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# Assessment of Fungicide and Biological Control agent against Foliar Diseases of Turmeric

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**A B S T R A C T**

Turmeric (*Curcuma longa* L.) known as golden spice as well as "spice of life" has emerged as low volume high value crop. Among various diseases attacking turmeric, leaf blotch disease caused by *Taphrina maculans* and leaf spot disease caused by *Colletotrichum capsici* are two most serious foliar disease. Turmeric yield losses have been recorded up to 37.6-52.9 per cent and upto 50 per cent in leaf blotch and spot disease respectively. Considering the seriousness of these diseases, present investigation was carried out on management of leaf blotch and leaf spot diseases of turmeric by fungicides and bio-control agents at Tirhut College of Agriculture, Dholi, Muzaffarpur (Bihar) during 2015-16 to 2017-18. Under disease management, Lowest disease *viz.*, *Colletotrichum* leaf spot (PDI=6.67) and *Taphrina* leaf spot (PDI=13.34) were recorded in treatment where pre-planting treatment of rhizome and spraying of crop at 90, 105 and 120 DAP was done with Propiconazole (25 EC) @0.1% and Zineb (75 WP) @0.1% respectively over control (PDI=43.89 & 47.22 respectively). Best treatment with respect to recording of highest yield of 38.09t/ha over control (25.77t/ha) and highest ICBR (1:22.22) were recorded in treatment where pre-planting treatment of rhizome and spraying of crop at 90, 105 and 120 DAP was done with Propiconazole (25 EC) @0.1% and Zineb (75 WP) @0.1% respectively.

## Introduction

Turmeric (*Curcuma longa* L.) is severely affected by several diseases, mostly fungal, have been recorded on turmeric. The crop is prone to many fungal diseases *viz.*, *Colletotrichum* leaf spot (*Colletotrichum capsici* [(Syd.), Butler and Bisby], leaf blotch (*Taphrina maculans* Butler) and Rhizome rot (*Pythium spp.*) are the most serious diseases resulting in yield losses in different parts of the country (Rathaiah, 1987; Annon., 1996). Leaf spot and leaf blotch is the most important among foliar diseases of turmeric which cause severe reduction in yield due to loss of photosynthetic area.

Leaf blotch disease caused by *Taphrina maculans* was reported for the first time reported from Rangapur, East Pakistan (Butler, 1911). Later, it was observed from all turmeric growing regions of the country (Upadhyay and Pavgi, 1967).

The disease is characterized by the appearance of several spots on both the surface of leaves and being generally more numerous on upper surface (Joshi and Sharma, 1982). The leaf spots first appear as pale yellowish discoloration which become dirty yellow and then deepen to the colour of old gold and sometimes to bay shade (Butler, 1911). The individual spots are small, 1-2 mm in diameter and coalesce freely.

In severe cases of attack, hundreds of spots appear on both the sides of leaves. The spots are discrete brownish black and mostly confined to lower leaves (Joshi and Sharma, 1982).

Leaf spot disease of turmeric caused by *Colletotrichum capsici* was first reported from Coimbatore district of Tamil Nadu (Mc Rae, 1917). The most characteristic symptom reported as chlorosis on upper surface of the leaf followed by small brown spots in the initial stage. Size of the spots increases measuring on an average 20-30mm long and 5-10mm broad. The centre of the spots become grayish surrounded by reddish margin. Heavily infected leaves eventually dries up. Further, the disease also spreads on petioles as oblong spots with grayish centres and reddish margins (Kodmelwar *et al*., 1986).

The poor productivity of the crop in the state has been attributed to leaf blotch and spot disease among other factors that hinder its production. Turmeric yield losses have been recorded up to 37.6-52.9 per cent and upto 50 per cent in leaf blotch and spot disease respectively (Ramakrishnan, 1954). When the infection of these diseases become severe, results in drying-up of entire foliage and yield loss becomes so colossal in some areas that turmeric cultivation has become uneconomical, especially where susceptible varieties were grown (Panja *et al.*, 2000).

The disease is such that, its rapid spread and spore production are favoured by warm, rainy and humid weather. Because of prevalence of such environmental factors almost throughout the year coupled with growing of susceptible commercial variety in Bihar, the disease causes a serious threat to turmeric cultivation.

