Technical Bulletin No. 73

Eco-friendly integrated pest and disease management technologies in major vegetable crops of Goa

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R. Ramesh

भा.कृ.अनु.प.-केंद्रीय तटीय कृषि अनुसंधान संस्थान
(भारतीय कृषि अनुसंधान परिषद)
ओल्ड गोवा ४०३ ४०२, गोवा, भारत

ICAR - Central Coastal Agricultural Research Institute
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Correct Citation: Maruthadurai. R and R. Ramesh (2023). Eco-friendly integrated pest and disease management technologies in major vegetable crops of Goa, Technical Bulletin No: 73, ICAR - Central Coastal Agricultural Research Institute (Indian Council of Agricultural Research), Ela, Old Goa-403 402, Goa, India. PP 1-52

Acknowledgement

The financial assistance from NABARD for this project "Empowerment of Farmers through Adoption of Sustainable and Eco-Friendly Integrated Pest and Diseases Management Technologies in Major Vegetable Crops in Goa" (NB. Goa. FSDD.1095.B.FSDD.2019-20) is acknowledged.

Foreword

Vegetables play an important role in providing nutritional security to the people, since they are easily available and cheaper sources of vitamins, minerals and other essential nutrients for human beings. Vegetables are cultivated in Goa on hill slopes and in paddy fallows during *Kharif* and *Rabi* season respectively. *Kharif* season vegetables are cucurbits (cucumber, ridge gourd, snake gourd, bitter gourd, pumpkin, etc), bhendi, chilli etc. *Rabi* season vegetables are chilli, brinjal, okra, leafy vegetables and sweet potato. These vegetables are cultivated an area about 7240 ha in Goa. The productivity of vegetable crops is reducing day by day and one of the main reasons is the losses caused by insect pests and diseases. The climatic condition in Goa is very hot and humid which is favourable for the incidence of insect pests and diseases in vegetable crops causing severe loss in the production and productivity and sometimes complete failure of crops. Management strategies for these insect pests and diseases mainly involve extensive use of pesticides, which may have a harmful effect on human health and the environment. Integrated pest and disease management technologies have been encouraged much as a viable alternative to chemical pesticide.

This technical bulletin is based on the scientific studies of a NABARD sponsored research project "**Empowerment of Farmers through Adoption of Sustainable and Eco-Friendly Integrated Pest and Diseases Management Technologies in Major Vegetables Crop in Goa".** Under the project, large scale on-field demonstrations and trainings have been organised in different taluk of Goa on use of IPDM technologies for sustainable management of insect pests and diseases of vegetable crops. This technical bulletin contains detailed information of damage symptoms, pest biology, use of bio-control agents, resistant varieties, grafting techniques and preparation of sticky traps. I hope this technical bulletin will be useful to agricultural officers, field extension personnel and progressive farmers.

Dr. Parveen Kumar
Director

Message

Vegetables are an integral part of Indian agriculture as they ensure the food and nutritional security of the country apart from enhancing per capita income of the farmers. However, Pest infestation is one of major constraint in vegetable production and can cause losses in the range of 10-30 per cent. To overcome this issue, farmers use chemical pesticides as first line of defence and generally resort to indiscriminate and non-judicious use of pesticides. Presently, integrated pest and disease management technologies are being encouraged as a viable alternative to chemical pesticide. Most of the farmers are not aware about the use of eco-friendly pest management approaches. Towards this objective, NABARD Goa Regional Office has sanctioned the project titled "**Empowerment of Farmers through Adoption of Sustainable and Eco-Friendly Integrated Pest and Diseases Management Technologies in Major Vegetables Crop in Goa"** to ICAR-Central Coastal Agricultural Research Institute under 'Farm Sector Promotion Fund (FSPF).

Under the project, ICAR-CCARI had conducted extensive awareness training programme and demonstrated sustainable management of pests and diseases in Chilli on 23 ha area. More than 850 farmers have been received the plan protection inputs like biocontrol agents, spinosad, chitosan, sticky traps and resistant brinjal varieties. Hands on training on use of biocontrol agents, preparation of yellow and blue sticky traps and grafting technique has also been imparted to the farmers. The project is successful in demonstrating the impact in terms of reduction in pests and increase in income of the farmers. I congratulate ICAR-CCARI, Goa for successfully implementing the project and their sincere efforts towards publication of this bulletin. I am sure, this bulletin will be useful to farmers and other extension personnel.

Dr. Milind R Bhirud
General Manager / Officer-in-Charge
NABARD, Goa RO, Panaji

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Eco-friendly integrated pest and disease management technologies in major vegetable crops of Goa

Introduction

Vegetables play a major role in Indian agriculture as they ensure the food and nutritional security of the country apart from enhancing per capita income of the farmers. Vegetables are cultivated in Goa on hill slopes and in paddy fallows during kharif and rabi season respectively. Kharif season vegetables are cucurbits (Cucumber, Ridge gourd, Snake gourd, Bitter gourd, Pumpkin, Ivy gourd etc), bhendi, chilli etc. Rabi season vegetables are Chilli, Brinjal, Okra, leafy vegetables and sweet potato. These vegetables are cultivated an area about 7240 ha in Goa. The productivity of vegetable crops in coastal region is reducing day by day and one of the main reasons is the losses caused by insect pests and diseases. The climatic condition in Goa is hot and humid which is favourable for the incidence of insect pests and diseases in vegetable crops causing severe loss in the production and productivity and sometimes complete failure of crops.

