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Management of early blight of Potato (*Solanum tuberosum* L.) incited by *Alternaria solani* (Ellis & Martin) Jones & Grout through fungicides

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ABSTRACT

The efficacy of some combination fungicides like fenamidone 10% + mancozeb 50% WDG, metiram 55% + pyraclostrobin 5% WG and cymoxanil 8% + mancozeb 64% WP along with commonly used fungicides *viz.*, dimethomorph 50% WP, fosetyl Al 80% WP, mancozeb 75 WP, metalaxyl 8% + mancozeb 64% WP, captan 70% + hexaconazole% WP and carbendazim 25% + mancozeb 50% WS were tested against early blight of potato *cv.* Kufri Pukhraj at Agricultural Research Station, Ladol, Gujarat. A variant with no application of fungicide was used as a control. All the treatments reduced the disease intensity significantly as compared to untreated check. The data on PDI of early blight of potato was recorded periodically at 40, 50, 60 and 70 days after sowing with consecutive three spray of fungicides at 15 days interval and was found low to moderate in range (12.94–20.64%). The lowest per cent disease intensity (PDI) 12.94 was observed in case of fenamidone 10% + mancozeb 50% WDG @ 0.2% treatment (2.5 gm/l) and it was at par with the treatment of metiram 55% + pyraclostrobin 5% WG @ 0.2% (2 gm/l) and cymoxanil 8% + mancozeb 64% WP @ 0.25% (2.5 gm/l) with its PDI per cent 14.04 and 14.94, respectively. It significantly reduced the early blight as compared to control. Similarly, the highest yield of potato tubers was recorded in fenamidone 10% + mancozeb 50% WDG @ 0.2% (2.5 gm/litre) against early blight with 60574 kg/ha followed by metiram 55% + pyraclostrobin 5% WG @ 0.2% (2.0 gm/litre) and cymoxanil 8% + mancozeb 64% WP @ 0.2% (2.5 gm/litre) with its yield 56778 and 50352 kg/ha, respectively. Thus, it can be said that combination of protective fungicides effectively suppressed pre- as well as post-infection activity and inhibited sporulation and/or restricted lesion expansion of early blight pathogen. Also found increase in the yield of potato as well.

Key words: Potato, Early Blight, *Alternaria solani*, Fungicides, Fenamidone, Mancozeb, Per cent Disease Intensity, management.

Potato (*Solanum tuberosum* L.) is one of the most important food and cash crop belonging to the family solanaceae. The major potato producing states are Uttar Pradesh, Bihar, Gujarat Karnataka, Orissa, Andhra Pradesh, Maharashtra, Madhya Pradesh, and West Bengal. In India, potato is grown in all the states producing 493 lakh tonnes from total area of 1.5 million ha. The crop has the potential to increase agricultural production in our region. In Gujarat, it is grown in area of 81.27 thousands ha producing 38.35 lakh tonnes which is contribute near about 8 per cent share of potato production with 30758 kg/ha average productivity at national level (Anonymous, 2018). The major potato growing districts of Gujarat are Banaskantha, Sabarkantha, Mehsana, Patan, Gandhinagar, Surat, Valsad, Vadodara, Navasari and Dang (Anonymous. 2009). India ranked second in the potato production worldwide (Anonymous, 2017). Potato is commonly affected by numerous fungal diseases *viz.*, Early blight [*Alternaria solani* (Ellis and Mart.)], Leaf blight [*Alternaria alternata* Fries (Keissler)], Late blight [*Phytophthora infestans* (Mont.) de Bary], Anthracnose [*Colletotrichum phomoides* (Sacc.) Chester], Fusarium wilt [*Fusarium*

