



# Efficacy of integrated disease management technologies in the management of basal stem rot disease in coconut

Dr.K.Rajappan and Dr.R.Vaithilingam\*

## Introduction

Coconut being a multi-utility crop, is cultivated in 93 countries in the world. India ranks first in production and third in productivity. In India coconut is cultivated in Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Orissa and West Bengal. Although over 50 different diseases have been reported in coconut through out the world, the basal stem rot (BSR) disease caused by the species of *Ganoderma* is one of the serious threats to coconut cultivation in Tamil Nadu and Andhra Pradesh. The pathogen is soil and water-borne and poses greater problems in devising the management strategies. Charting the management technologies for soil borne diseases are really a challenging task because of the year round availability of pathogen in the soil and that too coconut being a perennial crop it is needless to say the perpetuation of the inoculum in the soil.

Different management practices have been tested to contain the disease from time to time and some of them were found effective in managing the disease (Vijayan and Natarajan, 1975; Anon. 1978a;

Bhaskaran and Ramanathan, 1983). For a soil-borne disease like BSR in coconut, integration of disease control methods like agronomical / cultural, biological and chemical are very important to achieve a desirable result. The successful implementation of any community development programme (CDP) is purely based on the active participation and co-operation of the participating community. Apart from that the knowledge of the CDP on the participating side is also one of the key factors deciding the fate of the programme. Therefore, in the present project, efforts were undertaken to demonstrate the effectiveness of integrated disease management (IDM) technologies against BSR disease in coconut in farmers' fields through participatory approach with regular training to farmers and to assess the impact of this methodology on the socio-personal-economic variables of the participating farmers.

## Materials and methods

Twenty coconut gardens were selected in farmers fields at Thamarankottai, Parakkalakottai, Mannankadu, Krishnapuram and Mahizhankottai villages with an area

**The integrated Disease management technologies adopted against Basal stem rot disease in coconut have significantly increased the nut yield besides arresting the further spread of the disease. Further the adoption of IDM technologies led to enhanced rhizosphere population of *Trichoderma viride* and *Pseudomonas fluorescens*.**

\*Coconut Research Station, Tamil Nadu Agricultural University, Veppankulam-614 906



of one ha each and the following technologies were imposed.

### I. Agronomic/cultural

- Basin method of irrigation
- Application of recommended dose of fertilizers (RDF)
- Application of 5 kg of neem cake / palm / year
- Application of 50 kg of FYM / palm / year
- Basin management with 50 g of sunnhemp & *in situ* incorporation
- Intercropping with banana in two rows within two rows of coconut.

### II. Biological

- Application of *Trichoderma viride* @ 200 g / palm / year
- Application of *Pseudomonas fluorescens* @ 200 g / palm / year

### III. Chemical

- Root feeding with Calixin / Hexaconazole @ 2 ml with 100 ml of water at quarterly interval.

Nuts were harvested and nut yield / palm were calculated before and after imposing the treatments. The nuts were sold in the market and the Cost: Benefit ratio per palm was calculated at the end of third year. Before applying the treatments the initial disease index in all locations were worked out using the following formula,

$$DI = 23.6 + 17.7h + 3.6 \times r - 0.6 \times l$$

Where

h = height of bleeding in meters

r = reduction of leaf size in 0-4 scale

l = number of functional leaves in the crown

Subsequently the disease intensity was recorded at the end of first, second and third year. The population of *Trichoderma viride* and *Pseudomonas fluorescens* was recorded before imposing the treatments and at the end of first, second and third year. Among the first selected twenty farmers, ten were non co-operative in terms of failure of implementing full technologies included in the package and hence they were removed at the end of the first year and 10 new farmers were selected and included for second and third years.

### Training

Trainings were conducted to the farmers during the first, second and third years about the importance of the IDM technologies in managing the disease and exposure visits were also undertaken in all the three years. The feed back was collected from the farmers about this programme.

