



## The impact on scheduling fungicides application for the management of late blight (*Phytophthora infestans*) in Potato (*Solanum tuberosum* L.)

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### Abstract:

The present study were in two consecutive seasons of 2018-19 and 2019-20 at Vegetable Research Farm of Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, Uttar Pradesh, India with the objectives to find out the effect of scheduling fungicide for late blight management on different dates and late blight of potato is the major biotic constraint responsible for reduction in yield and economics of the potato crop. The experiment was laid out in Randomized Block Design with five replications. The experiment was comprised of eight treatments viz. two varieties i.e. Kufri Bahar and Kufri Pushkar for used fungicides i.e. Prophylactic spray (just at the time of canopy closure) with mancozeb @0.25% followed by cymoxanil + mancozeb @0.3% & one more spray + mancozeb 0.25% (T<sub>1</sub>), Mancozeb @0.25% followed by fluopicolide 62.5 + propamocarb hydrochloride 625 sc (0.3%) & one more spray + mancozeb 0.25% (T<sub>2</sub>), Mancozeb @0.25% followed by Azoxistrobin + Tebuconazole (0.1%) followed by one spray + mancozeb 0.25 % (T<sub>3</sub>) and unsprayed control (T<sub>4</sub>). The result revealed that minimum disease intensity and incidence were found when applied foliar spray with mancozeb 0.25% and cymoxanil 8% + mancozeb 64% @ 0.3 % and one more spray with mancozeb @0.25% in the both variety i.e. K. Bahar and K. Pushkar. Significantly lowest disease (9.38 and 9.84%) and highest yield i.e. 39.52 t/ha and 35.94 t/ha were observed in both variety, respectively. Potato variety Kufri Pushkar like in variety Kufari Bahar lowest incidence at harvest was recorded in treatment with mancozeb @0.25% followed by cymoxanil + mancozeb @0.3% & one more spray + mancozeb 0.25% was done before disease appearance followed by mancozeb @0.25%. Therefore, used Kufri Pushkar variety potato along with prophylactic spray (just at the time of canopy closer) with mancozeb @ 0.25% followed by cymoxanil + mancozeb @0.3% & one more spray + mancozeb 0.25% higher received in gross return of Rs. 2,74,896.00 in net return of Rs. 1,52,611.00 and B:C ratio 1:1.24 under pooled data in present experimentations.

**Key words:** Potato, Late Blight, Disease Management, Fungicide.

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### Introduction:

Potato is an economically important crop with potential to provide nutritional food security worldwide including developing countries. Especially, India when the humble spud is the staple food of millions. Traditionally, potatoes prefer cool, long days of summer in the hilly, temperate areas. Late blight of potato caused by an oomycete *Phytophthora infestans* (Mont.) de Bary is the most destructive disease of potato in hills and plain regions of India and caused yield losses up to 95% in epidemic conditions (Lal et al., 2015). Recently, reduction in 10-15% yield of potato was estimated due to occurrence of late blight in India on over all basis (Lal et al., 2016). Management strategies for its effective control include use of host resistance, chemicals, bio-control, forecasting, sanitation and even disease escape (Singh and Sharma, 2013). It is being observed that host resistance is broken down within a decade with subsequent increase in level of susceptibility to late blight. Generally, no such cultivar allows the commercial cultivation of potato without fungicides protection. The indiscriminate use of these chemicals not only poses a serious threat to the environment but also to the human health. Biological control by antagonists has attracted much attention because of being eco-friendly to environment and the crop (Harmendez et al., 2005). Since late blight spreads very fast in the fields when the environmental conditions are conducive, therefore, management of late blight through bio-agents only may not be effective. Therefore, present study was done with two varieties of Kufri Bahar and Kufri Pushkar in combination of fungicides against late blight with the objective to reduce the number of fungicidal sprays without compromising the economic yield.

### MATERIALS AND METHODS:

The experiments were conducted in Randomized Block Design with five replications at Vegetable Research Farm, Department of Vegetable Science, Chandra Shekhar Azad University of Agriculture & Technology, Kalyanpur, Kanpur during two consecutive *rabi* seasons i.e. 2018-19 and 2019-20. Eight treatment combinations two varieties cv. Kufri Bahar ( $V_1$ ) and Kufri Pushkar ( $V_2$ ) which are popular with farmers but Kufri Bahar highly susceptible and Kufri Pushkar resistant to late blight and four used fungicides viz. Prophylactic spray (just at the time of canopy closure) with mancozeb @0.25% followed by cymoxanil + mancozeb @0.3% & one more spray + mancozeb 0.25% ( $T_1$ ), Mancozeb @0.25% followed by fluopicolide 62.5 + propamocarb hydrochloride 625 sc (0.3%) & one more spray + mancozeb 0.25% ( $T_2$ ), Mancozeb @0.25% followed by Azoxistrobin + Tebuconazole (0.1%) followed by one spray + mancozeb 0.25% ( $T_3$ ) and unsprayed control ( $T_4$ ). Tubers were planted in last week of October and crop was raised as per recommended agronomic practices of the region. In fact rows were planted as borders of the experimental field to ensure smooth spread of late blight across the treatments. The tubers of *Kufri Bahar* and *Kufri Pushkar* were planted in a standard plot of 6.0 m<sup>2</sup> size having five rows of two meters length was used per treatment keeping 60 x 20 cm, Row x Plant to Plant spacing. Spraying was done as per treatment wise.

