

Original Research Article

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Efficacy of Bioresources on *Colletotrichum capsici*, Plant Growth and Yield Turmeric (*Curcuma longa* L.) *in vivo*

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ABSTRACT

Keywords

Leaf spot, Turmeric, Bioresources, *Colletotrichum capsici*, Disease intensity, Disease incidence, CODEX etc.,

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Turmeric (*Curcuma longa* L.), is an important and economical medicinal and aromatic crop, prone to many fungal, bacterial, viral and nematode diseases. The most important fungal diseases are leaf spot (*Colletotrichum capsici*), leaf blotch (*Taphrina maculans*), rhizome rot (*Pythium aphanidermatum*) etc., A detailed experiment was conducted to study the efficacy of bioresources against *Colletotrichum* leaf spot. Among all the treatments T5 (VC+SMC+NK) reduced disease incidence (%), disease intensity (%), CODEX (%) followed by T6 (MA), T1 (Carbendazim), T3 (VC), T2 (SMC), T4 (NK), T0 (Control). Similarly, among treatments T5 (VC+SMC+NK) maximised yield (gm), plant height (cm), leaf length (cm) & leaf count followed by T3 (VC), T2 (SMC), T6 (MA), T4 (NK), T1 (Carbendazim) and T0 (Control).

Introduction

Turmeric (*Curcuma longa* L.), a herbaceous monocot plant and important spices of the world belongs to family Zingiberaceae. It is originated from Tropical South Asia, which is also known as 'hidden Lilly' or 'golden spice' or 'Haldi' or 'Yellow root' (Herojit *et al.*, 2017). India is the world's largest producer of turmeric and it accounts for more than 80 per cent of the world's production, followed by China, Indonesia, Bangladesh, and Thailand

(Chavan *et al.*, 2002). Turmeric is cultivated for its underground rhizomes, which are used in many ways, such as condiment in culinary preparation, colouring agent in textiles, as food, confectionaries and medicinally turmeric powder is used for the treatment of biliary disorders, anorexia, hepatic disorders, rheumatism, and sinusitis. In addition, turmeric also possesses antimicrobial and anticancer properties (Gupta *et al.*, 2016). Major turmeric producing states in India are Telangana, Andhra Pradesh, Tamil Nadu,

Karnataka, Orissa, West Bengal and Maharashtra. The area, production and productivity of turmeric in India has been reported to be 223 thousand hectares, 1077 thousand tones and 4830 kg/ha, respectively, during year 2017-18. In Uttar Pradesh, the figures for the area and production of turmeric stand as 1828 ha and 5149 metric tonnes respectively (Mishra and Singh 2019). Turmeric is prone to many fungal, bacterial, viral and nematode diseases. The most important fungal diseases are leaf spot (*Colletotrichum capsici*), leaf blotch (*Taphrina maculans*), leaf blight (*Alternaria alternata*) and rhizome rot (*Pythium aphanidermatum*). *Colletotrichum capsici* causing leaf spot is the most important among foliar diseases of turmeric cause severe reduction in yield due to loss of photosynthetic area (Kothikar and Koche, 2017). The losses by leaf spot of turmeric caused by *Colletotrichum capsici* are always considered to be a limiting factor for quantitative and qualitative losses all over the country (Hudge and Ghugul, 2010). Organic amendments represent a key indicator for soil quality, both for agricultural and Environmental functions and are the main determinant of biological activity. Vermicompost is rich source of macro and micro-nutrients, vitamins, enzymes, antibiotics, growth hormones and micro flora and is found effective against seedling rots, damping off and soil-borne pathogens like *Fusarium etc.*, (Simsek *et al.*, 2014). The properties of neem as insecticide, antifeedant, hormonal, antifungal, antiviral and nematicide properties used in seed treatment, manurial application, increasing nutrient efficiency by which the yield in crops is enhanced and its impact is seen against plant diseases. (Subbalakshmi *et al.*, 2012). Spent mushroom compost use found effective against bacterial disease like bacterial wilt of tomato *etc.*, (Zeeshan *et al.*, 2016), fungal diseases like chickpea wilt *etc.*, (Wasnikar *et al.*, 2019).

