Int.J.Curr.Microbiol.App.Sci (2019) *8*(2): 3120-3126

International Journal of Current Microbiology and Applied Sciences
***ISSN: 2319-7706* Volume 8 Number 02 (2019)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2019.802.365

On Farm Assessment of Integrated Disease Management Practices with Emphasis on use of Bio-control Agents for Management of Rhizome Rot in Turmeric

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Keywords

Turmeric, Rhizome rot, IDM, Bio-control agents, *Trichoderma viridi*, Yield and net income

Article Info

Accepted:
22 January 2019
Available Online:
10 February 2019

A B S T R A C T

On farm trials in ten locations were conducted to evaluate efficacy of IDM practices with emphasis on use of bio-control gents for management of rhizome rot in turmeric and to create awareness among the farming community on rhizome rot management during Kharif, 2014-15 to 2016-17 in the farmer's fields in Krishna District of Andhra Pradesh. By adoption of IDM practices with emphasis on use of *Trichoderma viride* as seed treatment and soil application, neem cake and other cultural practices to remove excess water from the root zone in all the three years, the rhizome rot incidence was reduced on an average by 2.06 per cent compared to 5.53 per cent in farmers practice. The average dry rhizome yield in the treated plots was 77.5q/ha compared to 69.27q/ha with an increase of 11.87 per cent. This has resulted in reduction in the average cost of cultivation by Rs. 34100.00 per hectare and the average net income was improved by Rs. 86997.00 per hectare compared to the farmers practice. The average benefit cost ratio also improved to 2.06 compared to farmers practice of 1.58 and giving a clear message that adoption of IDM practices with emphasis on use of bio-control agents and neem cake helped in reducing the disease incidence levels, damage and improved yield; helped in improving the net income levels to the resource poor farmers.

Introduction

Turmeric (*Curcuma longa* L.) is one of the most important commercial spice crop grown in India in an area of 1.93 lakh Ha with a production of 10.52 lakh tonnes in 2016-17 (Indiastat). The major production is confined to Andhra Pradesh, Assam, Kerala, Maharashtra, Orissa and Tamil Nadu, which accounts for more than 75% of the turmeric produced in the country. Turmeric, native to South East Asia, is a herb with underground rhizomes, which constitute the turmeric commercial value. Several diseases, mostly fungal have been recorded on turmeric requiring attention for their management to reap the full yield potential. Among them, rhizome rot is the major disease caused by *Pythium* spp., is the most destructive disease reported from Andhra Pradesh and Tamilnadu (Rathaiah, 1982b; Ramakrishnan and Sowmini 1954). It causes more than 60 per

cent mortality of seedlings both in nursery and field condition and about 50-80 per cent losses during storage (Nirmal *et al.,* 1992); rhizome rot resulted in yield loss of 50 per cent in the Erode district of Tamil Nadu (Rajalakshmi *et al.,* 2016) and upto 50 per cent in Telangana region of Andhra Pradesh (Reddy *et al.,* 2003).

The disease is seen on isolated plants or may involve several adjacent clumps resulting in diseased patches. The infected plants show gradual drying up of leaves along margins; later the entire leaf dries. The symptoms appear at the base of the pseudostem as water soaked spots. The root system is adversely affected and it gets reduced to decaying and rotten ones. In advanced stages, the infection progresses into the rhizomes which become soft and rotten. The colour of rhizome changes from bright orange to different shades of brown. The infection gradually spreads to all the fingers and mother rhizome and eventually the plant die. When the affected rhizomes are split open, brown to dark brown fibrovascular tissues are seen (Nageshwar rao, 1995), the rotten rhizomes emit foul smell (Singh, 2009). In a majority of diseased rhizomes examined, active maggots of *Mimegrella coerulifrons* were found. This fly was found to be the primary causal agent of rhizome rot in Maharashtra State (Ajiri *et al.,* 1982). However in Kerala, it was found to be associated with rotten rhizomes only and does not play a significant role in causing the disease (Premkumar *et al.,* 1982). At Rudrur (Nizamabad District, Andhra Pradesh) the fly infestation was preceded by rhizome rot incidence (Sankaraiah *et al.,* 1991).

