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RESPONSES OF BANANA CIGAR END ROT PATHOGEN TO CHEMICAL FUNGICIDES

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ABSTRACT

In vitro study was carried out to investigate the responses of cigar end rot pathogen *Musicillium theobromae* (Turconi) Zare & W. Gams (syn. *Verticillium theobromae* E.W. Mason & S. Hughes) to chemical fungicides viz., Gemstar, Score, Tilt, Nativo, Tecto, Scholar and Aerosal. The efficacy of fungicides against cigar end rot was determined by measuring the colony growth, fresh weight of biomass and dry weight of biomass. Among seven fungicides evaluated against colony growth of M. theobromae, Tecto was highly effective followed by Aerosal and Score. Gemstar and Scholar appeared less effective than other fungicides. Although, all fungicidal treatments significantly reduced the fungus growth as compared to the control. The test pathogen *M. theobromae* failed to grow at all concentrations of Tecto; able to produce less growth at 0.1 ppm of Aerosal; 0.1 and 1 ppm of Score. Similarly, 100 and 1000 ppm of Tilt and Nativo appeared highly effective, as no growth of test pathogen was observed in these treatments. In regards of fresh biomass weight, all fungicidal treatments were effective in reducing the growth of *M. theobromae* in liquid culture. However, some were more effective than others. Fungicides like Score, Tilt, Nativo, Tecto and Aerosal were highly effective, their all concentrations produced no or negligible amount of fresh biomass of *M. theobromae*. Among different fungicides, Gemstar appeared significantly less effective than other fungicides; it's all concentrations produced more or less fresh biomass of test pathogen. The test fungus was only able to grow at lower concentration (0.1 ppm) of Scholar but produced negligible growth at 1 to 1000 ppm. In term of dry biomass production, most of the fungicides were highly effective against *M. theobromae*, produced either no or negligible dry biomass weight. However, few fungicides such as Scholar and Gemstar produced comparatively more dried biomass weight as compared to the control. Although, both of these fungicides produced significantly less dried biomass as compared to the control. The other fungicides like Aerosal, Nativo, Tecto, Score and Tilt were highly effective in reducing the dry biomass weight of M. theobromae. Further studies should be conducted to evaluate the effective fungicides like fungicides like Tecto, Score. Tilt, Nativo and Aerosal under field and storage conditions against cigar end rot of banana.

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INTRODUCTION

Banana (*Musa* sp.) belongs to the family Musaceae, is a major fruit crop of considerable importance in the developing countries (Stover and Simmonds, 1987). The banana is one of the most familiar fruit crop in the world, about 135 countries produced banana fruit (Vézina and Bergh, 2013). It is also considered a major fruit crop of Pakistan. It is grown on 34,800 hectares with production of 154,800 tons. It is mainly grown in Sindh province where the soil and climatic conditions are favorable for its successful cultivation (Junejo and Mehboob ul Haq, 2014). The total share of Sindh province alone in its cultivation is 87 percent. More than 95 percent of the area under a banana crop is covered by the Basrai variety (Cavendish dwarf) and the remaining under William Hybrid. Recent introduction includes variety Grand Nain (G-9) while the work is underway to introduce high yielding Chinese varieties *viz*., B-10, W-11 and Pisang (Junejo and Mehboob ul Haq, 2014).

In spite of its very essential nutritional and economic value, unfortunately banana sector of Pakistan is facing serious problems from production to post harvest management (Ahmed et al., 1995). Bananas are affected by a variety of insect pests and diseases that cause catastrophic yield losses (Jones, 2000). Post-harvest loss of fresh fruits is one of the major problems in the tropics (Diedhiou et al., 2014). The important field diseases that attacks banana plantation includes Panama wilt (*F. oxysporum* f. sp. *cubense*), leaf spot, leaf streak or Sigatoka disease (*Mycosphaerella fijiensis*), anthracnose (*Gloeosporium musae*), cigar end rot (*Verticillium theobromae* and *Trachsphaera fructigena*), stem-end rot (*Thielaviopsis paradoxa*), head rot (*Erwinia carotovora*), bacterial wilt or moko disease (*Pseudomonas solanacearum*), banana bunchy top virus (BBTV), banana streak virus (BSV) and banana bract mosaic virus (BBMV) (Jones, 2000).

