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Assessment of eco-friendly management modules against banana Fusarium wilt

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Abstract

Banana production across the globe takes place under diversified agro-ecological and social-economic conditions where disease pressure varies significantly. The production of banana can be curtailed by several fungal diseases. Among them, Fusarium wilt (FW) of bananas (FWB) caused by *Fusarium oxysporum* f. sp. *cubense* (Foc) is the main threat and limiting factor for different banana cultivars of economic and strategic importance all over the world (Kema *et al.*, 2021). Keeping this in view, an assessment (On-Farm Trial) with two different eco-friendly modules viz. TNAU module & NRCB module were tested in the farmers' field at five different locations to verify the efficacy and suitability in controlling Fusarium wilt in Banana during 2020-21. The OFT was carried out in five farmers' field at predominately banana growing villages viz., Kookur, Idayatrumangalam and Melavazhai of Lalgudi block of Tiruchirappalli district and the experiment design was Factorial Randomized Block design (FRBD) with five replications. The study results revealed that the incidence of wilt incidence was lesser in NRCB module (8.25%) followed by TNAU module (10.43%) when compared to that of with farmer's practice which recorded a disease severity of 29.82 percent. To conclude, the biocontrol agents have been proven to have a good effect on the fruit yield and weight besides the suppression of the pathogen. Biocontrol should not be considered as an independent tool, but adequately implemented in an integrated management framework.

Keywords: Banana, Fusarium wilt, eco-friendly management, Trichy district

Introduction

Banana, the world's most important fruit in terms of production, volume and trade. Banana production takes place under diverse agro-ecological and social-economic conditions where disease pressure varies significantly. Approximately 84% of the crop is cultivated by smallholders and delivered to domestic markets. The international trade represents about 16% of the global banana production consisting of just over 25 million metric tons which are exported from tropical areas to mainly countries in the temperate zones (FAOSTAT 2020). Banana is the fruit of a plant of the genus *Musa* (family Musaceae), which is cultivated primarily for food and secondarily for the production of fibre used in the textile industry are also cultivated for ornamental purposes. Banana production worldwide can be curtailed by several fungal diseases including aerial, (e.g., Anthracnose, Sigatoka Leaf Diseases) soil-borne (e.g., Fusarium Wilt or Panama Disease, root rot) and post harvest (e.g., Crown Mold, Crown Rot). Among them, Fusarium wilt (FW) of bananas (FWB) caused by *Fusarium oxysporum* f. sp. *cubense* (Foc) (E.F. Sm.) W.C. Snyder and H.N. Hansen (Foc), is the main threat and limiting factor for different banana cultivars of economic and strategic importance all over the world (Kema *et al.*, 2021) [6]. Colonization of the roots and pseudostem is quite advanced before external symptoms of disease become apparent, pseudostem is followed by colonization of the leaf sheaths and production of chlamyospores by the Foc pathogen in symptomatic plants. (Warman and Aitken, 2018) [9].

Banana growers of southern India generally rely on carbendazim for management of diseases and the frequency of application ranges from six to nine sprays depending upon the season and disease load. Repeated application of pesticide caused pesticide resistance. It is very difficult to eradicate soil borne pathogen. Biological control has gained great interest among the banana growers due to continuous efforts taken by KVK and NRCB in the last two years. This has been mainly due to inclination towards health life beside huge input cost of pesticides, resulting in economic constraint to the individual farmer and also damage to the ecosystem. Biological control must not be a strategy limited to organic farming (adopted in 1% of banana cultivated lands) (Liu and Prada, 2018) [7], but included within integrated disease management

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frameworks implemented in agricultural systems. The soil-based application of bio-inoculants is highly effective in controlling the soil borne pathogens. Further, it slows down the secondary spread of pathogen in the field and helps in sustainability. The application of ecofriendly bio-inoculants can prevent the pesticide residual effect and also reduction in the input cost. Keeping this in view, Krishi Vigyan Kendra, Tiruchirappalli, Tamil Nadu took an initiative to evolve location specific eco-friendly technology module for management of Fusarium wilt in Banana. For this, two different modules viz. TNAU module & NRCB module were tested in the farmers' field at five different locations to verify the efficacy and suitability in controlling Fusarium wilt in Banana. The field trial was done under KVK On-Farm Testing (OFT) mode during 2020-21. The parameters of the current study were Fusarium wilt incidence, significant change in bunch quality and quantity in turn economics.

Materials and Methods

The OFT was carried out in five farmers' field at predominately banana growing villages viz., Kookur, Idayatrumangalam and Melavazhai of Lalgudi block of Tiruchirappalli district. In these areas, generally banana is cultivated under upland condition and the soil type is mixed alluvium where the irrigation is by and large through canal from Cauvery river. The experiment was laid out in Factorial Randomized Block Design. The treatments were imposed in banana as detailed below.

Farmers Practice (As Check): Farmers followed soil drenching with Carbendazim @ 0.1% to control wilt and Uprooting and cutting of infected mother plants and allowing side sucker to grow

KVK interventions and Modules Assessed

Treatment Option 1 (TO-1) TNAU Module: Application of *Pseudomonas fluorescens* liquid formulation @ 4 lit/ha at planting, 2nd, 4th and 6th month after planting (MAP)

Treatment Option 2 (TO-2) NRCB Module: Soil application of *Trichoderma viride* + *Paecilomyces lilacinus* each @ 10 g/plant as basal, 2nd, 4th and 6th MAP.

To avoid the error, uniform plot size of 6000 m² area (@2000m² per Treatment) were chosen for the field trial with the above mentioned modules and the check. In each plot, incidence of wilt was assessed by counting the total number of plants and infected plants and expressed as per cent incidence.



