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Study on Effect of Bio Control Agent *Trichoderma viride* and Neem Cake on Rhizome Rot of Turmeric

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ABSTRACT

Turmeric (*Curcuma longa*) is one of the major spice crops in Andhra Pradesh, which is severely affected by rhizome rot (soil borne disease) and leaf spots (foliar diseases). There was drastic reduction in yield, which is majorly affected by soil borne fungus. So, the present study mainly intends to evaluate the performance of *Trichoderma viride* along with neem cake against rhizome rot disease. The experiment was conducted in three successive years at 10 villages and 30 locations of Krishna district as a Front-Line Demonstration of Krishi Vigyan Kendra, Ghantasala, Acarya N G Ranga Agricultural University. The treatment (TO1) consists of seed treatment, ridge sowing, excess water drainage and soil application of *T viride* culture 2 kg multiplied in 90 kg Farm Yard Manure and 10 kg neem cake at the last ploughing time and use of neem cake 300 kg/acre at 60 and 120 DAP at plant base. Whereas, the farmer's practice (TO2) was drenching of copper oxy chloride @ 3g /l of water only to control rhizome rot. In comparing the average data of both the treatments for three consecutive years, TO1 recorded highest yield of 49.12 t/ha of fresh turmeric with a yield improvement of 32.43 % over control. In case of rhizome rot incidence, the average percent incidence for the three consecutive years was reported as 3.37 % in demo and 10.72% in control. In case of net returns, Rs. 2,08,743/- per ha was obtained with a B:C ratio of 1.99:1 in demo and Rs. 93,428.17/- of per ha with 1.43:1 B:C ratio in control. It can be concluded that apart from using only chemicals, integrated management practices fetch better yield and returns too.

Keywords: Turmeric, *Trichoderma viride*, Neem cake, Copper oxy chloride, Rhizome rot.

INTRODUCTION

Turmeric (*Curcuma longa* L.), is a part of Indian cooking, health care as well as rites and rituals since time immemorial. It is an important spice crop of India. The anti-oxidant property of this crop protects the organic cells against the high energy free radical damage [1]. The antiviral, antibacterial, antifungal and anti-inflammatory properties of this crop appear as a powerful medicine for various diseases [2,3]. The colour and properties of turmeric rhizome mainly due to the component curcumin. It is a vital component of rhizome and been broadly used in several medicinal purpose. The demand and importance of turmeric increased due to prohibition on use of synthetic colours in food industry. It was used for various purposes. It supports in digestion and useful towards curing wounds, inflammation, infections, fever, arthritis, trauma, dysentery, injuries, jaundice and other liver problems. It is useful in treatment of blood disorders as it purifies blood and stimulates the production of blood. Hence, it is regarded as a safest herb in Unani medicine.

In India Turmeric was cultivated in 349 million hectares of area with the production of 1334 million tonnes [4]. Different varieties of turmeric like Mydukuru, Tekuripeta, Duggirala, Selam, Rajendra Sonali, Rajendra Sonia and Pragati are cultivating by the farmers of this area. Due to several reasons, there was a reduction in yield exceptionally and cultivating was not lucrative. The reasons were improper cultivation practices *i.e*., raising turmeric on flat beds, improper utilization of fertilizers, stagnation of water in field due to flooding method of irrigation, lack of awareness on importance of seed treatment, utilization of bio-control agents (*Trichodrema viride*) and biofertilizers which leads to the prevalence of rhizome rot disease.

Different species of *Phythium* were reported as the causal organism for rhizome rot in turmeric. *P. aphanidermatum, P. graminicolum, P. myriotylu etc.* It is a soil borne pathogen and spreads easily with irrigation water (flood irrigation), soil and seed material. The affected plant shows water-soaked spots on the plant base. Root becomes rotten and colour changes from orange to brownish. Thereby, the yield of the crop reduces drastically. For the management of this disease, serious efforts have been made using bio control agent *T. viride*. In this connection a trial was conducted on demonstration of rhizome rot management in turmeric using bio control agents as front-line demonstration.