Materials and Methods

The present study was carried out at Central Research Field, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Naini, Prayagraj during 2019-20, to study the effect of bioresources on Plant Growth, Yield and Colletotrichum leaf spot of Turmeric (variety 'Krishna'). Experimental plot of size 4m² was prepared. Organic amendments such as vermicompost (VC), neem cake (NK), spent mushroom compost (SMC) @ 10t/ha and combination VC+SMC+NK half doses of each compost were applied to the soil and irrigated the plots a week prior to sowing of turmeric rhizome. Microalgae @ 7.5 kg/ha was mixed in water and was applied to the rhizosphere area after one week of germination. Similarly, application of organic amendments was repeated at 45, 90 & 135DAS and observations were taken on plant height, leaf length, leaf count, yield, disease incidence, disease intensity and CODEX. Yield data was recorded after final harvest of turmeric crop. The experiment was laid out in Randomized Block Design (RBD) with 3 replications.

Symptoms, host range, epidemiology & characteristics of pathogen

Symptoms appear as brown spots of various sizes on upper surface of the leaves. The spots are irregular in shape, white or grey with acervuli in the centre. Later, spots may coalesce and form an irregular patch covering whole leaf. It has wide host range, crops like sesame, groundnut, cowpea, soybean, urdbean, chilli, turmeric *etc.*, and weeds like motha, janglichaulai *etc.*, (Yadav *et al.*, 2017). Infected seed material and crop debris as primary source of inoculum. Conidia dispersed by rain splash and wind. Temperature of 22-25⁰C and relative humidity above 80% is ideal for disease development. Conidiophores are 3-45 to 2-6 micrometer,

hyaline, cylindrical, unicellular or septate. Conidiogenous cells are 6-10 to 2.5-4 micrometer wide hyaline, ellipsoidal to subglobose; conidia are 7-14 to 2.5-3.5 micrometer, one celled, gluttulate, hyaline, fusiform with both ends pointed (Agrios, 2005).

Isolation and identification of the pathogen

Freshly infected leaves of turmeric showing typical symptoms of *Colletotrichum* leaf spot were used to isolate the pathogen from the infected area. The diseased leaf bits along with adjoining healthy portions were surface sterilized with 0.1% mercuric chloride ($HgCl_2$) solution for one minute and washed thrice with sterilized water taken in watch glasses to remove the traces if any. The diseased pieces were then dried by placing between two sterile filter papers, which were then transferred to sterilized petriplates containing solidified PDA medium in the laminar air flow chamber to avoid contamination. The inoculated petriplates were incubated at a temperature of $25\pm 1^\circ C$ and observed periodically for the growth of emerging fungus developed from diseased tissues. The hyphal growth of the fungus was then transferred to PDA slants and petriplates and incubated at $25^\circ C\pm 1^\circ C$ and pure culture thus obtained through hyphal tip was maintained. Then the colony characteristics of the isolated pathogen were studied. The slides were prepared from the culture of isolated plates and also directly from the diseased portion of leaves and were observed under microscope. The acervulus, setae, conidiophore and conidia of the isolated pathogen were observed for identification (Thilagam *et al.*, 2018).

All the observed infected leaves were individually scored on 0-9 scale (Mayee and Datar, 1986) presented in table 1. The data collected were subjected to statistical analysis

and the differences exhibited by the treatments were tested for their significance (Gomez and Gomez, 1986).

The percent disease index, incidence & CODEX was calculated by using formula (Wheeler, 1969).