Insect pests:

Sucking insects viz., thrips *Scirtothrips dorsalis*, mites *Polyphagotarsonemus latus* and Whitefly *Bemisia tabasi* are major problem in chilli and bhendi. Yield losses due to these pest attacks may range from 25-50 %. Fruit flies are the major pest in cucurbitaceous and cucumber being the most susceptible one. It causes damage to an extent of 30 per cent yield loss. Sweet potato weevil (SPW) is the major pest in sweet potato. It causes yield losses in the range of 25-45%.

Diseases:

Some of the major disease problems in the vegetables grown under coastal areas can be broadly grouped into soil borne (Bacterial wilt, *Fusarium* wilt, *Sclerotium* rot, *Rhizoctonia, Pythium, Phytophthora*); foliar (Leaf spots, leaf blight, downymildew, powderymildew, grey mould); bacterial (*Xanthomonas, Pseudomonas, Erwinia*) and Viral diseases. Among these bacterial wilt in brinjal, chilli and viral diseases of chilli are very severe. Bacterial wilt affects economically important solanaceous vegetables (brinjal, chilli, and tomato). Though the above crops are grown throughout the country, the severity of the disease is very high in western and southern coastal states including Goa (Ramesh *et al.*, 2014). No commercial chemicals are effective and majority of the varieties are susceptible. In recent times, viral diseases of chilli are quite serious and complete crop loss in rabi crop is reported.

At present, various pests in vegetables cause losses in the range of 10-30 per cent depending upon the infestation severity. Farmers use pesticides as first line of defense and frequently resort to indiscriminate and non-judicious use of pesticides. Vegetable crops receive considerably high quantity of pesticides, and with a cropped area of three per cent, they consume 13 per cent of the total pesticides in the country (Nigam and Murthy, 2000). The effect of chemical pesticide use is more harmful in vegetables. However these measures lead to several problems such as environmental pollution, pesticide residue in the harvested products, development of resistance/resurgence in pests, emergence of new pests, destruction of natural enemies and pollinators, and increased cost of production. These problems have necessitated the search for safer and effective methods of pest control, including behavioural, bio-control and botanical bio-pesticides. Eco-friendly pest management approach has been globally accepted in order to minimize the indiscriminate and injudicious use of chemical pesticides for achieving sustainability in Agriculture. The sustainable measures comprising of cultural practices, resistant/tolerant varieties, bio-control agents, botanicals and bio- pesticides.

Eco-friendly pest management approaches has become more relevant due to a number of advantages like safety to environment, pesticide-free food commodities and low input based crop protection programme etc. Most of the farmers are not aware about the use of eco-friendly pest management approaches. The project will focus on use of eco-friendly pest management approaches to manage the vegetable insect pests and diseases and to increase the productivity. Field demonstrations and hands on trainings will be provided to the farmers and other stakeholders on sticky trap preparation, placement, use of entomopathogenic fungus, preparation of neem bio-pesticides, use of resistant varieties, biocontrol agents for managing diseases, grafting techniques for wilt management and other eco-friendly pest management technologies. Besides trainings and demonstrations farmers also provided eco-friendly pest management technologies kit. Since the concept will reduce dependence on chemical pesticides and has relevance to Paramparagat krishi vikas yojana.

Objectives of the project

- To capacity building of farmers through organization of trainings and demonstrations on Integrated pest and disease management (IPDM) technologies
- To conduct field demonstrations on use of IPDM technologies

Major insect pests of chilli

Chilli Thrips: *Scirtothrips dorsalis Hood* (Thysanoptera: Thripidae)

Symptoms of damage

- Nymphs and adults suck the cell sap of tender leaves, buds, flowers and fruits leads to necrosis of the cell tissues.
- The growing tip of the plant and young leaves, especially the axillary leaves, are the main points of attack.
- Heavy infestation of the tender shoots, buds and flowers causes the leaves to crinkle and curl upward.
- Infested tender leaves and fresh buds become brittle and thicker resulting in complete defoliation.
- Infested fruits develop corky tissues
- Severe infestation leads to stunted growth, malformation of tender shoots and complete crop loss
- Yield loss due to thrips attack may range from 25-50 %.

Whitefly *Bemisia tabaci* ***(Gennadius)*** **(Hemiptera: Aleyrodidae)**

Symptoms of damage

- Presence of large number of nymphs and adults on the under surface of leaves
- Nymphs and adults suck the cell sap of leaves causes crinkling and curling of leaves
- The characteristic field symptoms are upward curling, puckering, vein thickening, shortened internode length and reduced size of leaves.
- Severely affected plants show stunted growth
- It excrete honey dew on which black sooty mould develops impairing the photosynthetic activity of the plant.

Aphids *Aphis gossypii* ***(Glover) and*** *Myzus persicae* ***(Sulzer)***

Symptoms of damage

- Presence of large number of nymphs and adults on the under surface of leaves, growing shoots, fruiting bodies and stems along with ant colonies.
- Both nymphs and adults suck the cell sap from leaves and tender apical shootscauses crinkling and curling of leaves
- Aphidsalso excrete honey dew on which black sooty mould develops impairing thephotosynthetic activity of the plant.
- The infested plants become weak, pale and stunted in growth

Yellow mite or muranai mite: *Polyphagotarsonemus latus*

Symptoms of damage

- Both nymphs and adults suck the sap from tender leaves and causes crinkling and downward curling of leaves.
- Affected leaves become narrow, twisted with elongated petiole.
- The affected leaves becoming inverted boat shaped and turning dark green in colour
- Clustering of younger leaves at the tip of branch
- Stunted growth of plants and dropping of flowers.