## Results and Discussion

### Nut yield

After the treatment the nut yield was recorded at the end of 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> year and the results are presented in table 2. The treatments had influenced both the yield and disease incidence over the years. The yield has increased gradually while the disease index remained the same and in some cases small reduction was observed. As far as nut yields are concerned the initial mean nut yield per palm per year was 58.75 / 57.40 and was gradually increased to 66.4, 67.3 and 70.3 respectively at the end of 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> year. With regard to the individual farmer's nut yield, in Mrs. M. Saroja's field, the initial nut yield recorded was 65 per palm / year

and it was increased to 85 / palm / year at the end of 3<sup>rd</sup> year resulting in an increase of 30.76%. In the case of Mrs. Senthamizhselvi's field, an increase of 34% in nut yield was recorded due to the adoption of IDM technologies, which have effectively contained the basal stem rot disease in coconut (Table 1).

### Disease incidence

The initial disease index before the application of IDM technologies was found to range from 2.0 to 45.2 with a mean of 22.4 / 60.6 while, at the end of 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> year, the mean disease index recorded was 22.1, 16.1 and 16.0 respectively.

Mrs. Kadugulakshmi's field at Vendakkottai has recorded the least disease index of 2.0 while, Mr. K. Balusamithevar's field at Parakalakottai has recorded the maximum disease index of 30.0 (Table 1).

### Effect of IDM technologies on the population dynamics of biocontrol agents

Integrated disease management technologies adopted to manage BSR in coconut had a profound effect on the population levels of biocontrol agents namely *Pseudomonas fluorescens* and *Trichoderma viride*. Initial population of the above two biocontrol agents was assessed before the implementation of the IDM technologies. The biocontrol agents were applied at the beginning of first, second and third year of the project and their population levels were estimated at the end of each year. The mean initial population of *Pseudomonas fluorescens* ranged from 32.2 to 45.4 x 10<sup>5</sup> cfu / gram

Table 1. Effect of integrated disease management practices on basal stem rot disease incidence and yield of coconut

| Name of the farmer                                  | Disease index    |             |             |             | Nut yield / palm / year |             |             |             |
|---|------------------|-------------|-------------|-------------|-------------------------|-------------|-------------|-------------|
|   | Initial          | I year      | II year     | III year    | Initial                 | I year      | II year     | III year    |
| Mrs. M. Saroja                                      | 20.5             | 19.6        | 19.6        | 19.0        | 65                      | 80          | 83          | 85          |
| Mr. R. Vairavasundaram                              | 28.2             | 28.0        | 28.0        | 28.0        | 65                      | 73          | 77          | 82          |
| Mrs. T. Ariyamuthu                                  | 14.9             | 14.5        | 14.5        | 14.0        | 70                      | 80          | 82          | 82          |
| Mr. V. Arunachalam                                  | 25.3             | 25.0        | 25.0        | 25.0        | 62                      | 69          | 72          | 72          |
| Mr. K. Balusami thevar                              | 35.5             | 30.0        | 30.0        | 30.0        | 65                      | 71          | 75          | 77          |
| Mr. R. Palanidurai                                  | 22.8             | 22.0        | 22.0        | 22.0        | 67                      | 75          | 75          | 77          |
| Mr. R. Balasubramanian                              | 20.8             | 20.8        | 20.5        | 20.0        | 60                      | 65          | 67          | 70          |
| Mr. Rajendran                                       | 10.9             | 10.9        | 10.9        | 10.9        | 55                      | 60          | 63          | 65          |
| Mrs. S. Tamilselvi                                  | 17.4             | 17.4        | 17.4        | 17.4        | 60                      | 65          | 67          | 70          |
| Mr. N. M. S. Jebaharali                             | 10.5             | 10.0        | 10.0        | 10.0        | 58                      | 63          | 67          | 70          |
| Mr. C. Subramanian*and<br>Mr. T. Thirunavukarasu**  | 40.010.0         | 40.0-       | -12.0       | -12.0       | 6255                    | 75-         | -62         | -67         |
| Mr. Kathavellalar *and<br>Mrs. Meenakshi **         | 24.512.0         | 23.0-       | -10.0       | -10.0       | 5252                    | 63-         | -62         | -65         |
| Mr. C. Narayanasamy *<br>and Mrs. Senbagavalli **   | 17.015.0         | 24.5-       | -12.0       | -12.0       | 5555                    | 60-         | -60         | -65         |
| Mr. K. Govindarajan *and<br>Mr. M. Rajapackiyam **  | 17.015.0         | 17.0-       | -15.0       | -15.0       | 6255                    | 70-         | -62         | -67         |
| Mr. A. Natarajan *and<br>Mr. Vaithilingam **        | 12.915.0         | 12.0-       | -15.0       | -15.0       | 6550                    | 70-         | -60         | -65         |
| Mr. I. Karthikeyan *and<br>Mrs. Jamuna **           | 15.515.0         | 20.5-       | -15.0       | -15.0       | 5052                    | 55-         | -60         | -63         |
| Th. P. Selvanayagam *<br>and Th. Mohamed Asiar **   | 45.215.5         | 45.2-       | -15.5       | -15.0       | 4550                    | 55-         | -62         | -65         |
| Th. B. Venkatachalam *<br>and Th. Sikkather **      | 18.517.0         | 18.0-       | -17.0       | 17.0        | 5550                    | 63-         | -60         | -65         |
| Mr. M. Abdul Munaf *<br>and Mrs. Senthamizhselvi ** | 25.212.0         | 25.0-       | -12.0       | -12.0       | 5250                    | 60-         | -65         | -67         |
| Mr. M. Basheer Ahamed*<br>and Mrs. Kadugulakshmi ** | 20.12.0          | 20.1-       | -2.0        | -2.0        | 5052                    | 57-         | -65         | -67         |
| <b>Mean</b>   | <b>22.4/16.6</b> | <b>22.1</b> | <b>16.1</b> | <b>16.0</b> | <b>58.75/57.40</b>      | <b>66.4</b> | <b>67.3</b> | <b>70.3</b> |

