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Efficacy of different fungicides against the *Alternaria solani* under *in vitro* conditions

Deshmukh HV, Deokar CD, Raghuwanshi KS, Khaire PB and Brahmane PR

Abstract
Among the six fungicides, most effective fungicides were found Mancozeb 75% WP which exhibited 100% inhibition in mycelium growth at 0.2% concentration followed by Tebuconazole 50% + Trifloxystrobin 25% w/w (75WG) 85% inhibition in mycelium growth at 0.1% concentration. However, Azoxystrobin (23% SC) shows the least inhibition in mycelium growth 36.11% at 0.1% concentration.

Keywords: Fungicides, *in vitro*, *Alternaria solani*, mycelial inhibition

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is a commonly cultivated vegetable in the world and is the second largest profitable solanaceous vegetable crop after potatoes (Sahu *et al*., 2013). Tomato is a model species for classical genetics and genomic research. Tomato is of high medicinal importance. It functions as a booster of gastric secretion and a purifier of blood. It is common because it supplies vitamin C and adds colour and flavour to food.

Tomato suffers from numerous pathogens, including fungi, bacteria, viruses, nematodes, etc., in many countries (Mark *et al*., 2006). More than 200 diseases have been reported to infect tomatoes worldwide (Atherton and Rudich, 1986). Huge numbers of fungal diseases such as early blight (*Alternaria solani*), late blight (*Phytophthora infestans*), Septoria leaf blight (*Septoria lycopersici*), Powdery mildew (*Oidiopsis taurica*), Fusarium wilt (*Fusarium oxysporum* f. sp. *lycopersici*), Collar rot (*Sclerotium rolfsii*) and Damping off (*Pythium* sp.) trigger significant tomato loses. Amongst these fungal diseases, the early blight caused by *Alternaria solani* is among the most economically significant diseases of the crop nation and the world (Jones *et al*., 1991). Genus *Alternaria* refers to deuteromycetes of various types, which are harmful plant parasites for families such as Solanaceae, cucurbitaceae, brasicaceae. The members of the *Alternaria* genus are cosmopolitan, living as saprophytes as well as weak parasites. In a variety of instances, tiny dark spots are often produced on pods and tender twigs (Valkonen and Koponen, 1990). *Alternaria*-related diseases are among the most prevalent diseases of many kinds of plants in the world. Absolute gross losses incurred by the numerous *Alternaria* in all their hosts are among the largest caused by any pathogen (Agrios, 2005). Khalid *et al*. (2004) and Deshwal offer a detailed, comparative account of the morphological distinction of the various types of Alternaria found in cucurbitaceous, brassicaceous and solanaceous crops (2004). Alternaria species are foliar pathogens that trigger comparatively slow degradation of host tissues through reducing photosynthetic ability. Infection contributes to the development of necrotic lesions, which often occur as goal due to growth interruptions due to unfavourable circumstances. The fungus remains in the middle of the lesion, which is surrounded by an uninvaded chlorotic halo, a symptom that is typically found in the course of necrotrophic pathogen infection.

Alternaria has no known sexual stage or overwintering spores, but the fungus may live for a long time as mycelium or spores on rotting plant debris or as a latent infection in seeds (Rotem, 1994). In Maharashtra, the disease is predominantly observed in all tomato-growing regions. To manage this disease, many fungicides like mancozeb, captan, carbendazim, propineb, copper oxychloried, tebuconazole and propiconazole are sprayed. Use of such chemicals will be further more in protective agriculture conditions as tomato is one of the vegetable crops promoted under intensive cultivation under protected (polyhouse) conditions. Farmers are already using fungicides for management of this pathogen. However, being a commercial crop, indiscriminate use of these fungicides will lead to residues in the fruits and also environmental, water and soil pollution.

Some alternative methods have been tried in the past but with limited success. Considering the economic importance of the crop and yield losses caused by early blight of tomato and its effect on yield, the present study is focus on *in vitro* efficacy of fungicides against *Alternaria solani.*

Material and Methods

In vitro evaluation of fungicides

The poisoned food technique (Falck, 1907) was followed to evaluate the efficacy of six different fungicides against *A. solani* at its recommended dose of applications (concentrations). Both non-systemic and systemic fungicides were tested *in vitro* against *A. solani*. Fungicides were added to the sterilized potato dextrose agar medium as per treatment details. Five mm disc of *A. solani* was taken from seven days old culture and placed at center of petri dish. Simultaneously, a control was also maintained by growing the fungus on fungicide free PDA medium.