Major diseases of chilli

Bacterial wilt (*Ralstonia solanacearum*)

Symptoms

- Symptoms manifest initially as leaf drooping followed by wilting of entire plant within a few days.
- Recently wilted plants look green, a distinct symptom when compared to other vascular wilt diseases which develops yellowing of the leaves.
- Vascular discoloration (brown) is also seen in the wilted plant.
- Disease develops very rapidly in warm weather.
- Symptoms are very clear during morning or immediately after irrigation.

Chilli leaf curl disease *(Begomovirus: Chilli leaf curl virus)*

Vector: Whitefly (*Bemisia tabaci*)

Symptoms

- Upward curling of leaves, puckering and reduced size of leaves.
- Shortening of internodes, vein clearing, vein swelling, vein thickening, and stunted growth.
- As infection progresses, symptoms of chlorosis, mosaic and mottling develop, and distortion is more prominent.
- The size of leaves and branches is reduced considerably in severely affected plants resulting in a bushy appearance. Such plants bear very few flowers and very few fruits.
- Severely affected plants were stunted and produced no fruit or fruit are small, discolored and distorted.

- If the disease persists later in the life cycle, flower buds will abscise and anthers will set without pollen grains, which ultimately results in poor fruit setting, resulting in distorted or underdeveloped fruit.

Chilli veinal mottle disease *(Potyvirus: Chilli veinal mottle virus, PVy)*

Vector:* Aphids *(Aphis gossypii, Myzus persicae)

Symptoms

- Mottling, vein banding, narrowing and distortion of leaves followed by stunted growth.
- Leaf mottle and dark green vein-banding are the most characteristic symptoms.
- Leaves of some cultivars are smaller and distorted.
- Symptoms are most obvious on the younger, smaller leaves.
- Plants infected when young become stunted and have dark-green streaks on their stems and branches.
- Most of their flowers drop before fruit formation. A few mottled, distorted fruit may be produced. Such symptoms contribute to significant yield losses.

Necrosis virus disease ***(Tospovirus: TSWV, GBNV, WBNV, CaCV)***

Vector: **Thrips** *(Thrips tabaci, Frankliniella schultzei, Scirtothrips dorsalis)*

Symptoms

- Yellow spots or patches followed by occasional chlorotic concentric rings on leaves.
- Bronzing and veinal necrosis of leaves.
- Necrosis of terminal bud/ die-back of shoots are the characteristic symptom.
- Plants infected early are bushy, stunted and die prematurely. In older plants, the symptoms are restricted to a few branches only.
- Leaf distortion in some cases.
- Chlorotic and necrotic spots and rings on leaves and fruits.

Fusarium wilt (*Fusarium oxysporum f.sp. capsici & F. solani*)

Symptoms

- Symptoms may appear at two stages, viz. seedling wilt and adult plant wilt.
- Seedlings show wilting after 3-4 weeks of planting. Foliage of such seedlings turn yellow and plans exhibit wilt symptoms and later dry.
- Disease symptoms often appear later in the growing season and are first noticed on the lower (older) leaves. In older plants, the foliage turns to yellow and gradually leaves wilt.
- As the disease progresses, the younger leaves will also be affected and the plant eventually dies.
- In many cases, only one branch or part of the plant shows symptoms (partial wilt).

Fungal root rot disease (*Phytophthora capsici, Sclerotium rolfsii, Macrophomina phaseolina, Rhizoctonia solani*)

Symptoms

- Seedlings affected by this infestation die soon after germination.
- Growth of infected plants slows as compared to healthy plants.
- Yellowing of older leaves and falling of the leaves.
- Leaf margins die and dry off.
- Presence of light to dark brown lesions and discolouration on the lower portion of the stem adjacent to the ground. This is followed by drooping and wilting of infected leaves and gradual wilting of the whole plant.
- Shredding of bark in the collar region can be seen in few cases.
- Roots appear dark brown or black and few or no healthy, white roots or root tips.

Fruit rot/ anthracnose (*Colletotrichum capsici*)

Symptoms

- Presence of small, circular spots on the skin of the fruit and later turned into large brown/ straw colour.
- Severely affected fruits turned straw coloured from normal red. On the discoloured area, numerous black fungal structures (acervuli) are seen.
- Inside of the diseased fruit was covered with black stromatic masses of the fungus. Seeds are also infected and turned into rusty colour.
- Die-back symptoms during vegetative growth period.

Empowerment of Farmers through Adoption of Sustainable and Eco-Friendly Integrated Pest and Diseases Management Technologies in Major Vegetables Crop in Goa

ICAR-CCARI with assistance from NABARD conducted awareness training programmes and field demonstrations on eco-friendly management of pest and diseases in vegetables.

Areas of implementation

- Tiswadi- Dulapi, Cumbarjua
- Mapusa- Giri-Parra
- Bicholim-mencurem
- Sanguem-Bhati, Vaddem
- Quepem-Pirla
- Canacona-Kinarwada
- Ponda-Farmagudi

Awareness programme, training, demonstration of sticky traps and grafting technology and distribution of Chitosan, Goa – Bio 1 and Goa Bio- 2, Spinosad and sticky traps to farmers for pest and diseases management in major vegetable crops

Programme 1

A field training programme on use of integrated pest and disease management in vegetable crops was organised at Mencurem, Goa on 04/01/2020. Insect pests and diseases of chilli and their management aspects were explained to the farmers by training Co-ordinators Dr. Maruthadurai. R and Dr. R. Ramesh. Field demonstration was given about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. More than 32 farmers were attended the training programme and 0.5 kg Goa-Bio-2, 3ml Spinosad, and 50 ml Chitosan were distributed to the each participated farmer.

