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SYNERGISTIC EFFECT OF DIFFERENT MICRONUTRIENTS ON THE GROWTH OF *FUSARIUM OXYSPORUM* F.SP. *CUBENSE* CAUSING PANAMA WILT OF BANANA

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ABSTRACT

Panama wilt, caused by *Fusarium oxysporum* f. sp. *cubense* (Foc), is one of the most devastating diseases affecting banana production worldwide. Micronutrients in soil are significant factors in plant health and disease resistance, as they affect both host-pathogen interactions and fungal growth dynamics. This study investigates the effect of some key micronutrients, such as Manganese, magnesium and boron, on the growth and pathogenicity of Foc. The paper would gain strength, for example by detailing concentrations of micronutrients studied and application methods. This means that it may be made reproducible or comparable to other studies. The inclusion of potential mechanisms on how this micronutrient is affecting growth of fungi and increased resistance by the plant makes the outcome more meaningful. In essence, therefore, this work presents a relevant contribution to the comprehension of relationships between micronutrient-pathogens and provides real practical insights into managing Panama wilt among banana cultivators.

INTRODUCTION

Fusarium oxysporum f. sp. *cubense*, commonly referred to as Foc, is a soil-borne fungal pathogen that causes Panama wilt disease. This is a highly devastating disease affecting banana production globally. The disease is not easy to control because the pathogen is highly persistent in the soil and is able to infect a large proportion of banana cultivars. Micronutrients are essential for plant-pathogen interactions; they affect both pathogen development and the defense mechanisms of the plant. The disease threatens the global production of bananas in suitable environmental conditions and poor nutrient management (Ploetz, 2015). Nutritional factors, particularly micronutrients, play an important role in the modulation of Foc growth and the disease it causes. Plant-pathogen interaction processes are enhanced with the participation of micronutrients such as Mn, Mg, and B. These important nutrients affect both pathogen development and host plant responses. Manganese is one component of an important group of enzymes that facilitate the biosynthesis of lignin: a molecule forming cell wall stiffening material; thus it slows pathogen spread in the cell walls (Marschner, 2012). Mg is a key central element for chlorophyll, which enhances photosynthesis and energy metabolism that indirectly increases the resilience of the plant (Hänsch & Mendel, 2009). B is important in maintaining cell walls and is associated with signaling pathways that regulate responses to defense mechanisms (Shireen et al., 2018).

The availability of these micronutrients can significantly affect the growth of Foc. For example, Mn can create adverse conditions for the growth of the fungus by triggering plant defense systems. Similarly, adequate Mg and B levels improve plant health and reduce susceptibility to infections. However, imbalances in these nutrients may inadvertently facilitate the proliferation of pathogens or weaken the host plant's defenses.It therefore tries to check on the influences of Mn, Mg, and B on *Fusarium oxysporum* f. sp. *cubense* growth toward the development of nutrient-based disease management strategies of Panama wilt disease. This investigation looks into a detailed understanding of how micronutrients interact in their complex web with the pathogen and its host plant with an aim towards making sustainable practices of disease control effective in the cultivation of banana plants.

MATERIAL AND METHODS

Field survey was made in different banana fields of Maharashtra State and Karnataka State for collection of infected pseudostem of banana plant (Grand Naine) from the farmer's field. The pure culture of *Fusarium oxysporum* f.sp. *cubense* was obtained by using hyphal tip technique. The fungi were identified by following suitable literature (Subramanian, 1971; Barnett and Hunter, 1972) and pathogenicity test was carried out. Pure cultures were transferred to CDA slants and kept in refrigerator at 40C for further use. Sensitivity test to benomyl was determined by food poisoning test (Dekker and Gielink, 1979). Benomyl Sensitive and Resistant isolate was obtained. Manganese, magnesium, boron was used for this study at 0.01 % in Czapek Dox Agar medium. Plates without micronutrients source served as control. The sensitive FOC-4 and resistant EMS-FOC-9 isolates were inoculated and plates were incubated at 28 + 2°C. Plates without micronutrients were served as control. The linear growth was measured at different intervals.

RESULTS AND DISCUSSION

Manganese, magnesium and boron were tested for the growth of benomyl resistant and sensitive *Fusarium oxysporum* f.sp. *cubense* isolates. There was maximum growth of sensitive and resistant isolates on manganese. Growth of sensitive and resistant isolate was completely inhibited on magnesium while boron also inhibited growth of both the isolates. (Tables 01 and 02, Figs. 01 and 02). Micronutrients inhibited the growth of sensitive and resistant isolate which indicates reduction in the benomyl resistance. These compounds when mixed with benomyl also prevented the infection of resistant isolate to banana plants. Many workers supported this phenomenon and have been discussed for *Phytophthora infestans* causing late blight of potato for mixing of different fungicides in metalaxyl (Arora et al., 1992). In this case many agrochemicals may be used to reduce the fungicide resistance. According to Shabi and Gilpatrick (1981) there was reduction in benomyl resistance in *Venturia inaequalis* when benomyl was used with captan, chlorothalonil and imazalil.

