Efficacy of Newer Fungicides against Leaf and Fruit Spot of Custard Apple Caused by *Colletotrichum Gloeosporioides*

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Received:- 06 February 2025/ Revised:- 13 February 2025/ Accepted:- 22 February 2025/ Published: 28-02-2025

Abstract— *Custard apple (Annona squamosal L.) belong to family Annonaceae is one of the finest fruits gifted to India by tropical America. The crop is badly infected with leaf and fruit spot disease caused by C. gloeosporioides . Five systemic, five contact and five ready mixed fungicides were evaluated against C. gloeosporioides under in vitro by poison food technique. Among the systemic fungicides, carbendazim 50WP was recorded highest mean mycelial inhibition (88.50%) followed by tebuconazole 25EC (81.10%). Among the non-systemic fungicides, copper oxychloride 50WP found superior for mean mycelial inhibition (94.43%) of C. gloeosporioides followed by mancozeb 75WP (89.10 %). Carbendazim 12% + mancozeb 63% WP recorded maximum mean mycelial growth inhibition (95.89%) which was at par with tebuconazole 50% + trifloxystrobin 25% WG (94.43%) in ready mixed fungicides.*

Keywords— Custard apple, leaf and fruit spot, Colletotrichum gloeosporioides, fungicides.

I. INTRODUCTION

Custard apple (*Annona squamosa* L.), is the most important fruit crop of the tropical and sub-tropical regions of the world it belonging to the family *Annonaceae*. It has hardy in nature and commercially grown on marginal land and hillocks with minimum inputs. *Annona squamosa* Linn. is a small, semi-deciduous tree, 3 - 7 m in height, with a broad, open crown or irregularly spreading branches, widely available in different agro-climatic zones of India. This fruit is sometimes also considered as “poor man’s rich food” in the arid zones of India and required dry climate with mild winter.

In India, custard apple was cultivated over 47 million hectares with an annual production of 402 MT (Anon, 2022). The area under cultivation of custard apple is increased only due to high economic returns obtained from this crop and that too at very low input cost. Since last 13-15 years, the crop is found to be badly infected with blackening of fruits *i.e.*, dry fruit spot caused by *Colletotrichum gloeosporioides*. It is prevalent in almost all custard apple growing areas of country. Now a day it has become a severe melody to this crop. About 60 - 70 per cent losses have been reported due to the disease (Somwanshi *et al*., 2021). Considering the severity of this disease and frequent occurrence in the fields, it has been felt necessity to develop effective management strategies. Thus, attempts have been made to evaluate the efficacy of newer fungicides against leaf and fruit spot disease.

II. MATERIALS AND METHODS

The *in vitro* efficacy of five systemic, five contact and five ready mixed fungicides were tested against *C. gloeosporioides* by poison food technique (Nene and Thapliyal, 1993) with Completely Randomized Design. This experiment was conducted in Department of Plant Pathology, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar, Gujarat during

2022-23. The measured quantities of fungicides were incorporated in melted sterilized PDA medium and poured it into sterilized Petri dishes aseptically. The Petri dishes were inoculated with pathogen in the centre by placing seven days old mycelial discs of 5 mm diameter and then incubated at 25 ± 1^0C temperature. Simultaneously, a suitable control was maintained by growing the fungus on fungicide free PDA medium. Radial mycelial growth of fungus was recorded on daily basis in control plates starting from the initiation of the fungal growth in correspondence to treatment plates till full mycelial growth of fungus was observed in control. The per cent inhibition of growth of the fungus in each treatment in comparison with control was calculated by the following equation (Vincent, 1927):

$$\mathbf{PGI} = \frac{\mathbf{C-T}}{\mathbf{C}} \times \mathbf{100} \quad (1)$$

Where,

PGI = Per cent growth inhibition

C = Growth of the test fungus in untreated control plates

T = Growth of test fungus in treated plates.

III. RESULTS AND DISCUSSION

3.1 Efficacy of systemic fungicides against *C. gloeosporioides*:

Among systemic fungicides, the highest mean mycelial growth inhibition was obtained with carbendazim (88.50%) followed by tebuconazole (81.10%) and difenoconazole (77.11%). Azoxystrobin recorded least inhibition of only 67.55 per cent mean mycelial growth inhibition of the fungus. Carbendazim and tebuconazole at 1000 ppm showed significant maximum growth inhibition of the pathogen *i.e.* 98.51 and 94.81 per cent. The next best treatment in order of merit were carbendazim at 750 ppm, pyraclostrobin at 1000 ppm and azoxystrobin at 1000 ppm which inhibited 93.33, 93.33 and 91.85 per cent mycelial growth inhibition, respectively. Azoxystrobin at 100 ppm found the least inhibition of only 52.22 per cent mycelial growth of test pathogen (Table 1). Watve *et al.* (2009) also found carbendazim and tebuconazole inhibited the growth and sporulation to the extent of 100 per cent of *C. gloeosporioides*. Patil *et al*. (2009) reported carbendazim and Ravi *et al*. (2021) reported tebuconazole as most effective fungicides for inhibiting the growth of *C. gloeosporioides.*