Programme 2

Field training cum distribution programme on use of integrated pest and disease management technologies in major vegetable crops was organised at Parra, Mapusa, Goa on 14/01/2020. Insect pests and diseases of chilli and their management aspects were briefly explained to the farmers by training Co-ordinators Dr. Maruthadurai. R and Dr. R. Ramesh. Field demonstration was given about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. More than 25 farmers were actively participated in the training and demonstration programme and 0.5 kg Goa-Bio-2, 3ml Spinosad, and 50 ml Chitosan were distributed to the each farmer.

Programme 3

A distribution cum field demonstration on use of Goa-Bio-2, Spinosad, and Chitosan in chilli fields was organised at Canacona, Goa on 12/01/2020. Insect pests and diseases of chilli and their management aspects were explained by Dr. Maruthadurai to the farmers. Field demonstration was carried out about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. More than 28 farmers were actively participated in the programme and 0.5 kg Goa-Bio-2, 3 ml Spinosad, and 50 ml Chitosan were distributed to the each participated farmer.

Programme 4

A distribution cum field demonstration on use of Goa-Bio-2, Spinosad and Chitosan in chilli fields was organised at Bhati Sanguem, Goa on 13/01/2020. Field demonstration was given about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. More than 27 farmers were attended the programme and 0.5kg Goa-Bio-2, 3ml Spinosad, and 50 ml Chitosan were distributed to the each farmer.

Programme 5

A field demonstration on use of Goa-Bio-1, Spinosad and Chitosan in chilli fields was organised at Pirla, Quepem, Goa on 13/01/2020. Insect pests and diseases of chilli and their management aspects were explained by Dr. Maruthadurai to the farmers. Field demonstration was given about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. More than 16 farmers were attended the programme and 0.5kg Goa-Bio-1, 3ml Spinosad, and 50ml Chitosan were distributed to the each farmer.

Programme 6

A distribution cum field demonstration on use of Goa-Bio-2, Spinosad and Chitosan in chilli fields was organised at Mencurem, Goa on 14/01/2020. Details of demonstrations like use of resistant varieties, raising of disease free seedlings, use of nylon nets, seed treatment with systemic insecticides and use of biopesticies to the farmers. Field demonstration was given about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. More than 32 farmers were attended the programme and 0.5kg Goa-Bio-2, 3ml Spinosad, and 50ml Chitosan were distributed to the each participated farmer.

Programme 7

A distribution cum field demonstration on use of Goa-Bio-2, Spinosad, and Chitosan in chilli fields was organised at Parra, Goa on 24/01/2020. Insect pests and diseases of chilli and their management aspects were explained by Sarvesh Deikar (Field Assistant) to the farmers. Field demonstration was conducted about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. More than 22 farmers were actively participated in the programme and 0.5 kg Goa-Bio-2, 3ml Spinosad, and 50ml Chitosan were distributed to the each farmer.

Programme 8

A field demonstration on use of Goa-Bio-1, Spinosad, and Chitosan in chilli fields was organised at Dulapi, Goa on 16/01/2020. Brinjal seedlings of varieties, Goa -1, 2, 3, 4, Agassaim and Taleigao were distributed to farmers. Insect pests and diseases of chilli and their management aspects were demonstrated to the farmers by Dr. Maruthadurai. Field demonstration was given about spray and use of Goa-Bio -1, Spinosad and Chitosan in chilli field. More than 37 farmers were actively participated in the programme and 0.5kg Goa-Bio-2, 3ml Spinosad, and 50ml Chitosan were distributed to the each farmer.

Programme 9

A field demonstration on use of Goa-Bio-2, Spinosad, and Chitosan in chilli fields was organised at Cumbarjua, Goa on 21/01/2020. Insect pests and diseases of chilli and their management aspects were explained by Dr Maruthadurai to the farmers. Field demonstration was conducted about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. More than 37 farmers were actively participated in the programme and 0.5 kg Goa-Bio-2, 3ml Spinosad, and 50ml Chitosan were distributed to the each farmer.

Programme 10

A distribution cum field demonstration on use of Goa-Bio-2, Spinosad and Chitosan in chilli fields was organised at Vaddem Sanguem, Goa on 13/06/2020.Insect pests and diseases of chilli and their management aspects were explained to the farmers. Field demonstration was given about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field.

Visit of NABARD officer and interaction with the beneficiaries

District development manager of NABARD, South Goa and North Goa, Shri. Sushil Naik visited the ongoing field trail and interacted with the farmers and beneficiaries on 13/6/2020 at Vaddem, Sanguem. More than 32 farmers were attended the programme and 0.5kg Goa-Bio-2, 3ml Spinosad and 50ml Chitosan were distributed to the each farmer.

Programme 11

A distribution cum field demonstration on use of Goa-Bio-2,Spinosad, Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Mencurem, Goa on 08/01/2021.Insect pests and diseases of chilli and their management aspects were explained to the farmers. Field demonstration was carried out about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. The method of installation and uses of Yellow and Blue sticky traps was explained and demonstrated to farmers. More than 76 farmers were attended the programme and 1kg Goa-Bio-2, 3ml Spinosad, 50ml Chitosan and Yellow and Blue sticky traps each were distributed to the each farmer.

Programme 12

A field demonstration on use of Goa-Bio-2,Spinosad, Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Parra, Goa on 08/01/2021.Insect pests and diseases of chilli and their management aspects were explained to the farmers. Field demonstration was given about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. The method of installation and uses of Yellow and Blue sticky traps was explained and demonstrated to farmers. More than 22 farmers were attended the programme and 1kg Goa-Bio-2, 3ml Spinosad, 50ml Chitosan and 2Yellow and Blue sticky traps were distributed to the each farmer.