TO-1: TNAU Module



TO-2: NRCB Module



Farmers Practice

Results and Discussion

The results (Table.1) revealed that the incidence of wilt was lesser in TO-2 (8.25%) followed by TO-1 (10.43%) when compared with farmer's practice which recorded a disease severity of 29.82 per cent. This might be due to influence of bio-inoculants. These antagonistic organisms induced systemic resistance in plants and in addition promoted plant growth (Bennett and Whipps, 2008 and Bennett *et al.*, 2009) [8, 9]. Root colonization by *Trichoderma* spp. also frequently enhances root growth and development, crop productivity, resistance to abiotic stresses and the uptake and use of nutrients. (Harman *et al.*, 2004) [4]. The mechanisms of action of *Trichoderma* isolates such as Mycoparasitism, Antibiosis, Competition and rhizosphere competence, Sclerotia colonization and parasitization, Induction of host resistance, Plant growth promotion, Tolerance to abiotic stress, Competition in the root habitat (Ghazanfar *et al.*, 2018) [8].

Plant Growth Promoting Rhizobacteria (PGPR), the important group of bacteria that play a major role in the plant growth promotion, induced systemic resistance, biological control of pathogens etc. *Pseudomonas* is the most favored bio-inoculant due to its significant properties in both plant growth and phytopathogen control during its synergistic association with the host plant. These properties include siderophore production, phosphate solubilization, nitrogen fixation, phenazines, antibiotics, and induced systemic resistance carried out by various *Pseudomonas* species like *Pseudomonas fluorescens*, *Pseudomonas putida*, and *Pseudomonas syringae*. The association of *Pseudomonas* with crop plants procures several secretory and electron-based feedback mechanisms in order to regulate the plant growth

and phytopathogen control activities through the secretion of several phytohormones (auxins, gibberellins, Indole-3-acetic acid), secondary metabolites (flavonoids) and enzymes (aminocyclopropane-1-carboxylate, phenylalanine ammonia-lyase). (Girija and Manoj, 2005 and Sah *et al.*, 2021)^[5, 10].

Both TNAU and NRCB technologies recorded higher yields of 34.75 and 35.75 t/ha, respectively as compared to 31.44 t/ha in Farmers practice. Likewise NRCB and TNAU

technologies fetched higher net income Rs. 2, 57, 500 and Rs. 2, 47,000 with BC ratio of 2.5 and 2.45 (Table. 1), respectively which might be due to lesser wilt incidence, higher plant population and bunch weight. Moreover, shiny light green coloured fingers from bio control agents treated plots had higher consumer preference than dark green dull fingers from farmers practice.

Table 1: Effect of bio-inoculants against Fusarium wilt disease in banana (2020-21)

Treatments	Wilt incidence (%)	Bunch weight (kg)	Yield (t/ha)	Gross income (Rs./ha)	Net returns (Rs./ha)	B:C Ratio
TO 1 (TNAU)	10.43	13.9	34.75	3,77,280	2,47,000	2.45
TO 2 (NRCB)	8.25	14.3	35.75	4,17,000	2,57,500	2.50
FP (Pesticide)	29.82	13.1	31.44	4,29,000	1,97,280	2.10
SEd.	0.464**	0.048	0.947	-	-	-
CD(0.05)	1.085	0.159	1.884	-	-	-

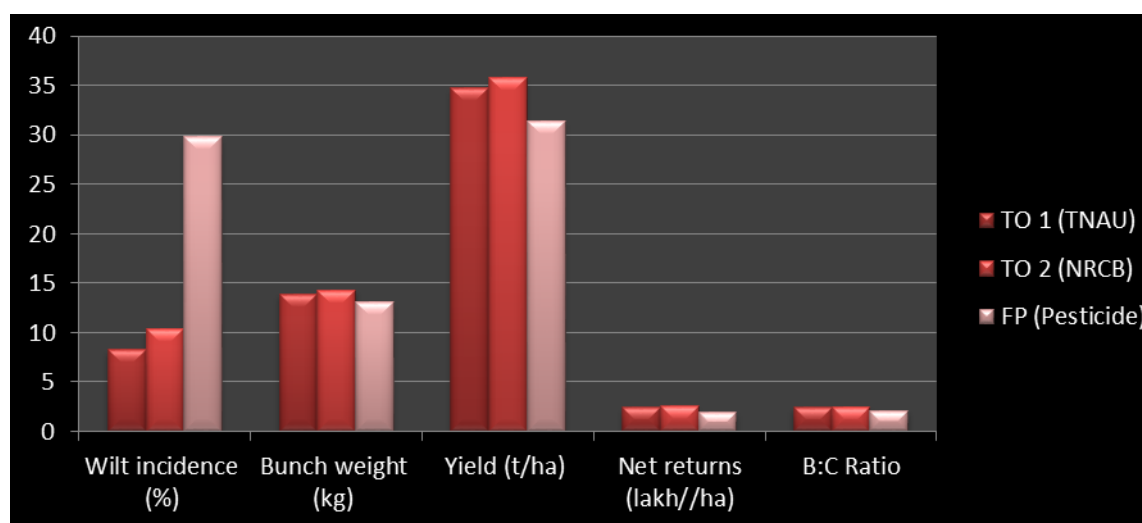


Fig 1: Yield and economics of Bio control agents

Conclusion

Bio control should not be considered as an independent tool, but adequately implemented in an integrated management framework. The application of cultural and biological control options can slow down the development of epidemics, but alone do not provide effective control, thereby merely contributing to gain time. The only long-term option proposed is to deploy new varieties with effective disease resistance. Bio control agents have been proven to have a good effect on the fruit yield and weight besides the suppression of the pathogen. To conclude, the Tiruchirappalli banana growers can opt for NRCB module for effective management of Banana wilt and also get sustainable yield and economic returns.

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