Cigar end rot is considered one of the important pre-harvest as well as post-harvest fungal disease of banana. Cigar end rot of banana was caused by at least two fungal species independently. They are *Musicillium theobromae* (Turconi) Zare & W. Gams (syn. *Stachylidium theobromae* Turconi, *Verticillium theobromae* E.W. Mason & S. Hughes) and *Trachysphaera fructigena* (Tabor and Bunting) (Beugnon et al., 1970). In case of cigar end rot disease, the pathogen enters the banana finger through the flower causing a dry rot of immature banana fingers. Infection is common in the early days of fruit emergence. The affected portion remains attached to the finger and looks like ash of a cigar. It damages the fruits in the field as well as during transportation and storage (Masudi and Bonjar, 2012). *M. theobromae* is more widespread than *Trachysphaera fructigena* and occurs in most banana growing regions of the world (Boubaker et al., 2008; Meredith, 1973) mostly in Asia (Alvindia et al., 2006; Bhangale and Patil, 1983; Masudi and Bonjar, 2012). *M. theobromae* is also one of the members of a pathogenic species complex, responsible for crown rot of banana fruits during transition (Ilyas et al., 2007; Slabaugh and Grove, 1982). Cigar end rot caused by *M. theobromae* is increasingly reported from Kenya, especially in Kisii and Western Kenya, where susceptible varieties like Dwarf Cavendish and Gross Michel were widely cultivated (Waweru, 2008). Control of the disease is by hand removal of the pistils 8-10 days after bunch formation and spraying the bunch with a fungicide and de-leafing banana plants and pruning shade trees to reduce humidity. But it is laborious and time consuming, so the aim of the current study is to reduce the cigar end rot damage to banana fruit using chemical control. Therefore, the present study was carried out to evaluate the response of cigar end rot caused by *M. theobromae* under *in vitro* conditions.

MATERIALS AND METHODS

Collection of diseased samples: A field survey of banana orchards near Tandojam was conducted to collect banana fruit affected with cigar end rot disease. These samples were immediately brought in the Plant Pathological laboratory, Department of Plant Protection, SAU Tandjam for symptomatology and isolation of causal pathogen.

Isolation of causal pathogen: To confirm the cause of the disease, isolation was carried out from the affected portion of the collected banana fruits on Potato Dextrose Agar (PDA) plates by tissue isolation method. For this purpose, the affected portions of the banana fruit skin having disease lesions including some symptomless part were cut into small pieces of about 0.5 cm with the help of a sterilized scalpers knife (Waller et al., 1998). Under aseptic conditions they were surface sterilized with the help of 5% Sodium hypochlorite solution for 2-3 minutes, dried on sterilized blotting paper and placed on the surface of PDA plates. These plates were incubated at ambient on laboratory benches. The appearing fungal colonies were purified on fresh PDA plates and identified on the basis of the morphological characters after reference to Barnett and Hunter (1972). The fungus *Musicillium theobromae*

was identified on the basis of the colony characteristics and conidial morphology studied under the compound microscope. The culture was purified by hyphal tip transfer method and multiplied on PDA medium for further use.

Pathogenicity test: The fresh unripe banana fruits which apparently free from any disorders were collected from the nearby banana orchard. They were surface sterilized with 5% commercial bleach and dried on sterilized blotter papers. The finger end (having ten banana fruits) was injured with fine sterilized needle. A 5 mm piece of *Musicillium theobromae* was cut from the 7 days old culture with the help of the sterilized cork borer and placed on the injured tissues of the banana fruit. These fruits were placed in a humid chamber lined with moistened blotter paper to facilitate the pathogen infection. After 24 hours, the cultural disks were removed, and fruits were stored at 20 ^{0}C for fruit ripening and symptom development. The fruits with agar disc were served as control.

***In vitro* evaluation of fungicides:** Five different fungicides Aerosal, Gemstar, Nativo, Score, Tecto and Tilt were against cigar end rot of banana caused by *M. theobromae* under *in vitro* conditions. The details of fungicides used are given in table 1. Each fungicide was tested with five different concentrations *viz*., 0.1, 1, 10, 100 and 1000 ppm by food poisoning method.

Efficacy of fungicides against colony growth of *M. theobromae*: The required concentrations of the fungicides were added in the PDA medium before pouring, concentration was calculated on the basis of active ingredient of fungicide and maintained by serial dilution method. PDA medium without fungicide served as control. After solidifying of the medium, 5 mm diameter agar disk of test fungus were cut from 8-10 days old culture and placed in the center of the PDA plate containing the fungicide amended medium. The data on colony growth was recorded daily until the plates were filled with the growth of test fungus in any treatment.

Table 1. Details of fungicides used in the experiments.