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oxysporum f. sp. *lycopersici* (Sacc.) Snyder and Hansen], etc. Among them, early blight of potato caused by *Alternaria solani* is one of the common and wide spread diseases. In every year, it appears in devastating form in major potato growing areas of Gujarat. The disease mainly infects leaves and tubers. Initially the symptoms occur on the lower and older leaves in the form of small (1-2 mm) circular to oval brown spots. These lesions have the tendency to become large and angular at later stage. Mature lesions on foliage look dry and papery, and often have the concentric rings, looking like bulls eye. The symptoms on the tuber comprise of brown, circular to irregular and depressed lesions with underneath flesh turning dry, brown and corky. Lesions tend to enlarge during storage and affected tubers later become shriveled. The various factors limiting yield of potato include lack of high yielding varieties, inadequate supply of healthy seed tubers and high intensity of diseases and pests. Among the fungal diseases early blight of potato incited by *Alternaria solani* (Ellis & Martin) Jones & Grout is the most destructive disease. In Gujarat, the disease occurs every year in not epidemic form but contributing to yield loss up to 30 per cent in unsprayed crop (Patel, 2007). Among the new fungicides, fenamidone 10% + mancozeb 50% WDG and metiram 55% + pyraclostrobin 5% WG have been evaluated as highly effective against *A. solani*. Both the combination of fungicides has already been used in different parts of the country for management of early and late blight of potato. However, it is quite essential to evaluate their efficacy against the disease for a particular climatic condition. Therefore, an experiment has been carried out to investigate the performance of some fungicides *viz.*, fenamidone 10% + mancozeb 50% WDG, cymoxanil 8% + mancozed 64% WP, dimethomorph 50% WP, fosetyl Al 80% WP, mancozeb 75 WP, metalaxyl 8% + mancozeb 64% WP, captan 70% + hexaconazole 5% WP, metiram 55% + pyraclostrobin 5% WG and carbendazim 25% + mancozeb 50% WS under North Gujarat agro climatic conditions.

MATERIALS AND METHODS

The experiment was conducted at Agricultural Research Station, S. D. Agricultural University, Ladol, Gujarat during the year 2015-16 in *Rabi* season using *cv.* Kufri Pukhraj for the management of early blight of potato caused by *Alternaria solani* (Ell. & Mart.) Jones and Grout. The soil of the experimental field was sandy loam. The experiment was laid out in a randomized block design with three replications. All recommended agronomic practices were followed. The potato tubers were sown in the last week of November at a distance of 50 cm X 20 cm spacing by using 20-25 q seed tubers ha^{-1} with the gross area of 6.0 m X 3.0 m = 18.0 m^2. Efficacies of nine fungicides with their prefixed concentrations (Table 1) were compared with untreated control.

Table 1 Treatment details with their dose.

Treatment No.	Treatments	Spray Conc. (gm/lit)
T_1	Fenamidone 10% + Mancozeb 50% WDG	2.5
T_2	Cymoxanil 8% + Mancozeb 64% WP	2.5
T_3	Dimethomorph 50% WP	1.0
T_4	Fosetyl Al 80% WP	2.0
T_5	Mancozeb 75 WP	2.5
T_6	Metalaxyl 8% + Mancozeb 64% WP	2.0
T_7	Captan 70% + Hexaconazole 5% WP	1.0
T_8	Metiram 55% + Pyraclostrobin 5% WG	2.0
T_9	Carbendazim 25% + Mancozeb 50% WS	1.5
T_{10}	Untreated Control	-

Three sprays of each fungicide with their prefixed concentration were applied at an interval of 15 days when the disease initiation was started. The per cent disease intensity was recorded as per three consecutive sprays of fungicides at 40, 50, 60 and 70 days after sowing. On the basis of symptoms (Figure A and Figure B) and microscopic studies, the fungus was identified as *Alternaria solani,* causative agent of

early blight of potato (Ellis and Martin, 1882). The observations on the intensity of early blight disease of potato were recorded from randomly selected 5 plants from each plot using 0-5 scale as mentioned below.

Disease Score		Disease Intensity
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.

Per cent Disease Intensity (PDI) was calculated by using the following formula given by Chestar, 1959 and Weeler, 1969.

$$PDI = \frac{\text{Sum of all disease ratings}}{\text{Total no. of observations (sample) X Maximal disease rating grade}} \times 100$$

Based on these observations, per cent disease intensity (PDI) of early blight of potato was recorded. The per cent disease intensity data was arcsine transformed before analysis of variance (ANOVA). Statistical analysis was done with using the standard procedure described by Gomez and Gomez (1986).

