Efficacy of sequential sprays of different fungicides against early blight *Alternaria solani* (Ellis and Martin) in potato *Solanum tubrosum* L.

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Abstract— *Potato is one of the world's fourth most important food crop belongs to family solanaceae. More than one billion peoples consume potatoes and richest source of energy highest dry matter, energy and edible proteins. The field experiments on Efficacy of sequential sprays of different fungicides against early blight Alternaria solani (Ellis and Martin) in potato Solanum tubrosum L. was conducted during kharif season on potato (cv. K. Pukharaj) for consecutive three years. The experiment was laid out in RBD design with 6 treatments and 4 replications. The results revealed that spray of Chlorothalonil 75 WP (0.25%) @ 2.5 gm/ liter of water followed by Hexaconazole 5 EC (0.05%) @ 0.5 ml /liter of water and then Chlorothalonil 75WP (0.25%) @ 2.5 gm/liter of water at 10 days interval was found significantly superior in controlling the early blight on potato The yield differences due to spraying of fungicides were significant and the highest yield (18.10 t/ha) was obtained in same treatment.*

Keywords— Potato, Alternaria solani Chlorothalonil, Hexaconazole, Mancozeb.

I. INTRODUCTION

Potato is one of the world's fourth most important food crop after rice, wheat and corn. More than one billion peoples consume potatoes worldwide and it is part of the diet of half a billion people in developing countries. It has been recognized as a wholesome food and richest source of energy highest dry matter, energy and edible proteins in most countries of the world where it forms important part of the human diet. Potato contains significant levels of phenolic compounds and vitamin C as potent antioxidants (Brown, 2005), which inactivate reactive oxygen species, reduce oxidative damage, lead to improved immune functions and reduce risk of cardiovascular diseases, cancer, cataract, diabetes and aging (Kour et al., 2004). In terms of area, India ranks third in the world after China and Russian and second in production after China. India has take leap in terms of potato area and production since independence. The average production of potato crop was 41.328 million tones of potato from1.89 million hectare areas during the year 2011-12. The Gujarat is one of the leading state in production of potato with 29.6 t/ha followed by 28.92 t/ha in West Bengal while the national average productivity of potato was 22.07 tonns/ha. However, this crop is highly susceptible to diseases viz. fungal, bacterial and viral pathogens and pests having a potential to drastically reduce its production.

Early blight, caused by *Alternaria solani* (Ellis and Martin) is a serious disease of potato that occurs in most potato growing regions world-wide. In recent years, increases in *A. solani* disease on potato foliage have been reported in various potato growing areas of Maharashtra state. Primary damage by early blight is attributed to premature defoliation of the potato plants and resulting in tuber yield reduction. Yield loss estimates resulting from foliar damage incited by early blight on potato vary by location, cropping season, cultivar and the stage of potato maturity. Early blight may also cause dry rot of tubers, reducing both the quantity and quality of marketable tubers. Environmental factors such as temperature, wetness duration and relative humidity (moisture) affect the development of early blight. Early blight is also enhanced through continuous potato production (Olanya et al., 2009). The young plants of potato show high resistance to early blight caused by *A. solani* as compared to older ones (Bambawale,1978). Within the same plant, the lower leaves which are physiologically different from middle and top ones are more susceptible to certain pathogens with resistance increasing in an acropetal direction. Potato early blight symptoms first occur on the

lower senescing leaves, which become chlorotic and abscise prematurely. Excessive defoliation may lead to death of the plant and consequent yield loss.

Several effective pesticides have been recommended against this pathogen but they not considered a long-term solution, due to concerns of expense, exposure risks and the hazards of its residues. Moreover, the development of resistance of pathogenic fungi towards synthetic pesticides is a great problem that can affect significantly the efficacy of chemical fungicides. Thus, to find safe, efficacious and environmentally friendly fungicides considered as a source of major concern (Mdee et al., 2009).

Under Maharashtra conditions, early blight of potato is posing a great threat for its cultivation. The systemic study on efficacy of the sequential sprays of different fungicides against early blight on potato has not been conducted so far under field conditions. Therefore keeping in view the devastating nature of disease a detailed investigation was undertaken under field conditions to devise management programme of the disease.

