

TRACE ELEMENT REQUIREMENT OF *FUSARIUM*  
*MONILIFORME* VAR. *SUBGLUTINANS* SHELDT.  
CAUSING MANGO MALFORMATION

BY

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Trace element requirement of *F. moniliforme* var. *subglutinans*, the causal organism of the malformation of mango was investigated. Low concentration of different trace elements is beneficial for the growth and sporulation of the said fungus. Maximum growth was noted at 0.25 ppm of Zinc. Iron, copper and manganese, on the other hand, promoted growth. Molybdenum inhibited growth as well as sporulation of the fungus. Best sporulation was obtained in iron followed by zinc. Sporulation was poor in trace element free medium.

INTRODUCTION

Fungi have relatively much smaller but definite requirements for at least five micronutrients as trace elements for their growth and reproduction. Of these, iron, zinc, copper, manganese and molybdenum are known to be essential and indispensable. Calcium is essential for some, but not all, fungi and boron is not known to be needed by fungi (Cochrane, 1958). There is an extensive literature on the metal ion requirements of fungi including reviews by Steinberg (1950), Foster (1939, 1949), Perlman (1949), Lavollay (1955), Lilly and Barnett (1951), Hawker (1950), Cochrane (1958) and Lilly (1965). Interest at the present time is shifting toward the problem of the metabolic function of these inorganic nutrients which play important roles on the enzymatic processes. The essentiality of iron in the metabolism of fungi has now been well established. Iron plays an important role in organic acid metabolism. (Foster, 1939; Perlman, 1951; and Perlman *et al*, 1946). Iron is also utilized directly by fungi (Cochrane, 1958) and is required as a constituent of various enzymes including the cytochromes, cytochromeoxidase, catalase and others. It is probable that deficiency or excess of iron acts directly on acid formation and interferes with the normal metabolism. The essentiality of zinc for fungal growth has been confirmed by Chesters and Rolinson (1951). It has been found that higher concentration of zinc may be toxic, especially at high pH (Lindeberg, 1944 and Nickerson *et al*, 1946). High

levels of zinc induce genetically stable variation in *Fusarium sp.* (Dimock, 1936). Zinc is known to activate few enzymes specifically and others non-specifically. Cochrane (1958) suggested the diverse effects of zinc on metabolism which is concerned with the synthesis of enzyme proteins. Copper is essential in the formation of a number of enzymes including tyrosinase and laccase. Medina and Nicholas (1957) showed that copper is involved in the biosynthesis of nitrite and hyponitrite reductases. It is also known that copper may possibly play a role in chlorine metabolism of fungi. Higher concentrations of copper are of course toxic. However, two fungi inhibited visible growth even in a saturated solution of copper sulphate (Starkey and Waksman, 1943). Manganese acts as natural activator of arginase and other enzymes and its deficiency causes a pronounced decrease in sporulation. Nason (1956) reviewed that molybdenum participates in electron transport system.

In view of the above facts it was decided to find out the effect of different trace elements on the growth and sporulation of *F. moniliforme* var. *subglutinans* Sheld., the causal agent of the malformation of mango.

#### MATERIAL AND METHODS

The test-fungus, *F. moniliforme* var. *subglutinans*, was isolated from malformations of mango inflorescence collected from Burdwan, West Bengal, 1972. Czapek's synthetic solution was taken as the basal medium. Only analar grade chemicals, double Pyrex glass distilled water and thoroughly cleaned Pyrex glass-ware were used throughout the experiment. The medium was purified as per the method of Steinberg (1950). The desired quantities of different trace elements were added separately in the flasks containing purified basal medium and the pH was adjusted to the optimum 6.8 before autoclaving. The different trace elements selected for the present experiment were iron, zinc, copper, manganese in the form of sulphate and molybdenum in the form of ammonium molybdate. 25 ml. of the medium was taken in each 250 ml. Erlenmyer flask, plugged and sterilized at 15 lbs. p.s.i. pressure for 15 minutes. A set of flasks without the trace elements was kept as control. Three replications were made for each treatment. Finally the flasks were inoculated with uniform discs of mycelia (5 mm. diam.) obtained from the Czapek's synthetic agar medium and incubated at 28°C for 6 days in complete darkness. After the experimental period, the mycelial mats were harvested on filter paper, washed and dried to a constant weight at 60°C and weighed. The sporulation was assessed by using a haemocytometer.

#### RESULTS AND DISCUSSION

The average dry weight of mycelia and quantum of sporulation of the fungus recorded on different trace elements are presented in Table 1.

Table : Effect of different concentrations of trace elements on the mycelial growth (dry wt. in mg.\*) and sporulation (in millions/ml.\*) of *F. moniliforme* var. *subglutinans* in culture.

Trace elements.		Concentration in ppm.					
		0.0	0.025	0.25	2.5	25.0	100.0
Zn	Mycelial wt.	—	46.5	76.8	68.3	59.0	52.0
	Sporulation	—	5.66	8.32	10.5	10.75	9.0
Fe	Mycelial wt.	—	33.6	39.0	36.0	34.3	31.0
	Sporulation	—	15.3	18.75	16.25	12.32	15.75
Cu	Mycelial wt.	—	35.0	33.0	30.3	25.6	20.0
	Sporulation	—	4.5	3.2	3.66	1.05	0.75
Mn	Mycelial wt.	—	36.0	34.0	33.0	26.3	21.6
	Sporulation	—	2.5	1.05	0.76	0.86	1.0
Mo	Mycelial wt.	—	16.6	12.3	0.8	7.3	4.0
	Sporulation	—	0.25	0	0	0	0
Control	Mycelial wt.	32.6	—	—	—	—	—
	Sporulation	0.95	—	—	—	—	—

\* Average of three replicates.

It was observed from the Table that except for molybdenum, all the trace elements tried proved beneficial and increased the mycelial growth at low concentrations. The mycelial growth was more than double that of control when the fungus was grown at 0.25 p.p.m. zinc. In case of iron, growth increased upto 0.25 p.p.m. and then gradually decreased with increased concentration thereby exhibiting a wide range of tolerance for iron. Copper and manganese showed optimum concentration at 0.25 p.p.m. The growth was gradually reduced with increase in concentration upto 2.5 p.p.m., above which distinct inhibition is evident. Molybdenum, which is required by number of organisms (Nicholas and Fielding, 1950 ; Steinberg, 1950), showed distinct inhibition, at all concentrations tried, in growth of the present organism.

Sporulation was also greatly influenced by the addition of these elements except molybdenum, where it was considerably reduced. In most of the cases, concentrations showing good vegetative growth exhibited good sporulation. Best sporulation was obtained in iron followed by zinc. It is interesting to note that zinc, which induced best vegetative growth, showed some sort of inhibition in sporulation, while iron exhibited some promotion in sporulation as reported by Nickerson *et al* (1946).

Foster (1939), Yogeshwari (1948), Grewal (1956), Thind and Rawla (1967), Bhatnagar and Prasad (1968) and Vir and Grewal (1973) have shown that zinc

increased the growth of the fungi. In the present investigation it is evident that iron, zinc, copper and manganese increased the growth of the test-fungus. Thind and Mandahar (1968) obtained similar results with these four trace elements while working with three species of *Cercospora* and *Pestalotia thea*. Iron induced excellent sporulation of the test-fungus in the present experiment. Similar results were reported by Grewal (1956) in *Alternaria tenuis*, Bhatnagar and Prasad (1968) in *Fusarium solani* f. *aurentifoliae* and Vir and Grewal (1973) in *Fusarium caeruleum*.

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