application of fertilizer and pesticides.	Coconut fruit yield increased due to management of nutrient, insect and diseases.	Fruit production increased

**Implementing Component : Entomology Division. BARI**

<b>General/specific objectives of the sub-project</b>	<b>Major technical activities performed in respect of the set objectives</b>	<b>Output</b>	<b>Outcome (short term effect of the research)</b>
Development and expansion of integrated pest management packages to manage insect pests of coconut	<ul style="list-style-type: none"> <li>- Survey program conducted to identify major insect pests of coconut</li> <li>- Conducted extensive field and lab research to develop sustainable management options against coconut eriophyid and rugose spiraling whitefly</li> </ul>	<ul style="list-style-type: none"> <li>- Invasive Roguse Spiraling Whitefly (RSW) was first recorded in Bangladesh.</li> <li>- Population dynamics of RSW documented and its sustainable management package developed</li> <li>- Sustainable management options against coconut eriophyid and rugose spiraling whitefly developed</li> </ul>	Insect pest management technologies for higher productivity of coconut

**Implementing Component: Plant pathology Division, BARI**

General/specific objectives of the sub-project	Major technical activities performed in respect of the set objectives	Output	Outcome (short term effect of the research)
Development and expansion of integrated disease management packages to manage different disease of coconut	Different cultural, biological and chemicals were applied to find out effective control measures and develop technology	Sanitation (two times) and fungicides (Autostin and Secure)	Disease management technology to increase crop yield and income generation

**E. Materials Development/Publication made under the Sub-project  
Coordinating Component : Pomology Division. HRC, BARI**

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/ leaflet/flyer etc.	01	Under preparation	
Journal publication	01	Under preparation	
Video clip/TV program			
News Paper/Popular Article			
Other publications, if any			

**Implementing Component: Entomology Division, BARI**

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/leaflet/flyer etc.	01		A factsheet on Management of rugose spiraling whitefly in coconut.
Journal publication		01	Dutta, N. K., D. Sarker., K. Begum, M. A. Sarkar., M. I. Islam & M. M. Rahman. 2019. First record of the invasive rugose spiraling whitefly, <i>Aleurodicus rugioperculatus</i> Martin (Hemiptera: Aleyrodidae) in Bangladesh with its host range and status as coconut pest. <i>Bangladesh j. entomol.</i> 29(2): 73-83.
Video clip/TV program			
News Paper/ Popular Article		04	Different project activities have been published in local and national dailies. (Annexure 01)
Other publications, if any			

**Component: Plant Pathology**

Publication	Number of publication		Remarks (e.g. paper title, name of journal, conference name, etc.)
	Under preparation	Completed and published	
Technology bulletin/ booklet/ leaflet/flyer etc.	-	-	-
Journal publication			
Video clip/TV program			
News Paper/Popular Article			

Other publications, if any			
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**G. Description of generated Technology/Knowledge/Policy**

- i. **Technology Factsheet (title of the technology, introduction, description, suitable location/ecosystem, benefits, name and contact address of author)**

**Technology Fact Sheet of Pomology Component**

**Title of technology: Application of Fertilizer in Coconut**

**Introduction:** In Bangladesh, coconut is considered as a crop of high economic value for its diversified uses. It is one of the most important fruit crops in Bangladesh. It provides coconut oil, coconut milk as well as mineral enriched water that are widely used all over the country. Fertilizer is the most important and costly input in order to enhance the coconut yield. It plays a very active role in increasing crop yield. Balanced fertilizer is an essential practice in the cultivation of coconut. Coconut palms require adequate nutrition for tree growth, flowering, fruit set, regular fruit bearing and high yields. Nitrogen is important in promoting leaf growth and development. Deficiencies in phosphorus retard palm growth and delay flowering. In potassium deficient soils, potassium fertilizers have a positive effect on the number of inflorescences, bunches, nuts per bunch and total nut production. Application of micronutrients increases the nut yield of coconut. Hence, there is a need to develop a recommendation of fertilizer for coconut.

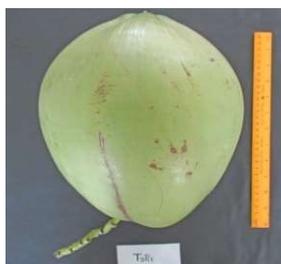
**Description of the Technology (For BARI Narikel-2):**

Fertilizer should be applied at the rate of N: 562-675 g/Plant (Urea-1220-1465 g/Plant) , P: 125-150 g/Plant (TSP-625-750 g/Plant), K: 1250-1500 g/Plant (MoP-2500-3000 g/Plant), S: 79-93 g/Plant (Gypsum-494-581 g/Plant), Zn: 26-32 g/Plant (ZnSo<sub>4</sub>-74-90 g/Plant), B: 6.25-7.5 g/Plant (Boric acid-36-44 g/Plant) and Cowdung: 20 Kg/plant in the plants of 15 years old and above.