MATERIALS AND METHODS

The present experiments were conducted for three consecutive years from 2017-18, 2018-19 and 2019-2020 at 30 locations of 10 different villages in Krishna district namely, Kosurivaaripalem, Uttara chiruvolulanka, Mellamertilanka, Nagaitippa, Bobbarlanka, Nadakuduru, Inapuru, K Kothapalem, Mopidevi and KVK Ghantasala farm. The soil of the experimental plots was sandy loam to black in the texture with medium fertility status and deficient in boron and zinc micro nutrients. The technical information regarding the trial was provided to the farmers by trainings, group discussions and method demonstration on preparation of *Trichoderma viride*, FYM and neem cake mixture. Short video was also provided in farmer WhatsApp groups to reach the technology in rapid mode. The experiment was laid out in completely randomized block design. The crop was raised in the month of June of every year at a spacing of 30 X 15 cm in the experimental field. The variety raised was Tekuripeta with a crop duration of 9 months. Each trial was conducted in one acre of land and same adjacent area of farmer kept as check as farmers' practice. Standard agronomic practices were followed to grow the crop. The IDM plots were maintained by following IDM practices *viz.*, seed treatment, ridge sowing, providing drainage facility to the crop and soil application of *T. viride* culture (2 Kg.) multiplied in FYM (90 kg) and mixed 10 kg neem cake at the time of last ploughing and application of neem cake 300 kg/acre at 60 and 120 DAP at plant base and need based application of recommended dose of fungicides and no rhizome treatment in local check (T2).

The plant biometric observations and rhizome yield parameters were recorded and computed yield to tons per hectare. The benefit - cost ratio (BC Ratio) of the treatments was calculated by estimating cost of cultivation and returns from rhizome yield after converting them to one hectare of land. The rhizome parameters and percent rhizome rot damage were also calculated. The economics were calculated using the following formula:

1. Gross returns = Yield x Market price
2. Net Returns = Gross Return - Total Cost of cultivation
3. B: C ratio = Gross Return / Total Cost of cultivation
4. % damage of rhizome rot = (No. of damaged plants/ Total no. of plants per acre) X 100

RESULTS AND DISCUSSION

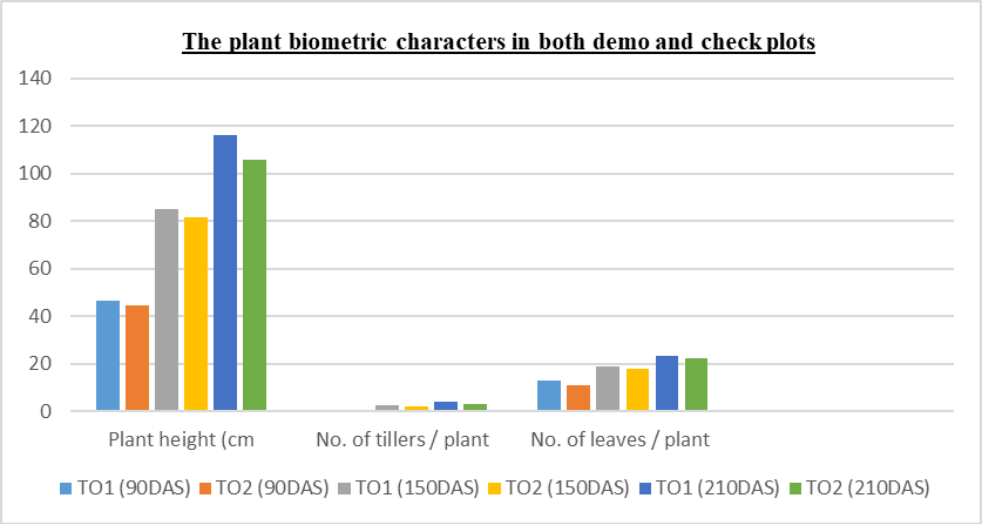
The present trial was conducted as Front-Line Demonstration of KVK, Ghantasala in 30 different locations at 30 farmers' fields in 10 different villages for three successive years from 2017-18 to 2019-20. The treatment details are as mentioned in the Table 1. In the demo plot all the package of practices were followed as mentioned in the Table 1. The biometric parameters were collected from 10 selected plants from each experimental plot to collect and average was calculated. The observed plant biometric characters are listed in Table - 2.