\* These farmers were rejected at the end of first year because of non co-operation.

\*\* These farmers were selected at the beginning of the second year.

dry soil and this was increased to 49.6, 68.1 and 78.6 x 10<sup>5</sup> cfu / gram dry soil respectively at the end of first, second and third year. Similarly the initial mean population of *Trichoderma viride* before the implementation of IDM technologies ranged from 40.6 to 46.9 x 10<sup>3</sup> cfu / gram dry weight of soil. The application of 200 g of talc based formulation of *Trichoderma*

*viride* per palm / year has increased the population level of this biocontrol agent. The mean population recorded at the end of first year was 59.9 x 10<sup>3</sup> cfu / gram dry soil and it was increased to 68.9 x 10<sup>3</sup> cfu / gram dry soil at the end of second year whereas it was further enhanced to 78.9 x 10<sup>3</sup> cfu / gram dry soil at the end of third year (Table 2).

### Socio-personal-economic variables of the participating farmers

The farmers selected under this programme are small farmers and their holdings ranged from 1-10 acres. They are on the lower layer of the society. The basal stem rot disease has severely reduced the yield potential of the palms and the average nut yield ranged from 57.40 to 58.75

Table 2. Effect of integrated disease management practices on the rhizosphere population of *Pseudomonas fluorescens* and *Trichoderma viride*.