Though some cultural practices have been advocated to manage the disease, the same has been practically possible by using chemicals. In this context little efforts have been made to screen effective fungicides to manage this disease.

Both systemic and non-systemic fungicides have been found effective to the disease by workers in different parts of country and advocated for disease management.

Very little information is available on fungicidal spray to control this disease. Keeping in view the above facts and losses caused by these diseases, the investigation was undertaken with an objective to access efficacy of fungicides and bio-control agents supplied from Indian Institute of Spices Research, Calicut, Kerala (IISR) against leaf blotch and leaf spot disease of turmeric.

## Materials and Methods

The field experiment was conducted during *Kharif* 2015-16 to 2017-18 at the Experimental Farm of Tirhut College of Agriculture, Dholi, Muzaffarpur, Bihar. The Experimental farm is situated at an altitude of 52.0 meter above mean sea level, at a latitude of 25.98° N and longitude of 85.67° E. The

climate is sub-humid type and monsoon receiving an average annual rainfall of 1250 mm mainly during the months June to October. The trail was laid in RBD with seven (7) treatments and three (3) replication. The treatments and other specification of the trial are as follows:

## Treatment details

$T_1$ = Rhizome treatment with IISR *Trichoderma* liquid formulation @1% + foliar spray with IISR *Trichoderma* liquid formulation @1% at 90, 105 & 120 DAP.

$T_2$ = Rhizome treatment with IISR *Pseudomonas* talc formulation @1% + foliar spray with IISR *Pseudomonas* talc formulation @1% at 90, 105 & 120 DAP.

$T_3$= Rhizome treatment with Propiconazole (25 EC) @1% + foliar spray with Propiconazole (25 EC) @1% at 90, 105 & 120 DAP.

$T_4$ = Rhizome treatment with Bordeaux mixture @1% + foliar spray with Bordeaux mixture @1% at 90, 105 & 120 DAP.

$T_5$ = Rhizome treatment with Copper Oxychloride (50 WP) @1% + foliar spray with Copper Oxychloride (50 WP) @1% at 90, 105 & 120 DAP.

$T_6$ = Rhizome treatment with Zineb (75 WP) @1% + foliar spray with Zineb (75 WP) @1% at 90, 105 & 120 DAP.

$T_7$ = Control.

Variety: Morangia (Susceptible to both the diseases)

Plot Size: 3 x 1m (Raised bed) and Spacing: 30 x 20cm

Both the diseases were recorded by following 0-4 disease scoring scale suggested by Annon., (2004) as described below:

| Disease score | % leaf area infected | Disease Reaction |
|---|---|---|
| 0 | 0-1 | HR |
| 1 | 1.1-10 | R |
| 2 | 10.1-20 | MR |
| 3 | 20.1-50 | S |
| 4 | >50 | HS |

For recording the observation, fifteen plants from each of the plot were selected. Observation pertaining to disease intensity was recorded under each treatment, after fifteen days of last (III$^{rd}$) foliar spray. Based on per cent leaf area infected, PDI was calculated as follows:

$$\text{PDI} = \frac{\text{Sum of all numerical rating}}{\text{Total number of Plants graded} \times \text{Maximum grade}} \times 100$$

Finally, the yield / plot were recorded at the time of harvest of turmeric rhizome and subsequently it was converted in tonne/ hectare. The incremental cost benefit ratio (ICBR) was also calculated as below:

$$\textbf{ICBR} = \frac{\text{Income from the yield over control per hectare}}{\text{Expenditure incurred for spraying per hectare (cost of fungicide / chemicals + cost of labour charge)}}$$

## Statistical analysis

The statistical analysis was done with the aid of off-campus OP-STAT analyses package and the method as suggested by Gomez and Gomez (1984). Critical difference (CD) was calculated at 5 per cent level of significance for comparison of treatment.

## Results and Discussion

The data from table 1 shows that during *Kharif* 2015-16, all the treatments have statistically significant effect on reduction of *Colletotrichum* as well as *Taphrina* leaf spot disease along with increase in yield over control.

Lowest disease *viz., Colletotrichum* leaf spot (PDI=6.67) and *Taphrina* leaf spot (PDI=3.33) were recorded in treatment where pre-planting treatment of rhizome and spraying of crop at 90, 105 and 120 DAP was done with Propiconazole (25 EC) @0.1% over control (PDI=58.33 and 18.33 respectively).

