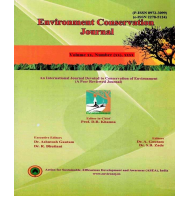




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Evaluation of different management practices against yellow Sigatoka disease of banana (*Musa* spp.) caused by *Mycosphaerella musicola* Leach

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ABSTRACT

Leaf spot or yellow sigatoka disease (caused by *Mycosphaerella musicola*) of banana causes significant yield loss as well as in quality of fruits in every year and reported up to 65% or even more under favorable epidemic conditions. In this perspective, an experiment was conducted at ZBNF project Research field, college of horticulture, Sirsi (Uttara Kannada district of Karnataka) for consecutive two seasons (2020-21 & 2021-22). Experiment accompanied with RBD statistical design with five replications and four treatments. Four different management practices involving viz. Propiconazole 25EC @ 0.1% (Recommended package of practices-UHS, Bagalkot), *Trichoderma harzianum* 10g/lit. (Organic farming), sour butter milk 5 lit. per 200 liter of water (Natural farming) and Tebuconazole 50% + Trifloxystrobin 25% WG @0.5gm/lit. (Chemical farming) were evaluated against sigatoka leaf spot disease. Among the management practices, chemical farming comprises tebuconazole 50%+ trifloxystrobin 25%WG@1gm/lit was found effective in managing the disease (12.38% PDI) followed by recommended package of practice comprises propiconazole 25%EC @1ml/l (16.33% PDI), organic farming comprises of talk-based *Trichoderma harzianum* 10g/lit (17.33% PDI). Natural farming showed least effective to combat disease recorded maximum disease severity (19.66% PDI) after 210 days after planting. Although chemical farming can effectively control the disease but results in the serious risk on human health and environmental hazards. Therefore, organic and natural farming are an alternative approach that are eco-friendly and economically viable against sigatoka leaf spot disease management.

Introduction

Banana is cashcrop for small land holding farmers countries in the world. Among several diseases which belong to the family *Musaceae*, native to the affecting banana plants, yellow Sigatoka leaf spot is the Malaysia-Indonesian region of South-East Asia. It is a serious fungal disease that involves ascomycetes fungi viz. *Mycosphaerella musicola* (anamorph: it is widely cultivated in tropical and subtropical

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Pseudocercospora musae) leads to 11-80% yield losses in banana by reducing the photosynthetic tissues through necrotic leaf lesions (Shanthiyaa *et al.*, 2013). Initial symptom of the disease comprises appearance of pale yellow or dark brown indistinct linear streaks parallel to the veins on the lower leaves. In advanced stages, these streaks enlarge to form necrotic lesions with yellow halo and light grey centers (Stover, 1972). These necrotic lesions later coalesce, causing complete drying of the leaves and defoliation, leading to delayed flowering, reduction in the number of hands and fingers, premature ripening and peel splitting of the fruits, small sized unmarketable bunches with subsequent post-harvest spoilage effects (SurrIDGE *et al.*, 2003; Selvarajan *et al.*, 2001). Conidial morphology mostly cylindrical, occasionally obclavate, 1-5-septate, same thickness throughout length no distinct basal hilum (Borah *et al.*, 2020). When leaves with rapidly developing young mass spots of black sigatoka were left lying on the ground to decay, discharge of ascospores was observed within 5 days and continued as long as 25 days. Ascospores of *M. musicola* survived as long as 8 weeks in the shade on leaf tissue above the ground (Stover, 1971). Time taken for ascospore survival on leaves lying on the ground in the shade depends on the rate of decomposition. Fallen leaves on ground if they subjected intermittent rainfall, dew and partial drying in the daytime continue to discharge ascospores in declining amounts for up to 4 weeks. Chemical control by spraying fungicides on a preventive or curative basis is the only acceptable strategy adopted in the management of this disease. Certain fungicides belonging to groups benzimidazole, dithio carbamates, strobilurins and triazole are currently used in managing Sigatoka disease in India. Continuous use of the systemic fungicides is reported to increase the risk of development of resistance to these fungicides in *Mycosphaerella musicola* (Hermanto *et al.*, 2010; Oliveira *et al.*, 2022) apart from the environmental pollution entailing from the rigorous application of these chemicals. There are only few reports on the satisfactory results obtained in managing Sigatoka diseases by including non-chemical methods such as the application of *Trichoderma harzianum* and sour butter milk which comprises millions of beneficial *Lactobacillus* bacteria are component of the integrated diseases management of Sigatoka