II. MATERIAL AND METHODS

The field investigations on the efficacy of the sequential sprays of different fungicides against early blight caused by *A. solani* on potato were conducted on the farmers' fields as farmers participatory research in Satara district for consecutive three years during kharif season in 2014, 2015 and 2016 by the All India Coordinated Research Project on Potato, National Agricultural Research Project, Ganeshkhind, Pune. The experiments were laid out with 6 treatment and 5 replications in a randomized block design. The potato variety *Kufri Pukhraj* was planted on medium well drained soil at 20 cm x 60 cm spacing. The net plot size 2.00 m x 3.00 m was kept for each treatment and replication. All other package of practices were followed as per the recommendations. 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 up to the harvest of crop. Fungicide application treatments were done by hand operated Knapsack sprayer. The first spraying of respective fungicidal treatments was carried out immediately after incidence of early blight while second and third spraying was done at 10 days interval. The treatments consisted newer fungicides like Mancozeb 75WP (0.25%), Chlorothalonil 75WP (0.25%), Hexaconazole 5EC (0.05%) and with control. The spray fluid used was 500 liter ha^{-1}. Five plants were selected randomly in each plot and observation on severity of the disease on the foliage was recorded by using 0-5 scale of Horsefall and Barette 1945 (Table1) and percent disease index (PDI) was worked out using formula of Wheeler (1969) as given here.

i) For Disease Intensity of Early Blight

Observations on intensity were recorded on 5 randomly selected plants per treatment per replication at 10 days interval from early blight disease appearance till to harvesting of experimental potato crop. The intensity was recorded by using 0 to 5 scale by visual observation on the basis of plant leaves and plant part affected. The final percent intensity of early blight was calculated by using following formula:

$$\textbf{Disease Intensity (\%)} = \frac{Sum\ of\ Disease\ Rating}{\text{Total no.of Plants Selected } \mathbf{x} \text{ Max.Rating}} \text{ X } 100$$

Table.1: Scale used for Rating of Early Blight:

Grade	Numerical Value	Leaf Area Infected (%)	Grade	Numerical Value	Leaf Area Infected (%)
I	0	Disease free	**IV**	3	26-50
II	1	01-10	**V**	4	51-75
III	2	11-25	**VI**	5	>76

ii) For Disease Incidence of Early Blight:

For calculating the disease incidence of Early Blight on potato, all plants from each treatment and replication were considered for recording observations and calculated with following formula:

$$\textbf{Disease Incidence (\%)} = \frac{\text{No.of Infected Plants due to Early Blight}}{\text{Total no.of Plants in Plot}} \textbf{ X 100}$$

The intensity and incidence of early blight on potato was recorded at 10 days interval from plant emergence till to date of harvesting. The spraying of respective treatment was done after first appearance of early blight on potato crop. The average mean intensity and incidence of early blight was statistically analyzed. The following treatments were sprayed as per the scheduled programme.

T1 : Control.

T2 : Three sprays of Mancozeb 75WP (0.25%) @ 2.5 gm/liter of water at 10 days interval.

T3 : Three sprays of Chlorothalonil 75WP (0.25%) @ 2.5 gm /liter of water at 10 days interval.

T4 : Three sprays of Hexaconazole 5EC (0.05%) @ 0.5 ml/liter of water at 10 days interval.

T5 : Spray of Mancozeb 75WP (0.25%) @ 2.5 gm/liter of water followed Hexaconazole 5EC @ 0.5ml /liter of water and then Mancozeb 75WP (0.25%) @ 2.5 gm/liter of water at 10 days

interval.

T6 : Spray of Chlorothalonil 75WP (0.25%) @ 2.5 gm /liter of water followed by Hexaconazole 5 EC (0.05%) @ 0.5 ml/liter of water and then Chlorothalonil 75WP (0.25%) @ 2.5 gm /liter of water at 10 days interval.

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.

III. RESULTS AND DISCUSSIONS

The data presented in Tab.2 for consecutive three years (2013-14 to 2015-16) observed that the treatment T6 (Spray of Chlorothalonil 75 WP (0.25%) @ 2.5 gm/ liter of water followed by Hexaconazole 5 EC (0.05%) @ 0.5 ml /liter of water and then Chlorothalonil 75WP (0.25%) @ 2.5 gm/liter of water at 10 days interval) was found significantly superior in controlling the early blight on potato and which was at par with the treatment T5 (Spray of Mancozeb 75WP @ 2.5 gm/liter of water followed Hexaconazole 5EC @ 0.5 ml /liter of water and then Mancozeb 75WP @ 2.5 gm/liter of water at 10 days interval) after appearance of disease. The lowest intensity and incidence of early blight was observed in treatment T6 (10.67% and 14.61 %, respectively) and T5 (10.93% and 14.85%, respectively). In case of Absolute control (treatment T1) showed 30.87 percent intensity and 45.06 percent incidence of early blight *A. solani* on potato crop. The yield differences due to spraying of fungicides were significant and the highest yield (18.10 t/ha) was obtained in same treatment i.e. T6.