**Time and method of application**

Fifty per cent of NPK has to be applied in the month of September/October and rest 50% of NPK should be applied in April/May. Gypsum, boron, zinc and cowdung are to be applied as blanket dose in September/October. Before using fertilizer, sanitation i.e., cleaning 2 times at April/May and September/October has to be performed.

Fertilizers along with cowdung are to be applied following circular basin method 1.0 m away from the base of the palm. The fertilizer has to be mixed with the soil of about 0.8 m area around the palm after 1.0 m and light irrigation has to be dispensed. Four times irrigation at an interval of 10 days starting from bud break or primordium initiation should be imparted.



**N<sub>675</sub> P<sub>150</sub> K<sub>1500</sub> S<sub>93</sub> Zn<sub>32</sub> B<sub>7.5</sub> g/plant + Cowdung @ 20 kg/plant**

**Farmer's practice : 20 kg Cowdung/plant**

**Suitable area/Location: All over Bangladesh**

**Benefit of the Technology:** Nut yield (Number of nuts/plant) and amount of water in green coconut will be increased. As a result, total production of coconut will be increased. Livelihood of the smallholder coconut farmers will be improved.

<b>Fertilizer</b>	<b>Number of fruits/plants</b>	<b>Price of green coconut</b>	<b>Total price</b>	<b>Total cost</b>	<b>Net profit</b>	<b>MBCR</b>	<b>ARR (%)</b>
T <sub>1</sub> : Urea-1220 g, TSP-625 g, MoP-2500 g, Gypsum-494 g, ZnSo <sub>4</sub> -74 g, Boric acid-36 g, Cowdung-20 kg	122.7	40/-	4908/-	1782/-	3126/-	2.36	510
T <sub>2</sub> : Urea-1465 g, TSP-750 g, MoP-3000 g, Gypsum-581 g, ZnSo <sub>4</sub> -90 g, Boric acid-44 g, Cowdung-20 kg	136.2	40/-	6248/-	1803/-	3645/-	62.8	335
T <sub>3</sub> : Farmer's practice (Sanitation, Cowdung application, weeding and harvesting )	63.8	40/-	2552/-	1080/-	1472/-	-	-

T<sub>2</sub> is the most profitable treatment, as the highest MBCR (62.81) and the highest ARR (510%) are found in T<sub>2</sub>.

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## **Implementing Component-1: Entomology Division, BARI**

### **Title: Management of Rugose spiralling whitefly attacking Coconut**

#### **Introduction**

Coconut production in Bangladesh presently is being seriously hampered due to attack of Rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin. The pest was first observed in Bangladesh infesting coconut leaves at Regional Agricultural Research Station (RARS), BARI, Jashore during May, 2019. In South Asia the pest was first identified in 2016 in India. The pest is highly polyphagous with more than 118 hosts belonging to 43 plant families, including several economically important crops. This pest usually damage the plants by sucking sap from leaves. Rugose spiralling whitefly can cause stress to the plant by removing nutrients and water, and by promoting the growth of black sooty molds. They excrete honeydew, which provides an excellent substrate for growth of sooty molds. Once it dries, the sooty mold forms thick layers on the host leaves and other non-plant surfaces. The layers of sooty mold on leaves may disrupt the photosynthetic process in the host leading to physiological disorders.



**Whitefly infested coconut leaf**

**Sooty mold on coconut leaf**

**Seriously infested coconut leaflet**

#### **Description of the Technology**

Rugose spiralling whitefly attack in Coconut can be successfully managed by the IPM package recently developed by Entomology Division, BARI under its PIU-BARC, NATP- phase II funded Coconut ICM sub project. The salient features of this IPM package are as follows:

1. Sanitation: Severely infested coconut leaves along with adults and nymphs of whitefly should be cut, removed and burned.
2. Rotation spraying of chemical insecticide Acetamiprid (e.g. Tundra 20SP, Platinum 20SP etc.) @ 1g/l of water and biopesticide Fizimite or Bioclean @ of 1ml/l of water at 15 days interval. Usually, 2-3 sprays are required to obtain good results.