Table 1: Treatment details of Font Line Demonstration on Rhizome rot management in turmeric

S. No.	Particulars	Details
1	Crop and variety	Turmeric var. Tekuripeta
2	Season	Kharif
3	Farming situation	Irrigated dry black deltaic soils
4	Problem diagnosed	Severe incidence of rhizome rot and its spread, leading to drastic reduction in the yield
5	Number of locations and area	30 locations in three years with 12 ha (4 ha. In each year) in 10 villages of Krishna district
6	Treatment details	TO1: Demo (a). Seed treatment with Mancozeb (3g/l), Monocrotophos (2ml/l) and *Trichoderma* (5g/l) (b). Growing plants on ridges (c). Excess water drainage (d). Application of *Trichoderma viride* (2 kg) + FYM (90 kg) and neem cake (culture at the time of last ploughing (kg) (e). Application of neem cake 300 kg/acre at 60 and 120 DAP at plant base (f). Spraying of micronutrients and need based chemicals. TO2: Check (Farmers' practice) (a) Without Seed treatment (b) Cultivation of Turmeric on flat beds (c) Imbalanced application of NPK fertilizers (d) No micronutrient sprayings

Table 2: The plant biometric characters in both demo and check plots

S. No.	Plant characters	TO 1 (Demo) 90 DAS	Check (FP) 90 DAS	TO 1 (Demo) 150 DAS	Check (FP) 150 DAS	TO 1 (Demo) 210 DAS	Check (FP) 210 DAS
1	Plant height (cm)	46.21	44.36	84.85	81.64	116.05	105.91
2	No. of tillers / plant	0	0	2.31	2.09	3.94	3.21
3	No. of leaves / plant	12.91	10.84	18.92	17.61	23.10	22.15



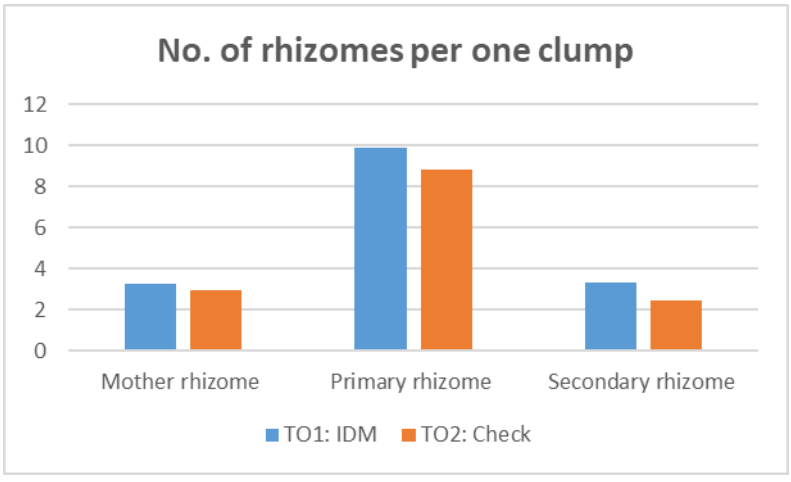
Graph 1: Observation of plant biometric characters in both demo and check plots

The plant biometric observations were recorded on selected plants from the plots at three different stages of the crop *i.e*., 90, 150 and 210 days after sowing the seed. From the Table 2 and Graph 1, it is evident that the plant parameters such as plant height, number of tillers per plant and number of leaves per plants reportedly highest in demo plots than check or farmers' practice at three stages of the crop i.e., 90, 150 and 210 days after sowing. The highest plant height was reported in TO1 as 116.05 cm in demo and lowest in check as 105.91 cm at 210 DAS. Similarly, number of tillers per plant and number of leaves per plant were observed highest in TO1 (3.94 and 23.10 respectively) and lowest in TO2 (3.21 and 22.15 respectively). The plant growth enhanced due to application of both organic and inorganic sources of nutrients. The growth of the plant continues from the starting to 210 days after sowing the crop and there after reduces, eventually the rhizome development enhances and slowly drying of the leaves starts later on. The findings are in close confirmation with earlier findings [5].