Trade name	Chemical name	Active ingredient	Chemical group
Aerosal	Thiophanate-methyl	70% Thiophanate-methyl	Thiophanate-methyl
Nativo	Trifloxystrobin+Tobuconazole	25% Trifloxystrobin + 50% Tobuconazole	Trifloxystrobin-Tobuconazole
Score	Difenoconazole	Difenoconazole 250 EC	Difenoconazole
Gemstar	Azoxystrobin	Azoxystrobin 250 EC	Strobilurins
Tilt	Propiconazole	Propiconazole 250 EC	Triazole
Tecto	Thiabendazole	Thiabendazole 500 SC	Benzimidazole
Scholar	Fludioxonil	Fludioxonil 230 EC	Group 12 fungicide

Efficacy of fungicides on fresh and dry biomass weight of cigar end rot pathogen: The above-mentioned fungicides with same concentrations were also evaluated to check their effects on fresh and dry biomass of *Musicillium theobromae.* For this purpose, potato dextrose broth was prepared and poured in several 100 ml conical flasks. These flasks were sterilized, and the required concentrations of fungicides were added when they became cool. A 5mm diameter agar disk of *Musicillium theobromae* were cut from 8-10 days old culture and placed in each conical flask. These flasks were incubated at room temperature for one month.

After 30 days on incubation, the fungal mycelial mat growing on the surface of the broth medium was harvested. For this purpose, the contents of the conical flask were filtered through a Buchner funnel by pre-weighed 9-cm Whatman No. 1 filter paper. The fresh biomass was weighed with the help of digital balance. Dry weights of the test fungus were obtained by placing the mycelial mate in a forced-air drying oven at 70 °C for 24 hours. The dry weight of the fungus was calculated by using the following formula:

$$\text{Dry weight} = (\text{weight of filter paper} + \text{mycelial weight}) - (\text{weight of filter paper})$$

The resulting data was analyzed by using student edition of "Statistix" to find out the significance of differences in different treatments.

RESULTS AND DISCUSSION

Isolation and pathogenicity test: The banana fruits affected with the cigar end rot disease showed black tip necrosis and dry rot of pulp. As the disease progresses, the diseased portion of the fingers becomes covered with grayish color fungal growth, which looks like the ash of burnt cigar (Figure 1).

Isolations were made from affected parts of collected banana fruits on PDA medium. *Musicillium theobromae* was frequently and consistently isolated with the banana fruits showing typical symptoms of cigar end rot disease along with the few saprophytic fungi in very rare frequencies. On PDA plates, *Musicillium theobromae* produced concentric growth pattern. From the upper/front side of culture plate, it produced initially white mycelium, which later on become olivaceous grey brown. On the backside of the PDA plate, it appears as dark brownish growth, which makes thick concentric rings surrounded by pale color fungal growth to black growth.

Figure 1. Banana fruits showing typical symptoms of cigar end rot.

On PDA medium it produced, abundant, vertically branched, erect, hyaline or brown conidiophores. They contain 3-6 phialides of 14-37 x 1.5-5 µm in size arising at each node. Conidia are mostly arising singly at the tip of the phialides, they are hyaline, ellipsoidal to sub-cylindrical 3-8 x 1.5-3 µm in size. The pathogenicity test carried out on healthy, un-ripe banana fingers proved that the *Musicillium theobromae* is the causal agent of cigar end rot disease of Banana. The tip of the inoculated fruits became necrotic and rotted. The pathogen infection and ultimate disease development manifest itself by ash like growth on the affected parts of fingers. This looks like a tip of a burnt cigar or cigarette from a distance. The decay covered up to 1/3 of the fruit. In re-isolation, the *Musicillium theobromae* was repeatedly isolated from the rotten part of the inoculated fingers.

Efficacy of fungicides against colony growth of *M. theobromae*

Aerosal: All concentrations of Aerosal were highly effective against *M. theobromae*. The test fungus failed to grow at 1, 10. 100 and 1000 ppm, only little growth of 17 mm was recorded at 0.1 ppm of Aerosal (Figure 2).

Gemstar: All the concentrations of Gemstar significantly checked the colony growth of *M. theobromae* as compared to the control (un-inoculated). Although, higher concentrations were more effective than lower ones. The significant minimum colony growth of 16.88 mm was recorded at 1000 ppm; while maximum growth of test pathogen was observed in control plates (77.38 mm) followed by 0.1 ppm (29.25 mm) (Figure 2).

Nativo: All concentrations of Nativo appeared more or less effective against the test pathogen as compared to the control. Among different concentrations maximum colony growth of *M. theobromae* was observed at 0.1 ppm followed by 1 ppm. No growth of test pathogen was observed at higher concentrations of 100 and 1000 ppm (Figure 2).

Scholar: All concentrations of Scholar more or less checked the colony growth of *M. theobromae* as compared to control. The growth of test fungus was gradually decreased with an increasing concentration of Scholar fungicide. Among different treatments, maximum growth of *M. theobromae* was recorded at 0.1 ppm (42.13 mm (followed by 1 ppm (37.63 mm); while significantly minimum growth was observed in 1000 ppm (15.5 mm) followed by 100 ppm (27.63 mm) (Figure 2).