**Symptoms:** The plants symptoms incoming infected spots (round or irregularly shaped areas that range in colour from dark green to purplish black and resemble frost injury) appear on the leaves, petioles and stems when, whitish growth of spore producing structures may appear at the margin of the lesions on the under leaf surfaces. Whereas, potato tubers symptoms create rottage up to 15 mm (0.6 inch) deep. Secondary fungi often invade potato tubers and produce rotting that result in maximum losses during storage and marketing.



**Phytophthora survival:** The *Phytophthora infestans* survival in store, dump piles, field plants and green house potatoes sexual oospores and asexual sporangia are dispersed by the wind to nearby plants, in which infections may occur within a few hours at temperature below 15<sup>0C</sup> (59<sup>0</sup> F) sporangia germinate by producing zoospores (a sexual spores with flagella) that encyst and later form a germ tube under certain temperature and humidity conditions. Above that temperature most sporangia produce a germ tube directly. Foliage blighting and a new crop of sporangia are produced within 4-6 days after infection. The cycle is repeated as long as cool moist weather prevails.

**Leaves:** In the incubation period then just after first symptoms pale green water soaked spots (2.10 mm) appear mostly on the margin and tips. In suitable weather spots may appear anywhere on the leaves, enlarge rapidly then turn necrotic and black killing the entire leaf instantly. On the corresponding lower side, whitish growth containing millions of sporangia forms around the dead area in the ring form.

**Stem and petiole:** The symptoms developed in stem and petiole is light brown lesions develop which elongated and encircles the stem and petioles breaking them and killing the plant/leaves instantly. The highest stem infection is more severe under low temperature and high humidity conditions symptoms of stem blight are observed.

**Tubers:** The symptoms show as like rust brown discoloration of the flesh is the typical symptoms of late blight outer tuber surface area, hard depressions with purplish tinge on the sides are a common feature. Normally, late blight infected tubers are hard but associated secondary pathogen may set in soft rot symptoms.

**Epidemiology:** Prior to germ theory, potato late blight was attributed to bad weather. However, later on, it was established that a fungus, *Phytophthora infestans* affects the potato crop with lightning speed under wet conditions causing this disease. Ambient temperature, RH, light, fogginess, rainfall, dew, wind velocity etc. were found to have a strong relationship with the blight pathogen and the disease.

### Results and Discussion:

The results revealed that the treatment T<sub>1</sub> (Prophylactic spray (just at the time of canopy closure) with mancozeb @0.25% followed by cymoxanil + mancozeb @0.3% & one more spray + mancozeb 0.25%.) was found in Kufri Bahar less disease percent incidence at harvest 24.73% along with higher tuber yield 36.91 t/ha and Kufri Pushkar less disease percent incidence at harvest 22.78% along with more tuber yield 38.18 t/ha followed by Mancozeb @0.25% followed by fluopicolide 62.5 + propamocarb hydrochloride 625 sc (0.3%) followed by one more spray with mancozeb 0.25%. Resulted in Kufri Bahar less disease percent incidence at harvest 29.42 along with more tuber yield 35.52 t/ha and Kufri Pushkar less disease percent incidence at harvest 22.78 % along with increase tuber yield 38.18 t/ha in pooled analysed data. These treatments performed better in both reducing disease incidence and increasing tuber yield. These treatments could be used for management of late blight without affecting economic yield and using chemical sprays. All used fungicides scheduling were also effective for reducing disease incidence against control. The applied of prophylactic spray (just at the time of canopy closure) with mancozeb @0.25% followed by cymoxanil + mancozeb @0.3% and one more spray with mancozeb 0.25%, with varieties of Kufri Bahar and Kufri Pushkar were more produced in gross income Rs. 2,74,896.00/ha and Rs 2,65,752.00/ha net income of Rs. 1,52,611.00/ha and Rs. 1,43,467.00/ha and benefit cost ratio of 1:1.24 and 1:1.17 with variety of Kufri



