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EFFICACY OF FUNGICIDE, BOTANICAL AND BIO-NANOFORMULATION FOR SUPPRESSION OF EARLY BLIGHT OF TOMATO CAUSED BY *ALTERNARIA SOLANI*

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ABSTRACT

The present studies were conducted to test the efficacy of newly molecule like (Cu-chitosan) and their combination along with commonly used fungicides *viz*., mancozeb and neem oil on tomato cultivar Uday to develop effective management strategies against early blight of tomato caused by *Alternaria solani*. Bio-nanoformulation (Cu-chitosan) was evaluated in integration with fungicide and botanicals in pot conditions during 2014. Two sprays were applied on diseased plans at the interval of 15 days. All fungicidal treatments reduce the disease severity as compared to untreated check. Under pot study the integration of three component; Cu- chitosan 0.1% as seed treatment with spray of mancozeb 0.25% and neem oil 2% was found best that gave maximum efficacy of disease control (43.01 and 50.81%) with minimum PDI mean (27.50 and 30.38%), respectively, at first and second spray of the treatment as compare to inoculated control. Use of neem oil and bio-nanoformulatio along with fungicides would be an eco-friendly strategy in managing early blight of tomato.

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INTRODUCTION

Tomato (*Lycopersicon esculentum* Mill) is belonging to family solanaceae and regarded as poor man's apple. It is one of the most remunerable and widely grown vegetable and ranks first among the processing crops in the world. In the world, tomato crop is growing over an area of 4815.71 million hectare, with the production of 163029.7 million tones, and the productivity is 33.9 tones/hectare. India shares about 9.4 % over total vegetable area, it is cultivated over 8.82 million hectare, the total production around 18735.9 metric tons with productivity of 21.2 metric tons/ha (Anon., 2014). Among the fungal diseases, early blight also known as target spot disease incited by *Alternaria solani* (Ellis and Martin) Jones and Grout is one of the world's most catastrophic disease of tomato (Abada *et al*., 2008). It is a serious disease in warm and humid regions, the disease appears on leaves, stems, petiole, twig and fruits under favorable conditions resulting in defoliation, drying off of twigs and premature fruit drop and thus causing loss from 50 to 86 percent in fruit yield (Mathur and Shekhawat, 1986). It is predominantly affected by early blight in various proportions lowering the yield considerably, the most critical early work was published by Jones (1896) and Jones and Grout (1897) while working at Vermont, United Kingdom. In India this disease was first noticed by Butler in Faizabad, U.P in 1905 (Singh, 2009). Disease severity was recorded up to 90 per cent in Indo-Gangetic region of the country (Pandey *et al.,* 2002). Similarly, various workers reported incidence 30 to 65% at various states of India ,early blight of tomato is important in reducing crop yields (Prasad *et al*., 2004, Hossain *et al*., 2010, Sahu *et al.,* 2013 and Munde *et al*., 2013).

The pathogen perpetuates in the crop debris in or on the soil, infection first take place on lower leaves, during warm, rainy, humid weather condition. The initiation as a small, isolated, scattered pale brown spots on the leaves and stem of the mature plant (Singh, 2009). The Fungicidal spectrum of mancozeb in controlling early blight of tomato was confirmed by (Choulwar and Datar, 1992). Plant extracts and new molecules like neem oil and Cu-chitosan are potential and environmentally safe alternatives and as components in integrated management programs (Patil *et al*., 2001,Bowers and Locke, 2004 Mate *et al.,* 2005 and Saharan *et al*.,2013)

, hence the present study was undertaken for eco-friendly management of early blight of tomato using different combinations of three component; Cu- chitosan 0.1%, mancozeb 0.25% and neem oil 2% that were found promising to control of early blight of tomato.

MATERIALS AND METHODS

Evaluation of fungicide, botanical and bio-nanoformulation (Cu-chitosan) in pots

Three promising fungicides; mancozeb 0.25 %,(75%WP Neem oil (2%) were selected on the basis of result published by workers which was found promising to control early blight of tomato along with newly developed bio-nanoformulation (Cu-Chitosan 0.1%) which was first tested *in vitro* for its bio-efficacy against early blight pathogen *A. solani* by poisoned food technique. These were further evaluated

alone as well as in different combinations as seed treatment and spray under inoculation of the pathogen in pots. Eight different combinations of treatment were framed out that presented in schematic form (Table-1). For comparison an inoculated control was also maintained without fungicidal/ botanical application. The experiment was conducted in pot grown tomato cultivar "Uday" in cage house having three plants in each pots with four replications in complete randomized design (CRD). For this purpose healthy tomato seedlings were raised in nursery plates and 28 days old seedlings were transplanted in to 30 x 15cm size earthen pots.

Disease severity for early blight of tomato was recorded on a standard 0-5 disease rating scale described by (Pandey *et al*., 2003)

Description of disease rating scale (0-5), for early blight in tomato

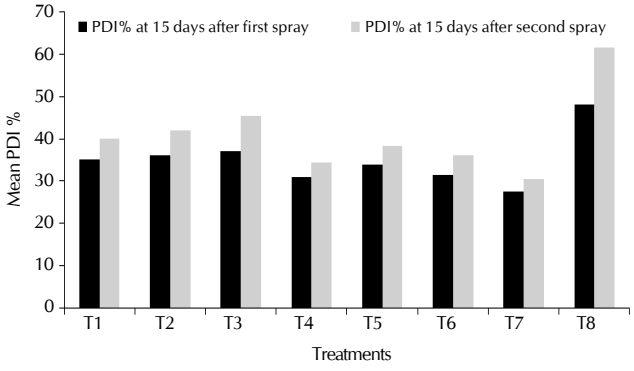
Scale	Description
0	Free from infection
1	< 10% surface area covering leaf, stem and fruitinfected by early blight.
2	11-25% foliage of plant covered with a fewisolated spots.
3	Many spots coalesced on the leaves, covering26-50% surface area of plant.
4	51-75% area of the plants infected, fruits also infected at peduncle end defoliation and blightening started. Sunken lesions with prominent concentric ring on stem, petioles and fruits.
5	< 75% area of plant part blighted, severe lesion on stem and fruit rotting on peduncle end.