Score: Most of the concentrations of Score were highly effective against *M. theobromae*. The test pathogen completely unable to grow at 10, 100 and 1000 ppm of Score. While, 1 and 0.1 ppm produced little growth of 2.5 and 15.5 mm, respectively (Figure 2).

Tecto: All concentrations of Tecto appeared highly effective against test pathogen. *M. theobromae* was completey failed to grow at any concentration of this fungicide (Figure 2).

Tilt: All concentrations of Tilt appeared effective against the test pathogen. Among different concentrations maximum colony growth of *M. theobromae* was observed at 0.1 ppm (30.38 mm) followed by 1 ppm (14.75 mm). No growth of test pathogen was observed at higher concentrations of 100 and 1000 ppm (Figure 2).

Overall comparison of all fungicides: Among seven fungicides, Tecto was highly effective followed by Aerosal and Score. Gemstar and Scholar appeared less effective than other fungicides. Although, all fungicidal treatments significantly reduced the fungus growth as compared to the control. The test pathogen *M. theobromae* failed to grow at all concentrations of Tecto; able to produce less growth at 0.1 ppm of Aerosal; 0.1 and 1 ppm of Score. Similarly, 100 and 1000 ppm of Tilt and Nativo appeared highly effective, as no growth of test pathogen was observed in these treatments (Table 2).

