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PR Muthanna
 Department of Plant Pathology,
 UAS, Dharwad, Karnataka,
 India

MR Ravikumar
 Professor, Department of Plant
 Pathology, UAS, Dharwad,
 Karnataka, India

DS Sunil Kumar
 Department of Plant Pathology,
 UAS, Dharwad, Karnataka,
 India

Corresponding Author:
PR Muthanna
 Department of Plant Pathology,
 UAS, Dharwad, Karnataka,
 India

Management of tip over disease of banana by using effective PGPRs and different chemicals

PR Muthanna, MR Ravikumar and DS Sunil Kumar

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Abstract

Banana is one of the most versatile plant that can be used to heal various kinds of illnesses in every aspect. However, its cultivation is hampered by many diseases like in other crops. The least known soft rot disease among farmers caused by *Erwinia carotovora* subsp. *carotovora* has become a threat to banana cultivation. The present study was aimed to identify suitable control measures of soft rot to avoid the plunging of banana yield. A field experiment was conducted during 2019 imposing seven different treatments. Among the treatments no disease incidence was recorded streptomycin (500 ppm) + COC (3000 ppm) and K-cyclin (500 ppm) + COC (3000 ppm). But the influence on plant height (49.40 cm), pseudostem girth (20.50 cm), number of leaves per plant (13.08) and number of scorched leaves per plant (0.87) were comparatively less in streptomycin (500 ppm) + COC (3000 ppm) treatment. *Pseudomonas aeruginosa* (B-8) + *Bacillus cereus* (B-13) treatment recorded highest plant height (52.00 cm), pseudostem girth (21.57 cm), number of leaves per plant (13.27) and number of scorched leaves per plant (3.17). *Pseudomonas aeruginosa* (B-8) also significantly influenced the growth promotion followed by *Bacillus cereus* (B-13). Whereas, untreated control was recorded with highest disease incidence and lowest growth parameters.

Keywords: Banana, tip over disease, chemical combinations, plant growth promoting rhizobacteria (PGPR)

Introduction

Banana is one of the oldest tropical fruit plants known to humanity, and in India which is next to mango. It was regarded as the cheapest, most abundant and most nourishing of all the fruits from time immemorial. Bananas are usually cultivated all year round throughout the nation and grow much better in hot and humid environments. Bananas are the most ideal fruits in the world because they are high in potassium, small in fat and a great source of vitamins and fiber. Bananas and plantains are significant staple food crop in developing nations for millions of individuals. Since, bananas are greater in vitamin B₆, anxiety and stress is reduced.

Rhizobacteria are competent bacteria in the rhizosphere capable of multiplying and colonizing on plant roots at all stages of plant growth in the presence of competing microflora (Antoun and Kloepper, 2001) ^[1] in contact with other microorganisms. Rhizosphere is the soil surface affected by plant root and is considered to play a pivotal role in plant growth and development (Hryniewicz and Baum, 2012) ^[4]. Rhizosphere may be neutral, harmful or beneficial to plant growth. Once reintroduced in the rhizosphere, approximately 2 to 5 per cent of rhizobacteria have beneficial effects on plant growth and are referred to as Plant Growth Promoting Rhizobacteria (PGPRs) (Kloepper and Schroth, 1978) ^[6].

Several factors are attributed to the constraints for high production of banana and the major being the occurrence of diseases. Among the bacterial diseases in Karnataka, tip over or bacterial rhizome banana rot has become important in recent years. The bacterial nature of banana head rot or rhizome rot first noticed in Allahabad (Uttara Pradesh) by Wardlaw (1950) ^[12]. Khan and Nagaraj (1998) ^[5] from Karnataka recorded the causal organism as *Erwinia carotovora*. But, Chattopadhyay and Mukherjee (1986) ^[2] from West Bengal implicated *Erwinia chrysanthemi* as the causal agent.

Material and Methods

The experiment on management of soft rot of banana also known as tip over disease of banana was implemented in disease prone field planted with tissue culture banana seedlings.

The study was conducted during 2019. The experiment comprised of seven treatments with three replications and in each replication 10 banana plants were maintained. The antibacterial chemical combinations and PGPRs were applied to the root zone by scraping the surface soil and treatments were drenched around the pseudostem region. About 1000 ml solution per plant was drenched depending on the plant growth, except bleaching powder, which was applied to the soil at 0.3 per cent per plant at the basin portion of the plant. The chemicals / antibiotics were drenched thrice. The first application was given to 41 days old crop and the second drench was given 20 days later while the third and fourth soil drench was given at 81 and 101 days old plants respectively. The observations on the per cent incidence of disease, plant height, pseudostem girth, total number of leaves and number of leaves scorched were recorded a day before and twenty days after the imposition of treatments.