RESULTS AND DISCUSSION

The experiment was conducted successfully at ARS, SDAU, Ladol farm with susceptible variety kufri pukhraj. We visually observed only one major disease infestation in the experiment. It was early blight disease caused by *Alternaria solani* (Ellis & Martin) Jones & Grout. There was no tuber infection found at the time of harvesting. The data on PDI of early blight of potato was recorded periodically at 40, 50, 60 and 70 days after sowing with consecutive three spray of fungicides at 15 days interval and was found low to moderate in range (12.94 – 20.64 per cent). It has also been found that in all treatments PDI increased with the age of the plants. The data on disease intensity revealed that all fungicides tested reduced the disease intensity significantly as compared to control. Table 2 revealed that the minimum PDI 12.94 per cent was recorded in case of T_1 *i.e.* spraying of fenamidone 10% + mancozeb 50% WDG @ 0.2% (2.5 gm/l) and it was at par with the treatment T_8 *i.e.* spraying of metiram 55% + pyraclostrobin 5% WG @ 0.2% (2 gm/l) and treatment T_2 *i.e.* spraying of cymoxanil 8% + mancozeb 64% WP @ 0.25% (2.5 gm/l) with its PDI per cent 14.04 and 14.94, respectively. It was significantly reduced the early blight as compared to control. The data showed that the best PDI reduction was observed with ranged from 12.94 to 14.94 as well as increase in yield ranged from 50352 to 60574 kg/ha. Most effective treatment with highest yield (60574 kg/ha) was T_1 (fenamidone + mancozeb) with minimum PDI 12.94 per cent followed by T_8 (metiram + pyraclostrobin) resulting yield of 56778 kg/ha with 14.04 PDI. Control plot was recorded the lowest tuber yield of 41926 kg ha^{-1}.

Result of the present study showed that among the nine different fungicide treatments, two combination fungicides *viz.*, T_1 (fenamidone 10% + mancozeb 50% WDG) @ 0.2% (2.5 gm/litre) and T_8 (metiram 55% + pyraclostrobin 5% WG) @ 0.2% (2.0 gm/litre) were found significantly superior for the management of early blight of potato disease as compared to others. These fungicides acted as the best fungicides when applied as prophylactic as well as curative measures. Other fungicides such as T_2 (cymoxanil 8% + mancozeb 64% WP) @ 0.2% (2.5 gm/l), T_9 (carbendazim 25% + mancozeb 50% WS) @ 0.2% (2.0 gm/l) and T_5 (mancozeb 75 WP) @ 0.2% (2.7 gm/litre) were also found effective against *A. solani* after T_1 & T_8 treatments. Similar results were obtained by Asit, *et. al.*, 2017, they tested sequential spraying of fenamidone 10% + mancozeb 50% WDG (0.25%) two to three times from 45 day after transplanting at 10 days intervals for better management of early blight of tomato, enhancement of fruit yield and assurance of high economic return. They found minimum disease incidence (10.61%) in case of involving fungicides (Fenamidone 10% + Mancozeb 50% WDG) having both systemic and contact action gave better reduction of early blight disease over other treatment combinations in tomato. Preventive fungicides inhibit

the spore germination and penetration but pathogen can derive resistance against fungicide application so repeated application of fungicides at proper dose and interval of time is mandatory (Hossain and Hossain, 2009). 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). Ganeshan and Chethna, (2009) also found pyraclostrobin 25% EC significantly reduced disease and resulted in increased yield as compared to captan, mancozeb and control. Arunakumara *et al.*, 2010; Horsfield *et al.*, 2010 and Sahu *et al.*, 2013 also tested the efficacies of some newer fungicides in field conditions for the management of early blight of tomato and they found pyraclostrobin, azoxystrobin and carbendazim + mancozeb were highly effective for the management of early blight. All the treatments showed significantly better foliage controlled as well as tuber yield over non- treated control. The results of this study were consistent with previous studies and indicated that the application of protective fungicides could reduce foliar early blight to acceptable levels. Thus, in the present study, it can be said that combination of protective fungicides may be effectively had suppression of pre as well as post-infection activity and inhibited sporulation and/or restricted lesion expansion of early blight pathogen. Also found not only to manage early blight but increase in the yield of potato as well (Table 2).

Table 2 Efficacy of fungicides tested as foliar spray on intensity of early blight disease and their impact on yield on potato.