leaf spot (Aman and Rai, 2016; George and Cherian, 2020). As of now in this particular banana crop, none of the literatures comprised sour butter milk as one among the organic approaches to manage sigatoka disease moreover it is a sustainable approach for crop production. Hence these taking into account, present study was to evaluate of different farming systems management practices to combat Sigatoka leaf spot disease in banana.

Material and Methods

The field trial was carried out at experimental field of Natural farming project (Zone-9), College of Horticulture, Sirsi (Latitude 14.6039° N and longitude 74.8467° E) Uttara Kannada district of Karnataka, India during 2020-2022. The experiment was laid out in randomized block design with 5 replications using Yelakki variety of banana. Tissue culture plantlets were used for planting with the plant to plant and row to row spacing 2.5m x 1.8m, respectively. The fertilizers were applied at the rate of N:P:K- 400:240:500 Kg/ha. and FYM at the rate of 40 T/ha. Other intercultural operations were practiced as recommended by University of Horticultural Science, Bagalkot for commercial cultivation of banana. Treatment were imposed after appearance of symptoms and severity was recorded subsequently at 30 days of intervals. It included spraying of Tebuconazole 50%+ Trifloxystrobin 25% WG @0.5gm/lit. from chemical farming propiconazole 1ml/lit. from recommended package of practice. *Tichoderma harzianum* 10gm/lit. (talc-based formulation) from organic farming and sour butter milk (5liters per 200 liters of water) from natural farming.

Measurement of Sigatoka leaf spot disease severity index in banana

To find out the effect of treatment to combat disease severity, which is expressed in terms of Percent disease index (PDI). For that, plants were selected for observation excluding the border plants in order to avoid the border effect. Observation were taken for two years at monthly intervals amid the time of treatment imposition to harvest of the crop. A 0-6 disease scale was followed for scoring the sigatoka leaf spot symptoms and the schematic representation of Gauhl's modification (1993) of the Stover's severity scale (1972b) (Carlier *et al.*,

2002). Description of each grade is also shown in Table 1. The total number of leaves was scored as per the scale based on the area of infection. Using the score values the extent of infection was estimated based on the proportion of the area affected by the leaf spot infection in relation to the total leaf area and calculated the disease index using the Gauthier's formula (1993) modified from Stover's disease severity scale.

$$\text{Percent Disease Index (PDI):} \\ \frac{\text{sum of all disease rating}}{\text{Total number of rating} \times \text{maximum grade in disease score}} \times 100$$

Table 1: Disease score scale for yellow Sigatoka disease given by Carlier *et al.* (2002)

Score	Description
0	No symptoms
1	Not more than 1% of leaf area affected
2	Less than 5% of the leaf area affected
3	From 6 to 15 % of the leaf area affected
4	From 16 to 33% of the leaf area affected
5	From 34% to 50% of the leaf area affected
6	More than 50% of the leaf area affected

The area under the disease progress curve (AUDPC) is a helpful quantitative measurement of disease intensity over period, comparison across years, management strategy. The trapezoidal method, which is the most popular technique for determining the AUDPC, involves discretize time variable (hours, days, weeks, months and years) and determine the average disease's intensity prevalence between each pair of adjacent time points (Madden *et al.* 2007). We can consider the sample time points in a sequence $\{t_i\}$, where the time interval between two time points may be consistent or fluctuate and we also have associated measures of the disease level (y_i). We define $y(0) = y_0$ as the initial infection or the disease level at $t = 0$ (*i.e.*, the first disease severity observation in our study). $A(t_k)$, the AUDPC at $t = t_k$, is the total accumulated disease until $t = t_k$, given

$$A_k = \sum_{i=1}^{N_i-1} \frac{(y_i + y_{i+1})}{2} (t_{i+1} - t_i)$$

Statistical analysis:

The collected data were compiled and analyzed statistically using the analysis of variance

(ANOVA) technique as per the method described by Gauthier and Hawley (2015).