Per cent disease Incidence

The incidence was calculated according to the formula

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

Per cent disease Index

Percent disease index was calculated by the formula

$$\text{Per cent disease Index} = \frac{\text{Sum of all numerical ratings in plants infected}}{\text{Total rating} \times \text{maximum disease score}} \times 100$$

Coefficient of disease index (CODEX)

CODEX was calculated by the formula

$$\text{CODEX} = \frac{\text{Percent disease incidence} \times \text{percent disease index}}{100}$$

Results and Discussion

Results based on field experiment, the effectiveness of Bio-resources (Vermicompost (VC), Spent Mushroom Compost (SMC), Neem cake (NK), Microalgae (MA), VC+SMC+NK and Carbendazim) on Plant growth parameters significantly increases as compared to control. As shown in Table 2, plant height significantly increased from untreated control T0 (37.06cm). Maximum plant height was observed in treatment T5 (VC+SMC+NK - 60.86cm) followed by T3 (VC -52.30cm), T2 (SMC -49.70cm), T6 (MA -46.56cm), T4 (NK -45.30cm) and T1 (Carbendazim -

41.83cm). Effect of bioresources on leaf length of turmeric is maximum leaf length was observed in T5 (VC+SMC+NK - 31.66cm) followed by T3 (VC -29.20cm), T2 (SMC -27.73cm), T6 (MA -26.23cm), T4 (NK -24.70cm) and T1 (Carbendazim - 23.46cm), while minimum leaf length was observed in untreated Control T0 (21.63cm). Impact on leaf count of turmeric is maximum

count was observed in T5 (VC+SMC+NK - 8.06) followed by T3 (VC -7.73), T2 (SMC - 7.53), T6 (MA -7.33), T4 (NK -7.06) and T1 (Carbendazim -6.83), while minimum count was observed in untreated control T0 (6.43). And Yield of turmeric significantly increased from untreated control T0 (478.33g) (Fig. 1– 4).

Table.1 Scale given by Mayee and Datar (1986)

Score	Description
0	No symptoms
1	Spots covering less than 1% leaf area
3	Spots covering 1-10% leaf area
5	Spots covering 11-25% leaf area
7	Spots covering 26-50% leaf area
9	Spots covering more than 51% leaf area

Table.2 Efficacy of bioresources on plant height, leaf length and leaf count of turmeric at different days of interval

Treatment	Mean of Plant Height (cm) of three replicates at		Mean of Leaf length (cm)of three replicates at		Mean of Leaf count of three replicates at		Mean of Yield (g/4m ²)of three replicates
	45DAS	180DAS	45DAS	180DAS	45DAS	180DAS	
T0	26.50	37.06	16.16	21.63	5.80	6.43	478.33
T1	31.86	41.83	18.50	23.46	6.03	6.83	517.00
T2	35.50	49.70	22.16	27.73	6.60	7.53	755.66
T3	39.40	52.30	23.00	29.20	6.86	7.73	763.66
T4	33.10	45.30	20.16	24.70	6.30	7.06	649.00
T5	47.80	60.86	24.16	31.66	7.26	8.06	842.33
T6	34.30	46.56	21.16	26.23	6.46	7.33	670.00
C.D.	2.54	3.36	0.96	2.40	0.21	0.19	186.04
SE(m)	0.81	1.07	0.43	0.77	0.07	0.06	59.71
SE(d)	1.15	1.52	2.58	1.09	0.09	0.08	84.45

Table.3 Efficacy of bioresources against *Colletotrichum* leaf spot intensity, incidence & CODEX of turmeric at different days of interval

Treatment	Mean of Percent disease incidence of three replicates at			Mean of Percent disease intensity of three replicates at			Mean of CODEX of three replicates at		
	60DAS	120DAS	180DAS	60DAS	120DAS	180DAS	60DAS	120DAS	180DAS
T0	33.11	51.74	63.56	34.07	69.26	83.92	11.22	35.59	53.22
T1	24.33	37.96	42.42	28.41	47.93	63.49	6.89	16.79	28.24
T2	32.42	41.59	54.25	25.51	45.77	75.82	8.30	19.04	41.18
T3	27.19	38.35	48.36	21.18	42.49	71.91	5.74	16.28	34.75
T4	32.25	45.49	55.97	26.07	56.78	78.97	8.39	25.87	44.25
T5	16.96	23.85	31.37	20.87	41.88	56.82	3.50	9.96	17.86
T6	20.52	28.81	38.88	22.05	42.69	57.05	4.51	12.49	24.91
C.D.	3.70	6.07	4.61	2.45	7.75	11.95	1.11	3.28	2.94
SE(m)	1.18	1.95	1.48	0.78	2.49	3.83	0.35	1.05	0.94
SE(d)	1.68	2.75	2.09	1.11	3.52	5.42	0.50	1.48	1.33