**Suitable area/Location:** All over Bangladesh

**Benefit of the Technology:** The technology would contribute significantly in increasing overall productivity of coconut crop in Bangladesh reducing approximately 78% rugose spiralling whitefly adult population over untreated plants.

#### **Name and address of the Researcher(s):**

Dr. Nirmal Kumar Dutta, Chief Scientific Officer, Entomology Division, BARI, Gazipur; Mobile: +8801794714560 and E-mail: nk Dutta83@yahoo.com

Dr. Kohinoor Begum, Principle Scientific officer, Entomology Division, BARI, Gazipur; Mobile: 01552450007, Email: kohinoor.ento@gmail.com

#### **Implementing Component-2: Plant Pathology Division**

### **Title: Management of Gray leaf spot and bud rot disease of coconut**

**Introduction:** Coconut is an important cash crop of Bangladesh. Each part of the plant can be used in various purposes. There are a number of factors that reduce total productivity of coconut in Bangladesh. Coconut can be grown in almost all the districts of Bangladesh, coastal areas are more suitable for its production. Though it has potential for contributing in national economy, still there are many impediments in its production. Among them, diseases are the most important part. Coconut plants are affected by more than 50 diseases worldwide. Among the diseases, root (wilt) disease (RWD) caused by phytoplasma, grey leaf spot caused by *Pestalotia palmarum*, leaf rot disease caused by a number of fungi (*Colletotrichum* spp., *Fusarium* spp., *Curvularia* spp), bud rot caused by *Phytophthora palmivora* are most important in Bangladesh.

**Description of the Technology:**

- Sanitation (Two times, one at May and another one at October)
- Spraying of Autostin (canbendazim) @ 2 g/l water two times at 15 days interval to control grey leaf spot + Secure @ 2 g/l water 2 times at 15 days interval to control bud rot disease

**Suitable Locations:** Barishal, Patuakhali, Jashore, Satkhira, Gazipur, Kushtia

**Benefit:** Gray leaf spot and bud rot disease will be reduced and coconut production will be increased

**Contact for more information:**

Dr. Md. Mynul Islam, Senior Scientific Officer, Plant Pathology Division, BARI, Gazipur, Phone: 01783581022, Email: mynul\_bari@yahoo.com

- ii. Effectiveness in policy support (if applicable)

**H. Technology/Knowledge generation/Policy Support (as applied)**

- i. Immediate impact on generated technology (commodity & non-commodity)
- ii. Generation of new knowledge that help in developing more technology in future
- iii. Technology transferred that help increased agricultural productivity and farmers’ income
- iv. Policy support

**I. Information regarding Desk and Field Monitoring**

**i. Desk Monitoring [description & output of consultation meeting, monitoring workshops/seminars etc.)**

Quarterly, half yearly and annual reports have been submitted. Meeting on progress of project activities were conducted in every month.

**ii. Field Monitoring (date & no. of visit, name and addresses of team visit and output)  
Year 2020**

Sub-project Title & ID	:	Development of Integrated Crop Management Technologies for Higher Production of Coconut in Bangladesh (ID: 026)
Implementing Organization	:	Bangladesh Agricultural Research Institute, Gazipur.
Date of visit	:	18 January 2021
Visiting Place	:	BARI, Gazipur
Team Member (s) & address	:	1. Dr. Md. Abdul Jalil Bhuyan, Research Management Specialist, PIU-BARC, NATP-2 2. Md. Ashequr Rahman, Assistant Manager (Accounts), PIUBARC, NATP-2

	3. Dipok Kumar, Monitoring Associate, PIU-BARC, NATP-2 4. Md. Hasan Mahmud, Capacity Development Associate, PIUBARC, NATP-2
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SI #	Recommendation	Progress of Implementation
1.	Bio-rational based insecticides need to be used	Bio-rational based insecticides are being used
2.	Management approaches of new insects and diseases should be developed	It will be done
3.	Economic analysis should be done	An economic analysis will be done
4.	Leaflets on the generated technologies need to be published	It will be done

#### Year 2021

Sub-project Title & ID	:	Development of Integrated Crop Management Technologies for Higher Production of Coconut in Bangladesh (ID: 026)
Implementing Organization	:	Bangladesh Agricultural Research Institute, Gazipur.
Date of visit	:	26 September 2021
Visiting Place	:	BARI, Gazipur
Team Member (s) & address	:	1. Dr. Md. Abdul Jalil Bhuyan, Research Management Specialist, PIU-BARC, NATP-2. 2. Dipok Kumar, Monitoring Associate, PIU-BARC, NATP-2.