| Name & address of the farmer                        | Population of<br><i>Pseudomonas fluorescens</i><br>(Cfu x 10 <sup>2</sup> /g dry soil) |              |              |             | Population of<br><i>Trichoderma viride</i><br>(Cfu x 10 <sup>2</sup> /g dry soil) |              |              |             |
|---|--|--------------|--------------|-------------|---|--------------|--------------|-------------|
|   | Initial  | I year       | II year      | III year    | Initial   | I year       | II year      | III year    |
| Mrs. M. Saroja                                      | 37.0   | 51.7         | 70.2         | 80.0        | 37.0  | 51.7         | 65.0         | 75.0        |
| Mr. R. Vairavasundaram                              | 37.0   | 45.3         | 60.0         | 78.0        | 33.5  | 70.6         | 77.0         | 82.0        |
| Mrs. T. Ariyamuthu                                  | 32.0   | 46.6         | 52.5         | 80.0        | 38.5  | 65.0         | 75.0         | 80.0        |
| Mr. V. Arunachalam                                  | 25.5   | 46.0         | 65.0         | 75.0        | 40.8  | 65.5         | 70.0         | 78.0        |
| Mr. K. Balusami thevar                              | 27.5   | 51.3         | 68.0         | 80.0        | 67.0  | 72.0         | 75.0         | 82.0        |
| Mr. R. Palanidurai                                  | 50.5   | 70.3         | 75.0         | 88.0        | 50.0  | 69.0         | 72.0         | 85.0        |
| Mr. R. Balasubramanian                              | 31.2   | 52.3         | 65.0         | 75.0        | 35.0  | 70.0         | 75.0         | 80.0        |
| Mr. Rajendran                                       | 30.1   | 43.6         | 52.0         | 70.0        | 45.2  | 62.0         | 65.0         | 80.0        |
| Mrs. S. Tamilselvi                                  | 40.1   | 53.6         | 62.0         | 72.0        | 42.0  | 65.8         | 70.0         | 85.0        |
| Mr. N. M. S. Jehabarali                             | 33.1   | 49.2         | 72.0         | 82.0        | 38.0  | 56.0         | 65.0         | 75.0        |
| Mr. C. Subramanian*<br>and Mr. T. Thirunavukarasu** | 28.060.0   | 50.0-        | -80.0        | -85.0       | 45.350.0  | 60.3-        | -70.0        | -82.0       |
| Mr. Kathavellalar *<br>and Mrs. Meenakshi **        | 35.055.0   | 50.3-        | -70.0        | -77.0       | 40.247.0  | 67.0-        | -60.0        | -75.0       |
| Mr. C. Narayanasamy *<br>and Mrs. Senbagavalli **   | 28.060.0   | 50.0-        | -70.0        | -75.0       | 39.245.0  | 55.3-        | -65.0        | -80.0       |
| Mr. K. Govindarajan *<br>and Mr. M. Rajapackiyam ** | 28.155.0   | 47.0-        | -67.0        | -75.0       | 42.255.0  | 55.0-        | -70.0        | -80.0       |
| Mr. A. Natarajan *<br>and Mr. Vaithilingam **       | 33.060.0   | 47.0-        | -70.0        | -79.0       | 33.750.0  | 65.0-        | -65.0        | -75.0       |
| Mr. I. Karthikeyan *<br>and Mrs. Jamuna **          | 34.260.0   | 45.0-        | -75.0        | -82.0       | 35.050  | 45.0-        | -70.0        | -77.0       |
| Mr. P. Selvanayagam *<br>and Mr. Mohamed Asiar **   | 28.550.0   | 41.3-        | -67.0        | -75.0       | 40.255.0  | 50.0-        | -65.0        | -77.0       |
| Mr. B. Venkatachalam *<br>and Mr. Sikkantner **     | 23.250.0   | 46.0-        | -65.0        | -79.0       | 32.345.0  | 48.0-        | -55.0        | -65.0       |
| Mr. M. Abdul Munaf *<br>and Mrs. Senthamizhselvi ** | 29.855.0   | 55.3-        | -82.0        | -85.0       | 38.060.0  | 50.0-        | -80.0        | -85.0       |
| Mr. M. Basheer Ahamed*<br>and Mrs. Kadugulakshmi ** | 32.360.0   | 52.0-        | -75.0        | -80.0       | 39.055.0  | 55.0-        | -70.0        | -80.0       |
| <b>Mean</b>   | <b>32.20/45.45</b>   | <b>49.69</b> | <b>68.13</b> | <b>78.6</b> | <b>40.60/46.95</b>  | <b>59.91</b> | <b>68.95</b> | <b>78.9</b> |

\* These farmers were rejected at the end of first year because of non co-operation.

\*\* These farmers were selected at the beginning of the second year.

per palm per year. Since, the yield potential of their palms was low; the income generated through selling of nuts was also low.

The implementation of integrated disease management technologies for basal stem rot in coconut has arrested the further spread of the disease both vertically and

horizontally. This has improved the health and vigour of the palms, which resulted the in increased nut yields. At the end of third year the average nut yield recorded / palm / year was 70.3 when compared to the initial average of 58.75. Hence, it is clear that the adoption of integrated disease management technologies for basal stem rot disease in coconut

has ultimately resulted in improving the income of the farmers.