Results and Discussion

In the absence of resistant cultivars in banana, use of fungicides to manage the disease is an old-age practice and now it becomes the prominent component of integrated disease management strategy however due to environmental and health hazards, fungicides have been a concern since they were introduced in agriculture hence present study comprised the treatment of sour butter milk, is an alternative to pesticides for resistance management in fungus. Sigatoka is not one among the catastrophic disease of banana and prevalent thought-out the worldwide. An experiment was conducted to evaluate the effectiveness of different management practices. The effects of the different management practices showed consistent trends in efficacy during the two consecutive years of evaluation. The perusal of data pertaining to Table 2 and Table 3 revealed that among the four different management practices to combat Sigatoka leaf spot disease in banana. During 2020-21, chemical farming (Tebuconazole 50%+ Trifloxystrobin 25% WG @ 0.5gm/lit.) found effective against managing disease with significant decrease in disease severity (9.90% PDI) at 210 days after planting which was followed by recommended package of practices (12.50% PDI) and organic farming (18.75% PDI). More severity of disease was noticed in natural farming (21.85% PDI). During 2021-22, similar trend was observed with a least disease severity was observed in chemical farming with a tone of 10.12% PDI. These results are in confirmatory with Ruth and Nagalakshmi (2017) were conducted field trial comprises of eleven different fungicides among that tebuconazole 50% + trifloxystrobin 25% WG @ 0.5 g/lit. was found effective against Sigatoka leaf spot of banana. Apart from chemical farming, recommended package of practice (12.52% PDI) showed effective. The recorded observations are in parallel with Pradhan *et al.* (2020) and Paresh (2009) who observed propiconazole was found effective against banana leaf spot disease. In organic farming disease severity was recorded with 15.61% PDI. Dattatray (2013), Castro (2015) and Samuelian (2016) are found *Trichoderma harzianum* potential for controlling yellow sigatoka leaf spot of banana.

Table 2: Evaluation of different management practices against Sigatoka disease of bananaduring 2021& 2022

Treatment		Per cent Disease Index (PDI)									
		2020-21					2021-22				
		Before spray	120 DAP	150 DAP	180 DAP	210 DAP	Before spray	120 DAP	150 DAP	180 DAP	210 DAP
T ₁	RPP	29.50±0.58 (5.86)	18.94±0.73 (4.34)	18.06±0.82 (4.24)	17.18±0.77 (4.14)	12.50±0.58 (5.86)	31.50±0.58 (5.86)	17.95±1.25 (4.23)	16.31±0.62 (4.03)	15.74±0.82 (3.96)	12.52±1.18 (3.93)
T ₂	Organic farming	31.75±0.72 (6.25)	21.16±0.42 (4.59)	20.12±0.75 (4.48)	19.10±0.69 (4.36)	18.75±0.72 (6.25)	33.75±0.72 (6.25)	19.10±0.69 (4.36)	18.97±0.80 (4.36)	17.15±0.74 (4.13)	15.61±0.73 (4.08)
T ₃	Natural farming	28.85±0.84 (5.92)	26.21±0.76 (5.11)	24.11±1.08 (4.91)	22.60±0.67 (4.75)	21.85±0.84 (5.92)	30.85±0.84 (5.92)	27.17±1.12 (5.21)	22.80±0.58 (4.77)	20.99±1.29 (4.57)	18.67±0.82 (4.31)
T ₄	Chemical farming	30.90±0.57 (6.05)	16.31±0.62 (4.03)	15.98±0.92 (3.99)	15.73±0.92 (3.95)	9.90±0.57 (6.05)	29.90±0.57 (6.05)	13.89±0.65 (3.72)	13.46±0.60 (3.66)	12.65±0.81 (3.54)	10.12±0.72 (3.33)
S.Em±		0.73	0.06	0.12	0.09	0.10	0.73	0.18	0.14	0.13	0.07
C.D @ 5%		0.21	0.19	0.30	0.24	0.31	0.21	0.37	0.34	0.34	0.22