Results and Discussion

Field experiment was conducted during 2019 on integrated management of tip over disease of banana caused by *E. c.* subsp. *carotovora*. Treatments were imposed in Randomized Completely Block Design (RCBD). The results (Table 1) indicated that, per cent disease incidence before the initiation of treatments was non-significant among treatments. No disease incidence was recorded in treatments, streptocycline (500 ppm) + COC (3000 ppm) and K-cycline (500 ppm) + COC (3000 ppm), 20 days after fourth drenching (120 DAP). The next best effective treatment was *Pseudomonas aeruginosa* (B-8) + *Bacillus cereus* (B-13) with 13.33 per cent disease incidence followed by *Pseudomonas aeruginosa* (B-8) (16.67 %) and *Bacillus cereus* (B-13) (20.00 %) treatments respectively.

The results of present investigation on the efficacy of antibacterial chemical combinations such as streptocycline (500 ppm) + COC (3000 ppm) and K-cycline (500 ppm) + COC (3000 ppm) agreed with the findings of earlier workers, wherein it was clearly stated that, agrimycin and streptomycin

were very effective in inhibiting the growth of bacteria and in managing the disease under field conditions (Stover, 1959; Mahmoud *et al.*, 1981; Farag *et al.*, 1984; Parashar and Sindhan, 1988 and Nirmaljit Singh *et al.*, 1979) [11, 7, 3, 10].

Among the various antibacterial chemicals and PGPRs applied, highest plant height (52.00 cm) was recorded in *Pseudomonas aeruginosa* (B-8) + *Bacillus cereus* (B-13) followed by *Bacillus cereus* (B-13) (50.87 cm), streptocycline + COC (49.40 cm) and K-cycline + COC (49.20 cm) compared to untreated control (34.58 cm) at 120 days after planting (Table 2). Maximum pseudostem girth (21.57 cm) was recorded in *Pseudomonas aeruginosa* (B-8) + *Bacillus cereus* (B-13) treated plants followed by *Bacillus cereus* (B-13) (20.78 cm) (Table 3). Maximum number of leaves per plant (Table 4) was recorded in *Pseudomonas aeruginosa* (B-8) + *Bacillus cereus* (B-13) (13.27) followed by *Pseudomonas aeruginosa* (B-8) (13.21). Least number of scorched (Table 5) leaves was found in K-cycline + COC (0.92) followed by streptocycline + COC (0.87).

Similarly, Nagaraj (2002) [8] reported that, no disease was recorded in *Bacillus subtilis* followed by *Pseudomonas fluorescense* and Vesicular Arbuscular Mycorrhiza (VAM) at 90 days after third application. The maximum plant height (172 cm) was recorded in mycorrhizal treated plants. Maximum pseudostem girth (51.61 cm) and number of leaves per plant (29.33) in *Bacillus subtilis* treated plants.

Conclusion

Streptocycline (500 ppm) in combination with copper oxychloride (3000 ppm) was found to be the most effective in controlling the pathogen under field condition. Among the PGPRs evaluated, *Pseudomonas aeruginosa* (B-8) in combination with *Bacillus cereus* (B-13) was found to be most effective in managing the pathogen under field condition. *Pseudomonas aeruginosa* (B-8) performed well in managing the disease and also had positive influence on the plant growth.

Table 1: Effect of antibiotics and PGPRs on tip over disease incidence under field condition