The plates were incubated at 25 ± 2^{0}C. Each treatment was replicated four times. The efficacy of fungicides was recorded by measuring the colony diameter of *A. solani* in each treatment and compared with control. The per cent growth inhibition of the fungus in each treatment in comparison with control was calculated by the equation given by Vincent (1947). *In vitro* evaluation of fungicides treatment details is given below:

Treatments details:

Table 1: Treatments details of Fungicides

Treatment No.	Recomended dose (% Concentration)	Name of Fungicides
T_1	0.2	Mancozeb (75% WP)
T_2	0.1	Carbendazim (50% WP)
T_3	0.3	Copper Oxychloried (50% WP)
T_4	0.1	Nativo (75 WG)
T_5	0.25	Propineb (70% WP)
T_6	0.1	Azoxystrobin (23% SC)
T_7	-	Control

Replications: Four, Design: CRD

Observation recorded

The radial growth of the fungus on the poisoned medium was recorded at time of mycelium growth reached 90 mm in control. Per cent inhibition of mycelium growth of the fungus was calculated by using the formula described by Vincent (1947).

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

Where,
I = Per cent inhibition
C = Radial growth in control
T = Radial growth in treated (fungicide/ botanicals/ bioagents).

Result and Discussion

Evaluation of fungicides against *Alternaria solani*

Six fungicides *viz.* Mancozeb (75% WP), Carbendazim (50% WP), Copper oxychloride (50% WP), Tebuconazole 50% + Trifloxystrobin 25% w/w (75 WG), Propineb (70% WP) and Azoxystrobin (23% SC) were assessed *In vitro* to find out the most effective fungicide against *A. solani* at its recommended concentrations using poison food technique.

The results are presented in Table 4.20 reveal that the significant difference among fungicides against *A. solani* was observed. Fungus growth was checked in Mancozeb (75% WP) at 0.2%, followed by Tebuconazole 50% + Trifloxystrobin 25% w/w (75 WG) at 0.1% and Copper oxychloride (50% WP) at 0.25% concentration (Plate 4.10).

Table 2: *In vitro* evaluation of different fungicides against *Alternaria solani*

Tr. No.	Treatment Details	Recommended Dose. (% concentration)	Average Mycelium growth (mm)*	Average mycelium growth inhibition over control. (%)
T_1	Mancozeb (75% WP)	0.2	00.00	100 (90.00)
T_2	Carbendazim (50% WP)	0.1	54.75	39.16 (38.74)
T_3	Copper oxychloride (50% WP)	0.25	22.00	75.55 (60.37)
T_4	Tebuconazole 50% + Trifloxystrobin 25% w/w(75 WG)	0.1	13.50	85.00 (67.21)
T_5	Propineb (70% WP)	0.25	52.00	42.22 (40.52)
T_6	Azoxystrobin (23% SC)	0.1	57.50	36.11 (36.94)
T_7	Control	--	90.00	00.00 (0.00)
	S.Em. ±	CD at 5%	CD at 1%	CV (%)
	0.76	2.24	3.05	3.68

CD at 5% level of significance
*Average of four replications
Values in parenthesis (s) are angular transformed value.

Among the six fungicides, most effective fungicides were found Mancozeb 75% WP which exhibited 100.00 per cent inhibition in mycelium growth at 0.2% followed by Tebuconazole 50% + Trifloxystrobin 25% w/w (75 WG) 85 per cent inhibition in mycelium growth at 0.1% and Copper oxychloride (50% WP) 75.55 per cent inhibition in mycelium growth at 0.25% concentration. However, Azoxystrobin (23% SC) shows the least inhibition in mycelium growth 36.11 at 0.1 per cent concentration (Fig. 1).

Fig 1: Least inhibition in mycelium growth 36.11 at 0.1 per cent concentration

The present findings are similar with the result of Choulwar and Datar (1994) [6] reported that the Mancozeb (1000 ppm) was the most effective fungicide with 77 per cent growth inhibition followed by Captafol. Kamble *et al.* (2000) [13] tested different fungicide and reported that mancozeb was most effective followed by copper oxychloride inhibiting the mycelial growth of *A. alternata* causing leaf spot of tomato. Prasad and Naik (2003) found iprodione, mancozeb and copper oxychloride as most effective and thus inhibited more than 75.00 per cent of mycelial growth at 0.25 per cent concentration. Similar type of result were also obtained by Roopa *et al.* (2014) [28] found that, there was a significant difference among contact fungicides in inhibiting the growth of *A. solani.* Among the three contact fungicides evaluated, mancozeb (63.20%) was significantly superior over other treatments.

Sadana and Didwania (2015) [29] tested seven fungicides against *Alternaria solani* and highest reduction in the disease was achieved by applying Mancozeb (1500 ppm) that caused 86.4 per cent inhibition of mycelial growth of *Alternaria solani*. Similar results were also obtained by El-Nazar *et al.* (1970) [8], Lodha and Prasad (1975) [27] found that Dithane Z-78 effectively checked the growth *of A. solani* in pot trials and *In vitro*, Petkar and Utikar (1976) [26] reported that mancozeb was effective against *A. solani*, Kalra and Sohi (1984), Mohammad (1988), Abhinandan *et al.* (2004) [1], Chethana *et al.* (2012) [4].

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