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Assessing the resistance of different varieties against black leg and soft rot of potato caused by *Pectobacterium carotovora* subsp. *carotovora*

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Abstract

Soft rot of potato tubers caused by *Pectobacterium carotovora* subsp. *carotovora* (Pcc) is a major threat to profitable potato production wherever the crop is grown. Among a total of 10 potato varieties screened against Pcc, seven varieties viz., Kufri Pukhraj, Kufri Khyati, Kufri Pushkar, Kufri Surya, Kufri Ganga, Kufri Lima and Kufri Neelima were found highly resistant lines against the pathogen, while three varieties were categorized as moderate resistant (Kufri Sindhuri, Kufri Nilkanth and Kufri Bahar).

Keywords: Potato, soft rot, *Pectobacterium carotovora* subsp. *carotovora*, potato varieties

Introduction

Potato (*Solanum tuberosum* L.) is an annual herbaceous, self-pollinated and one of the most important cultivated tuber crop belong to the family Solanaceae. *Solanum stenotomum* is considered as a probable ancestor of all cultivated potatoes (Reddy *et al.*, 2018). The importance of this food crop is understood by most of the developing countries specially in urban areas. In India, it is considered as a cash crop that provides excellent income to farmers. It is rich in carbohydrate and contains little fat. It is also rich in vitamin C, vitamin B and potassium, while Its skin provides substantial fiber. Lot of compounds in it also contributes to antioxidant activities. Freshly harvested potatoes contains water (75-80%), carbohydrates (16-20%), crude protein (2.5-3.2%), minerals (0.8-1.2%), fats (0.1-0.2%), fiber (0.6%) and some vitamins (Camire *et al.*, 2009).

Bacterial diseases pose a serious threat to potato cultivation. Soft rot and blackleg, primarily caused by *Pectobacterium carotovora* (formerly *Erwinia carotovora*), are responsible for significant losses both in the field and during storage. These pathogens cause seed tuber decay, poor plant emergence and post-harvest deterioration. Bacterial wilt, caused by *Ralstonia solanacearum*, is particularly destructive in tropical and subtropical regions due to its soil and tuber-borne nature (Hayward, 1991; Perombelon, 2002). Common scab, caused by *Streptomyces scabies*, affects tuber quality by producing corky lesions on the surface, thereby reducing market value (Loria *et al.*, 2006).

Soft rot is characterized by the breakdown of tuber tissues, which initially appear as small, water-soaked lesions around lenticels or stolon attachment points. Under low humidity, lesions become dark and sunken, whereas high humidity favors rapid enlargement and spread (Czajkowski *et al.*, 2015).

Blackleg and soft rot are caused by Gram-negative, facultatively anaerobic, rod-shaped bacteria with peritrichous flagella, belonging to genera *Pectobacterium* and *Dickeya*. *Pectobacterium carotovora* is a soil borne pathogen mainly survives in clay and heavy soil association with low calcium concentration. Bacteria get enter the seed potatoes through wounds and injuries (Olivieri *et al.*, 2004).

Therefore, the identification and screening of resistance potato varieties is a crucial step in any integrated disease management program. Varietal screening involves the evaluation of different varieties under artificial inoculation condition to determine their relative resistance

for susceptibility to black leg and soft rot disease. This process helps plant breeders and pathologists to identify promising lines that can be used directly in cultivation or as donors in breeding program. Moreover the knowledge gained from screening can assist in understanding the genetic basis of resistance, facilitating the development of improved cultivars through conventional and molecular breeding approaches. This ensures that newly released varieties retain effective resistance in the field. It also contributes to a sustainable crop protection strategy that minimizes dependence on fungicide and supports eco-friendly agriculture. Therefore, some potato cultivars commonly cultivated by farmers in Rajasthan were screened for resistance to tuber soft rot (Rashid *et al.*, 2013).

Materials and Methods

The field experiment was conducted at Horticulture Research Farm, of Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan. To know the resistance reaction of soft rot development in potato 10 varieties viz., Kufri Pukhraj, Kufri Khyati, Kufri Sindhuri, Kufri Pushkar, Kufri Surya, Kufri Ganga, Kufri Lima, Kufri Neelima, Kufri Nilkanth and Kufri Bahar were screened under artificial inoculation through pin prick methods. Pcc was isolated from potato tubers expressing soft rot symptoms using the semi-selective medium technique as described by Bdliya and Langerfeld (2005) which was used throughout the experiments.

The evaluation was based on the incidence of tuber soft rot. Disease incidence (DI) was determined by counting the number of infected potato tuber expressed as a percentage of the total number of tubers observed. The severity of tuber soft rot was assessed on a scale of 0-5 as described by Bdliya and Langerfeld (2005) where:

0-no symptom of rot

1-1-15% of tuber rotten

2-16-30% of tuber rotten

3-31-45% of tuber rotten

4-46-60% of tuber rotten

5 $\geq$ 61% of tuber rotten.