SI #	Recommendation	Progress of Implementation
1.	The sub-project completion report (PCR) need to be submitted within revised time schedule	It will be done in schedule time

#### iii. Weather data, flood/salinity/drought level (if applicable) and natural calamities

#### J. Sub-project Auditing (covers all types of audit performed)

##### Coordinating Component: Pomology Division, HRC, BARI

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
FAFAD	No observation/ issues raised	–	–	–
FAFAD	No observation/ issues raised			

##### Component-1: Entomology Division, BARI

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks

FAFAD	No observation/ issues raised			
FAFAD	No observation/ issues raised			

**Component-2: Plant Pathology Division, BARI**

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
FAFAD	No observation/ issues raised			
FAFAD	No observation/ issues raised			

**Component-3:SSURDA**

Types of audit	Major observation/ issues/ objections raised; if any	Amount of Audit (Tk.)	Status at the sub-project end	Remarks
FAFAD	No observation/ issues raised			
FAFAD	No observation/ issues raised			

**K. Lessons Learned:**

**Coordinating Component: Pomology Division, HRC, BARI**

- i) Farmers generally do not follow any management practices. They do not apply fertilizer, irrigation and other production increasing practices.
- ii) Project on perennial crops should be designed for more than five years duration
- iii) Coconut growers of Bangladesh rarely use recommended fertilizers and do follow any pest management strategy

**Component-1: Entomology Division, BARI**

- i) Project on perennial crops should be designed for more than five years duration
- ii) Coconut growers of Bangladesh usually do not apply any insecticides against insect pests

**Component-2: Plant Pathology Division, BARI**

- i) Coconut growers generally do not apply chemicals for disease control
- ii) Bud rot and leaf spot are harmful diseases for coconut production.

**Component-3: SSURDA**

- i) With the application of integrated management packages, number of green coconut increased drastically
- ii) Time for validation trial in the farmers field should be more

**L. Challenges (if any):**

**Coordinating Component: Pomology Division, HRC, BARI**

- Research activities were hampered due to Covid-19 pandemic situation.
- Field experiments, farmers training and organizing field days were challenging for lockdown situations.

### **Component-1: Entomology Division, BARI**

Due to Covid-19 pandemic situation conducting field experiments and organizing field days were some what difficult

### **Component-2: Plant Pathology Division, BARI**

Due to Covid-19 pandemic situation, field experiments, farmers training and organizing field days were challenging.

### **Component-3: SSURDA**

Due to Covid-19 pandemic situation, validation trials in the farmers field and organizing field days were challenging.

### **M. Suggestions for Future Planning (if any):**

Use of nutrients and pesticide including sanitation can improve fruit yield of coconut. There is huge potential of growing coconut in Bangladesh and it may be an exportable item for Bangladesh. Steps should be taken to disseminate developed technology and create awareness of using coconut ICM technologies for the production of better yield of coconut.

### **N. References (in alphabetical order):**

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- Sundararaj, R. and Selvaraj, K. 2017. Invasion of rugose spiraling whitefly, *Aleurodicus rugioeperculatus* Martin (Hemiptera: Aleyrodidae): a potential threat to coconut in India. *Phytoparasitica*. 45, 71-74, DOI:10.1007/s12600-017-0567-0

Signature of the Coordinator  
Date .....  
Seal

Counter signature of the Head of the  
organization/authorized representative  
Date .....  
Seal

## Annexure-1

নারিকেল চাষ সম্পর্কিত জরীপ

সাক্ষাতকার গ্রহণের তারিখ : .....

কৃষকের নাম : ..... পিতার নাম : .....

গ্রাম : ..... ইউনিয়ন : ..... উপজেলা : ..... জেলা : .....

মোবাইল নম্বর : .....

কৃষকের তথ্য :

১। পুরুষ/মহিলা

২। বয়স : ..... বৎসর

৩। শিক্ষাগত যোগ্যতা : ৫ম শ্রেণী পর্যন্ত/৮ম শ্রেণী পর্যন্ত/এসএসসি পাশ/এইচএসসি পাশ/স্নাতক/মাস্টার্স/লেখাপড়া করেন নাই।

৪। খামারের অভিজ্ঞতা :

(ক) কৃষি কাজে ..... বৎসর

(খ) ফল চাষে ..... বৎসর

(গ) নারিকেল চাষে ..... বৎসর

৫। মোট আবাদী জমি ..... হেক্টর

(ক) ফল চাষে মোট জমির পরিমাণ ..... হেক্টর

(খ) নারিকেল চাষে মোট জমির পরিমাণ ..... হেক্টর

(গ) মোট নারিকেল গাছের সংখ্যা ..... টি

৬। নারিকেলের যে সকল জাত চাষ করেন .....