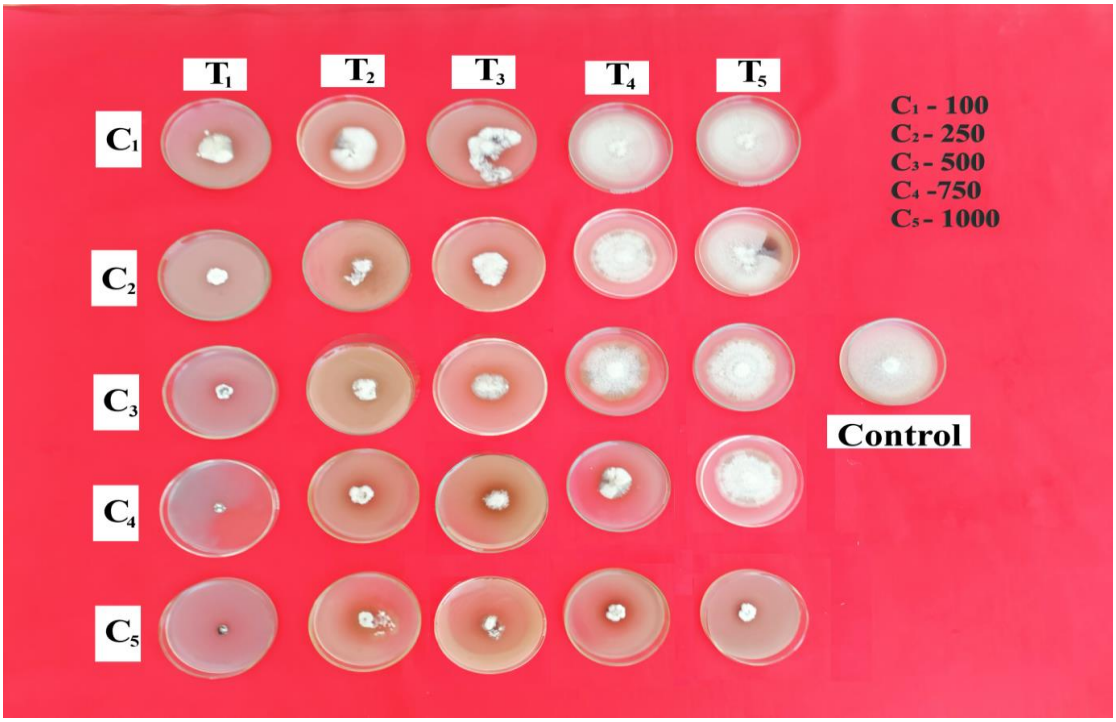

PLATE 1: Growth inhibition of *C. gloeosporioides* by systemic fungicides at different concentration *in vitro*

TABLE 1
EFFICACY OF DIFFERENT SYSTEMIC FUNGICIDES AGAINST *C. GLOEOSPORIOIDES IN VITRO*

Tr. No.	Treatments	Per cent growth inhibition over control Concentration (ppm)					
		100	250	500	750	1000	Mean
T1	Carbendazim 50WP	62.95	66.27	70.59	75.62	84.43	71.97
		(78.8)*	83.3	88.48	93.3	98.51	88.5
T2	Tebuconazole 25EC	59.21	61.43	63.23	64.85	77.48	65.24
		73.33	76.7	79.25	81.5	94.81	81.1
T3	Difenoconazole 25EC	53.23	59.21	62.45	65.77	69.95	62.12
		63.7	73.3	78.14	82.6	87.77	77.1
T4	Pyraclostrobin 20WG	47.6	56.61	58.73	68.05	75.92	61.32
		54.07	60	72.59	85.6	93.33	75
T5	Azoxystrobin 23 SC	46.54	51.03	53.91	56.38	73.92	56.36
		52.22	60	64.81	68.8	91.85	67.6
T6	Control	4.5	4.5	4.5	4.5	4.5	4.5
		0	0	0	0	0	0
Mean		45.88	50.05	52.44	56.07	64.52	-
		53.69	60.4	63.88	68.6	77.71	
		Treatment		**Concentration**		**Treatment x Concentration**	
S. Em.±		0.271		0.248		0.607	
C.D. at 5%		0.768		0.701		1.716	
C.V.%		1.95					