Best treatment with respect to recording of lowest PDI gave yield of 39.00t/ha, which was also found statistically *at par* where IISR *Trichoderma* liquid formulation (1%) or IISR *Pseudomonas* talc formulation (1%) was used in treatment giving yield of 39.50t/ha over control (21.50t/ha.).

All the treatments were found to be have statistically significant effect on reduction of *Colletotrichum* as well as *Taphrina* leaf spot disease along with increase in yield over control (Table 2). Lowest disease *viz.*, *Colletotrichum* leaf spot (PDI=5.0) and *Taphrina* leaf spot (PDI=1.67) were recorded in treatment where pre-planting treatment of rhizome and spraying of crop at 90, 105, 120 DAP was done with Zineb (75 WP) @ 0.1% over control (PDI=50.0 and 15.0 respectively). Best treatment with respect to recording of lowest PDI gave yield of 43.62t/ha over control (24.14t/ha). Maximum disease reduction over control (90.0%) and consequently highest yield increase over control (99.70%) was recorded in the treatment where Rhizome treatment with Zineb (75 WP) @0.1% + foliar spray with Zineb (75 WP) @0.1% at 90, 105 and 120 DAP.

All the treatments were found to be have statistically significant effect on reduction of *Colletotrichum* as well as *Taphrina* leaf spot disease along with increase in yield over control (Table 3). Lowest disease *viz.*, *Colletotrichum* leaf spot (PDI=6.67) and *Taphrina* leaf spot (PDI=11.67) were recorded in treatment where pre-planting treatment of rhizome and spraying of crop at 90, 105, and 120 DAP was done with Propiconazole (25 EC) @0.1% and Zineb (75 WP) @0.1% over control (PDI=23.33 & 55.00 respectively). Best treatment with respect to recording of highest yield (40.63t/ha) over control (21.65t/ha) was found in treatment where pre-planting treatment of rhizome and spraying of crop at 90, 105 and 120 DAP was done with Zineb (75 WP) @0.1%. Maximum disease reduction over control *i.e.*, 71.41% & 78.78% was recorded for leaf spot & leaf blotch disease in the treatment where pre-planting treatment of rhizome and spraying of crop at 90, 105, 120 DAP was done with Propiconazole (25 EC) @0.1% and Zineb (75 WP) @0.1% respectively. Highest yield increase over control (87.67%) was recorded in the treatment where Rhizome treatment as well as spraying was done with Zineb (75 WP) @0.1% at 90, 105 and 120 DAP.

After three consecutive years (2015-16 to 2017-18) of field experimentation**,** table 4 shows all the treatments to be statistically significant in their effect on reduction of *Colletotrichum* as well as *Taphrina* leaf spot disease along with increase in yield over control. Lowest disease *viz., Colletotrichum* leaf spot (PDI=6.67) and *Taphrina* leaf spot (PDI=13.34) were recorded in treatment where pre-planting treatment of rhizome and spraying of crop at 90, 105 and 120 DAP was done with Propiconazole (25 EC) @0.1% and Zineb (75 WP) @0.1% respectively over control (PDI=43.89 & 47.22 respectively). Best treatment with respect to recording of highest yield of 38.09t/ha over control

(25.77t/ha) and highest ICBR (1:22.22) were recorded in treatment where pre-planting treatment of rhizome and spraying of crop at 90, 105 and 120 DAP was done with Propiconazole (25 EC) @0.1% and Zineb (75 WP) @0.1% respectively.

In the present study, three spray of Propiconazole (25 EC) and Zineb (75 WP) @0.1% proved to be the best fungicide in terms of recording lowest disease severity of 6.67 and 13.34 per cent and reducing disease severity to the extent of 84.80 and 71.74 per cent in case of leaf spot and leaf blotch disease respectively. Though some efforts have been made to screen the fungicide in Indian context but information on these aspects are very limited in other turmeric growing countries. However, the credibility of best fungicide *i.e.*, Propiconazole (25 EC) and Zineb (75 WP) as observed in the present study can also be substantiated by the findings of work performed at different coordinating centres under All India Coordinated Research Project on Spices in the country. At Dholi (Bihar) during 2010-11 and 2014-15 foliar spray of Tricyclazole @0.1 per cent twice at 45 and 90 days after sowing (DAS) was able to reduce the disease and thus disease severity of 7.44 to 26.09 per cent with 49.68 per cent reduction in disease severity was recorded (Annon., 2010; 2011 and 2015). Similar observation were also made from study carried out at different geographical location of the country. Study carried out at Coimbatore (Tamil Nadu), Jagital (Andhra Pradesh) and Kumarganj (Uttar Pradesh) revealed role of twice foliar spray of Tricyclazole at 45 and 90 days after sowing (DAS) in reducing the leaf blotch severity 28.55 to 46.37 per cent (Annon., 2016, 2017).