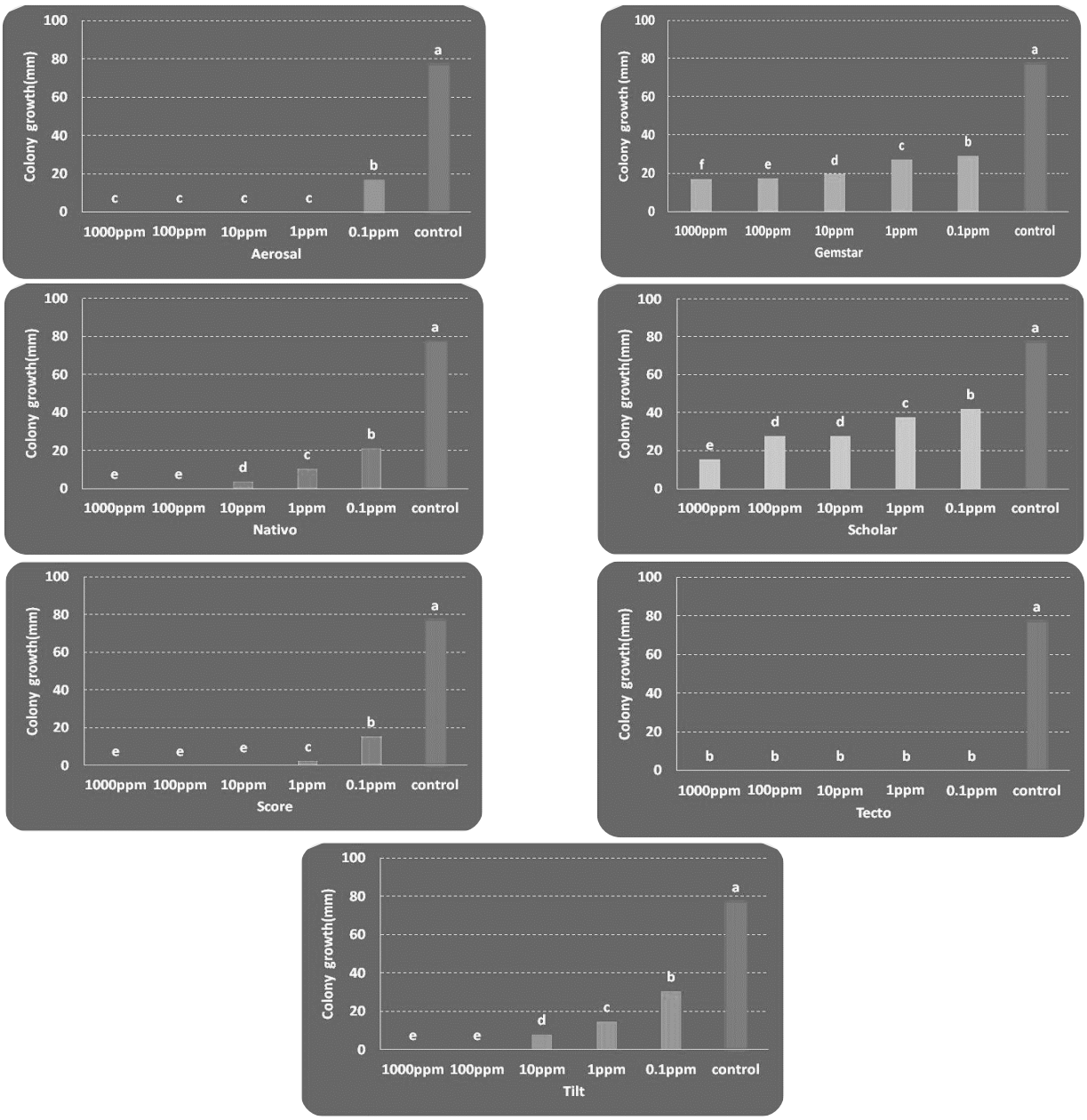

Figure 2. Effect of different concentrations of various fungicides on the colony growth of *Musicillium theobromae*. Bars labeled with the different letters indicating that the mean values are statistically different ($p < 0.05$, Tukey·s test).

Table 2. Comparative effectiveness of different fungicides on the colony growth of *M. theobromae*.

Fungicides	Concentrations				
	1000 ppm	100 ppm	10 ppm	01 ppm	0.1 ppm
	Colony growth (mm)				
Aerosal	0 s	0 s	0 s	0 s	17 r
Gemstar	16.88 k*	17.5 j	19.5 i	27.25 g	29.25 e
Nativo	0 s	0 s	3.88 p	10.63 n	21.25 h
Scholar	15.5 l	27.63 f	27.75 f	37.63 c	42.13 b
Score	0 s	0 s	0 s	2.5 q	15.5 l
Tecto	0 s	0 s	0 s	0 s	0 s
Tilt	0 s	0 s	7.75 o	14.75 m	30.38 d
Control			77.38 a		

*values labeled with the different letters indicating that the mean values are statistically different ($p < 0.05$, Tukey's test).

Efficacy of fungicides on fresh biomass weight of cigar end rot pathogen

Aerosal: All concentrations of Aerosal were highly effective against *M. theobromae*. They completely inhibited the growth of test fungus in broth medium. While same fungus produced significantly maximum fresh biomass of 11.86 mg in the control treatment (broth medium without fungicide) (Figure 3).

Gemstar: All concentration of Gemstar produced more or less fresh biomass of *M. theobromae*, which was significantly less with those produced in control. Among different concentrations significant minimum fresh biomass weight of test fungus was recorded at 1000 ppm (2.7 mg) followed by 100 ppm (3.66 mg). The 0.1 ppm of this fungicide produced significantly maximum biomass of test pathogen (9. 83 mg) followed by 1 ppm (9.3 mg) (Figure 3).

Nativo: All concentrations of Nativo were also highly effective to inhibit the biomass production of test pathogen in broth culture. All treatments produced negligible amount of biomass of *M. theobromae* (Figure 3).

Scholar: Among different concentrations of Scholar, significantly maximum fresh biomass was recorded at 0.1 ppm (8.0 mg); whereas, other concentrations produced negligible amount of biomass of *M. theobromae* (Figure 3).

Score: The concentrations of Score were highly effective against *M. theobromae*, as they produced no or negligible fresh biomass of test pathogen in liquid culture (Figure 3).

Tecto: All concentrations of Tecto appeared highly effective against *M. theobromae* in broth culture as compared to the control. The fungus failed to grow at all concentrations of Tecto in liquid culture; whereas control (culture without fungicide) produced 11.86 mg fresh biomass of *M. theobromae* (Figure 3).

Tilt: Similarly, all concentrations of Tilt were also highly effective, as no or negligible fresh biomass production of *M. Theorem* was occurring in these treatments (Figure 3).

Overall comparison: Generally, all treatments were effective in reducing the growth of *M. theobromae* in liquid culture. However, some were more effective than others. Fungicides like Score, Tilt, Nativo, Tecto and Aerosal were highly effective, their all concentrations produced no or negligible amount of fresh biomass of *M. theobromae*. Among different fungicides, Gemstar appeared significantly less effective than other fungicides, it's all concentrations produced more or less fresh biomass of test pathogen. The test fungus was only able to grow at lower concentration (0.1 ppm) of Scholar but produced negligible growth at 1 to 1000 ppm (Table 3).

Effect of fungicides on dry biomass weight of cigar end rot pathogen

Aerosal: All concentrations of Aerosal produced negligible dry biomass of test fungus as compared to the control (Figure 4).

Gemstar: The dry biomass weight of test pathogen was gradually decreased with increasing concentrations of Gemstar. The maximum dry biomass was recorded in control (2.54 mg) followed by 0.1 ppm (2.4 mg) and 1 ppm (2.2 mg). The significantly lowest dry biomass of *M. theobromae* was observed in 1000 ppm (0.13 mg) followed by 100 ppm (0.91 mg) (Figure 4).