The above results are congruent with the finding of Hawamdeh and Shabir (2011), Braithwaite *et. al.* (1996) recommended that chlorothalonil was the best fungicides against *Alternaria* species in vivo. Ashoka (2005) also listed chlorothalonil among the most effective fungicides. Gondal *et. al.* (2012) revealed that weekly sprays of mancozeb at 12 g/L of water were cost effective and eco-friendly for the management of *Alternaria* blight of tomato. Ganie *et. al.* (2013) observed minimum disease intensity of 4.91% in plants of potato treated with mancozeb 75 WP (seed treatment) + hexaconazole 5 EC (foliar spray) + datura extract (foliar spray) + *T. harzianum* (foliar spray). Hassan *et. al.* (2014) showed that Chlorothalonil has better effectiveness as compared to others followed by clipper and antracol. The most effective dose of Helonil (Chlorothalonil) was recorded as 400 ppm with inhibition of (82.85%) followed by clipper (64.70%) at 500 ppm and Antracol (46.66%) at 1000 ppm. Least inhibition was observed in Ridomil (7.74%) and Desomil (8.57%) with concentration of 300 ppm against early blight of tomato.

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Table. 2 : Efficacy of the Sequential Sprays of Different Fungicides against Intensity and Incidence of Early Blight (Alternaria solani) onPotato Solanum tuberosum L.
(Pooled data of three years 2013, 2014 and 2015)

Treatment No.	Treatment Details	Intensity of Early Blight on Potato				Incidence of Early Blight on Potato				Yield (t/ha)
		Pre count	Days after first spraying			Pre count	Days after first spraying			
			10	20	30		10	20	30	
T1	Control.	6.73 (15.00)	16.23 (23.73)	25.20 (30.13)	30.87 (33.77)	6.91 (15.23)	27.68 (31.76)	37.97 (38.00)	45.06 (42.19)	11.96
T2	Three sprays of Mancozeb 75WP (0.25%) @ 2.5 gm/liter of water at 10 days interval.	7.40 (15.68)	8.74 (17.16)	10.94 (19.28)	16.26 (23.81)	6.82 (4.73)	14.72 (22.55)	17.54 (24.73)	20.83 (27.13)	16.13
T3	Three sprays of Chlorothalonil 75WP (0.25%) @ 2.5 gm/liter of	6.52 (14.77)	8.40 (16.85)	13.25 (21.30)	15.57 (23.26)	7.06 (15.45)	13.93 (21.89)	17.06 (24.43)	19.70 (26.35)	15.67

	water at 10 days interval.									
T4	Three sprays of Hexaconazole 5EC (0.05%) @ 0.5 ml /liter of water at 10 days interval.	6.06 (14.30)	10.33 (18.72)	13.05 (21.13)	16.27 (23.81)	6.68 (15.00)	14.54 (22.38)	17.27 (24.58)	21.63 (27.69)	15.00
T5	Spray of Mancozeb 75WP @ 2.5 gm/liter of water followed Hexaconazole 5EC @ 0.5 ml /liter of water and then Mancozeb 75WP @ 2.5 gm/liter of water at 10 days interval.	6.36 (14.65)	8.13 (16.54)	8.22 (16.64)	10.93 (19.28)	7.07 (15.45)	14.73 (22.55)	15.50 (23.19)	14.85 (22.63)	17.91
T6	Spray of Chlorothalonil 75 WP (0.25%) @ 2.5 gm/ liter of water followed by Hexaconazole EC (0.05%) @ 0.5 ml /liter of water and then Chlorothalonil 75WP (0.25%) @ 2.5 gm/liter of water at 10 days interval.	6.43 (14.65)	7.98 (16.32)	8.54 (16.95)	10.67 (19.09)	8.19 (16.64)	13.63 (21.64)	13.88 (21.81)	14.61 (22.46)	18.10
	SE±	N.S.	0.87	0.45	0.64	N.S.	0.92	0.84	0.77	0.49
	CD at 5%		2.61	1.37	1.92		2.78	2.53	2.32	1.54

*Figures in parenthesis are arcsine transformed value

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