T1-RPP (Recommended Package of Practice): Propiconazole 25EC @ 1 ml/l T2-OF (Organic farming): *Trichoderma harzianum* (talk based) 10g/lit

T3-NF (Natural Farming): Sour butter milk (5l per 200 l of water) T-4 CF (Chemical Farming): Tebuconazole 50%+ Trifloxystrobin 25% WG @ 0.5 gm/lit.

Note:DAP- Days after planting, Figures in the parenthesis are square root transformed values.

Table 3: Pooled Per cent disease incidence of Sigatoka disease caused by banana

Treatments	Management practices	Per cent Disease Index* (PDI)					AUDPC
		120 DAS	150 DAS	180 DAS	210 DAS		
T ₁	RPP Propiconazole 25EC @ 1 ml/l	18.44±0.54 (23.02)	17.18±0.54 (23.54)	16.46±0.84 (22.10)	16.33±0.58 (20.58)	2637.15	
T ₂	Organic farming <i>Trichoderma harzianum</i> (talk based) 10g/lit.	20.17±0.37 (24.19)	19.54±0.69 (25.18)	18.12±0.72 (26.23)	17.33±0.49 (26.65)	2899.50	
T ₃	Natural farming Sour butter milk (5lit. per 200 lit. of water)	26.69±0.80 (26.31)	23.45±0.85 (27.81)	21.79±0.75 (28.95)	19.66±0.87 (31.09)	3653.85	
T ₄	Chemical farming Tebuconazole 50%+ Trifloxystrobin 25% WG @ 0.5 gm/lit	15.10±0.46 (23.80)	14.72±0.62 (23.81)	14.19±0.83 (24.74)	12.38±0.68 (24.59)	2185.50	
S.Em±		0.47	0.52	0.60	0.35	-	
C.D @ 5%		1.45	1.60	1.85	1.10	-	

Note:DAS- Days after sowing, PDI- Per cent disease index, Figures in the parenthesis are arc sine transformed values, Figures with same alphabetical superscripts are statistically non-significant (p<0.05) by DMRT. * Pooled data of two years, AUDPC- Area under disease progress

Maximum disease severity was noticed in natural farming (18.67% PDI) at 210 days after planting. (Samuelian2016). Pooled disease severity of two years experimental period resulted that least disease severity was noticed in chemical farming (12.38% PDI) with 2185.50 AUDPC followed by recommended package of practice (16.33% PDI) with 2637.15 AUDPC and organic farming (17.33% PDI) with 2899.50 AUDPC. Maximum incidence was noticed in natural farming treatment with sour butter milk (19.66% PDI) with 3653.85 AUDPC. Chemical farming showed effective management against Sigatoka leaf spot disease of banana with an irrespective time intervals after spraying. While natural farming found least effective when compare to other treatments.

Conclusion

In the present studies, Among the evaluated management practice, the fungicides spraying of tebuconazole + trifloxystrobin was showed effective which is followed by propiconazole under field condition due to specific mode of action of

fungicides and translaminar movement of systemic fungicides can effectively suppress the disease by fungistatic and antisporeulant mechanisms. However, application of *Tichoderma harzianum* and sour butter milk not found effective compared to fungicides. Even though sour butter milk which is component of natural farming was not found effective but it is an alternative, ecofriendly, sustainable approach to combat disease.

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Conflict of interest

The authors declare that they have no conflict of interest.

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