**Table.1** Effect of Fungicide and Biological control agents against foliar disease of turmeric (2015-16).

| Treatm-ent | *Colletotr-ichum* leaf spot (PDI) | Disease reduction over control (%) | *Taphrina* leaf spot (PDI) | Disease reduction over control (%) | Yield (t/ha) | Yield increase over control (%) |
|---|---|---|---|---|---|---|
| $T_1$ | 11.67 (19.89) | 80 | 5.00 (12.92) | 72.72 | 39.50 | 83.72 |
| $T_2$ | 8.33 (16.60) | 85.72 | 5.00 (12.92) | 72.72 | 39.50 | 83.72 |
| $T_3$ | 6.67 (14.76) | 88.57 | 3.33 (8.61) | 81.83 | 39.00 | 81.40 |
| $T_4$ | 28.33 (32.09) | 51.43 | 8.33 (16.60) | 54.56 | 30.50 | 41.86 |
| $T_5$ | 21.67 (27.71) | 62.85 | 11.67 (19.89) | 36.33 | 33.50 | 55.81 |
| $T_6$ | 16.67 (24.02) | 71.42 | 6.67 (14.67) | 63.61 | 35.50 | 65.11 |
| $T_7$ | 58.33 (49.83) | - | 18.33 (25.30) | - | 21.50 | - |
| CD (*p*= 0.05) | 8.12 | - | 4.62 | - | 3.53 | - |
| CV (%) | 21.06 | - | 31.16 | - | 5.81 | - |

**Note:** Figure within parentheses represent the angular transformed value of corresponding data.

**Table.2** Effect of Fungicide and Biological control agents against foliar disease of turmeric (2016-17).

| Treatment | *Colletotr-ichum* leaf spot (PDI) | Disease reduction over control (%) | *Taphrina* leaf spot (PDI) | Disease reduction over control (%) | Yield (t/ha) | Yield increase over control (%) |
|---|---|---|---|---|---|---|
| $T_1$ | 16.67 (24.12) | 66.67 | 13.33 (3.67) | 11.13 | 39.96 | 65.53 |
| $T_2$ | 13.33 (21.39) | 73.34 | 6.67 (2.65) | 55.53 | 41.29 | 71.04 |
| $T_3$ | 6.67 (15.0) | 86.67 | 3.33 (1.80) | 77.80 | 42.46 | 75.89 |
| $T_4$ | 26.67 (31.11) | 46.70 | 8.33 (2.94) | 44.47 | 34.46 | 42.75 |
| $T_5$ | 20.00 (25.56) | 60.0 | 11.67 (3.47) | 22.20 | 38.13 | 57.95 |
| $T_6$ | 5.0 (12.92) | 90.0 | 1.67 (1.26) | 88.87 | 43.62 | 80.70 |
| $T_7$ | 50.00 (45.00) | - | 15.0 (3.94) | - | 24.14 | - |
| CD (*p*= 0.05) | 7.64 | - | 0.67 | - | 4.70 | - |
| CV (%) | 21.74 | - | 21.60 | - | 7.01 | - |