৭। (ক) নারিকেল গাছের পরিচর্যা নিজে/তৃতীয় পক্ষ দ্বারা করেন? (খ) ফসল উত্তোলন নিজ ব্যবস্থাপনায়/বিক্রয় পূর্বক ব্যবস্থাপনায় করেন?

৮। নারিকেল চাষে যে সকল সমস্যা মনে করেন :

(ক) পোকা মাকড়ের আক্রমণ (মাকড়/গন্ডার পোকা/রেড পাম উইভিল/উইপোকা বা অন্যান্য .....)/

(খ) রোগবালাই-এর প্রাদুর্ভাব (এ্যানথ্রাকনোজ বা ফোঙ্কা রোগ/পাউডারী মিলডিউ/বাড রট/ক্ষ্যাব বা দাদ রোগ বা অন্যান্য.....)/.....(আক্রান্ত গাছের সংখ্যা:.....)

(গ) ফুল ও কচি ফল ঝরে পড়া/বা অন্যান্য..... (ঘ) পানি সেচের অভাব/ (ঙ) সার প্রয়োগ/

(চ) অন্যান্য .....

৯। আপনি কি নারিকেলের ভাল ফলন না হবার প্রকৃত কারণ জানেন? যদি জানেন, তাহলে কারণগুলো উল্লেখ করুন।

(ক) ..... (খ) ..... (গ) .....

(ঘ) ..... (ঙ) ..... চ) .....

১০। যখন কচি ডাব ও নারিকেল ঝরে যাবার সমস্যা প্রকট হয় তখন আপনি কি করেন? .....

১১। বিগত বছর ডাব ও নারিকেল ঝরে যাবার কারণে আপনার কি পরিমাণ ক্ষতি হয়েছিল? হ্যাঁ/না। হয়ে থাকলে ক্ষতির পরিমাণ

আনুমানিক কত ছিল? ..... % বা ..... টাকা।

১২। বিগত বছর আপনার নারিকেল বাগানে/গাছে কোন কোন পোকা-মাকড় বা রোগবালাই দেখেছেন?

(ক) ..... (খ) ..... (গ) .....

(ঘ) ..... (ঙ) ..... চ) .....

১৩। বিগত বছর আপনার নারিকেল বাগানে/গাছে পোকা-মাকড় বা রোগবালাই/অন্য কোন সমস্যার সমাধান কিভাবে করেছিলেন?

(ক) কীটনাশক প্রয়োগ করে (খ) ছত্রাকনাশক প্রয়োগ করে (গ) কীটনাশক ও ছত্রাকনাশক একত্রে প্রয়োগ করে (ঘ) দুই বা

ততোধিক কীটনাশক ও ছত্রাকনাশক একত্রে মিশিয়ে প্রয়োগ করে (ঙ) হরমোন প্রয়োগ করে (চ) সার ও পানি সেচের মাধ্যমে (ছ)

অন্য উপায়ে .....

১৪। কখন এবং কার পরামর্শে আপনি আপনার নারিকেল বাগানে/গাছে কীটনাশক, ছত্রাকনাশক, হরমোন প্রয়োগ করে থাকেন?

.....  
.....

১৫। নারিকেল গাছে কতবার এবং কোন সময়, কোন কীটনাশক, ছত্রাকনাশক, হরমোন প্রয়োগ করেন? কীটনাশক, ছত্রাকনাশক, হরমোনের নাম প্রয়োগের সংখ্যা ফসলের অবস্থা (ড্রপ স্টেজ) ফলাফল

১৬। গাছ প্রতি কি পরিমাণ এবং কোন ধরনের সার বিগত বছর আপনি আপনার বাগানে প্রয়োগ করেছিলেন? উল্লেখ করুন।

.....

১৭। বিগত বছর আপনি কতবার এবং কোন পদ্ধতিতে আপনার নারিকেল বাগানে/গাছে পানি সেচ দিয়েছিলেন? উল্লেখ করুন।

.....

১৮। নারিকেলের বেশী ফলন পাবার জন্য কোন ধরনের ব্যবস্থাপনা সবচেয়ে বেশী কার্যকর বলে আপনি মনে করেন? উল্লেখ করুন।

.....