Table 1: Scale for Disease Resistance (%) described by Bdliya and Langerfeld (2005)

Resistance level rating	Disease percentage
Highly resistant	0-15.9
Moderately resistant	16-30.9
Moderately susceptible	31-45.9
Highly susceptible	$\geq$ 46

Results and Discussion

Per cent disease incidence-The observation in the *Rabi* season 2022-23 data presented in Table-2 revealed that minimum PDI (3.53%) was recorded in variety Kufri Surya followed by Kufri Neelima variety was recorded 4.76 percent PDI. Kufri Ganga, Kufri Pushkar, Kufri Lima, Kufri Pukhraj, Kufri Khyati, Kufri Bahar and Kufri Sindhuri were recorded 7.32, 11.14, 8.79, 11.55, 12.97, 14.67 and 15.38 percent PDI respectively. Highest PDI 20.76 percent was recorded in Kufri Nilkanth.

Similarly, in the *Rabi* season 2023-24 data presented in Table-2 revealed that minimum PDI (3.45%) was recorded in variety Kufri Surya followed by Kufri Neelima variety was recorded 6.90 percent PDI. Kufri Ganga, Kufri Pushkar, Kufri Lima, Kufri Pukhraj, Kufri Khyati, Kufri Bahar and

Kufri Sindhuri were recorded 5.83, 7.16, 7.15, 8.52, 9.88, 11.40 and 13.45 percent PDI respectively. Maximum PDI 17.38 percent was recorded in Kufri Nilkanth.

Pooled data presented in Table-2 revealed that minimum PDI (3.49%) was recorded in variety Kufri Surya followed by Kufri Neelima variety was recorded 5.83 percent PDI. Kufri Ganga, Kufri Pushkar, Kufri Lima, Kufri Pukhraj, Kufri Khyati, Kufri Bahar and Kufri Sindhuri were recorded 6.57, 9.15, 7.97, 10.03, 11.43, 13.03 and 14.42 percent PDI respectively. Maximum PDI 19.07 percent was recorded in Kufri Nilkanth.

Per cent tuber rot incidence: The observation on percent tuber rot incidence presented in Table-2 revealed that minimum percent tuber rot incidence (11.78%) was recorded in variety Kufri Surya followed by Kufri Neelima variety was recorded 12.50 percent tuber rot incidence. Kufri Ganga, Kufri Lima, Kufri Pushkar, Kufri Pukhraj, Kufri Khyati, Kufri Sindhuri and Kufri Nilkanth were recorded 14.64, 15.66, 16.71, 17.32, 18.18, 19.23 and 19.33 percent tuber rot incidence, respectively. Maximum percent tuber rot incidence (23.90%) was recorded in Kufri Bahar.

Similarly, in the *Rabi* season 2023-24 data presented in Table-2 revealed that minimum percent tuber rot incidence (8.91%) was recorded in variety Kufri Surya followed by Kufri Neelima variety was recorded 9.20 percent tuber rot incidence. Kufri Ganga, Kufri Lima, Kufri Pushkar, Kufri Pukhraj, Kufri Khyati, Kufri Bahar and Kufri Sindhuri were recorded 10.75, 11.65, 12.28, 12.55, 13.30, 13.92 and 14.04 percent tuber rot incidence, respectively. Maximum percent tuber rot incidence (16.08%) was recorded in Kufri Nilkanth.

Pooled data presented in Table-2 revealed that minimum percent tuber rot incidence (11.06%) was recorded in variety Kufri Surya followed by Kufri Neelima variety was recorded 11.14 percent tuber rot incidence. Kufri Ganga, Kufri Pushkar, Kufri Pukhraj, Kufri Khyati, Kufri Bahar and Kufri Sindhuri were recorded 12.69, 14.50, 14.59, 15.74, 16.31 and 16.61 percent tuber rot incidence, respectively. Maximum percent tuber rot incidence (19.36%) was recorded in Kufri Nilkanth.

Evaluation of potato varieties against the black leg and soft rot of potato

Host resistance is a most effective, easy, eco and environmental friendly approach of disease management. To find out the source of resistance against Pcc, a total of 10 potato varieties were screened under artificially inoculation conditions for consecutive two crop seasons, *Rabi* 2022-23 and 2023-24. The disease incidence of each test line was recorded as per the standard rating scale of 0-5 as described by Bdliya and Langerfeld (2005).