Table 01. Effect of different micronutrient sources on the linear growth (mm) of *Fusarium oxysporum* f.sp. *cubense* isolate sensitive to benomyl on Czapek Dox Agar medium

Micronutrients (0.01 %)	Sensitive							
	Days							
	1	2	3	4	5	6	7	8
Manganese	11.00	16.33	20	29.66	35	44.33	52.66	60.00
Magnesium	10.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boron	11.00	14.00	16.33	18.00	20.66	26.00	35.00	38.66
Control	17.66	21.00	25.33	32.33	40.00	56.00	64.00	68.00

P at 0.05 DF= 7 T value= 2.365
Standard Error Mean = 4.507
Critical Difference Mean = 10.66
F (between Micronutrients sources) = 5.256503 P = 0.0014
F (between days) = 23.860658 P < 0.0001

Fig. 01. Effect of different micronutrient sources on the linear growth (mm) of *Fusarium oxysporum* f.sp. *cubense* sensitive isolate (FOC- 4)

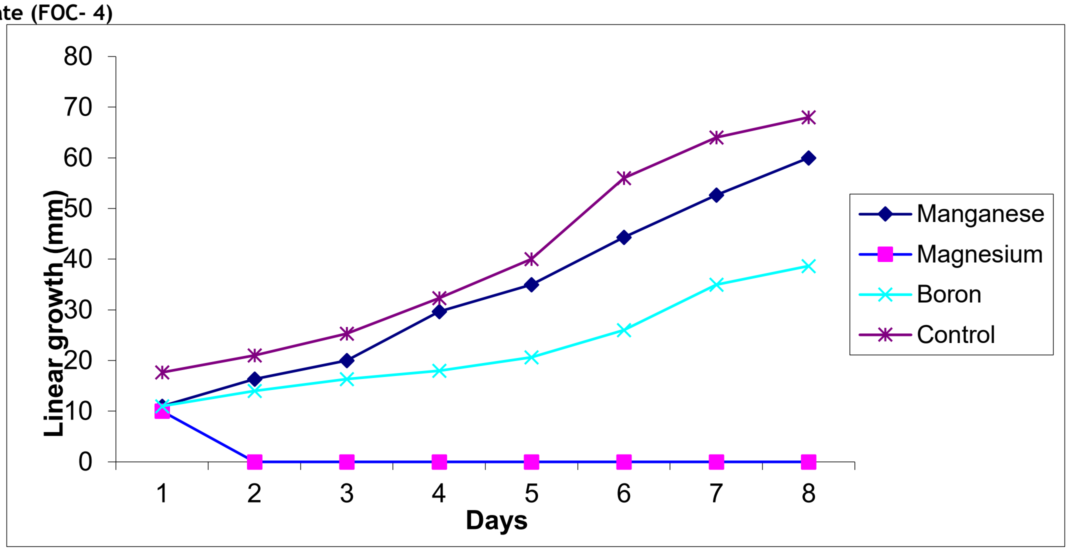


Table 02. Effect of different micronutrient sources on the linear growth (mm) of *Fusarium oxysporum* f.sp. *cubense* isolate resistant to benomyl on Czapek Dox Agar medium

Micronutrients (0.01 %)	Resistant							
	Days							
	1	2	3	4	5	6	7	8
Manganese	12.00	20.33	24.00	32.66	38.33	46.66	56.33	62.00
Magnesium	11.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Boron	12.00	16.00	18.33	20.00	20.66	26.00	35.00	38.66
Control	16.00	24.00	27.66	36.00	42.00	58.00	66.00	69.00

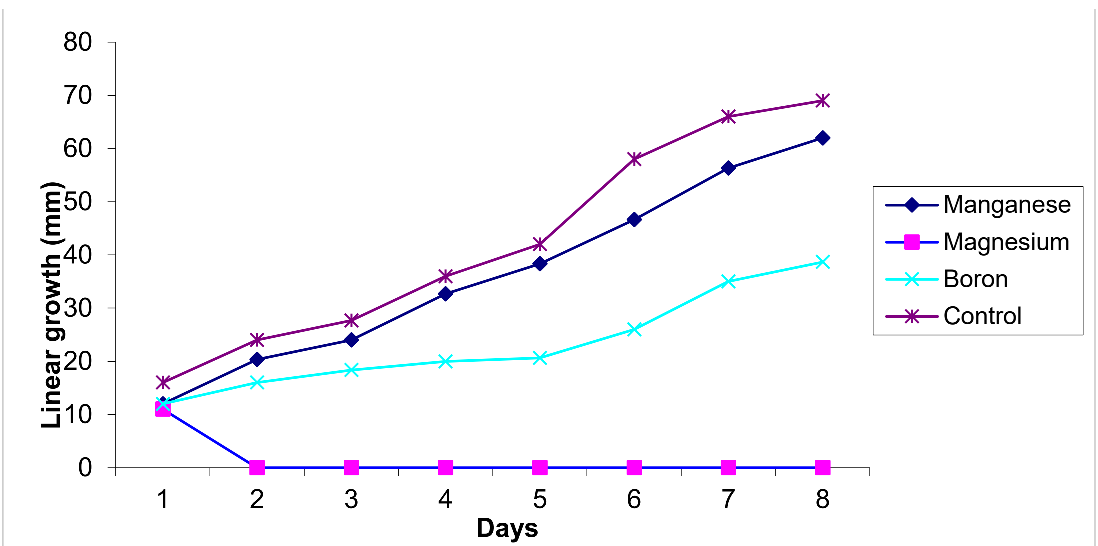
P at 0.05 DF= 7 T value= 2.365

F (between days) = 25.24898 $P < 0.0001$

P at 0.05 DF= 7 T value= 2.365
Standard Error Mean = 4.494
Critical Difference Mean = 10.63

F (between Micronutrients sources) = 4.769593 P = 0.0024

Fig. 02. Effect of different micronutrient sources on the linear growth (mm) of *Fusarium oxysporum* f.sp. *cubense* resistant isolate (EMS- FOC -9)



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