Different species of *Pythium* were recorded as pathogens of rhizome rot. Ramakrishnan and Sowmini (1954) reported *P. graminicolum* as the causal organism of disease and *P. aphanidermatum* was reported from Sri Lanka (Park, 1934). In addition to *P. aphanidermatum*, rhizome rot of turmeric caused by *P. myriotylu* was reported from Assam (Rathaiah 1982a). Sagar, (2006) and Ushamalini *et al.,* (2008) confirmed the pathogenecity of *P. aphanidermatum* in turmeric by sick soil method. The pathogen is soil and seed borne, has ability to grow on a wide range of substrates with efficient mechanisms for dispersal and survival in soil and in plants for many years as sporangiospores.

For management of this serious disease continuous efforts were made with emphasis on use of bio-control agents. Rathaiah (1982b) reported that dipping of seed rhizomes and soil drenching with Ridomil at the first appearance of symptoms controlled rhizome rot and increased the yield. Pugalendhi *et al.,* (2003) indicated that soil application of *Trichoderma viride* was effective in controlling the soft rot disease of turmeric. Sagar (2006) reported that several strains of *T. harzianum* were most effective in inhibition of *P. aphanidermatum* causing rhizome rot of turmeric and ginger. Latha (2012) observed that *Pseudomonas fluorescens* was most effective against *Sclerotium* spp., and *T. harzianum* against *Pythium* spp., causing rhizome rot in turmeric.

Keeping in view of the above, an attempt was made to evaluate use of integrated disease management practices with emphasis on use of bio-control agents and other cultural practices for management of rhizome rot in turmeric in the farmers' fields.

Materials and Methods

The present investigation was carried out in ten locations in farmers' fields of adopted villages of KVK, Ghantasala in Mopidevi mandal of Krishna district for three years from 2014-15 to 2016-17, where farmers cultivate turmeric in large area during *Kharif*

season. On farm trials were conducted in selected farmers' fields with an objective to evaluate the performance of integrated disease management practices with emphasis on use of bio-control agent *Trichoderma viridi* and neem cake and certain cultural practices so that the same package may be popularized among the farming community with less dependence on pesticides.

T1 – IDM practices with emphasis on use of bio-control agents

1. Provision of proper drainage facility
2. Application potash fertilizers
3. Rhizome treatment with *Trichoderma viridi* @ 10 gm/kg
4. Application of *T. viridi* @ 5 Kg/ha multiplied in 250 kg. FYM
5. Neem cake application@ 625 kg/ ha

T2 – Farmers practices (Non IDM)

Use of only fungicides for management of rhizome rot after disease incidence

Each treatment was imposed in 0.4 Ha with turmeric "Tekurpeta red and Mydakuru" varieties. Recommended package of practices were followed for raising the crop. Rhizomes before sowing were treated with *T. viridi* @ 10 gm/kg as seed treatment to protect the rhizome from initial attack of the pathogen. Later *T. viridi* was multiplied in the field conditions by mixing 2 kg of *T. viridi* in 90 kg. of farm yard manure and 10 kg of neem cake. The mixture was placed in shade for 15 days covered with gunny bags and moisture was maintained to allow the growth of the fungus. The multiplied *T. viridi* was applied in rows near the root zone of the crop when the moisture in the soil is available. Proper drainage facility was provided to quickly remove excess rain water from the field. Since the incidence of the rhizome fly is the precursor for the onset of rhizome rot disease, neem cake @ 625 kg/ha was applied to manage rhizome fly. Before application of the neem cake, light irrigation was given, on the moist soil a layer of neem cake was applied in the root zone so that extract from the neem cake will seep into the soil and form a layer on the rhizomes preventing the development of rhizome fly and rot. Potash fertilizers as per recommendation were applied. In farmer practice when the disease appeared, they applied chemical fungicides like copper oxy chloride and mancozeb with least efficacy.

In the turmeric field, 5 x 5 mt areas were randomly selected and observations were recorded on rhizome rot incidence by counting per cent mortality. Per cent rhizome rot disease incidence (PDI) was calculated by using the following formula.

$$\text{Per cent disease incidence} = \frac{\text{Number of plants infected}}{\text{Total number of plant observed}} \times 100$$

Results and Discussion

The results indicate (Table 1) that adoption of IDM practices with emphasis on use of bio-control agents for seed treatment and soil application; proper provision of drainage facility, neem cake application and application potash fertilizers resulted in reduction of rhizome rot disease incidence and damage in turmeric. Farmers cultivate turmeric varieties Mydakuru and Tekurepet Red, which are high yielders and fetch good market price but are not tolerant to rhizome rot disease. To reduce the disease incidence, they practice ridge and furrow method of planting of the turmeric rhizomes so that excessive water may not stagnate in the field conditions but due to frequent occurrence of cyclonic rains in this area, water stagnate in fields in rainy days making the crop prone to disease incidence.