Per cent disease index (PDI) was calculated by using following formula given by Wheeler (1969).

$$\text{Per cent disease index (PDI)} = \frac{\text{Sum of all individual disease rating}}{\text{Total no. of plant observed x Maximum disease rating}} \times 100$$

RESULTS AND DISCUSSION

The trial were, conducted in pot conditions on tomato cultivar "Uday" under inoculated conditions on foliage, the individual treatments resulted in significant reduction in the disease severity as compared to the inoculated untreated control. Maximum reduction in disease severity by the integration of three component, Cu- chitosan 0.1% as seed treatment with spray of mancozeb @ 0.25% and neem oil @ 2% was found best that gave maximum efficacy of disease control (43.01 and 50.81%) with minimum PDI mean (27.50 and 30.38%), respectively. Followed by the integration of mancozeb @ 0.25% as seed treatment with spray of neem oil @ 2% was found better to all other treatments with mean PDI (31.45% and 36.20%) and percent efficacy of disease control (34.82 and 41.38) at first and second spray of the treatment as compare to inoculated control where mean PDI was 48.25%



T1: Mancozeb (ST); T2: Neem oil (ST); T3: Cu-chitosan (ST); T4: Mancozeb (ST + SP); T5: Neem oil (ST + SP); T6: Mancozeb (ST) + Neem oil (SP); T7: Cu-chitosan (ST) + Mencozeb (SP) + Neem oil (SP); T8: Inoculated control

Figure 1: Relative efficacy of seed treatment and foliar spray of promising fungicide, botanical and Cu- chitosan against early blight of tomato

Table 1: Schematic presentation of treatments:

S.No.	Treatments	Seed treatment	Spray application
1.	Dithane M-45 [mancozeb] at 0.25%,	+	-
2.	Neem oil (2%)	+	-
3.	Bio-nanoformulation (CU-Chitosan 0.1%)	+	-
4.	Dithane M-45 [mancozeb], 0.25%	+	+
5.	Neem oil (2%)	+	+
6.	Mancozeb, 0.25%, (ST) + Neem oil 2% (Spray)	+	+
7.	CU-Chitosan 0.1% ST + Mancozeb 0.25%, (Spray) + Neem oil 2% (Spray)	+	+
8.	Control (Pathogen inoculation)	-	-

*ST = Seed treatment

Table 2: Evaluation of Cu-chitosan based bio-nanoformulation against *A. solani in vitro*

Treatment	Colony diameter (mm)* Concentration (PPM)			Percent growth inhibition		
	10	50	100	10	50	100
Cu-chitosan	52.9	26.6	20.5	41.20 (39.92)	70.44 (57.06)	77.22 (61.40)
Control	90	90	90	0	0	0
SEm+	0.31					
CD ($p = 0.05$)	0.91					
CD ($p = 0.1$)	1.25					

* Mean of three replication, Values in parenthesis (s) are angular transformed value

Table 3: Relative efficacy of seed treatment and foliar spray of promising fungicide, botanical and Cu- chitosan against early blight

S.N.	Treatments	PDI, 15 days after first spray	PEDC	PDI, 15 days after second spray	PEDC
1	Mancozeb 0.25), seed treatment (ST)	35.18(36.38)	27.10(31.36)	40.10(39.29)	35.06(36.30)
2	Neem oil 2%, (ST)	36.20(36.99)	24.97(29.98)	42.05(40.42)	31.90(34.39)
3	Cu-chitosan 0.1%, (ST)	37.20(37.58)	22.90(28.59)	45.38(42.35)	26.52(30.99)
4	Mancozeb 0.25%, (ST+ Spray)	31.05(33.86)	35.65(36.65)	34.43(35.92)	44.25(41.69)
5	Neem oil (2%),(ST+ Spray)	33.78(35.53)	30.00(33.21)	38.65(38.44)	37.41(37.70)
6	Mancozeb (0.25%) (ST)+Neem oil (2%) Spray	31.45(34.11)	34.82(36.16)	36.20(36.99)	41.38(40.03)
7	Cu-Chitosan0.1%(ST)+Mancozeb,0.25% (Spray) +Neem oil 2%, (Spray)	27.50(31.63)	43.01(40.97)	30.38(33.44)	50.81(45.46)
8	Inoculated control	48.25(44.00)	0.00	61.75(51.80)	0.00
SEm+		0.41 0.29		0.37 0.25	
CD ($p=0.05$)		1.20 0.92		1.09 0.74	
CV%		2.27 3.38		1.88 3.26	

*Mean of four replications, Values in parenthesis (s) are angular transformed value, ST = Seed treatment

and 61.75% recorded after first and second spray, respectively, (Fig. 1). These findings are in agreement with the earlier findings the effectivity of fungicide mancozeb (Mate *et al.,* 2005, Jambhulkar, *et al.,* 2012 and Sahu *et al.*, 2013), and neem seed and leaf extract (Patil *et al*., 2001, Afifi and Sahar, 2009) have been reported for management of early blight of tomato. Although, the bio-nanoformulations (Cu-chitosan) was found less effective compare to fungicides but found significantly effective on control. (Sathiyabama *et al.,* 2014) reported antifungal properties of chitosan and its role in protection of tomato from early blight disease.

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