**Note:** Figure within parentheses represent the angular transformed value of corresponding data.

**Table.3** Effect of Fungicide and Biological control agents against foliar disease of turmeric (2017-18).

| Treatment | *Colletotric hum* leaf spot (PDI) | Disease reduction over control (%) | *Taphrina* leaf spot (PDI) | Disease reduction over control (%) | Yield (t/ha) | Yield increase over control (%) |
|---|---|---|---|---|---|---|
| $T_1$ | 8.33 (16.74) | 64.29 | 16.67 (24.12) | 69.71 | 37.66 | 81.48 |
| $T_2$ | 10.0 (18.43) | 57.14 | 20.00 (26.57) | 63.63 | 37.96 | 75.33 |
| $T_3$ | 6.67 (15.00) | 71.41 | 15.00 (22.79) | 72.72 | 39.79 | 83.79 |
| $T_4$ | 15.0 (22.79) | 35.71 | 40.00 (39.23) | 27.27 | 29.97 | 38.43 |
| $T_5$ | 15.0 (22.79) | 21.43 | 26.67 (31.11) | 51.50 | 34.30 | 58.43 |
| $T_6$ | 13.33 (21.39) | 42.86 | 11.67 (20.00) | 78.78 | 40.63 | 87.67 |
| $T_7$ | 23.33 (28.86) | - | 55.00 (47.87) | - | 21.65 | - |
| CD (*p*= 0.05) | 7.38 | - | 7.72 | - | 10.23 | - |
| CV (%) | 19.75 | - | 14.39 | - | 12.23 | - |

**Note:** Figure within parentheses represent the angular transformed value of corresponding data.

**Table.4** Effect of Fungicide and Biological control agents against foliar disease of turmeric (Pooled data).

| Treatment | *Colletotr-ichum* leaf spot (PDI) | Disease reduction over control (%) | *Taphrina* leaf spot (PDI) | Disease reduction over control (%) | yield (t/ha) | Yield increase over control (%) | ICBR |
|---|---|---|---|---|---|---|---|
| $T_1$ | 12.22 (20.44) | 72.15 | 15.0 (22.79) | 68.23 | 35.71 | 38.57 | 1:2.20 |
| $T_2$ | 10.55 (19.00) | 75.96 | 17.22 (24.50) | 63.53 | 34.00 | 31.94 | 1:9.40 |
| $T_3$ | 6.67 (15.00) | 84.80 | 13.89 (21.89) | 70.58 | 38.09 | 47.80 | 1:10.27 |
| $T_4$ | 14.00 (21.97) | 68.10 | 27.22 (31.44) | 42.35 | 31.65 | 22.82 | 1:0.76 |
| $T_5$ | 18.89 (25.77) | 56.96 | 19.45 (26.21) | 58.80 | 31.99 | 24.14 | 1:11.10 |
| $T_6$ | 11.67 (20.00) | 73.41 | 13.34 (21.39) | 71.74 | 36.60 | 42.02 | 1:22.22 |
| $T_7$ | 43.89 (41.50) | - | 47.22 (43.39) | - | 25.77 | - | - |
| CD (*p*= 0.05) | 8.83 | - | 7.74 | - | 2.51 | - | - |
| CV (%) | 20.49 | - | 20.61 | - | 3.98 | - | - |

**Note:** Figure within parentheses represent the angular transformed value of corresponding data.

Effect of different treatment on yield parameter in the present study indicates that with respect to first two top rankers of treatment with respect to yield parameter are the same as recorded in case of reducing disease severity. It also refers that reduction in disease severity is one of the major factor directly influencing the yield parameter in most of the cases.

In support of above statement Tricyclazole @ 0.1 per cent was found to increase the rhizome yield by registering the range of yield from 10.55 to 38.50 t/ha in studies carried out at different location of country *i.e.*, Coimbatore, Jagital, Kumarganj during 2009; Dholi; Coimbatore during 2010; Raigarh during 2011 and Kumarganj during 2013 (Annon., 2009, 2010, 2011 and 2013).

Feasibility of a treatment for adoption at farmers level can be adjudged by considering the economics or income obtained from additional yield obtained over central in terms of incremental cost benefit ratio (ICBR) resulting due to effect of a particular treatment. In the present study, second lowest disease severity, second highest yield and consequently maximum ICBR of 1:22.22 was recorded in treatment comprising of rhizome treatment along with thrice foliar spray with Zineb 75 WP @ 0.1 per cent at fortnightly interval.

Finding pertaining to ICBR in the present study is in close agreement with the findings of earlier similar study carried at Dholi (Bihar) during 2014-15 where ICBR of 1:23.04 higher than present study was

registered by foliar spray of Tricyclazole (0.1%) at 45 and 90 DAS. Realization of ICBR primarily depends on factors like labour wages with pace of time besides the fact of increase in fungicide cost and probably the prevailing less sale price of produce at that time. In consonance to the outcome of present study, more return and benefit cost ratio was realized by some other workers by fungicidal treatment (Panja *et al.*, 2001; Singh *et al.*, 2003 and Singh, 2009).

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