Nativo: All concentrations of Nativo highly effective and produced negligible dry biomass weight of *M. theobromae*. While, control treatment produced significant very high amount of dry biomass of test fungus (Figure 4).

Scholar: The significant highest dry biomass weight was recorded in the control (2.54 mg) followed by 0.1 ppm of Scholar (0.33 mg). All other concentrations produced a very little quantity of dry biomass of *M. theobromae* (Figure 4).

Score: Similarly, all concentrations of Score were also highly effective, they almost inhibited the dry biomass production of *M. theobromae* (Figure 4).

Tecto: It was also a highly effective fungicide against *M. theobromae*. It's all concentrations produced minimum or negligible quantity of dry biomass of test fungus (Figure 4).

Tilt: All concentrations of Tilt significantly inhibited the growth of *M. theobromae* in broth culture. Therefore, all concentrations produced negligible dry biomass weight of test pathogen (Figure 4).

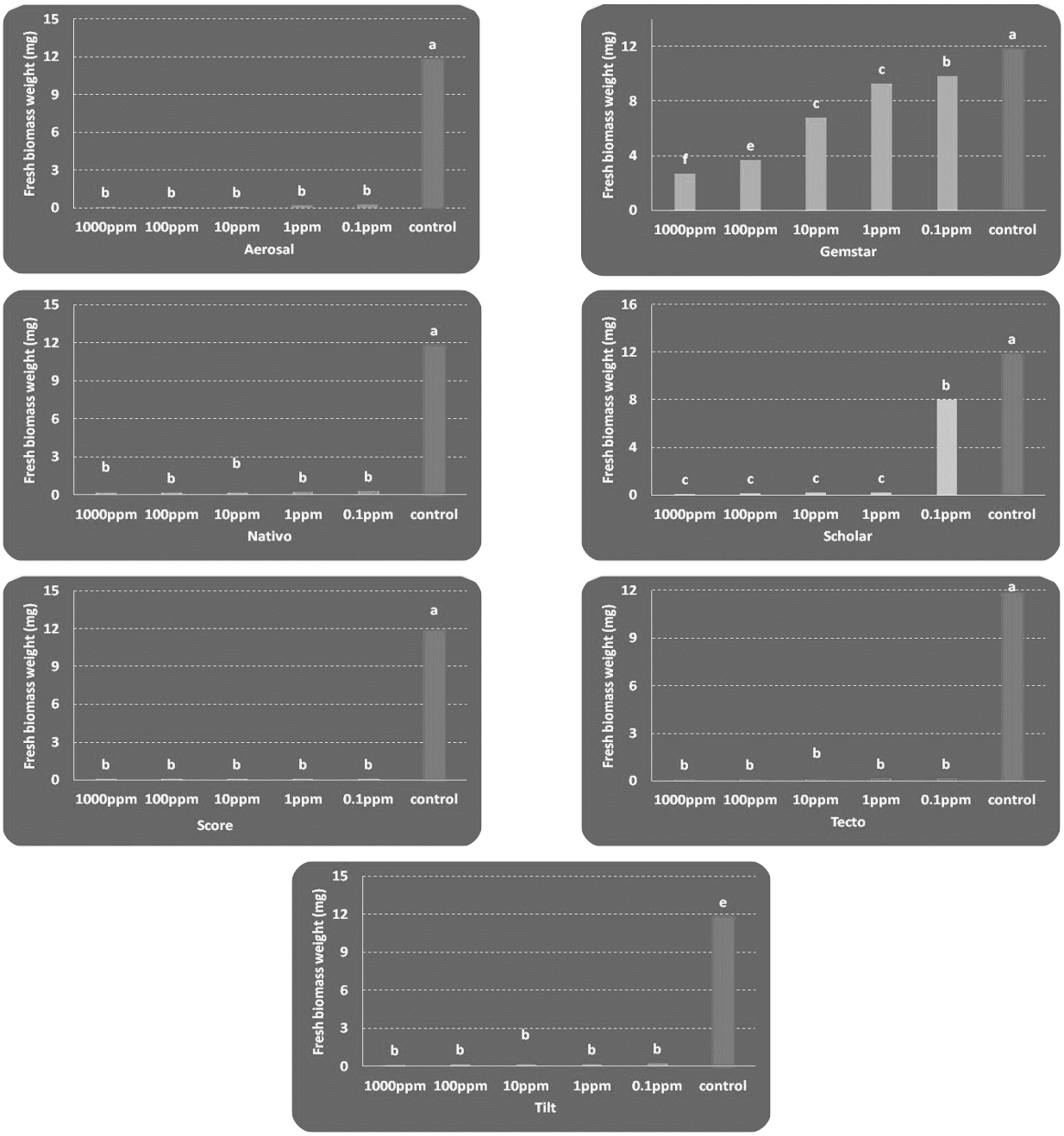

Figure 3. Effect of different concentrations of various fungicides on the fresh biomass weight of *Musicillium theobromae*. Bars labeled with the different letters indicating that the mean values are statistically different ($p < 0.05$, Tukey's test).