Figures in parentheses are original values and outside are arc-sine transformed values

3.2 Efficacy of non-systemic fungicides against *C. gloeosporioides*:

Among the seven different non systemic fungicides, copper oxychloride was found most effective with highest mean mycelial growth inhibition with 94.43 per cent found significantly superior over rest of fungicides. Next best fungicide was mancozeb with 89.10 per cent mean mycelial growth inhibition. Captan was found next effective to inhibit 82.29 per cent mycelial growth inhibition of the fungus and significantly superior over propineb (69.10 %).

Copper oxychloride at 2500, 2000 and 1500 ppm showed significantly maximum growth inhibition of pathogen i.e. 98.51, 97.03 and 94.44 per cent, respectively. The next best fungicide was mancozeb at 2500 ppm which inhibited the fungal growth as 93.70 per cent. Fungal growth of the pathogen generally decreased with increased concentration of the tested fungicides (Table 2). Rewale *et al*. (2016) found copper oxychloride and mancozeb as most effective with highest average mycelial growth inhibition of *C. graminicola*. Devamma *et al*. (2012) also found mancozeb as highly effective in inhibiting the mycelial growth of pathogen.

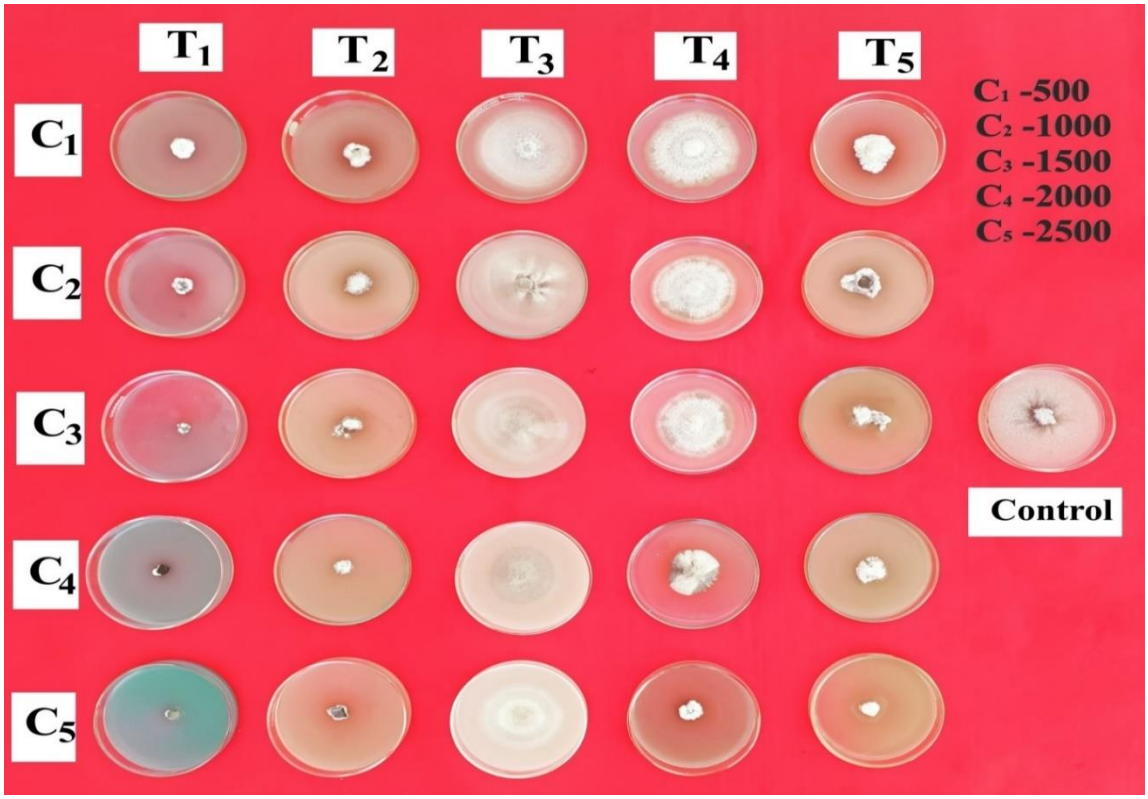

PLATE 2: Growth inhibition of *C. gloeosporioides* by non-systemic fungicides at different concentration *in vitro*

