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EVALUATION OF NEWER FUNGICIDE FOR MANAGEMENT OF EARLY BLIGHT OF TOMATO IN CHHATTISGARH

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ABSTRACT

The present studies were conducted to test the efficacy of some newer molecules like pyraclostrobin, boscalid, and their combination maccani, pristine along with commonly used chemicals *viz*., mancozeb, copper oxychloride and chlorothalonil against early blight of tomato cultivar Pusa Ruby. A variant with no application of fungicide was used as a control. Average yield was calculated after fifteen pickings. Phytotoxicity effect of newer molecules was evaluated using a single spray. All fungicide treatments reduce the disease severity as compared to untreated check. Pristine 38%WG @ 64+126g a.i. /ha (31.88%) significantly reduced the disease followed by maccani 16%WG @ 60+180g a.i./ha (33.31%) and increase the yield from 33.50 tonnes/ha (Pristine 38%WG @ 64+126g a.i. /ha) and 32.44 tonnes/ha (maccani 16%WG @ 80+ 240g a.i./ha) as compared to a maximum disease (76.2%) and minimum yield of only 21.15 tonnes/ha in control. Overall results revealed that Pristine at both concentrations (64+126g a.i./ha and 76.8+151.2g a.i./ha) was found significantly effective in reducing the disease and increasing the fruit yield over control.

INTRODUCTION

Tomato is second most important remunerable solanaceous vegetable crops after potato either for local consumption and exportation. It is native to South America and is widely cultivated in 140 countries of the world with an annual production of 16826000 metric tonnes (Anonymous 2011). High nutritive value and varied climatic adaptability made the tomato cultivation more popular. Area under tomato in the country is about 8.65 lakh hectares and it is about 10.2% of the total cropped land under vegetables. Annual production of tomato in India is 1, 68, 26,000 metric tonnes which is 11.5% of the total vegetable production and productivity of 19.5 metric tonnes per hectare (Kumar, 2011).

There has been a gradual increase in the area under tomato while the production has been fluctuating due to various diseases and insect pest damage. There are several diseases on tomato caused by fungi, bacteria, viruses, nematodes and abiotic factors (Balanchard, 1992; Gomaa, 2001; Abdel-Sayed, 2006 and Abada *et al*., 2008). Among the fungal diseases, early blight caused by *Alternaria solani* (Ellis and Martin) Jones and Grout, is the most threatening one (El-Abyad *et al*., 1993; Gomaa, 2001; Abdel-Sayed, 2006 and Abada *et al*., 2008), which causes great reduction in the quantity and quality of fruit yield. It is an important disease of tropical and sub-tropical areas. It is now found on all continents of the world. It is a serious disease in warm and humid regions (Sherf and MacNab, 1986) and in semiarid areas where frequent and prolonged night dew (Rotem and Reichert, 1964) and high relative humidity (Lawrence *et al*., 1996) occurs. The fungus causes disease in tomato, potato and eggplant. The causal organism is air borne and soil inhabiting cause disease on foliage (leaf blight), stem (collar rot) and fruit (fruit rot) and can result in severe damage during all stages of plant development (Foolad *et al*., 2000) disseminated by fungal spores (Datar and Mayee, 1981). It is increasingly becoming a limiting factor for successful cultivation of tomato and causes yield losses varies from 15-100% (Sohi, 1984 and Mathur and Shekhawat, 1986). Tomato crop is damaged due to severe infection of *A. solani* every year in India. The disease severity was recorded up to 90% in Varanasi region by Pandey *et al*., 2002.

Primary methods of controlling early blight include preventing long periods of wetness on the leaf surface, cultural scouting, sanitation, and development of the host plant resistance with the application of fungicides (Namanda *et al*., 2004; Kirk *et al*., 2005 and Kumar and Srivastava, 2013). Cultivation of resistant varieties is the ultimate control of this disease. Although heritable resistance has been reported for *A. solani* (Christ, 1991; Herriot *et al*., 1986 and Holley *et al*., 1983), the disease is still primarily managed by use of foliar fungicides. However frequent application of these fungicides over a period of time has led to the development of fungicidal resistance in *Alternaria* resulting in emergence of fungicidal resistant strains.