Bahar and Kufri Pushkar respectively. The gain assessment of net profit (Rs. 1,39,840.00/ha and Rs. 1,35,304.00/ha) over without application of fungicides in relations to Kufri Bahar and Kufri Pushkar variety of potato, respectively in pooled analysis. Many researchers have similar results noted by *Day et al., (2004)*, *Ajay and Sunaina (2005)*, *Singh et al. (2010)*, *Yao et al., (2016)* and *Yuan - Hang et al., (2014)* The systemic/translaminal/contact fungicides are known suppressor of the late blight disease and final application of combination of cymoxanil + mancozeb @0.3% and one more spray with mancozeb 0.25% low level of inoculum further suppressed the disease in our experimental fields. The results of the present study clearly demonstrated that all the treatments are able to provide control of late blight to some extent as against unsprayed control.

**Table-1: Pooled data of incidence % in different days stages of potato crop during 2018-19 and 2019-20.**

Treatments	Incidence (%) in different days							At harvest
	7 days	14 days	21 days	28 days	35 days	42 days	49 days	
V <sub>1</sub> F <sub>1</sub>	3.98	9.24	5.32	9.87	6.15	12.36	22.80	24.73
V <sub>1</sub> F <sub>2</sub>	5.79	12.88	7.06	11.25	7.43	18.34	27.29	29.42
V <sub>1</sub> F <sub>3</sub>	6.97	13.57	9.51	12.72	8.13	22.09	31.69	34.86
V <sub>1</sub> F <sub>4</sub>	9.79	18.29	24.29	33.26	42.18	57.87	63.75	64.39
V <sub>2</sub> F <sub>1</sub>	1.65	7.27	5.33	10.65	7.66	13.80	20.58	22.78
V <sub>2</sub> F <sub>2</sub>	4.01	8.67	7.45	11.98	9.00	13.13	25.56	27.33
V <sub>2</sub> F <sub>3</sub>	5.21	10.89	9.68	13.50	9.67	22.26	29.50	31.69
V <sub>2</sub> F <sub>4</sub>	8.22	15.90	25.37	34.79	42.07	58.60	64.09	64.99
CD@5%	<b>3.89</b>	<b>3.87</b>	<b>4.69</b>	<b>2.85</b>	<b>2.41</b>	<b>4.42</b>	<b>6.19</b>	<b>6.42</b>

**Table-2: Pooled data of yield and economics of potato crop during 2018-19 and 2019-20.**

Treatments	Yield (t/ha)	Cost of cultivation (Rs./ha)	Gross income (Rs./ha)	Net return (Rs./ha)	B:C
V <sub>1</sub> F <sub>1</sub>	36.91	122285.00	265752.00	143467.00	1:1.17
V <sub>1</sub> F <sub>2</sub>	35.32	122285.00	254304.00	132019.00	1:1.07
V <sub>1</sub> F <sub>3</sub>	32.59	122285.00	234648.00	112363.00	1:0.92
V <sub>1</sub> F <sub>4</sub>	17.21	120285.00	123912.00	3627.00	1:0.03
V <sub>2</sub> F <sub>1</sub>	38.18	122285.00	274896.00	152611.00	1:1.24
V <sub>2</sub> F <sub>2</sub>	35.70	122285.00	257040.00	134755.00	1:1.10
V <sub>2</sub> F <sub>3</sub>	33.79	122285.00	243288.00	121003.00	1:0.98
V <sub>2</sub> F <sub>4</sub>	19.11	120285.00	137592.00	17307.00	1:0.14
CD@5%	<b>4.14</b>	-	-	-	-

**Conclusion:**

Present finding revealed that the combination of prophylactic spray (just at the time of canopy closure) with mancozeb @0.25% followed by cymoxanil + mancozeb @0.3% and one more spray with mancozeb 0.25% with three sprays, first at before appearance of late blight, second at appearance and third after appearance could be adopted in both variety Kufri Bahar and Kufri Pushkar for



cultivation of potato. Moreover, treatment comprising spray of Mancozeb @0.25% followed by fluopicolide 62.5 + propamocarb hydrochloride 625 sc (0.3%) followed by one more spray with mancozeb 0.25%. before late blight appearance and one spray of Cymoxanil8+mancozeb 64% WP at appearance followed by final spray of with mancozeb @0.25% followed by azoxystrobin + tebuconazole (0.1%) followed by one spray with mancozeb 0.25% was highly effective for managing late blight of potato in used variety of Kufri Bahar and Kufri Pushkar, respectively. Thus, saving two sprays of fungicides and reducing related costs of fungicides and labour without compromising tuber yield of potato.

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