১৯। নারিকেলের বেশী ফলন পাবার জন্য আপনি কার বা কোন প্রতিষ্ঠানের পরামর্শ নিয়ে থাকেন?

প্রতিবেশীর/সম্প্রসারণ কর্মী/বিজ্ঞানী/  
এনজিও কর্মীর/পেস্টিসাইড ডিলার/রেডিও/টেলিভিশন /অন্যান্য .....

২০। আপনি কি কোন কৃষক সংগঠনের সদস্য? হ্যাঁ/না

হ্যাঁ হলে, সংগঠনের নাম উল্লেখ করুন .....

২১। আপনি কি নারিকেলের উন্নত উৎপাদন প্রযুক্তি বা বালাই ব্যবস্থাপনার উপর কোন প্রশিক্ষণ পেয়েছেন? হ্যাঁ হলে, প্রশিক্ষণের বিষয়

..... এবং

আয়োজনকারী প্রতিষ্ঠানের

নাম.....

সাক্ষাতকার গ্রহণকারীর স্বাক্ষর : .....

সাক্ষাতকার গ্রহণকারীর নাম ও পদবী : .....

## Annexure-2

### Field day organized by Coordination Component (Pomology Division)





**Field day on Application of Fertilizer and Irrigation in Coconut, RARS, Rahmatpur, Barishal, 09 October 2021**





**Field day on “Integrated Crop Management of Coconut” at Fruit Research Farm, BARI, Gazipur**

**Annexture-3**

**(Project activities published in local/ National Dailies by Component-1: Entomology Division, BARI)**

আমরা জনগণের পক্ষে

# বাংলাদেশ প্রতিদিন

আপডেট : ১৬ নভেম্বর, ২০২০ ২১:৩৩

## বরিশালে নারিকেলের পোকা দমন ব্যবস্থাপনা মাঠ দিবস অনুষ্ঠিত বিজয় প্রতিবেদক, বরিশাল



বরিশালে নারিকেলের ক্ষতিকর পোকামাকড়ের সমন্বিত দমন ব্যবস্থাপনা শীর্ষক কৃষক মাঠ দিবস অনুষ্ঠিত হয়েছে।

সোমবার বিকেলে বাগুজ্ঞের রহমতপুর আঞ্চলিক কৃষি গবেষণা কেন্দ্রের (আরএআরএস) হলরুমে বিএআরআই'র কীটতত্ত্ব বিভাগ এবং আরএআরএস'র বৌখতাবে কৃষকদের ব্যবহারিক প্রশিক্ষণের (মাঠ দিবস) আয়োজন করে। মাঠ দিবসের অনুষ্ঠানে জেলায় উজিরপুর ও বাগুজ্ঞের ৫০ জন কৃষক-কৃষানী অংশগ্রহণ করেন।

এ উপলক্ষে এক আশোমনা সভায় প্রধান অতিথি ছিলেন বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউটের (বিএআরআই) পরিচালক ড. মুহাম্মদ সামসুল আলম।

আরএআরএস'র মুখ্য বৈজ্ঞানিক কর্মকর্তা মো. রফি উদ্দিনের সভাপতিত্বে অনুষ্ঠানে বিশেষ অতিথি ছিলেন বিএআরআই কীটতত্ত্ব বিভাগের মুখ্য বৈজ্ঞানিক কর্মকর্তা ড. নির্মল কুমার দত্ত এবং ভাসমান কৃষি প্রকল্পের পরিচালক ড. মো. মোজাম্মিল রহমান তালুকদার।

আরএআরএস'র বৈজ্ঞানিক কর্মকর্তা ড. মো. মাহবুবুর রহমানে সভাপনতায় অনুষ্ঠানে বৈজ্ঞানিক কর্মকর্তা ড. সুপ্রভাস আহমেদ, বৈজ্ঞানিক কর্মকর্তা ড. মো. শাহ আলম, উপবর্তন বৈজ্ঞানিক কর্মকর্তা ড. মো. আনওয়ারুল মোমিন, এলএসএস মো. রফিকুল ইসলাম এবং কৃষি তথ্য সার্ভিসের কর্মকর্তা নাহিদা বিন রফিক অন্যদের মধ্যে উপস্থিত ছিলেন।

