



# IN VITRO AND IN VIVO EVALUATION OF FUNGICIDES AGAINST EARLY BLIGHT OF POTATO CAUSED BY *ALTERNARIA SOLANI* (ELLIS AND MARTIN) JONES AND GROUT

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## Abstract

Out of twelve different fungicides tested *in vitro* against *Alternaria solani* hexaconazole, tebuconazole, propiconazole, penconazole, combi products zineb 68% + hexaconazole 4% and captan 70% + hexaconazole 5% are equally effective and significantly superior with 100% inhibition at all the concentrations which are on par with difenconazole (100% inhibition) at 0.1 and 0.15 per cent concentration, mancozeb (99.33% inhibition) at 0.25% concentration, propineb (99.11% inhibition) at 0.25% concentration. In case of field evaluation the best fungicide was found to be zineb 68% + hexaconazole 4% (21.50% PDI), which was on par with tebuconazole 25% EC (22% PDI) and captan 70%+ hexaconazole 5% (24.66% PDI). The highest yield (18.83 tonnes/ha) was obtained in zineb 68% + hexaconazole 4% with cost benefit ratio of 4.55, which is on par with tebuconazole 25% EC (18 t/ha) with incremental cost benefit ratio of 4.30 and captan 70% + hexaconazole 5% (17.83 t/ha) with B:C ratio of 4.29.

**Key words :** *Alternaria solani*, early blight, fungicides, *in vitro*, *in vivo* and potato.

## Introduction

Potato is considered as 'The King' in food staples and hardly any domestic kitchen is available, which does not use it in one or the other form as it possesses all the attributes to be a potential food crop. Potato is the only non cereal food crop to command such a high position in the world since being nutritious, it can solve the problem of malnutrition and under nutrition, if adopted as a major food crop. It has been recognized as a wholesome food and richest source of energy in most countries of the world where it forms important part of the human diet.

Among all the fungal diseases early blight of potato caused by *Alternaria solani* (Ellis and Martin) Jones and Grout has assumed a very serious problem all over the world. Some of the site-specific fungicides with broad-spectrum protectants, combiproducs aid in resistance management as well as provide broader protection against a range of foliar pathogens. Good coverage, particularly on lower canopy and oldest leaves will enhance early season control – leading to overall reduction in field disease pressure throughout the season. So, some of the

effective, conventional fungicides were evaluated against early blight of potato both under laboratory and field conditions.

## Materials and Methods

### *In vitro* evaluation of fungicides

The efficacy of systemic, non systemic and combi products were assessed by poison food technique. The pathogen *A. solani* was grown on PDA medium in Petri plates for ten days prior to setting the experiment. The details are mentioned below.

Fungicide suspension was prepared in PDA by adding required quantity of fungicide to obtain the desired concentration on the basis of active ingredient and whole product present in the chemical. Twenty ml of poisoned medium was poured in each of the sterilized Petriplates. Mycelial disc of 0.5 cm was taken from the periphery of ten day old culture and was placed in the center and incubated at 25±1°C till growth of the fungus touched the periphery in control plate. Suitable checks also maintained without addition of any fungicide, three replications were maintained for each treatment. The

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diameter of the colony was measured in two directions and average was worked out. The per cent inhibition of growth was calculated by using the formula given by Vincent (1947).

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

Where,

I= Per cent inhibition of mycelium

C= Growth of mycelium in control

T= Growth of mycelium in treatment

The per cent values were converted to arc sin transformations the data were analysed statistically.

### **In vivo evaluation of fungicides**

A field experiment on potato crop was conducted at Narendra village, Dharwad district during *kharif* 2013 to know the efficacy 12 fungicides. The experiment was laid out in Randomized Block Design (RCBD) with three replications. Potato var. Kufri Jyoti seeds were sown on 7<sup>th</sup> July 2013 and harvesting was done on 23<sup>rd</sup> September 2013. Three sprays of the fungicides were given at 15 days interval. The first spray was given immediately after the first appearance of early blight symptoms *i.e.* 35 days after planting. 2<sup>nd</sup> spray was given at 50 days after planting and 3<sup>rd</sup> spray 65 days after planting. Ten plants in each subplot were scored for disease and data were converted into per cent disease index (PDI) by following 0-9 scale (Mayee and Datar, 1986). The details of the scales are shown below.

Numerical rating	Description
0	No symptoms on leaf
1	Small, irregular brown spots covering 1% or less of the leaf area
3	Small, irregular, brown spots with concentric rings covering 1-10% of the leaf area.
5	Lesions enlarging, irregular, brown with concentric rings covering 11-25% of the leaf area.
7	Lesions coalesce to form irregular brown patches with concentric rings covering 26-50% of the leaf area. Lesions also on stem and petioles.
9	Lesions coalescing to form irregular, dark brown patches with concentric rings covering 51% or more of the leaf area. Lesions seen on the stem and petiole.