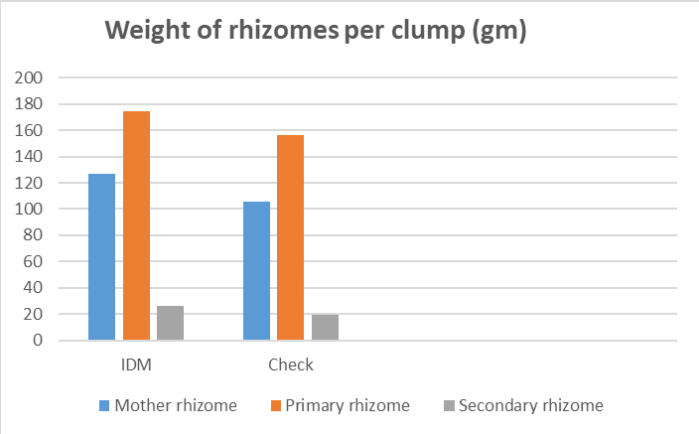
Rhizome yield is an ultimate aim that a farmer can successfully get his returns with highest benefit cost ratio. From the Table- 3, it can be concluded that both the number and weight of mother, primary and secondary rhizomes were reported highest in demo than in control (Graph 2 and 3). The highest number of mother rhizomes per clump were reported as 3.24 in demo and lowest in check as 2.95. Similarly, maximum weight of mother rhizome was observed as 126.95 gm in demo and lowest in check as 105.62 gm. This is due to healthy growth of plant with the available sources of nutrients at all the stages of the crop. These findings were in accordance with the earlier of turmeric findings [6,7] and in ginger [8].

Table 3: Characteristics of rhizome in demo and check plots

Rhizome characters	No. of rhizomes per one clump			Weight of rhizomes per clump (gm)		
	Mother rhizome	Primary rhizome	Secondary rhizome	Mother rhizome	Primary rhizome	Secondary rhizome
TO1: IDM	3.24	9.91	3.34	126.95	174.53	26.41
TO2: Check	2.95	8.84	2.42	105.62	155.97	19.12



Graph 2: Observation of number of rhizomes per clump in demo and check

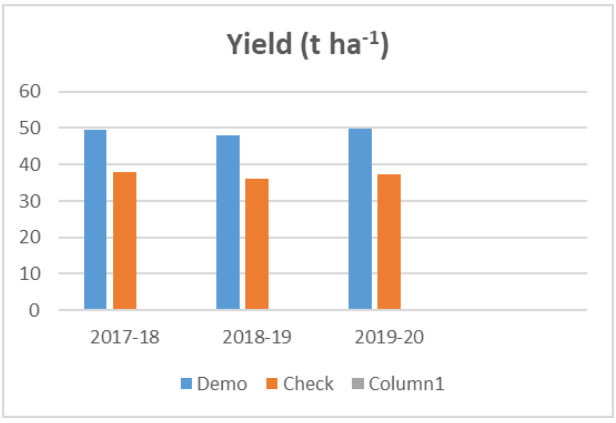


Graph 3: observation of weight of rhizomes per clump (gm)

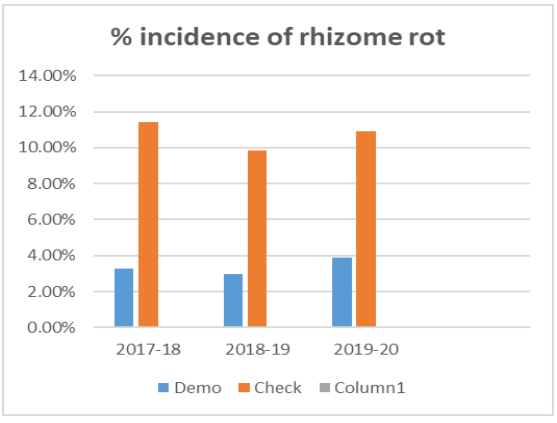
From Table- 4, it is clear that the yield is higher in demo plot for the three consecutive years. The application of *T. viride* (2 kg) along with FYM (90 kg) and neem cake (10 kg) after its multiplication helped in controlling soil borne fungus in demo plots. Along with this application of neem cake 300 kg at 60 and 120 days after sowing particularly with the coincidence of rains helped the farmer in controlling rhizome rot. Apart from this neem cake also adds nutrients to the crop. An average yield was calculated from 10 farmers in each year and finally average of the three years data has been drawn for overall conclusion. Highest yield for the three consecutive years has been reported in demo and lowest in control. It was due to following Integrated Disease Management practices in demo (Graph 4). An average yield of 49.12 t/ha has been reported in demo whereas, it was 37.09 t/ha only in control. The percent increase in yield is reported as 30.60 %, 32.63 % and 34.06 % respectively in three consecutive years. The average percent increase in yield for the three years has been reported as 32.43 %. The percent rhizome rot incidence was also calculated from the 10 farmers in each year and average was presented in Table 4. From the data (Table - 4), the overall average percent incidence of rhizome rot was observed as 3.37 % in demo and 10.72 % in control (Graph 5). The treatment parameters such as, seed treatment, planting on ridges, drainage of excess water, application of *T. viride*, FYM, and neem cake, balanced use of fertilizers particularly nitrogen and potash fertilizers supported the crop in controlling rhizome rot and attaining good quality yield to the farmer. As the soils of experimental area are black deltaic, there is a chance of slow drainage. Hence, excessive rains, lack of proper drainage facility also played a major role in severity of rhizome rot incidence. Whereas in farmers' practice, the incidence was more due to lack of proper management practices and they followed drenching of copper oxy chloride only as and when required. Similar result was also reported by earlier findings [9]. The seed treatment of rhizomes with mancozeb 0.3 percent for 30 minutes before storage and once again before planting reduces the incidence of disease [10].