Programme 13

A distribution cum field demonstration on use of Goa-Bio-2,Spinosad,Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Pirla Quepem, Goa on 06/01/2021.Insect pests and diseases of chilli and their management aspects were explained to the farmers. Field demonstration was carried out about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. The method of installation and use of Yellow and Blue sticky traps were explained and demonstrated to farmers. More than 22 farmers were attended the programme and 1kg Goa-Bio-2, 3ml Spinosad, 50ml Chitosan and 2Yellow and Blue sticky traps were distributed to the each farmer.

Programme 14

A distribution cum field demonstration on use of Goa-Bio-2,Spinosad,Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Cumbarjua, Goa on 16/01/2021.Insect pests and diseases of chilli and their management aspects were explained by training co-ordinator Dr Maruthadurai to the farmers. Field demonstration was conducted about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. The method of installation and uses of Yellow and Blue sticky traps were explained and demonstrated to farmers. More than 45 farmers were actively participated in the programme and 1kg Goa-Bio-2, 3ml Spinosad, 50ml Chitosan and 2Yellow and Blue sticky traps were distributed to the each farmer.

Programme 15

A distribution cum field demonstration on use of Goa-Bio-2,Spinosad,Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Canacona, Goa on 06/01/2021.Insect pests and diseases of chilli and their management aspects were explained by Sarvesh Deikar (Field Assistant) to the farmers. Field demonstration was carried out about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. The method of installation and uses of Yellow and Blue sticky traps were explained and demonstrated to farmers. More than 50farmers were actively participated in the programme and 1kg Goa-Bio-2, 3ml Spinosad, 50ml Chitosan and 2Yellow and Blue sticky traps were distributed to the each farmer.

Programme 16

A distribution cum field demonstration on use of Goa-Bio-2, Spinosad, Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Bhati Sanguem, Goa on 06/01/2021. Insect pests and diseases of chilli and their management aspects were explained to the farmers. Field demonstration was conducted about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. The method of installation and uses of Yellow and Blue sticky traps were explained and demonstrated to farmers. More than48 farmers were attended the programme and 1kg Goa-Bio-2, 3ml Spinosad, 50ml Chitosan and 2Yellow and Blue sticky traps were distributed to the each farmer.

Programme 17

A distribution cum field demonstration on use of Goa-Bio-2, Spinosad, Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Dulapi, Goa on 29/01/2021. Insect pests and diseases of chilli and their management aspects were explained by training co-ordinator Dr. Maruthadurai to the farmers. Field demonstration was conducted about spray and uses of Goa-Bio-2, Spinosad and Chitosan in chilli field. The method of installation and use of Yellow and Blue sticky traps were explained and demonstrated to the farmers. More than 25 farmers were actively participated in the programme and 1kg Goa-Bio-2, 3ml Spinosad, 50ml Chitosan and 2 Yellow and Blue sticky traps were distributed to the farmer.

Programme 18

A distribution cum field demonstration on use of Goa-Bio-2 in RidgeGourd fields was organised at Farmagudi, Goa on 02/07/2021.Insect pests and diseases of Ridge Gourd and their management aspects were explained by Sarvesh Deikar (Field Assistant) to the farmers before distribution. Field demonstration was conducted about method and dose of Goa-Bio-2 drenching in Ridge Gourd. ZAO of ponda Miss Pradnya Gaude Priolkar and BTM of Ponda Master Palesh P. Gawas participated in the programme and interacted with the farmers. More than 25 farmers participated in the programme and 1kg Goa-Bio-2 was distributed to the each participated farmer.

Programme 19

A distribution cum field demonstration on use of Goa-Bio-2,Spinosad,Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Vaddem, Sanguem, Goa on 04/07/2021.Insect pests and diseases of chilli and their management aspects were explained to the farmers. Field demonstration was given about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. The method of installation and uses of Yellow and Blue sticky traps were explained and demonstrated to farmers. More than 45 farmers were attended the programme and 1kg Goa-Bio-2, 3ml Spinosad, 50ml Chitosan and 2 Yellow and Blue sticky traps were distributed to the each farmer.

Programme 20

A distribution cum field demonstration on use of Goa-Bio-2,Spinosad,Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Cumbarjua, Goa on 09/02/2022.Insect pests and diseases of chilli and their management aspects were explained by Sarvesh Deikar (Field Assistant) to the farmers. Field demonstration was given about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. The method of installation and uses of Yellow and Blue sticky traps were explained and demonstrated to farmers. More than 29 farmers were actively participated in the programme and 1kg Goa-Bio-2, 6ml Spinosad, 100ml Chitosan and 2 Yellow and Blue sticky traps were distributed to the each farmer.

Programme 21

A distribution cum field demonstration on use of Goa-Bio-2,Spinosad,Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Mencurem, Goa on 04/02/2022.Insect pests and diseases of chilli and their management aspects were explained to the farmers. Field demonstration was given about spray and use of Goa-Bio-2, Spinosad and Chitosan in chilli field. The method of installation and uses of Yellow and Blue sticky traps were explained and demonstrated to farmers. More than 35 farmers were attended the programme and 1kg Goa-Bio-2, 6ml Spinosad, 100ml Chitosan and 2 Yellow and Blue sticky traps were distributed to the each farmer.






Programme 22

A distribution cum field demonstration on use of Goa-Bio-2,Spinosad,Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Dulapi, Goa on 31/01/2022. Insect pests and diseases of chilli and their management aspects were explained to the farmers. Field demonstration was conducted about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. The method of installation and uses of Yellow and Blue sticky traps were explained and demonstrated to farmers. More than 25 farmers were actively participated in the programme and 1kg Goa-Bio-2, 6ml Spinosad, 100ml Chitosan and 2 Yellow and Blue sticky traps were distributed to the each farmer.