TABLE 2

EFFICACY OF NON-SYSTEMIC FUNGICIDES AGAINST *C. GLOEOSPORIOIEDS IN VITRO*

Tr. No.	Treatments	Per cent growth inhibition over control Concentration (ppm)					
		500	1000	1500	2000	2500	Mean
T1	Copper oxychloride 50WP	72.03	74.34	77.02	80.98	84.43	77.76
		(89.99)*	92.2	94.4	97	98.5	94.43
T2	Mancozeb 75WP	67.14	68.98	71.32	73.52	76.04	71.4
		84.44	86.7	89.3	91.5	93.7	89.1
T3	Chlorothalonil 75WP	47.17	50.17	51.47	52.78	57.07	51.73
		53.33	58.5	60.7	63	70	61.1
T4	Propineb 70WP	48.88	51.69	53.44	60.44	70.97	57.08
		56.29	61.1	64.1	75.2	88.9	69.1
T5	Captan 75WP	57.31	62.72	65.13	69.95	75.22	66.07
		70.36	78.5	81.9	87.8	93	82.29
T6	Control	4.5	4.5	4.5	4.5	4.5	4.5
		0	0	0	0	0	0
Mean		49.71	52.27	54.02	57.23	61.58	-
		59.07	62.8	65.1	69.1	74	
		Treatment		**Concentration**		**T x C**	
S. Em.±		0.245		0.224		0.549	
C.D. at 5%		0.694		0.633		1.551	
C.V.%		1.73					

Figures in parentheses are original values and outside are arc-sine transformed values