Table 4: The yield and % incidence of disease of turmeric in demo and check.

Year	No. of farmers	Area (ha)	Yield (t ha^{-1})		% increase in yield	% incidence of rhizome rot	
			Demo	Check	Demo	Demo	Check
2017-18	10	4	49.50	37.90	30.60	3.25 %	11.44 %
2018-19	10	4	48.00	36.19	32.63	2.98 %	9.82 %
2019-20	10	4	49.87	37.20	34.06	3.87 %	10.91 %
Overall			49.12	37.09	32.43	3.37 %	10.72 %



Graph 4: Observation of Rhizome yield



Graph 5: Observation of percent incidence of rhizome rot

Table 5: The yield and economics of turmeric in demo and check.

Year	Economics of demonstration I (Rs. ha^{-1})				Economics of check (Rs. ha^{-1})			
	Gross cost	Gross returns	Net returns	BCR	Gross cost	Gross returns	Net returns	BCR
2017-18	192166	445500	253334	2.32:1	204392	341100	136707	1.67:1
2018-19	214200	398400	184200	1.86:1	224600	300377	75777	1.34:1
2019-20	235200	423895	188695	1.80:1	248400	316200	67800	1.27:1
Total	213855	422598	208743	1.99:1	225797	319226	93428	1.43:1

The economic parameters like cost of cultivation, gross returns, net returns and benefit cost ratio of the three years were drawn after calculating the average performance of 10 farmers' fields in each year and were presented in Table- 5. From the Table- 5, it can be observed that the average net returns for the three years of the crop was observed as Rs. 2,08,743 /- in demo, whereas it was Rs. 93,428.17 /- in check. From the study, it can also be observed that there was an average variation (for three years) of Rs. 11,942.20 /- in the cost of cultivation of turmeric in control over demo (Table- 4). By following Integrated Management practices farmers could able to make an average profit of Rs. 11,942.20 /- by reducing the cost of cultivation. The benefit cost ratio of the experiment was also observed as highest in demo than in control for the three years. The average benefit cost ratio for the three years observed as 1.99: 1 in demo plot and 1.43: 1 in check.

CONCLUSION

From the present study it can be concluded that by using Integrated Disease Management practices *viz.*, seed treatment, raising crop on ridges, creation of proper drainage facility to the crop, balanced use of fertilizers, use of bio control agents like *T. viride* (2 kg) along with FYM (90 kg), neem cake (10 kg) and application of neem cake at two stages helped the farmer in getting higher yield with good net returns along with reduced cost of cultivation in demo than in control. The average rhizome rot incidence for the years was observed as 3.37 % and 10.72 % in demo as well in check respectively. The average net returns were observed as Rs. 2,08,743 /- in demo and Rs. 92,428.17 /- in control. Thereby, it can be concluded that apart from using only chemicals, integrated management practices fetch better yield and returns too.

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Author contribution

The author contributed inputs like *Trichoderma viride* (bio control agent) and neem powder to the selected farmers' fields under study. Organized training programmes, group discussions and diagnostic field visits on control of rhizome rot. Apart from this method demonstration was also conducted on the preparation of Farm Yard Manure, *T. viride* and neem powder and its application in main field. A short video is also prepared on preparation of the above manure for the benefit of farmer and its wide publicity among farming community. Finally, field day was conducted on demonstration of turmeric rhizome rot management.

Conflict of interest

The authors declared no conflict of interest.

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