Percent disease index was calculated by using the following formula (Wheeler, 1969).

$$(PDI) = \frac{\text{Sum of numerical ratings}}{\text{Total number of leaves observed} \times \text{Maximum disease score}} \times 100$$

Finally yield data was taken after harvest and cost benefit ratio was calculated.

## **Results and Discussion**

Out of twelve fungicides tested, four were non systemic, five were systemic and three were combi products. These were evaluated by means of poisoned food technique and data were presented in table 1 and 1a. Hexaconazole, tebuconazole, propiconazole, penconazole at 0.05, 0.1 and 0.15 per cent concentration, combi products zineb 68% + hexaconazole 4% and captan 70% + hexaconazole 5% at 0.1, 0.2 and 0.25% concentrations are equally effective and significantly superior with 100% inhibition, which are on par with difenconazole (100% inhibition) at 0.1 and 0.15 per cent concentration, mancozeb (99.33% inhibition) at 0.25% concentration, propineb (99.11% inhibition) at 0.25% concentration.

Least effective chemical was found to be chlorothalonil at all the concentration (0.1%, 0.2% and 0.25%) tested. At higher concentration of chlorothalonil the inhibition recorded was 44.73% followed by zineb (46.55%) at 0.1 per cent concentration. The results obtained are in confirmation with the work of Singh and Singh (2006) who reported that hexaconazole was effective with 100% inhibition. Arunkumar (2006) reported propiconazole best at 0.1% concentration. Ganie (2012), who reported that among the systemic fungitoxicants hexaconazole (0.03 %) followed by penconazole (0.03%) proved significantly superior at all tested concentration.

### **Field evaluation of fungicides**

Totally twelve fungicides were tested in farmers's field of Narendra village near UAS Dharwad and data were represented in Table 2. Three sprays were given in fifteen days interval starting from the initiation of the disease. Observations on disease severity was recorded before the first spray, which is non significant. But later it is observed that at 50, 65 and 75 DAS the treatment differ significantly over the unprotected check. Maximum per cent disease index was noticed in control 72.66% followed by mancozeb (52%) at 75 DAS. The least PDI was noticed in zineb 68% + hexaconazole 4% (21.50%) which is on par with tebuconazole 25% EC (22%) and

**Table 1 :** *In vitro* evaluation of contact fungicides and combi -products against mycelial growth of *Alternaria solani*.

Fungicides	Inhibition (%)			
	Concentrations (%)			Mean
	0.1	0.2	0.25	
<b>Contact fungicides</b>				
Mancozeb 75%WP	57.22 (48.91)*	65.23 (53.88)	99.33 (87.29)	73.92 (63.36)
Chlorothalonil 75%WP	15.23 (22.96)	34.31 (35.85)	44.73 (41.98)	31.42 (33.60)
Zineb 75% WP	46.55 (43.02)	62.77 (52.40)	52.33 (46.45)	53.88 (47.29)
Propineb 70%WP	47.28 (43.44)	57.31 (49.20)	99.11 (86.87)	67.9 (59.84)
<b>Combiproducs</b>				
Carbendazim 12% + Mancozeb 63% WP.	55.20 (47.99)	66.39 (54.57)	74.24 (59.51)	65.27 (54.02)
Captan 70% + Hexaconazole 5% WP	100 (90)	100 (90)	100 (90)	100 (90)
Zineb 68% + Hexaconazole4% WP	100 (90)	100 (90)	100 (90)	100 (90)
	<b>S.Em. ±</b>		<b>CD at 1%</b>	
Fungicides (F)	0.42		1.58	
Concentration (C)	0.22		1.03	
F x C	1.36		2.75	

\*=Arcsine values.

**Table 1a :** *In vitro* evaluation of systemic fungicides against mycelial growth of *Alternaria solani*.

Fungicides	Inhibition (%)			
	Concentration (%)			Mean
	0.05	0.1	0.15	
Difenconazole 25%EC	91.11 (72.67)*	100 (90.00)	100 (90.00)	97.03 (84.22)
Hexaconazole 5%EC	100 (90)	100 (90)	100 (90)	100 (90)
Tebuconazole 25%EC	100 (90)	100 (90)	100 (90)	100 (90)
Propiconazole 25%EC	100 (90)	100 (90)	100 (90)	100 (90)
Penconazole 10% EC	100 (90)	100 (90)	100 (90)	100 (90)
	<b>S.Em. ±</b>		<b>CD at 1%</b>	
Fungicides (F)	0.06		0.25	
Concentration (C)	0.05		0.19	
F x C	0.21		0.43	

\*=Arcsine values.

captan 70%+ hexaconazole 5% (24.66%). The next best treatment was found to be mancozeb 63% + carbendazim 12% (27%) followed by hexaconazole 5% EC (28.66%) at 75 DAS.

Similar results were obtained by Roopa (2012) who reported that zineb 68% + hexaconazole 4% at 0.2% effectively controlled the disease followed by hexaconazole (0.1%) on early blight of tomato. Rao (2006) and Tofali *et al.* (2003) used combi products for the management of *Alternaria* leaf spot of sunflower

and early blight of tomato respectively. Abhinandan *et al.* (2004); Ilhe *et al.* (2008), Sali *et al.* (2010) reported the efficacy of triazoles for management of early blight.