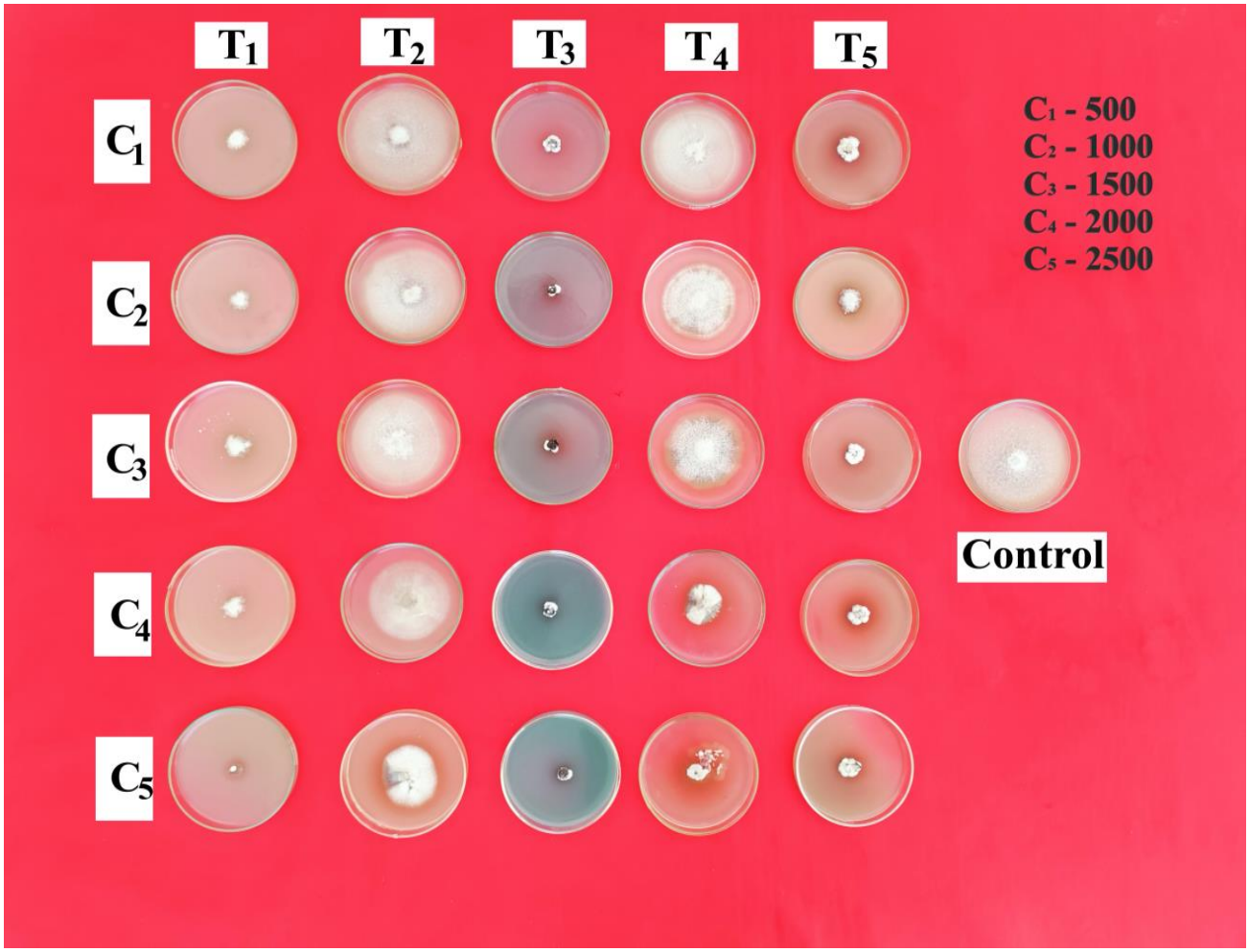

PLATE 3: Growth inhibition of *C. gloeosporioides* by ready mixed fungicides at different concentration *in vitro*

3.3 Efficacy of ready mixed fungicides against *C. gloeosporioides* under *in vitro*:

All the ready mixed fungicides were found effective at 2500 ppm concentration. Among them, carbendazim + mancozeb was found significantly higher than the rest of the ready mixed fungicides with 95.89 per cent mean mycelial growth inhibition followed by tebuconazole + trifloxystrobin, azoxystrobin + difenoconazole and metiram + pyraclostrobin with percentages of 94.43, 86.38 and 73.69, respectively. Azoxystrobin + mancozeb recorded the least mean mycelial growth inhibition of only 66.27 per cent of test fungus.

In combine fungicides, tebuconazole + trifloxystrobin and carbendazim + mancozeb at 2500 ppm both inhibited 98.51 per cent mycelial growth inhibition and it was at par with both same fungicides at 2000 ppm. The next best treatment was carbendazim + mancozeb at 1500 ppm and metiram + pyraclostrobin at 2500 ppm recorded with 96.29 and 95.18 per cent mycelial growth inhibition. Azoxystrobin + mancozeb and Metiram + pyraclostrobin both at 500 ppm recorded the least mycelial growth inhibition of only 51.85 and 52.59 per cent, respectively. Similar results were obtained in the investigations made by Kadam *et al*. (2014) who found carbendazim + mancozeb completely inhibited growth of *C. gloeosporioides*. Ann and Mercer (2017) also observed that tebuconazole + trifloxystrobin showed complete mycelial inhibition of *C. gloeosporioides*.

IV. CONCLUSION

Among systemic fungicides, carbendazim, followed by tebuconazole and difenoconazole, exhibited the highest mean mycelial growth inhibition. Among non-systemic fungicides, copper oxychloride was the most effective, exhibiting the highest mean mycelial growth inhibition against *C. gloeosporioides*. Carbendazim + mancozeb showed higher mean mycelial growth inhibition against *C. gloeosporioides*.

TABLE 3
EFFICACY OF READY MIXED FUNGICIDES AGAINST *C. GLOEOSPORIOIEDS IN VITRO*

Tr. No.	Treatments	Per cent growth inhibition over control Concentration (ppm)					
		500	1000	1500	2000	2500	Mean
T1	Tebuconazole50+ Trifloxystrobin 25 WG	72.03	74.34	77.02	80.98	84.43	77.76
		(89.99)*	92.22	94.44	97.03	98.51	94.43
T2	Azoxystrobin11.5+ Mancozeb 30 WP	46.32	51.69	55.18	58.49	63.26	54.99
		51.85	61.1	66.92	72.22	79.25	66.27
T3	Carbendazim 12 WP + Mancozeb 63 WP	75.62	77.02	79.67	80.89	84.43	79.53
		93.33	94.44	96.29	96.88	98.51	95.89
T4	Metiram 55 + Pyraclostrobin 5 WG	46.75	55.47	57.07	66.27	78.06	60.72
		52.59	67.4	69.99	83.33	95.18	73.69
T5	Azoxystrobin18.2+ Difenoconazole11.4 SC	66.27	68.35	69.62	68.8	70.97	68.8
		83.33	85.92	87.4	86.4	88.88	86.38
T6	Control	4.5	4.5	4.5	4.5	4.5	4.5
		0	0	0	0	0	0
Mean		52.12	55.43	57.38	60.19	64.48	-
		61.84	66.84	69.17	72.64	76.72	
		Treatment		**Concentration**		**Treatment x concentration**	
S. Em.±		0.325		0.297		0.728	
C.D. at 5%		0.921		0.84		2.05	
C.V.%		2.18					

Figures in parentheses are original values and outside are arc-sine transformed values

ACKNOWLEDGEMENT

Staff working under AICRP on Arid Zone Fruits scheme, Agroforestry Research Station and Department of Plant Pathology, C. P. College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar help in giving facilities for conducting said research work.

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