#### Cost-Benefit ratio of the technology

The adoption of integrated disease management technologies for basal stem rot disease management has resulted in increased yield of the palms in all



demonstration trials undertaken under the farmer holdings and the Cost-Benefit ratio of the technology is presented in table 3.

Table.3. Cost -Benefit ratio of the integrated disease management technologies for basal stem rot disease in coconut.

| Name of the farmer      | C:B ratio / palm at the end of third year |
|-------------------------|---|
| Mrs. M. Saroja          | 1:1.95                                    |
| Mr. R. Vairavasundaram  | 1:1.85                                    |
| Mrs. T. Ariyamuthu      | 1:1.85                                    |
| Mr. V. Arunachalam      | 1:1.50                                    |
| Mr. K. Balusamy thevar  | 1:1.67                                    |
| Mr. R. Palanidurai      | 1:1.67                                    |
| Mr. R. Balasubramanian  | 1:1.43                                    |
| Mr. Rajendran           | 1:1.25                                    |
| Mrs. S. Tamilselvi      | 1:1.43                                    |
| Mr. N. M. S. Jebaharali | 1:1.43                                    |
| Mr. T. Thirunavukkarasu | 1:1.32                                    |
| Mrs. Meenakshi          | 1:1.25                                    |
| Mrs. Senbagavalli       | 1:1.25                                    |
| Mr. M. Rajapackiyam     | 1:1.32                                    |
| Mr. Vaithilingam        | 1:1.25                                    |
| Mrs. Jamuna             | 1:1.18                                    |
| Mr. Mohamed Asiar       | 1:1.25                                    |
| Mr. Sikkantner          | 1:1.25                                    |
| Mrs. Senthamizhselvi    | 1:1.32                                    |
| Mrs. Kadugulakshmi      | 1:1.32                                    |
| <b>Mean</b>             | <b>1:1.43</b>                             |

The C: B ratio ranged from 1:1.18 to 1:1.95 with a mean C: B ratio of 1:1.43 at the end of third year

### Training

Through the training, the following were inferred from the participants,

- They gained knowledge about Basal stem rot disease initiation, nature of symptoms, spread, advanced stage and the name of causal agent (*Ganoderma lucidum*) and integrated disease management
- They have understood the importance of banana intercropping in minimizing the

severity of the BSR through root exudates from banana root.

- They obtained additional income from banana.
- The farmers have realized the importance and activities of neem cake, sunnhemp, Calixin root feeding and recommended dose of fertilizers in minimizing the disease.
- They felt the significance of bio fungicide application like *Trichoderma viride* & *Pseudomonas fluorescens* in increasing the nut yield

### Impact

The integrated Disease management technologies adopted against Basal stem rot disease in coconut have significantly increased the nut yield besides arresting the further spread of the disease. Further the adoption of IDM technologies led to enhanced rhizosphere population of *Trichoderma viride* and *Pseudomonas fluorescens*. The farmers were impressed upon the effectiveness of IDM technologies in containing the further spread of the disease both by vertical and horizontal means. The farmers are now advocating their fellow farmers and relatives about the effectiveness of IDM technologies in the successful management of basal stem rot disease in coconut. The IDM technologies recommended for containment of BSR are listed below.

1. Basin method of irrigation to avoid horizontal spread of BSR disease.
2. Application of 50 kg FYM / palm / year along with recommended dose of inorganic fertilizers.

Urea : 1.3 kg / palm / year  
Super Phosphate : 2.0 kg / palm / year  
Muriate of Potash : 2.0 kg / palm / year

3. Application of 5 kg neem cake / palm / year
4. Basin management with green manure crop viz., sunnhemp and *in situ* incorporation in soil before flowering
5. Intercropping with banana
6. Avoidance of injury to roots
7. Application of *Trichoderma viride* @ 200 g / palm / year.
8. Application of *Pseudomonas fluorescens* @ 200 g / palm / year.
9. Root feeding with Tridemorph 2% @ 100 ml / palm at quarterly interval thrice / year to the BSR infected palms only
10. Swabbing with Sevin @ 3g / lit to the bark beetle infested palms only.

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