Sr. No.	Name of Treatment	Per cent Disease Intensity (PDI)				Yield (kg/ha.)
		40 (DAS)	50 (DAS)	60 (DAS)	70 (DAS)	
T_1	Fenamidone 10% + Mancozeb 50% WDG	6.96 (1.48)	8.83 (2.37)	10.62 (3.40)	12.94 (5.03)	60574.00
T_2	Cymoxanil 8% + Mancozeb 64% WP	8.53 (2.22)	10.38 (3.26)	11.30 (3.85)	14.94 (6.66)	50352.00
T_3	Dimethomorph 50% WP	11.49 (4.00)	13.31 (5.33)	16.71 (8.29)	19.45 (11.11)	44444.00
T_4	Fosetyl Al 80% WP	13.31 (5.33)	14.93 (6.66)	17.89 (9.48)	20.38 (12.15)	44296.00
T_5	Mancozeb 75 WP	9.11 (2.51)	10.62 (3.40)	14.59 (6.37)	16.09 (7.70)	45648.00
T_6	Metalaxyl 8% + Mancozeb 64% WP	11.71 (4.14)	13.31 (5.33)	16.72 (8.29)	18.20 (9.77)	44537.00
T_7	Captan 70% + Hexaconazole 5% WP	9.62 (2.81)	11.74 (4.15)	15.09 (6.81)	16.71 (8.29)	45500.00
T_8	Metiram 55% + Pyraclostrobin 5% WG	8.25 (2.07)	10.38 (3.26)	11.95 (4.29)	14.04 (5.92)	56778.00
T_9	Carbendazim 25%+ Mancozeb 50% WS	8.25 (2.07)	10.81 (3.55)	12.55 (4.74)	15.76 (7.41)	49648.00
T_{10}	Control (Water spray)	14.25 (6.07)	15.25 (6.96)	18.05 (9.63)	20.64 (12.44)	41926.00
	SE(m) ±	0.34	0.33	0.43	0.47	2793.00
	C.D. at 5 %	1.01	0.99	1.29	1.42	8297.00
	C.V. %	5.80	4.78	5.13	4.86	10.00

Figure A: Concentric ridges forms on infected leaves

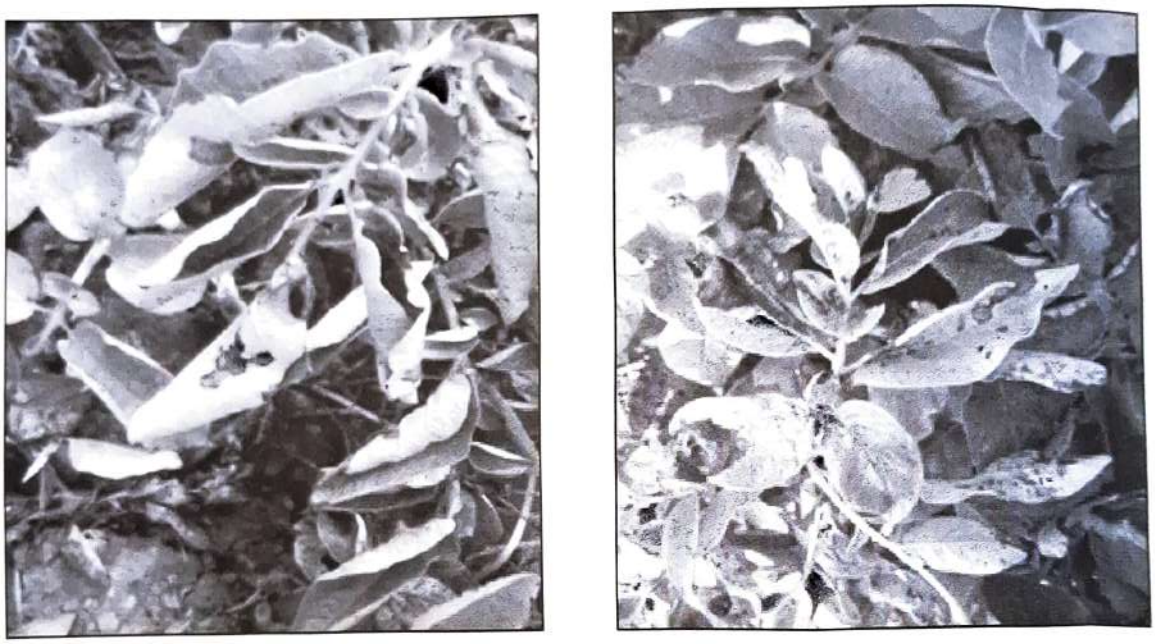

Figure B: Concentric ridges forms on infected leaves

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