Programme 23

A distribution cum field demonstration on use of Goa-Bio-2, Spinosad, Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Canacona, Goa on 18/02/2022. Insect pests and diseases of chilli and their management aspects were explained to the farmers. Field demonstration was carried out about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. The method of installation and uses of Yellow and Blue sticky traps were explained and demonstrated to farmers. More than 50 farmers were attended the programme and 1kg Goa-Bio-2, 6ml Spinosad, 100ml Chitosan and 2 Yellow and Blue sticky traps were distributed to the each farmer.

Programme 24

A field demonstration on use of Goa-Bio-2, Spinosad, Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Pirla, Goa on 15/01/2022. Insect pests and diseases of chilli and their management aspects were explained to the farmers. Field demonstration was conducted about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. The method of installation and uses of Yellow and Blue sticky traps were explained and demonstrated to farmers. More than 22 farmers were actively the programme and 1kg Goa-Bio-2, 6ml Spinosad, 100ml Chitosan and 2Yellow and Blue sticky traps were distributed to the each farmer.






Programme 25

A distribution cum field demonstration on use of Goa-Bio-2,Spinosad,Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Parra, Goa on 29/01/2022. Insect pests and diseases of chilli and their management aspects were explained by Sarvesh Deikar (Field Assistant) to the farmers. Field demonstration was given about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. The method of installation and uses of Yellow and Blue sticky traps were explained and demonstrated to farmers. More than 22 farmers were attended the programme and 1kg Goa-Bio-2, 6ml Spinosad, 100ml Chitosan and 2Yellow and Blue sticky traps were distributed to the each farmer.

Programme 26

A distribution cum field demonstration on use of Goa-Bio-2,Spinosad,Chitosan and Yellow and Blue sticky traps in chilli fields was organised at Bhati Sanguem, Goa on 15/01/2022.Insect pests and diseases of chilli and their management aspects were explained by Sarvesh Deikar (Field Assistant) to the farmers. Field demonstration was carried out about spray and use of Goa-Bio -2, Spinosad and Chitosan in chilli field. The method of installation and uses of Yellow and Blue sticky traps were explained and demonstrated to farmers. More than 30 farmers were actively the programme and 1kg Goa-Bio-2, 6ml Spinosad, 100ml Chitosan and 2Yellow and Blue sticky traps were distributed to the each farmer.

Programme 27

A field training and demonstration on grafting in brinjal crop (Root stock: wild brinjal and Scion: Agassaim and Taleigao Brinjal) was organised at Netravali on 29/10/2021. The use of this grafting technique for wilt diseases management in brinjal crop was explained to farmers. Around 43 farmers of Netravali, Goa region attended and benefited from this programme. Farmers expressed their thankfulness to ICAR and NABARD for arranging this beneficial programme. Now many farmers of that region are using this technique for wild diseases management in brinjal and encouraging others to go for it.

Programme 28

A training cum demonstration on preparation of yellow and blue sticky traps for the management of whitefly, thrips and aphids was organised at Mencureum on 04/02/2022. The preparation of yellow and blue sticky traps using locally available material like chart paper, yellow and blue paint and grease was demonstrated to the farmers and the placement, servicing and traps replacement was explained to the farmers. More than 35 farmers actively participated in the programme and total 130 yellow and blue sticky traps were distributed to farmers.

Preparation of yellow and blue sticky traps

Coloured sticky traps are used to monitor and mass trapping of insect pests. Many insects are found to attract certain type of light wavelengths. Yellow sticky traps are known to attract white flies, aphids and leaf miners in different crops such as cotton, vegetables, mustard and various flower crops. Blue sticky traps are known to attract thrips in crops like cotton, paddy, vegetables and flowers. White sticky traps are known to attract flea beetles and plant bugs.

Materials required

- Used empty oil tin (1 or 2 litre size)
- Ply wood board or hard board or card board (1.5 ft X 1.0 ft)
- Yellow or blue colour chart
- Yellow colour oil paint
- Blue colour oil paint
- Glue or white grease
- Wire or rope
- Bamboo poles

Procedure for preparation of yellow or blue sticky trap

- Take new or used sheet of plywood board or hardboard or Take new or used empty 1 or 2 litres oil tin or Yellow or blue colour chart.
- Paint it with yellow or blue colour oil paint.
- allow to dry
- Apply grease or glue
- Erect traps above crop canopy with the help of bamboo poles

No. of traps per acre: 8-10

Grafting of cultivated brinjal on *Solanum torvum*/Surya/ other rootstocks

Solanum torvum, and other bacterial wilt resistant brinjal rootstocks were selected as rootstocks for making grafts and evaluation in fields. Seeds were sown in nursery beds and standard nursery management practices were followed. About 5-6 cm tall seedlings were transplanted into nursery bags (70x 140mm size) containing pot mixture (2:1:1 red soil, farm yard manure and sand).

About 45-50 days-old seedlings of *S. torvum* and 30-35 days-old seedlings of other rootstocks (stem: 3 mm dia) were selected for making grafts. Locally preferred and bacterial wilt susceptible cultivars, Agassaim and Taleigao were used as scion material. Seeds Agassaim and Taleigao were sown in nursery beds/trays with the above mentioned pot mixture. About 30-35 days-old seedlings (stem: 3 mm dia) were selected as scion. Top wedge grafting method was used to prepare the grafts. The graft union was tied with thin polythene sheet (50-100 micron) to keep the union intact till the tissues were healed. The grafted plants were maintained in high humidity chambers (3x2x2M) with less direct sunlight for 8-10 days and the new leaf emergence was noticed after 5-7 days. Hardening of the grafts was done in open field conditions for 3-4 days and then used in field planting.