As shown in Table 3, Percent of disease incidence, Intensity and CODEX of turmeric increased significantly from T5 (VC+SMC+NK) followed by T6 (MA), T1 (Carbendazim), T3 (VC), T2 (SMC), T4 (NK) and T0 (untreated control)

Fig.1 Efficacy of bioresources on plant growth parameters & yield during crop growth period

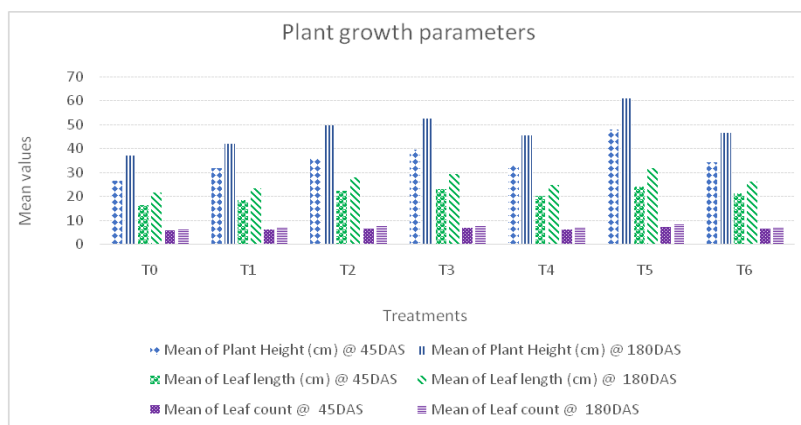


Fig.2 Efficacy of bioresources against disease incidence, intensity & CODEX of *C. capsici* at 60, 120 & 180DAS

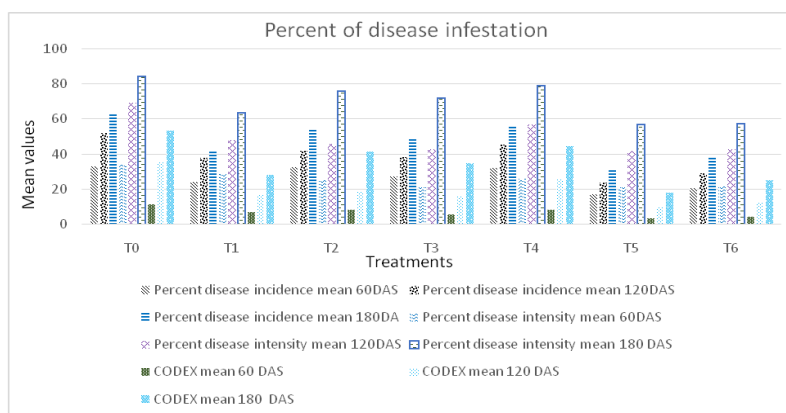


Fig.3 Leaf spot symptoms of *Colletotrichum capsici* with acervuli fruiting body



Fig.4 Scoring of disease intensity in Turmeric



Maximum yield was observed in T5 ((VC+SMC+NK -842.33g) followed by T3 (VC -763.66g), T2 (SMC - 755.66g), T6 (MA -670g), T4 (649g) and T1 (Carbendazim - 517g).

In conclusion the present experimental study clearly indicates that T5 (VC+SMC+NK) shows minimum disease incidence (31.37%), disease intensity (56.82%) & CODEX (17.86%), with highest yield (842.33g), plant height (60.86cm), leaf length (31.66cm). So, using Bioresources can be economical, long lasting and also free from harmful residual side effects.

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