Regarding the management of early blight of tomato many workers had done lot of works based on the chemical control. Earlier workers reported application of fungicides is the most effective method of *Alternaria* blight control and found that Tetra methyl thiram disulphide (TMTD), Dithane M-45, Bavistin, Dithane Z-78, Difoltan, Blitox, Captafol and Bordeaux mixture effectively manage the disease fungicides (Verma and Verma, 2010). Ashour (2009) reported that fungicides were the most efficient in managing the natural infection of the early blight and resulted in producing the highest fruit yield compared with antioxidants as well as the alternation between them. Mancozeb was also effective in reducing the disease intensity and increase the yield of Pusa Ruby (Maheswari *et al*., 1991; Choulwar, 1992; Bassler and Hausladen, 2003; Arunakumara *et al*., 2010; Gondal *et al*., 2012 and Chourasiya *et al*., 2013). Patil *et al*. (2003) reported that carbendazim was best fungicides to minimize the disease incidence and highest fruit yield while according to Datar and Mayee (1985), Fentin hydroxide and mancozeb were superior for the controlling the disease. Kumar *et al*. (2007) reported that hexaconazole (0.05%) and azoxytrobin (0.2%) was very effective in managing early blight of tomato.

Most of the new generation fungicides are highly specific and single site in mode of action. Thus a novel fungicide with novel mode of action needs to be identified and evaluated under field conditions. One of the newer generation fungicidal groups is the strobilurin group of fungicides. Strobilurin compounds are broad- spectrum and site specific fungicides active against a wide range of diseases in many crops. They are excellent inhibitors of spore and known for their protectant activity. Pyraclostrobin, boscalid, dithianon and azoxystrobin are member of the Strobilurin group of fungicides. Our objective was to determine the efficacies of different doses of newer generation fungicidal formulations of strobilurin groups to develop a management module for early blight of tomato.

MATERIALS AND METHODS

The field experiments for the evaluation of fungicides were conducted at the Horticulture Research Farm, IGKV Raipur during *Rabi* 2012-13. Twenty five day old tomato seedlings raised in portrays were transplanted to in a plot size of 3 x 2.7 m experimental plots, with row spacing of 60 cm and plant spacing of 45 cm. The experiment was laid out in randomized complete block design with three replications using variety Pusa Ruby. All recommended agronomic practices were followed.

Four new fungicidal molecules *i.e.* pyraclostrobin 38% WG, boscalid50% WG and their combined molecules maccani16%WG (pyraclostrobin 4% + dithianon 12%WG), pristine 38%WG (pyraclostrobin 12.8% + boscalid 25.2% WG) were evaluated against *A. solani* and compared with check fungicides i.e. chlorothalonil 75% WP, mancozeb 75%WP and copper oxychloride 50%WP and untreated control.

The details of treatments are: T1- Three sprays of mancozeb75% WP (1500g a.i./ha); T2- Three sprays of blitox 50%WP (1000g a.i./ha); T3- Three sprays of boscalid 35%WG (140g a.i./ha); T4- Three sprays of pyraclostrobin 20%WG (100g a.i./ha); T5- Three sprays of maccani 16%WG (60+180 g a.i./ha); T6- Three sprays of pristine 38%WG (164+126g a.i./ha); T7- Three sprays of maccani 16%WG (80+ 240g a.i./ ha); T8- Three sprays of Pristine 38%WG (76.8+151.2g a.i./ ha); T9- Three sprays of chlorothalonil 75%WP (100g a.i./ha); T10- Untreated control.

Fungicide application treatments were done by Knapsack sprayer. Three sprays of fungicides were applied at regular intervals of ten, twenty and thirty days. Data on the disease severity was recorded after every fifteen days intervals. First observation on disease severity was recorded before the beginning of first spray and subsequent observations after first spray and before second and third spray and finally disease severity was recorded 105 days after planting (DAP).

Tomato leaf damage by *A. solani*

Five plants were selected randomly in each plot and observation on severity of the disease on the foliage was recorded using 0-5 scale of Horsefall and Barette, 1945 (Table 1) and percent disease index (PDI) was worked out using formula of Wheeler (1969) as given here:

$$PDI = \frac{\text{Sum of all the numerical disease rating} \times 100}{\text{Total no. of leaves observed} \times \text{Maximum disease rating (5)}}$$

Statistical analysis

The disease severity data was arcsine transformed before analysis of variance (ANOVA). Recorded data were subjected to statistical analysis using ANOVA of SAS statistical data analysis software. Duncan's multiple range tests was used to determine the most significant treatment (Steel *et al.*, 1997).