| Treatments | Concentration | Disease incidence (percent disease incidence) | | | | |
|---|--|---|---------------|---------------|---------------|---------------|
| | | Before Drenching (40 DAP) | 60 DAP | 80 DAP | 100 DAP | 120 DAP |
| <i>Pseudomonas aeruginosa</i> (B-8) | 7×10^6 cfu ml ⁻¹ (1000 ml) | 23.33 (28.87)* | 33.33 (35.25) | 30.00 (33.20) | 23.33 (28.87) | 16.67 (24.09) |
| <i>Bacillus cereus</i> (B-13) | 7×10^6 cfu ml ⁻¹ (1000 ml) | 26.67 (31.08) | 36.67 (37.25) | 33.33 (35.25) | 23.33 (28.87) | 20.00 (26.55) |
| <i>Pseudomonas aeruginosa</i> (B-8) + <i>Bacillus cereus</i> (B-13) | 7×10^6 cfu ml ⁻¹ (500 ml + 500 ml) | 23.33 (28.87) | 33.33 (35.25) | 30.00 (33.20) | 20.00 (26.55) | 13.33 (21.41) |
| Streptocycline + COC | 500 ppm + 3000 ppm | 26.67 (31.08) | 23.33 (28.87) | 16.67 (24.09) | 6.67 (14.96) | 0.00 (0.00) |
| K-cycline + COC | 500 ppm + 3000 ppm | 30.00 (33.20) | 26.67 (31.08) | 16.67 (24.09) | 10.00 (18.43) | 0.00 (0.00) |
| Bleaching powder + ZnSO ₄ | 3000 ppm + 3000 ppm | 26.67 (31.08) | 36.67 (37.25) | 43.33 (41.15) | 46.67 (43.07) | 56.67 (48.81) |
| Control | - | 23.33 (28.87) | 36.67 (37.25) | 43.33 (41.15) | 53.33 (46.89) | 63.33 (52.71) |
| S.Em. ± | | 2.77 | 2.21 | 2.06 | 2.73 | 1.81 |
| C.D. (5 %) | | 8.54 | 6.81 | 6.37 | 8.43 | 5.60 |

*Arc sine transformed value

Table 2: Effect of antibiotics and PGPRs on plant height of banana under field condition

| Treatments | Concentration | Plant height (cm) | | | | |
|---|--|---------------------------|--------|--------|---------|---------|
| | | Before Drenching (40 DAP) | 60 DAP | 80 DAP | 100 DAP | 120 DAP |
| <i>Pseudomonas aeruginosa</i> (B-8) | 7×10^6 cfu ml ⁻¹ (1000 ml) | 19.78 | 28.60 | 36.00 | 40.12 | 49.09 |
| <i>Bacillus cereus</i> (B-13) | 7×10^6 cfu ml ⁻¹ (1000 ml) | 21.53 | 28.00 | 38.73 | 44.57 | 50.87 |
| <i>Pseudomonas aeruginosa</i> (B-8) + <i>Bacillus cereus</i> (B-13) | 7×10^6 cfu ml ⁻¹ (500 ml + 500 ml) | 18.36 | 28.40 | 39.67 | 45.00 | 52.00 |
| Streptocycline + COC | 500 ppm + 3000 ppm | 21.13 | 29.93 | 37.17 | 43.38 | 49.40 |
| K-cycline + COC | 500 ppm + 3000 ppm | 21.13 | 30.33 | 37.97 | 43.28 | 49.20 |
| Bleaching powder + ZnSO ₄ | 3000 ppm + 3000 ppm | 20.67 | 25.30 | 29.18 | 34.67 | 37.00 |
| Control | - | 20.33 | 24.67 | 28.67 | 30.83 | 34.58 |
| S.Em. ± | | 1.14 | 1.18 | 2.44 | 2.47 | 2.61 |
| C.D. (5 %) | | 3.52 | 3.64 | 7.53 | 7.62 | 8.04 |

7×10^6 cfu ml⁻¹

Table 3: Effect of antibiotics and PGPRs on pseudostem girth of banana under field condition

| Treatments | Concentration | Pseudostem girth (cm) | | | | |
|---|--|---------------------------|--------|--------|---------|---------|
| | | Before Drenching (40 DAP) | 60 DAP | 80 DAP | 100 DAP | 120 DAP |
| <i>Pseudomonas aeruginosa</i> (B-8) | 7 x 10 ⁶ cfu ml ⁻¹ (1000 ml) | 5.17 | 6.37 | 13.17 | 16.03 | 20.56 |
| <i>Bacillus cereus</i> (B-13) | 7 x 10 ⁶ cfu ml ⁻¹ (1000 ml) | 5.00 | 6.50 | 13.17 | 16.03 | 20.78 |
| <i>Pseudomonas aeruginosa</i> (B-8) + <i>Bacillus cereus</i> (B-13) | 7 x 10 ⁶ cfu ml ⁻¹ (500 ml + 500 ml) | 5.70 | 6.63 | 13.40 | 17.00 | 21.57 |
| Streptocycline + COC | 500 ppm + 3000 ppm | 5.77 | 6.70 | 12.28 | 16.36 | 20.50 |
| K-cycline + COC | 500 ppm + 3000 ppm | 5.00 | 6.70 | 12.27 | 16.33 | 20.32 |
| Bleaching powder + ZnSO ₄ | 3000 ppm + 3000 ppm | 5.63 | 6.63 | 9.50 | 12.17 | 13.43 |
| Control | - | 5.70 | 5.93 | 8.33 | 10.67 | 11.27 |
| S.Em. ± | | 0.26 | 0.32 | 0.59 | 0.14 | 0.44 |
| C.D. (5 %) | | 0.73 | 0.99 | 1.8 | 0.42 | 1.34 |