In 2014-15 in the IDM plot, the per cent rhizome rot incidence was 1.5 per cent and in the farmers practice it was 4.5 per cent wherein only chemical fungicides were used. In IDM plot, the dry weight of the turmeric rhizomes was 72.5 qt/ha with 11.9 per cent increase over farmers practices (64.8 q/ha). In 2015-16 in the IDM plot, the per cent rhizome rot incidence was 3.5 per cent and in the farmers practice it was 5.5 per cent. In the IDM plot, the dry weight of the turmeric rhizomes was 88.5 qt/ha with 12.02 percent increase over farmers practices (79.0 q/ha). In 2016-17 in the IDM plot, the per cent rhizome rot incidence was 2.8 per cent and in the farmers practice it was 6.6 per cent. In the IDM plot, the dry weight of the turmeric rhizomes was 72.5 qt/ha with 11.9 per cent increase over farmers practices (64.8 q/ha).

The rainfall received in the crop growth period (Figure 1) indicates that in 2014 and 2016 the rainfall was 32.29 (813.1 mm) and 21.42 per cent (943.6 mm) less than normal rainfall (1200.9 mm). However in 2015 the rainfall (1431.4 mm) exceeded the normal rainfall with majority of it received in the months of June (501.6 mm) and November (213.2 mm) which are 456 and 52.94 per cent more than the normal rainfall. In 2016 also in the month of June excess rainfall (272.6 mm) was received which is 202.21 per cent excess than the normal rainfall. In all other months, the rainfall received was less than the normal rainfall. Normally whenever there is high rainfall, water stagnates in the rows for more period and induce higher percent of rhizome rot incidence. In 2015 due to the receipt of high rainfall, the disease incidence was more in both demonstration plots and farmers practice plots. Lowest incidence of the disease was observed in 2014 where the rainfall received was low compared to normal rainfall in both demonstration plots and farmers practice plots. Shankariah *et al.,* (1991) observed that continuous rain for a week in September induced rhizome rot disease in turmeric. They also reported a positive correlation between continuous rain and rhizome rot occurrence in Nizamabad district of Andhra Pradesh. The survey conducted in these areas shows that the rainfall during finger formation increases the chance of infection. Anoop *et al.,* (2014) reported that the major differences observed in cultivation practices of turmeric is the use of the raised bed system (Kerala) and ridge and furrow system (Tamil Nadu, Andhra Pradesh and Karnataka) which influence the rhizome rot incidence. In Kerala, where raised bed system is practiced, comparatively less disease incidence was observed. Moreover, since it is a rainfed crop in Kerala, the disease occurrence was found only during the rainy season when soil moisture was high. The bed system is supposed to help the water to drain off easily. In ridge and furrow system, the irrigation sometimes causes flooding, increasing the chance of infection irrespective of the season.

The cost of cultivation, average gross returns, average net returns and benefit cost ratios calculated in each year were presented in table 2 indicates that adoption of IDM practices with emphasis on use of bio-control agents resulted in reduction of the incidence of rhizome rot, reduced cost on disease management, thus reducing the cost of cultivation and improving the net income levels. In 2014-15, through adoption of IDM practice, the cost of cultivation was reduced by Rs. 23000.00 with an increase of Rs. 107000.00 in net returns compared to the farmers practice, the benefit cost ratio was 2.28 compared to 1.67 in farmers practice. In 2015-16, the cost of cultivation was reduced by Rs. 26550.00 with an increase of Rs. 58890.00 in net returns in IDM plots compared to farmers practice. The benefit cost ration was 2.2 compared to 1.82 in farmers practice. In 2016-17, through

adoption of IDM practice, the cost of cultivation was reduced by Rs. 52750.00 with an increase of Rs. 95100.00 in net returns compared to the farmers practice, the benefit cost ratio was 1.7 compared to 1.24 in farmers practice.