The two years pooled data presented in Table-2 reveals that among a total of 10 potato varieties screened against Pcc, seven varieties viz., Kufri Pukhraj, Kufri Khyati, Kufri Pushkar, Kufri Surya, Kufri Ganga, Kufri Lima, and Kufri Neelima were found highly resistant lines against the pathogen, while three varieties were categorized as moderate resistant (Kufri Sindhuri, Kufri Nilkanth and Kufri Bahar). Our findings are parallel to the results of various workers Tripathi and Verma (1975) reported that Kufri Deva a potato var. resistant to *Erwinia carotovora* pv. *carotovora* contains a higher phenol contents and poly phenol oxidase activity in the pool and the tuber than the

susceptible. C-1769 chlorogenic acid and caffeic acid are present in higher quantities in Kufri Dewa and the oxidation products of these may be important in resistance to the bacterium. Somani *et al.* (1988) found that there was progressive increase in soft rot incidence in tuber of cultivar (K. Chandramukhi) harvested from January to March and kept for storage. Wounded cork formation in the tuber cannot be taken at the criterion of resistance. Wright *et al.* (2005) assessed ten potato cultivars for resistance to bacterial soft rot caused by *Erwinia carotovora* pv. *atroseptica* and black spot bruising as tuber specific gravity increased. The severity of bacterial soft rot decreased and the severity of the bruising increased. Abraham *et al.* (2020)

assessed Five potato tuber varieties (Patista, Marabel, Christian Lady, Nicola and Caruso) were screened for resistance to soft rot in Dadin-Kowa of Gombe State, Nigeria. Artificially wounded and inoculated potato tubers of each variety were incubated under the anaerobic condition for 3 days and dump condition for 15 and 30 days. The results showed that all the potato varieties expressed a similar trend of response to tuber soft rot irrespective of incubation conditions and durations. Caruso and Marabel expressed high and moderate resistance respectively while Christian Lady and Nicola were highly susceptible to soft rot

Table 2: Screening of potato varieties for percent disease incidence and percent tuber rot incidence of black leg and soft rot of potato

S. No.	Variety Name	Percent disease incidence		Pooled	Percent tuber rot incidence		Pooled	Response
		2022-23	2023-24		2022-23	2023-24		
T ₁	Kufri Pukhraj	11.55 (19.87)	8.52 (16.90)	10.03 (18.38)	17.32 (24.59)	12.55 (20.71)	14.59 (22.36)	HR
T ₂	Kufri Khyati	12.97 (21.07)	9.88 (18.08)	11.43 (19.58)	18.18 (25.23)	13.30 (21.38)	15.74 (23.30)	HR
T ₃	Kufri Sindhuri	15.38 (22.99)	13.45 (21.46)	14.42 (22.22)	19.23 (25.99)	14.04 (21.97)	16.61 (23.97)	MR
T ₄	Kufri Pushkar	11.14 (19.49)	7.16 (15.52)	9.15 (17.51)	16.71 (24.12)	12.28 (20.47)	14.50 (22.30)	HR
T ₅	Kufri Surya	3.53 (10.83)	3.45 (10.70)	3.49 (10.77)	11.78 (20.06)	8.91 (17.31)	11.06 (19.41)	HR
T ₆	Kufri Ganga	7.32 (15.70)	5.83 (13.81)	6.57 (14.75)	14.64 (22.49)	10.75 (19.12)	12.69 (20.81)	HR
T ₇	Kufri Lima	8.79 (17.15)	7.15 (15.51)	7.97 (16.33)	15.66 (23.30)	11.65 (19.91)	13.65 (21.60)	HR
T ₈	Kufri Neelima	4.76 (12.43)	6.90 (15.23)	5.83 (13.87)	12.50 (20.67)	9.20 (17.65)	11.14 (19.44)	HR
T ₉	Kufri Nilkanth	20.76 (27.10)	17.38 (24.59)	19.07 (25.84)	23.90 (29.17)	16.08 (23.64)	19.36 (25.90)	MR
T ₁₀	Kufri Bahar	14.67 (22.47)	11.40 (19.73)	13.03 (21.10)	19.33 (26.08)	13.92 (21.86)	16.31 (23.72)	MR
S Em±		1.15	1.22	1.05	1.26	0.72	0.78	
CD at 5%		3.41	3.62	3.17	3.73	2.14	2.25	
CV (%)		17.94	24.11	19.93	12.85	10.19	13.16	

*Mean of three replications,

Figure in parentheses√arcsine percent angular transformed values. HR = Highly resistant, MR = Moderate resistant

Conclusion

It was concluded from this study that the ten potato varieties screened showed varying responses to tuber soft rot. Among a total of 10 potato varieties screened against Pcc, seven varieties viz., Kufri Pukhraj, Kufri Khayati, Kufri Pushkar, Kufri Surya, Kufri Ganga, Kufri Lima and Kufri Neelima were found highly resistant lines against the pathogen, while three varieties were categorized as moderate resistant (Kufri Sindhuri, Kufri Nilkanth and Kufri Bahar).

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Competing Interests

Authors have declared that no competing interests exist.

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