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Evaluation of Fungicidal Resistance Among *Colletotrichum gloeosporioides* Isolates Causing Mango Anthracnose in Agri Export Zone of Andhra Pradesh, India

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ABSTRACT

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Six isolates of *Colletotrichum gloeosporioides* were collected from Agri Export Zone (AEZ) of Andhra Pradesh and one from Tamil Nadu and designated as Cg1 to Cg7. Fungicidal resistance / sensitivity among the isolates was studied using four systemic fungicides *viz*., carbendazim-50ppm, thiophanate- methyl-50 ppm, propiconazole-25 ppm and hexaconazole-25 ppm and two non-systemic fungicides *viz*., mancozeb-1000 ppm and copper oxychloride-1000 ppm in poisoned food technique. All isolates were highly sensitive to sensitive for systemic fungicides except Cg3 which was moderately resistant to thiophanate-methyl. Isolates Cg1, Cg3 and Cg6 were highly sensitive, Cg5 and Cg7 were resistant and Cg2 and Cg4 were highly resistant to mancozeb. All isolates were resistant to copper oxychloride. These results indicated the differential resistance / sensitivity to commonly used fungicides against *C. gloeosporioides* and allowed to recommend a specific fungicide on regional basis in the Agri Export Zone of Andhra Pradesh, India.

Key words: *Colletotrichum gloeosporioides*, Fungicidal resistance, Mango, Anthracnose

The mango (*Mangifera indica* L.) is native to India and south East Asia. India is the world's largest producer and Andhra Pradesh ranks first in production (45,89,000 tonnes) and productivity (12.10 tonnes/ha) with an area of 3,79,000 ha among Indian states [(3)]. Many diseases are affecting mango, of which anthracnose caused by *Colletotrichum gloeosporioides* Penz. is the most devastating disease and major constraint in production and export of mango. Several fungicides have been used to manage the mango anthracnose at field level in India. Excessive use of benomyl, thiophanate-methyl and thiobendazole as pre- and post-harvest sprays has led to a

reduction in effectiveness in certain areas where pathogen resistance to fungicides has been reported [8]. During the survey conducted in the Agri Export Zone (AEZ) in Chittoor district of Andhra Pradesh, it was found that the efficacy of some commonly used fungicides has been reduced in different areas, indicating the possible development of resistance in *C. gloeosporioides* population. The aim of the study was to investigate the resistance/sensitivity of *C. gloeosporioides* to anthracnose specific fungicides so as to develop an effective spray schedule on regional basis.

Seven isolates of *C. gloeosporioides* were isolated from leaf samples in India, of which six from major mango growing regions of Agri Export Zone of Andhra Pradesh and one from Tamil Nadu (Table 1). Variability in fungicidal resistance/sensitivity among the *C. gloeosporioides* was evaluated by poisoned food technique [6] using potato dextrose agar with four systemic fungicides *viz*., carbendazim-50 ppm (Bavistin 50%WP, BASF (I) Ltd., Mumbai), thiophanate-methyl-50 ppm (Topsin-M 70%WP, Motilal pesticides (I) Ltd., Madhura), propiconazole-25 ppm (Tilt 25%EC, Syngenta (I) Ltd., Mumbai) and hexaconazole-25 ppm (Conzol 5%EC, Hyderabad chemical supplies Ltd., Hyderabad) and two non-systemic fungicides *viz*., mancozeb-1000 ppm (Dithane M-45, Bayer (I) Ltd., Mumbai) and copper oxychloride-1000 ppm (Blitox 50%WP, Rallis (I) Ltd., Mumbai). Three replications were maintained for all the treatments with the inoculation of single 5mm mycelial disc per plate. Percent reduction in radial growth over control was calculated by the following formula.

$$I = \frac{C - T}{C} \times 100$$

Where,

I = Per cent reduction in growth of test pathogen

C = Radial growth (mm) in control

T = Radial growth (mm) in treatment

The isolates were classified based on their reaction to different fungicides as given below: 1) Highly sensitive (>90% inhibition); 2) Sensitive (> 75-90% inhibition); 3) Moderately resistant (>60-75% inhibition); 4) Resistant (>40-60% inhibition) and 5) Highly resistant (< 40% inhibition).

The colonies of the isolates were initially white and later became dark brown with sparsely septate mycelium. Conidia were hyaline and cylindrical with rounded ends and aseptate. The isolates showed differential resistance/sensitivity to all fungicides under the study. The systemic fungicides *viz*., carbendazim, thiophanate-methyl, propiconazole and hexaconazole effectively inhibited the growth of all isolates within the class of sensitive (>75-90% inhibition) to highly sensitive (>90% inhibition) except isolate Cg3, which was moderately resistant (>60-75% inhibition) to thiophanate-methyl. Among them carbendazim was most effective than others. In non-systemic fungicides, isolates Cg1, Cg3 and Cg6 were highly sensitive (>90%inhibition), Cg5 and Cg7 were resistant (>40-60% inhibition) and Cg2 and Cg4 were highly resistant (<40% inhibition) to mancozeb. All isolates were resistant (>40-60% inhibition) to copper oxychloride (Table 2). Benzimidazoles like carbendazim, thiophanate-methyl and benomyl were most effective compared to non-systemic fungicides in controlling mango anthracnose [5]. Systemic fungicides are important tools because they are capable of moving within a plant system. The introduction of benzimidazole fungicides such as benomyl, carbendazim and thiophanate-methyl in the early 1960's revolutionized the disease control [7]. On the other hand, all the isolates showed differential sensitivity to mancozeb. All the isolates were resistant to copper