সভায় কৃষি বিশেষজ্ঞরা বলেন, ফসলের ক্ষতিকর প্রাণীসহ কিছু পোকামাকড় দূশমান। আবার কিছু আছে খালি চোখে দেখা যায় না। এরা প্রথমে আক্রমণ করে। পরে রোগের সৃষ্টি হয়। তাই নারিকেল এবং অন্যান্য ফসলের সুরক্ষার জন্য এদের দমন জরুরি। তবে সেটা অবশ্যই নিরাপদ উপায়ে হতে হবে।

বিডি-প্রতিদিন/বাণিত হোসেন

দৈনিক শুদ্ধ সাংবাদিকতার অঙ্গীকার

# দখিনের সময়

www.dokhinersomoy.com

■ মঙ্গলবার ■ ১৭ নভেম্বর ২০২০ ■ ২ অখ্যায় ১৪২৭ ■ ৩০ খণ্ডি আঠাল ১৪৪২



নারিকেলের ক্ষতিকর পোকামাকড়ের সমন্বিত দমন ব্যবস্থাপনা শীর্ষক কৃষক মাঠ দিবসের আয়োজন করে বিএআরআই'র কীটতত্ত্ব বিভাগ এবং আরএআরএস'র বৌখতাবে আয়োজন করে। মাঠ দিবসের অনুষ্ঠানে জেলায় উজিরপুর ও বাগুজ্ঞের ৫০ জন কৃষক-কৃষানী অংশগ্রহণ করেন।

## কৃষি গবেষণা কেন্দ্রে নারিকেলের পোকা দমনের ওপর মাঠদিবস অনুষ্ঠিত

**স্টাফ রিপোর্ট :** নারিকেলের ক্ষতিকর পোকামাকড়ের সমন্বিত দমন ব্যবস্থাপনা শীর্ষক কৃষক মাঠ দিবসের আয়োজন করে বিএআরআই'র কীটতত্ত্ব বিভাগ এবং আরএআরএস'র বৌখতাবে কৃষকদের ব্যবহারিক প্রশিক্ষণের (মাঠ দিবস) আয়োজন করে। মাঠ দিবসের অনুষ্ঠানে জেলায় উজিরপুর ও বাগুজ্ঞের ৫০ জন কৃষক-কৃষানী অংশগ্রহণ করেন।

**প্রধান অতিথি :** এ উপলক্ষে এক আশোমনা সভায় প্রধান অতিথি ছিলেন বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউটের (বিএআরআই) পরিচালক ড. মুহাম্মদ সামসুল আলম। আরএআরএস'র মুখ্য বৈজ্ঞানিক কর্মকর্তা মো. রফি উদ্দিনের সভাপতিত্বে অনুষ্ঠানে বিশেষ অতিথি ছিলেন বিএআরআই কীটতত্ত্ব বিভাগের মুখ্য বৈজ্ঞানিক কর্মকর্তা ড. নির্মল কুমার দত্ত এবং ভাসমান কৃষি প্রকল্পের পরিচালক ড. মো. মোজাম্মিল রহমান তালুকদার।

সভায় কৃষি বিশেষজ্ঞরা বলেন, ফসলের ক্ষতিকর প্রাণীসহ কিছু পোকামাকড় দূশমান। আবার কিছু আছে খালি চোখে দেখা যায় না। এরা প্রথমে আক্রমণ করে। পরে রোগের সৃষ্টি হয়। তাই নারিকেল এবং অন্যান্য ফসলের সুরক্ষার জন্য এদের দমন জরুরি। তবে সেটা অবশ্যই নিরাপদ উপায়ে হতে হবে।

দৈনিক বরিশাল

# ভোরের আলো

১১ নভেম্বর ২০২০  
১৬ নভেম্বর ২০২০  
৩০ খণ্ডি আঠি ১৪৪২

মঙ্গলবার

## বরিশালে নারিকেলের পোকা দমন ব্যবস্থাপনা মাঠ দিবস অনুষ্ঠিত

বিজয় প্রতিবেদক ১

নারিকেলের ক্ষতিকর পোকামাকড়ের সমন্বিত দমন ব্যবস্থাপনা শীর্ষক কৃষক মাঠ দিবসের আয়োজন করে বিএআরআই'র কীটতত্ত্ব বিভাগ এবং আরএআরএস'র বৌখতাবে কৃষকদের ব্যবহারিক প্রশিক্ষণের (মাঠ দিবস) আয়োজন করে। মাঠ দিবসের অনুষ্ঠানে জেলায় উজিরপুর ও বাগুজ্ঞের ৫০ জন কৃষক-কৃষানী অংশগ্রহণ করেন।