Table 4: Effect of antibiotics and PGPRs on number of leaves of banana under field condition

| Treatments | Concentration | Total number of leaves | | | | |
|---|--|---------------------------|--------|--------|---------|---------|
| | | Before Drenching (40 DAP) | 60 DAP | 80 DAP | 100 DAP | 120 DAP |
| <i>Pseudomonas aeruginosa</i> (B-8) | 7 x 10 ⁶ cfu ml ⁻¹ (1000 ml) | 8.10 | 8.90 | 11.40 | 12.37 | 13.21 |
| <i>Bacillus cereus</i> (B-13) | 7 x 10 ⁶ cfu ml ⁻¹ (1000 ml) | 7.99 | 8.63 | 11.00 | 11.80 | 13.17 |
| <i>Pseudomonas aeruginosa</i> (B-8) + <i>Bacillus cereus</i> (B-13) | 7 x 10 ⁶ cfu ml ⁻¹ (500 ml + 500 ml) | 7.30 | 8.87 | 11.67 | 12.50 | 13.27 |
| Streptocycline + COC | 500 ppm + 3000 ppm | 7.83 | 8.80 | 11.00 | 11.67 | 13.08 |
| K-Cycline + COC | 500 ppm + 3000 ppm | 8.00 | 9.03 | 10.77 | 11.73 | 12.21 |
| Bleaching powder + ZnSO ₄ | 3000 ppm + 3000 ppm | 8.43 | 8.97 | 9.37 | 9.85 | 11.35 |
| Control | - | 8.07 | 8.40 | 8.53 | 8.87 | 9.50 |
| S.Em. ± | | 0.46 | 0.44 | 0.38 | 0.44 | 0.46 |
| C.D. (5 %) | | 1.43 | 1.36 | 1.17 | 1.36 | 1.41 |

Table 5: Effect of antibiotics and PGPRs on number of scorched leaves under field condition

| Treatments | Concentration | Number of scorched leaves | | | | |
|---|--|---------------------------|--------|--------|---------|---------|
| | | Before Drenching (40 DAP) | 60 DAP | 80 DAP | 100 DAP | 120 DAP |
| <i>Pseudomonas aeruginosa</i> (B-8) | 7 x 10 ⁶ cfu ml ⁻¹ (1000 ml) | 1.60 | 2.55 | 3.87 | 3.95 | 3.40 |
| <i>Bacillus cereus</i> (B-13) | 7 x 10 ⁶ cfu ml ⁻¹ (1000 ml) | 1.70 | 2.97 | 4.01 | 3.92 | 3.42 |
| <i>Pseudomonas aeruginosa</i> (B-8) + <i>Bacillus cereus</i> (B-13) | 7 x 10 ⁶ cfu ml ⁻¹ (500 ml + 500 ml) | 1.10 | 2.22 | 3.63 | 3.92 | 3.17 |
| Streptocycline + COC | 500 ppm + 3000 ppm | 1.00 | 1.28 | 1.30 | 1.17 | 0.87 |
| K-cycline + COC | 500 ppm + 3000 ppm | 1.13 | 1.87 | 1.90 | 1.26 | 0.92 |
| Bleaching powder + ZnSO ₄ | 3000 ppm + 3000 ppm | 2.10 | 2.44 | 4.70 | 5.07 | 5.30 |
| Control | - | 1.27 | 3.01 | 5.13 | 6.07 | 6.31 |
| S.Em. ± | | 0.24 | 0.26 | 0.1 | 0.23 | 0.18 |
| C.D. (5 %) | | 0.74 | 0.79 | 0.31 | 0.72 | 0.56 |

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