Table 1. Details of *Colletotrichum gloeosporioides* isolates collected from Agri Export Zone of Andhra Pradesh and from Tamil Nadu, India

Isolate No.	Location (Place of collection)	District	State
Cg1	Rompicherla	Chittoor	Andhra Pradesh
Cg2	S.V. Agricultural college orchard	Chittoor	Andhra Pradesh
Cg3	Damalcheruvu	Chittoor	Andhra Pradesh
Cg4	Irala	Chittoor	Andhra Pradesh
Cg5	Puttur	Chittoor	Andhra Pradesh
Cg6	Anantharajupet	Kadapa	Andhra Pradesh
Cg7	Chennimalai	Erode	Tamil Nadu

Table 2. Classification of different isolates of *Colletotrichum gloeosporioides* based on Resistance / Sensitive to anthracnose specific fungicides

Fungicide	Concentration (ppm)	Isolate						
		Cg1	Cg2	Cg3	Cg4	Cg5	Cg6	Cg7
Carbendazim	50	HS	S	HS	HS	HS	HS	S
Thiophanate-methyl	50	S	S	MR	S	HS	HS	S
Propiconazole	25	S	S	HS	S	HS	HS	S
Hexaconazole	25	S	S	HS	S	HS	S	S
Mancozeb	1000	HS	HR	HS	HR	R	HS	R
Copper oxychloride	1000	R	R	R	R	R	R	R

HS: Highly sensitive; S: Sensitive; MR: Moderately resistant; R: Resistant;
HR: Highly resistant

oxychloride and it became totally ineffective in controlling anthracnose in mango. The mango-growing farmers of this region are also in agreement with these results (personal communication) indicating that the disease is not controlled effectively by copper oxychloride. Copper fungicides are recommended for control of mango anthracnose but their efficacy is lower than dithiocarbamate (mancozeb) under high pressure [1]. In general, non-systemic fungicides are multi-site inhibitors and having low risk of resistant development. But in mango the resistance development may be attributed to continuous and indiscriminate use of fungicides without rotation or alternating with other fungicides. Benzimidazole compounds are widely used usually alternating with protectants to reduce the risk of resistance development and have been very effective [4]. High levels of resistance in most of the fungal species were attributed to amino acid substitution in β-tubulin gene [2]. The present investigation shows the development of resistance among the isolates of *C. gloeosporioides* due to continuous and indiscriminate use of same fungicide. The information generated in the present investigation allows recommend a specific fungicide for the management of *C. gloeosporioides* on mango on regional basis in Agri Export Zone of Andhra Pradesh and thus it has more practical relevance.

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摘 要

Kumar, A. S.[1], Reddy, N. P. E.[1, 4], Reddy, K. H.[2], and Devi, M. C.[3] 2007. 印度安得拉邦農業外銷區芒果炭疽病菌抗殺菌劑的評估. 植病會刊 16: 157-160. ([1] 植物病理系、[2] 基因與植物育種系， S. V. Agricultural College, 蒂魯伯蒂，安得拉邦，印度；[3] 應用微生物系，S. P. Mahila Viswavidyalayam, 蒂魯伯蒂，安得拉邦，印度；[4] 聯絡作者，電子郵件：eswarnp@yahoo.com；傳眞號碼：+0091-877-2248667)

七個炭疽病菌菌株編號爲 Cg1 至 Cg7 作爲供試菌株，其中六個菌株分離自安得拉邦的農業外銷區，一個菌株分離自坦米爾納德。並以四個系統性殺菌劑如 50ppm 的貝芬替、50ppm 的甲基多保淨、25ppm 的普克利和 25ppm 的菲克利，二個非系統性殺菌劑如 1000ppm 的鋅錳乃浦和 1000ppm 的氯氧化銅等評估炭疽病菌對殺菌劑的抗感性。結果顯示除菌株 Cg3 對甲基多保淨爲中抗外，其餘菌株對四種系統性殺菌劑均呈極感或敏感。菌株 Cg1、Cg3 和 Cg6 對鋅錳乃浦表現爲極感，Cg5 和 Cg7 表現抗性，而 Cg2 和 Cg4 則表現極抗。另外，所有供試菌株對氯氧化銅表現抗性。本試驗結果說明菌株對一般常用的殺菌劑有不同的抗感性，依此可推薦用於安得拉邦農業外銷區地區性的特定殺菌劑。

關鍵詞：炭疽病菌、抗殺菌劑、芒果、炭疽病