Bacterial wilt

Wild brinjal

Preparation of root stock

Preparation of grafts

Details of project implemented areas and total beneficiaries and inputs distribution

SOUTH GOA		Inputs						TOTAL AREA	CROPS	Total farmers
TALUKA	VILLAGE	GOA-BIO-2 (Kg)	GOA-BIO-1 (Kg)	SPINOSAD (ml)	CHITOSAN (ml)	STICKY TRAPS	BRINJAL SEEDLING			
SANGUEM	BHATI	69		1062	6750	216	1377	1.57	Chilli	105
	VADDEM	52		660	5250	186	560	1.4	Chilli	76
QUEPEM	PIRLA	49	16	555	4475	176	750	1.2	Chilli	60
CANACONA	KINARWADA	110		1174.5	10500	400	900	3.82	Chilli	137
PONDA	FARMAGUDI	26.5		27	100			1.5	Ridge gourd	50
NORTH GOA										
TISWADI	DULAPI	0	64	585	7375	200	2100	1.97	Chilli	79
	CUMBARJUA	85		939	9050	270	610	2.5	Chilli	112
MAPUSA	GIRI-PARRA	59	20	531	6500	176		1.4	Chilli	66
BICHOLIM	MENCUREM	157		1794	14250	282		7.6	Chilli	172
Total		607.5	100	7327.5	64250	1906	6297	22.96		857

Impact of wide spread adoption of integrated pest and disease management technologies in chilli

Problems/ Constraints

Chilli (*Capsicum* spp.) is an important commercial spice and vegetable crop. Pest infestation is one of the major constraints in chilli production. Sucking insects viz., whiteflies, thrips, aphids and mites and diseases like bacterial wilt, viral diseases, fusarium wilt and fruit rot are the major problem in chilli. Yield losses due to these pest attacks may range from 25-50 %. Farmers use pesticides as first line of defense and frequently resort to indiscriminate and non-judicious use of pesticides. However these measures lead to several problems such as environmental pollution, pesticide residue in the harvested products, development of resistance/resurgence and increased cost of production. These problems have necessitated the search for safer and effective methods of pest control, including bio-control, botanical and bio-pesticides.

TECHNOLOGY DEVELOPED

Studies on seed treatment and six sprays with a plant growth promoting antagonistic bacterial bio-formulation (Goa Bio-2) @ 1.0%, spinosad (a natural product based insecticide) @ 0.03%, insecticide (imidacloprid @ 0.03%) and other biological components was conducted. Two years of field evaluation indicated that seed treatment and spray of Goa Bio-2, spinosad recorded reduced ChiLCV disease incidence compared to control throughout the crop period. Green chilli yield of 34 to 40t/ha was recorded in Goa Bio-2, spinosad treatments which is 32 to 52 % increases compared to control.

TECHNOLOGY DEMONSTRATION

This technology was demonstrated in 22 ha area of chilli under NABARD funded project in the state of Goa. More than 250 farmers were provided the inputs for demonstration for two consecutive years (2019 to 2021). Based on the field evaluation and considering the ease of application, soil application of Goa Bio-2 @ 1.25g/plant and four sprays of spinosad (15, 30, 45 and 60 DAP) @ 0.03% was taken up. Disease incidence and dry chilli yield were recorded from about 50 demonstrations in each year. Results of two years demonstrations indicated that 33% reduction in ChiLCV disease incidence and 40% increase in dry chilli yield in the fields where soil application of Goa Bio-2 and spinosad spray treatment compared to control. Other benefits of this technology include lesser incidence of thrips, whiteflies, aphids and other diseases the demonstration plots.

Success stories

Success stories 1

Prasad Naik
Cumbarjua, Tiswadi,Goa
Mobile: 9504493384

I am managing a chilli field of around 1000 sq. m and had been facing severe problem due to the damage of insect pest and diseases. Because of insect pest and diseases, I used to loss around 25-30% yield in every year. There was a great difficulty to manage these insect pests and diseases. Thanks to ICAR-CCARI scientist for providing me Goa-bio-2, Spinosad and sticky traps. They solved our problems to the greater extent. There was a significant reduction in the damage caused by insect pests and diseases after using Goa-bio-2, Spinosad and sticky traps. I got around10-15% more yield in chilli.

Success stories 2

Dhasharat Madgaonkar
Giri Parra, Mapusa, Goa
Mobile: 9923765969

I am growing different types of vegetables like chilli, radish, cabbage, red amaranths etc. Chilli crop occupies around 500 sq.m field area. A month after planting these vegetables I used to suffer from wilt and leaf curl diseases and sucking insect pest attack. With the assistance from ICAR-CCARI, I have started using Goa-bio-2, spinosad and sticky traps in vegetables especially in chilli. I could see that slowly the damage incidence of insect pests has been reduced. So I used to apply Goa-bio-2, Spinosad and sticky traps to get good crop yield and more profit. I thank ICAR-CCARI scientists for providing me Goa-bio-2, Spinosad and sticky traps for last 3 years. I have encouraged the other farmers in my neighbourhood to use Goa-bio-2, Spinosad and sticky traps. Thank for ICAR-CCARI scientists.