From the farmers point of view the economics of disease management is essential. Using of fungicides not only helps in reducing the disease severity but also helps in increasing the tuber yield of potato giving high benefit to the farmers. So the fungicides should be cost effective. So keeping this points in view the economic analysis for the management of early blight of potato has been done.

**Table 2 :** Field efficacy of fungicides for the management of early blight of potato.

Treatments	Conc (%)	Percent Disease Index (PDI)			
		Before 1 <sup>st</sup> spray (35DAS)	Before 2 <sup>nd</sup> Spray (50DAS)	Before 3 <sup>rd</sup> Spray (65 DAS)	10 days after last spray (75DAS)
Mancozeb 75% WP	0.2	14.13 (22.08)*	32.00 (34.41)	40.67 (39.61)	52.00 (46.15)
Cholorothalonil 75% WP	0.2	14.00 (21.96)	30.33 (33.41)	39.33 (38.77)	47.00 (43.28)
Zineb 75% WP	0.2	13.26 (21.36)	18.33 (25.34)	27.33 (31.48)	37.00 (37.46)
Propineb 70% WP	0.2	13.5 (21.55)	24.00 (29.32)	30.33 (33.41)	40.16 (39.33)
Difenconazole 25% EC	0.1	12.30 (20.53)	21.00 (27.22)	25.67 (30.34)	33.16 (35.15)
Hexaconzole 5% EC	0.1	11.96 (20.23)	18.50 (25.46)	20.33 (26.76)	28.66 (32.29)
Tebuconazole 25% EC	0.1	15.00 (22.78)	11.83 (20.12)	16.67 (23.98)	22.00 (27.97)
Propiconazole 25% EC	0.1	13.66 (21.68)	16.00 (23.57)	25.00 (29.84)	31.83 (34.34)
Penconazole 10% EC	0.1	14.00 (21.94)	23.33 (28.28)	32.67 (34.84)	39.00 (38.64)
Mancozeb 63% + Carbendazim 12% WP	0.2	14.66 (22.49)	14.33 (22.17)	18.00 (25.10)	27.00 (31.16)
Captan 70% + Hexaconazole 5% WP	0.2	15.33 (23.04)	9.67 (18.08)	17.00 (24.33)	24.66 (29.70)
Zineb 68% + Hexaconazole 4% WP	0.2	14.06 (22.02)	9.00 (17.30)	15.67 (23.29)	21.50 (27.61)
Control	-	14.00 (21.96)	37.33 (39.54)	53.66 (47.11)	72.66 (58.57)
<b>Mean</b>		<b>13.83</b>	<b>20.43</b>	<b>27.87</b>	<b>36.66</b>
S.Em.		0.59	1.33	1.73	1.48
CD at 5%		NS	3.89	5.04	4.33

\* = Arcsine values.

**Table 3 :** Economic analysis of management of early blight of potato.

Treatments	PDI	Yield (t/ha)	B:C ratio
Mancozeb 75% WP	52.00 (46.15)*	11.50	2.41
Cholorothalonil 75% WP	47.00 (43.28)	12.67	2.73
Zineb 70% WP	37.00 (37.46)	14.17	3.20
Propineb 70% WP	40.16 (39.33)	15.33	3.53
Difenconazole 25% EC	33.16 (35.15)	16.83	3.88
Hexaconzole 5% EC	28.66 (32.29)	17.17	4.03
Tebuconazole 25% EC	22.00 (27.97)	18.00	4.30
Propiconazole 25% EC	31.83 (34.34)	16.50	3.87

*Table 3 continued...**Table 3 continued...*

Penconazole 10% EC	39.00 (38.64)	16.30	3.77
Mancozeb 63% + Carbendazim 12% WP	27.00 (31.16)	16.83	3.97
Captan 70% + Hexaconazole 5% WP	24.66 (29.70)	17.83	4.29
Zineb 68% + Hexaconazole 4% WP	21.50 (27.61)	18.83	4.55
Control	72.66 (58.57)	8.50	1.54
S.Em. ±	1.48	1.38	
CD at 5%	4.33	4.04	

\* = Arcsine values

The results are presented in table 3. The highest yield (18.83 tonnes/ha) was obtained in zineb 68% + hexaconazole 4% with cost benefit ratio of 4.55 which is on par with tebuconazole 25% EC (18 t/ha) with cost benefit ratio of 4.30 and captan 70% + hexaconazole 5% (17.83 t/ha) with B:C ratio of 4.29. Yield was least in

control (8.50 t/ha) and cost benefit ratio was 1.54. Hence zineb 68% + hexaconazole 4% (0.2%), tebuconazole (0.1%) and captan 70% + hexaconazole 5% (0.25%) can be recommended to the farmers for early blight management.

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