Phytotoxicity evaluation

Phytotoxicity effect of fungicides at different concentration was observed after one spray was administered. Observations on chlorosis, necrosis, wilting, scorching, hyponasty and epinasty were recorded at 1, 3, 5, 7 and 10 days after 1^{st} spray by visual observations based on 0-10 scale (Table 2).

RESULTS AND DISCUSSION

The data on PDI of early blight was recorded periodically from 45 to 105 days after planting (DAP) with an interval of 15 days (Table 3). It has been found that in all treatments PDI increased with age of the plants. Data on disease severity showed that all fungicide tested reduced the disease intensity significantly

Table 1: Disease rating scale for the assessment of early blight of tomato

Scale	Description of the symptom
0	Leaves free from infection
1	Small irregular spots covering <5% leaf area
2	Small irregular brown spots with concentric rings covering 5.1-10% leaf area
3	Lesions enlarging, irregular brown with concentric rings covering 10.1-25% leaf area
4	Lesions coalease to form irregular and appears as a typical blight symptom covering 25.1-50% leaf area
5	Lesions coalease to form irregular and appears as a typical blight symptom covering >50% leaf area

Table 2: Phytotoxicity observations scale

Scale	% Crop Health Affected
0	No Phytotoxicity effect
1	1-10
2	11-20
3	21-30
4	31-40
5	41-50
6	51-60
7	61-70
8	71-80
9	81-90
10	91-100

compared to control. From the table we also conclude that in all the treatments, there was increases in disease index from 45 to 105 DAP. However, the rate of increase in PDI was slow in case of newer fungicides treated plots compared to check treatments and control.

The percent disease severity in different treatments at 105 days after planting (DAP) demonstrated that minimum disease severity was recorded in T6 (pristine 38%WG @ 164+126g a.i./ha) followed by T5 (maccani 16%WG @ 60+180g a.i. / ha) with PDI of 31.88% and 33.31%. The PDI recorded in new fungicide treated plots are 36.51% (T3 *i.e.* Boscalid 50 % WG @ 140g a.i./ha), 34.19% (T4 *i.e.* Pyraclostrobin 38% WG @ 100g a.i./ha), 33.31% (T5 *i.e.* maccani 16%WG @ 60+180g a.i. /ha), 32.88% (T6 *i.e.* pristine 38%WG @ 164+126g a.i./ha), 36.97% (T7 i.e. Maccani 16%WG @ 80+ 240g a.i./ha) and 36.82% (T8 *i.e.* Pristine 38%WG @ 76.8+151.2g a.i./ha) as compared to 45.42, 43.53, 41.93 and 76.2% in T1 (mancozeb 75% WP @1500g a.i./ ha), T2 (copper oxychloride 50% WP @ 1000g a.i./ha), T9 (chlorothalonil 75%WP @ 100g a.i./ha) and T10 (untreated control). The percentage disease reduction was highest in recorded in T6 (58.16%) followed by T5 (56.29%) resulted in increased yield compared to T1 (40.39%), T2 (42.87%) and T9 (44.97%).

After fifteen pickings, yield of each treatments was calculated which demonstrated that the fruit yield was significantly more in all the fungicidal treatment (29.75 to 33.50 tonnes ha^{-1}) compared to control (21.15 tonnes ha^{-1}) indicating the positive effect of fungicides on increase in yield of tomato. Maximum fruit yield (33.50 tonnes ha^{-1}) was obtained in plots sprayed with T6 (Pristine 38%WG @ 164+126g a.i./ha) followed by T7 (32.44 tonnes ha^{-1}). Least yield was obtained by T1 sprayed plot (51.43 tonnes ha^{-1}). Control plot recorded the lowest fruit yield of 21.15 tonnes ha^{-1}.