Success stories 3

Dhilan J. Padkar
Canacona, Goa.
Mobile: 9405208712

I am having a chilli field around 500sq.m area. Every year I used to encounter with white fly, thrips, aphids, wilt and leaf curl damage and a yield loss of around 25-40% every year in chilli crop. ICAR-CCARI provided us Goa-bio-2, chitosan and sticky traps. These products were effective in controlling the damage caused by insect pests and diseases and reduced the loss of yield by 15-20%. There was significant reduction in chilli pest and diseases like white fly, thrips, aphids,wilt etc. I would like to thank ICAR-CCARI and the concern scientist for providing me Goa-bio-2, chitosan and sticky traps. I encouraged the other farmers to use Goa-bio-2, chitosan and sticky traps.



Success stories 4

Mukesh Phaldessai
Pirla, Quepem, Goa.
Mobile: 9657635082

I am doing vegetables farming from many years. Mainly grown vegetables in my farm are chilli, cowpea, lady finger, etc. In chilli I was facing leaf curl, wilt, insect pest damages etc. So I used to get lower yield. ICAR-CCARI intervention helped me to overcome these problems in chilli. I thankful to ICAR-CCARI for helping me to get more yields and I encourage other farmers to use Goa-bio-2, Spinosad and sticky traps.


Success stories 5

Dhaku Dhulapkar
Dulapi, Tiswadi, Goa
Mobile: 9764234392

I am having different types of vegetables like chilli, red amranthus, French beans, etc. I used to face around 30% of yield loss due to insect pest and disease problems especially white fly, thrips, aphids, and wilt in my chilli field. I started using Goa-bio-1, chitosan and sticky traps with the assistance from ICAR-CCARI for last 3 years. The infestation was greatly reduced due to implementation of Goa-bio-1,chitosan and sticky traps in chilli field. I got absolutely satisfying result and express my sincere thanks to ICAR-CCARI for providing me Goa-bio-1, chitosan and sticky traps. With the success in my field I have been encouraging other chilli farmers in my neighbourhood to use Goa-bio-1, chitosan and sticky traps.

Success stories 6

Bharat K. Naik
Mencurem, Goa
Mobile: 9921853500

Before January 2020 I was very depressed as being a small time vegetables grower like chilli, knol-khol etc. were infested by insect pests like white fly, thrips, aphids and wilt diseases in my chilli field. However after use of Goa-bio-2 and chitosan given by ICAR-CCARI scientist the infestation was greatly reduce. I am in a good profit now. I thank for the ICAR-CCARI scientist for providing me Goa-bio-2 and chitosan.

Summary of achievements

- Popularised integrated pest and disease management technologies in chilli, brinjal and cucurbitaceous vegetables
- Chilli leaf curl complex and thrips were recorded the major hindrance in realising the potential yield of chilli.
- Application of bio-agents and spraying of spinosad reduced the disease incidence and enhanced the chilli yield around 32-40%.
- Demonstrated 23 ha area of chilli in both North and South Goa for successful integrated management of pests and diseases. Distributed 700 kg of Goa Bio –I and Goa Bio-II, 8 litres of spinosad, 64 litres of chitosan to 857 farmers.
- Hands on training, demonstration provided to the farmers on preparation and use of sticky traps viz., yellow and blue colour. Further distributed 1906 yellow and blue sticky traps to the vegetable farmers
- Hands on training and demonstration provided to the farmers on grafting technique for the management of wilt diseases.
- Enhanced the technical knowledge of the vegetable farmers on use of various IPDM technologies through trainings and demonstrations. A total of 10 trainings and 25 demonstrations have been conducted for various integrated pest and diseases management technologies in vegetables like chilli, brinjal and cucurbitaceous vegetables.
- A total of 6297 resistant brinjal varieties of ICAR-CCARI have been distributed to the farmers.
- Resistant brinjal varieties performed better and recorded less than 5% of wilt against the local varieties which has recorded more than 90% of wilt incidence.
- Large scale demonstration of IPDM technologies in chilli for three consecutive years benefitted the farmers. Enhanced the technical skill of the farmers on preparation of sticky traps and grafting technique.

Recommendations

Integrated pests and disease management in Chilli

The following measures are recommended for chilli IPDM

- Adjust the date of sowing so as to avoid vector population build up.
- Grow resistant varieties.

Management in nursery

- Raise nursery in fumigated soil
- Seed treatment: Imidacloprid @ 5-10g per kg of seeds + Thirum @ 2g per kg of seeds
- Nursery application: Talc formulation of *Trichoderma/ Bacillus* (Goa Bio-1& 2) @ 50g per m^{-2} before sowing
- Cover the nursery area with insect proof net
- Vector control in nursery: Spray Acephate @ 1g per litre of water or Metasystox @ 1mL per litre of water at 15 days after sowing

Management in main field

- Soil amendment with lime @ 8-10 t per ha
- Place stick traps like yellow and blue colour @ 5-8/ acre.
- Avoid frequent watering and flooding
- Raise barrier crops like maize/ sorghum in the borders and inside if the field is large
- Soil application/ seedling drench during transplanting: Talc formulation of *Trichoderma/ Bacillus* (Goa Bio-1 & 2) @ 1 to 1.5g per plant
- Insect/ vector and other disease control in the field as per the schedule given below

Spray No.	Insecticide	Dose	Spray date
1	Spinosad or Imidacloprid	0.3 mL per litre	15 DAT
2	Acephate + Dicofol or Chitosan	2g per litre 3mL per litre 5 ml per litre	30 DAT
3	Dimethoate (and) Wettable Sulphur	1mL per litre 3g per litre	45 DAT
4	Fipronil + Carbendazim	0.5mL per litre 2g per litre	60DAT

भाकृअनुप
ICAR

हर कदम, हर डगर
किसानों का हमसफर
भारतीय कृषि अनुसंधान परिषद

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