Table 3. Comparative effectiveness of different fungicides on the fresh biomass weight of *M. theobromae*.

Fungicides	Fungicide concentrations				
	1000 ppm	100 ppm	10 ppm	01 ppm	0.1 ppm
	Fresh biomass weight (mg)				
Gemstar	2.7 g*	3.66 f	6.8 d	9.3 c	9.83 b
Aerosal	0.1 i	0.1 i	0.1 i	0.2 hi	0.27 h
Nativo	0.2 hi	0.2 hi	0.2 hi	0.23hi	0.27 h
Scholar	0.1 i	0.13 hi	0.23 hi	0.23 hi	8 h
Score	0.1 i	0.1 i	0.1 i	0.1 i	0.13 hi
Tecto	0.1 i	0.1 i	0.13 hi	0.17 hi	0.17 hi
Tilt	0.1 i	0.2	0.2 hi	0.2 hi	0.23 hi
Control			11.86 a		

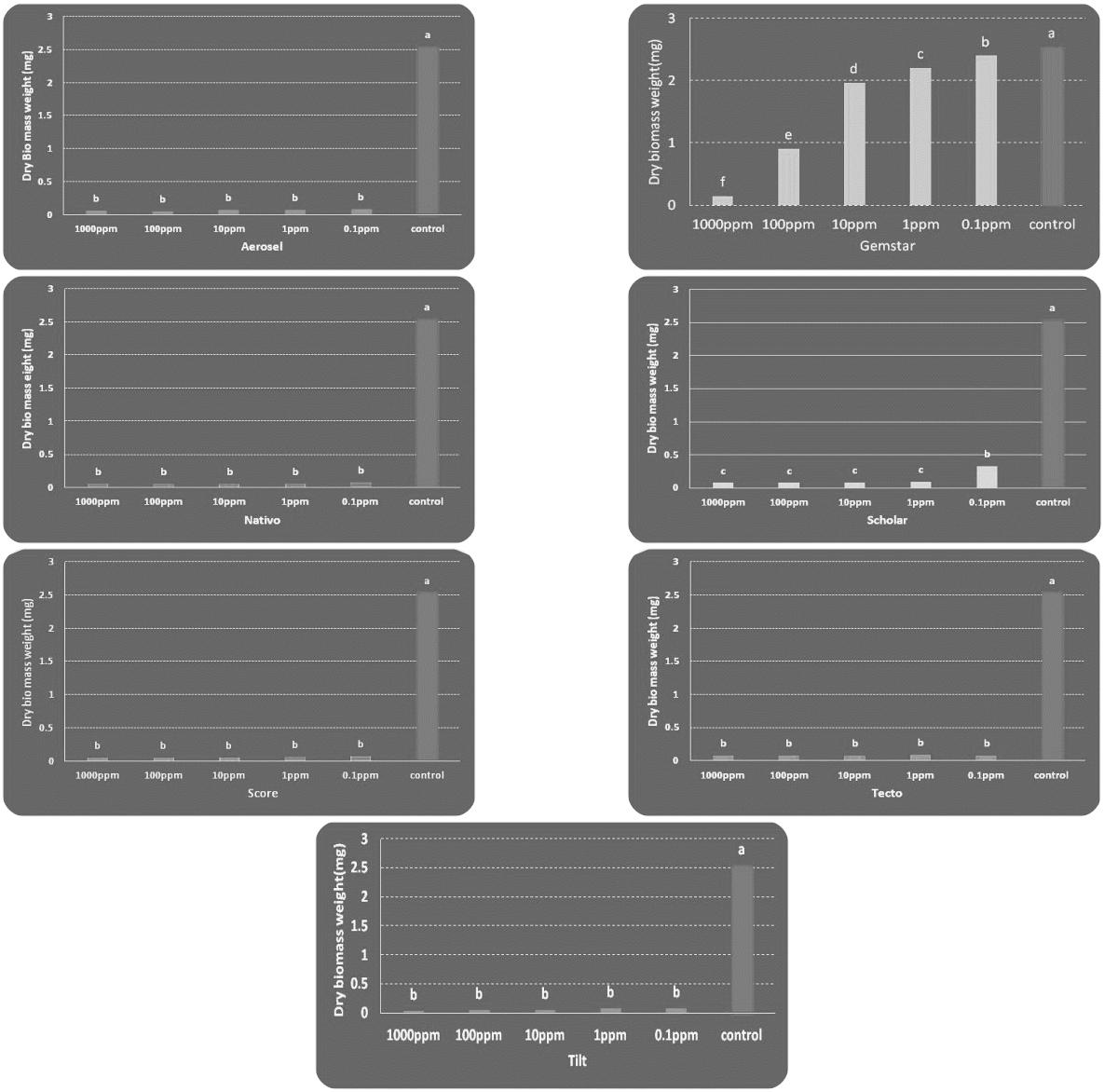

Figure 4. Effect of different concentrations of various fungicides on the dry biomass weight of *Musicillium theobromae*. Bars labeled with the different letters indicating that the mean values are statistically different ($p < 0.05$, Tukey·s test).