All the newer fungicides tested *viz*. pyraclostrobin 38%WG (100g a.i/ha), boscalid 50%WG (140g a.i./ha), pristine 38% WG and maccani 16% WG could significantly reduce the early blight disease and increase the yield also compared to check fungicides and control. The percentage reduction in disease ranged from 40.39 to 58.16% and increase in yield ranged from 40.66 to 58.38%.

Pyraclostrobin significantly reduced the early blight and increased the yield in tomato and potato has reported by many workers (Ganeshan and Chethana, 2009; MacDonald *et al.*, 2007 and Ivey *et al.*, 2004). Pyraclostrobin alternated with maneb and pyraclostrobin + boscalid alternated with maneb significantly reduced the anthracnose incidence in bell pepper as compared to control. Best disease control with highest yields and fruit quality was reported in combination product of pyraclostrobin+metiram effective against both early blight and late blight has reported by Capriotti *et al.* (2005). Horsfield *et al.* (2010) reported that boscalid most effective in the control of early blight disease of potatoes. Jambhulkar *et al.* (2012) reported spray of azoxystrobin 23% SC showed promising results by reducing disease severity by 38.9% as compare with control. Mancozeb as effective fungicide for the management of early blight and maximum fruit yield was reported by several workers (Maheshwari *et al.*, 1991; Choulwar and Datar, 1992; Singh *et al.*, 2001; Kapsa and Osowski, 2003; Sobolewski and Robak, 2004 and Chourasiya *et al.*, 2013). Results of the present study showed that all fungicide treatments significantly controlled the early blight infection on tomato as compared to untreated control. There was a significant difference in all the treatments. In our finding pristine at both the concentration controlling the disease significantly, and increasing yield. Our study clearly indicates that 3 sprays of pristine when applied give maximum protection against *A. solani*. Other fungicides such as maccani, boscalid, pyraclostrobin and mancozeb also found effective against *A. solani* among the tested fungicides. Application of Pristine

Table 3: Efficacy of fungicides tested as foliar spray on severity of early blight disease and their effect on yield of tomato

S.N.	Treatment	PDI (%) at different days after planting (DAP)					Reductionin PDI(%)	Yield (tonnes/ha)	Increase in yield (%)
		45	60	75	90	105*			
1	Mancozeb 75% WP(1500g a.i./ha)	2.70	8.24	16.82	27.62	45.42(42.36)	40.39	29.75	40.66
2	Copper oxychloride 50% WP (1000g a.i./ha)	2.82	7.94	14.62	26.59	43.53(41.27)	42.87	30.88	46.01
3	Boscalid 50 % WG(140g a.i./ha) T3	1.69	7.08	13.62	21.41	36.51(37.17)	52.09	31.30	47.97
4	Pyraclostrobin 38% WG(100g a.i./ha) T4	1.83	7.12	13.94	24.04	34.19(35.73)	55.13	31.81	50.40
5	Maccani 16%WG(60+180 g a.i./ha) T5	1.84	6.37	14.47	21.74	33.31(35.24)	56.29	32.03	51.46
6	Pristine 38%WG(164+126g a.i./ha) T6	0.89	5.87	14.38	21.72	31.88(34.94)	58.16	33.50	58.38
7	Maccani 16%WG(80+ 240g a.i./ha) T7	1.61	7.23	13.85	22.82	36.97(37.41)	51.48	32.44	53.38
8	Pristine 38%WG(76.8+151.2g a.i./ha) T8	1.67	7.49	14.74	18.75	36.82(37.35)	51.68	32.16	52.06
9	Chlorothalonil 75%WP(100g a.i./ha) T9	2.68	8.28	14.86	25.85	41.93(40.34)	44.97	31.70	49.88
10	Control T10	5.24	14.72	27.26	52.94	76.2(60.80)	-	21.15	-
SEm±						0.81		1.82	
C.D. (5%)						2.43		5.43	

* figures in parenthesis are arc sine transformed value

(164+126g a.i./ha) and (76.8+151.2g a.i./ha) showed best results followed by maccani. Thus, it can be said that newer molecules tested in the present study may be effectively used not only to manage early blight but increase the yield of tomato as well.

Phyto-toxicity

All the newer fungicides tested did not cause any phytotoxicity symptoms in terms of chlorosis, necrosis, wilting, scorching, hyponasty and epinasty on 1, 3, 5, 7 and 10 days after fungicide.

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