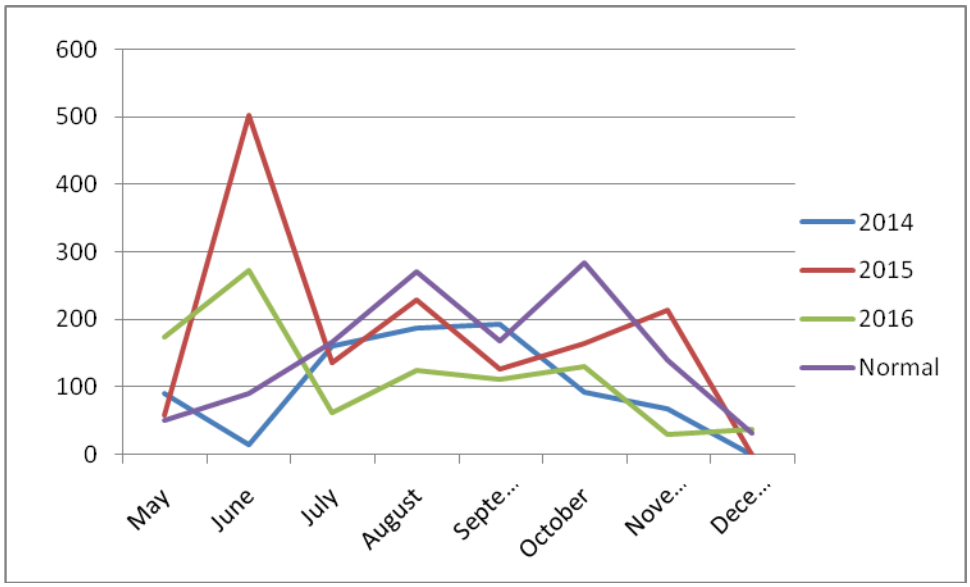
Table.1 Details of the turmeric crop yields obtained and rhizome damage

Year	Variety	No. of Farmers	Yield (q/ha)		Increase in yield (%)	Per cent rhizome damage	
			Demo	Check		Demo	Check
2014-15	Tekurpet Red	10	71.5	64	11.7	1.5	4.5
2015-16	Tekurpet Red	10	88.5	79	12.02	3.5	5.5
2016-17	Mydakuru	10	72.5	64.8	11.9	2.8	6.6

Table.2 Details of cost of cultivation, average gross and net income levels

Year	Average Cost of cultivation (Rs.ha^{-1})		Average Gross Return (Rs.ha^{-1})		Average Net Return (Profit) (Rs.ha^{-1})		BC ratio	
	Demo	Local Check	Demo	Local Check	Demo	Local Check	Demo	Local Check
2014-15	202250	225250	462120	378120	259870	152870	2.28	1.67
2015-16	212350	238900	467540	435200	255190	196300	2.20	1.82
2016-17	234750	287500	398750	356400	164000	68900	1.70	1.23

Figure1 Graph showing the rainfall (mm) received during the crop growth period



The data indicates that application of *T. viridi* as seed treatment and soil application effectively controlled rhizome rot disease and improved the net returns. Shanmugam *et al.*, (2015) reported that application of *T. harzianum* @ 4 gm / kg for 30 minutes and soil application of 2.5 kg / ha of *T. harzianum* in 50 Kg FYM as basal and top dressing on 150 days after planting was found to be highly effective in managing rhizome rot with 79.31 per cent disease reduction over control. Ramarethinam and Rajagopal, (1999) also observed that through soil application of *T. viride* at the rate of 1kg/ha rhizome rot of turmeric was effectively suppressed. Similarly application of a mixture of introduced biocontrol agents would more closely mimic the natural dynamics and might broaden the spectrum of bio-control activity and enhance the efficacy and reliability of control (Duffy and Weller, 1995).

Application of neem cake also played a significant role in the management of rhizome rot of turmeric not directly but acting as repellent to the infestation of rhizome fly, since it was reported that in majority cases, its association was observed before or after disease incidence. It prevents rhizome fly attack, there by the entry of the pathogen into the rhizome is reduced; prevents the purification of the rhizome tissues by dipteran maggots. Ajiri *et al.*, (1982) reported that rhizome fly is the primary causal agent of rhizome rot while Premkumar *et al.*, (1982) and Koya (1990) observed that dipteran maggots play a secondary role of putrefying the rotten tissues. Sankaraiah *et al.*, (1991) also reported that fly infestation was preceded by rhizome rot incidence.

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How to cite this article:

Sudha Jacob, P. and Revathi, K. 2019. On Farm Assessment of Integrated Disease Management Practices with Emphasis on use of Bio-control Agents for Management of Rhizome Rot in Turmeric. *Int.J.Curr.Microbiol.App.Sci.* 8(02): 3120-3126.
doi: https://doi.org/10.20546/ijcmas.2019.802.365