**প্রধান অতিথি :** এ উপলক্ষে এক আশোমনা সভায় প্রধান অতিথি ছিলেন বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউটের (বিএআরআই) পরিচালক ড. মুহাম্মদ সামসুল আলম। আরএআরএস'র মুখ্য বৈজ্ঞানিক কর্মকর্তা মো. রফি উদ্দিনের সভাপতিত্বে অনুষ্ঠানে বিশেষ অতিথি ছিলেন বিএআরআই কীটতত্ত্ব বিভাগের মুখ্য বৈজ্ঞানিক কর্মকর্তা ড. নির্মল কুমার দত্ত এবং ভাসমান কৃষি প্রকল্পের পরিচালক ড. মো. মোজাম্মিল রহমান তালুকদার।

সভায় কৃষি বিশেষজ্ঞরা বলেন, ফসলের ক্ষতিকর প্রাণীসহ কিছু পোকামাকড় দূশমান। আবার কিছু আছে খালি চোখে দেখা যায় না। এরা প্রথমে আক্রমণ করে। পরে রোগের সৃষ্টি হয়। তাই নারিকেল এবং অন্যান্য ফসলের সুরক্ষার জন্য এদের দমন জরুরি। তবে সেটা অবশ্যই নিরাপদ উপায়ে হতে হবে।

বৃহস্পতিবার

১৫ আশ্বিন ১৪২৮  
৩০ সেপ্টেম্বর ২০২১

দৈনিক বরিশাল

# ভোরের আলো

২২ সফর ১৪৪২

## বরিশালে নারিকেলের পোকা দমন ব্যবস্থাপনা বিষয়ক মাঠ দিবস অনুষ্ঠিত

বিজয় প্রতিবেদক ১

নারিকেলের ক্ষতিকর পোকামাকড়ের সমন্বিত দমন ব্যবস্থাপনা শীর্ষক কৃষক মাঠ দিবসের আয়োজন করে বিএআরআই'র কীটতত্ত্ব বিভাগ এবং আরএআরএস'র বৌখতাবে কৃষকদের ব্যবহারিক প্রশিক্ষণের (মাঠ দিবস) আয়োজন করে। মাঠ দিবসের অনুষ্ঠানে জেলায় উজিরপুর ও বাগুজ্ঞের ৫০ জন কৃষক-কৃষানী অংশগ্রহণ করেন।

**প্রধান অতিথি :** এ উপলক্ষে এক আশোমনা সভায় প্রধান অতিথি ছিলেন বাংলাদেশ কৃষি গবেষণা ইনস্টিটিউটের (বিএআরআই) পরিচালক ড. মুহাম্মদ সামসুল আলম। আরএআরএস'র মুখ্য বৈজ্ঞানিক কর্মকর্তা মো. রফি উদ্দিনের সভাপতিত্বে অনুষ্ঠানে বিশেষ অতিথি ছিলেন বিএআরআই কীটতত্ত্ব বিভাগের মুখ্য বৈজ্ঞানিক কর্মকর্তা ড. নির্মল কুমার দত্ত এবং ভাসমান কৃষি প্রকল্পের পরিচালক ড. মো. মোজাম্মিল রহমান তালুকদার।

সভায় কৃষি বিশেষজ্ঞরা বলেন, ফসলের ক্ষতিকর প্রাণীসহ কিছু পোকামাকড় দূশমান। আবার কিছু আছে খালি চোখে দেখা যায় না। এরা প্রথমে আক্রমণ করে। পরে রোগের সৃষ্টি হয়। তাই নারিকেল এবং অন্যান্য ফসলের সুরক্ষার জন্য এদের দমন জরুরি। তবে সেটা অবশ্যই নিরাপদ উপায়ে হতে হবে।

**Annexture-4 (Project activities in photographs)  
Component-1: Entomology Division, BARI**



**Field day at RARS, Jashore, 31 October, 2020**



**Field day at RARS, Barishal, 16 November, 2020**



**Field day at Kestopara, Jashore, 11 December, 2020**



**Field day at RARS, Jashore, 12 December, 2020**



**Field day at RARS, Barishal, 18 January, 2021**



**Filed validation trial at Barishal**

**(Project activities by Component-3: SSURDA)**



**Fig 1. Farmers Field in Jashore**



**Coconut disease at Satkhira**



**Farmers field at Satkhira**



**Irrigation application**



**Application of fertilizer**



**Spraying of chemical**



**After treatment: Production in**

## Field day organized by Component-3: SSURDA



Field day at Jashore



Field day at Satkhira