Overall comparison: In term of dry biomass production, most of the fungicides were highly effective against *M. theobromae*, produced either no or negligible dry biomass weight. However, few fungicides such as Scholar and Gemstar produced comparatively more dry biomass weight as compared to the control. Although, both of these fungicides produced significantly less dry weight as compared to the control. The other fungicides like Aerosal, Nativo, Tecto, Score and Tilt were highly effective in reducing the dry biomass weight of *M. theobromae* (Table 4). *Verticillium theobromae* is widespread in the tropics. Its hosts include *Musa*, *Bambusa, Heliconia bihai* and *H. brasiliensis* (Hawksworth and Holliday, 1970). Roy et al. (1989) also isolated *Drechslera spicifera, Acremonium strictum, Chalara paradoxa, Pestalotiopsis disseminate, Drechslera musae-sapientum, Alternaria alternata and Musicillium theobromae* from plant and fruit bananas samples collected from Bhagalpur, India.

Table 4. Comparative effectiveness of different fungicides on the dry biomass weight of *M. theobromae*.

Fungicides	Fungicide concentrations				
	1000 ppm	100 ppm	10 ppm	01 ppm	0.1 ppm
	Dry biomass weight (mg)				
Aerosal	0.0532 g	0.0631 g	0.0765 g	0.0765 g	0.0899 g
Gemstar	0.14 g*	0.91 e	1.97 d	2.2 c	2.4 b
Nativo	0.0532 g	0.0532 g	0.0532 g	0.0564	0.0765 g
Scholar	0.0765 g	0.0765 g	0.0832 g	0.0899 g	0.33 f
Score	0.0532 g	0.0532 g	0.0532 g	0.0631 g	0.0765 g
Tecto	0.0765 g	0.0765 g	0.0832 g	0.0899 g	0.0832 g
Tilt	0.0532 g	0.0765 g	0.0765 g	0.0765 g	0.0832 g
Control			2.54 a		

*values labeled with the different letters indicating that the mean values are statistically different ($p < 0.05$, Tukey-s test).

Cigar end rot disease of banana was either caused *Musicillium theobromae* or *Trachysphaera fructigena* independently (Mwangi, 2007). It is among the most important banana fruit disease in the Eastern and Central Africa. Waweru (2008) reported that the occurrence of fungal disease cigar end rot caused by *Musicillium theobromae* (syn. *Verticillium theobromae*), became more in Kisii and Western Kenya regions of Kenya. The disease was more severe on Dwarf Cavendish and Gross Michel varieties. The incidences of *Musicillium theobromae* along with many other diseases and pathogens were also recorded in Sistan and Baluchestan provinces of Iran (Amani et al., 2008). This pathogen may cause 25-30 percent losses to banana fruit during storage and during transportation (Kachhwaha et al., 1992). Diedhiou et al. (2014) reported post-harvest losses of banana in Senegal upto 60 percent due to *Musicillium theobromae* and other related post-harvest banana diseases.

The literature survey on chemical control of cigar end rot of banana revealed that very little work was done so far on this issue. Igeleke and Ayanru (2007) evaluated three fungicides *viz*., Benomyl, Tridomorph and Mancozeb against in vitro growth of *Musicillium theobromae* (*Verticillium theobromae*). They found Tridomorph as highly effective followed by Benomyl and Mancozeb. . Boubaker et al. (2008) observed that in most banana growing regions of Morocco the resistance has become developed in the most population of *Musicillium theobromae* against Benzimidazole fungicides such as Benomyl and Thiophanate-methyl. They collected 274 isolates of *Musicillium theobromae* from Biougra, Belfâa and Ouled-teima regions where these fungicides have been in use for more than 10 years. Their studies revealed that out of 274 isolates, 67% were resistant to Thiophanate-methyl, 65% were resistant to Benomyl and 65% were resistant to both Thiophanate-methyl and Benomyl.

Further studies should be conducted to evaluate the effective fungicides like Tecto, Score. Tilt, Nativo and Aerosal under field and storage conditions against cigar end rot of banana.

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