

KUFRI RATAN: A NEW RED SKIN POTATO VARIETY

SK Luthra^{1*}, Dalamu², Babita Chaudhary¹, VK Gupta¹, Vinod Kumar³, Sanjay Rawal¹,
Pooja Mankar¹, Mehi Lal¹, Jagdev Sharma³ and Brajesh Singh³

ABSTRACT: Kufri Ratan is a medium-maturing, high-yielding table potato variety recommended for cultivation in the North Indian plains and plateau regions during the main growing season. It is a clonal selection derived from a cross between CP3391 and Kufri Sutlej. The plants are medium-tall and vigorous, exhibiting field resistance to late blight. This variety produces aesthetically appealing red coloured, ovoid tubers with shallow to medium eyes, yellow flesh, and a mealy texture. It contains approximately 18% tuber dry matter content and demonstrates excellent storage quality. Kufri Ratan is responsive to crop nutrition and is capable of yielding 36–38 t/ha in the North Indian plains and 20–22 t/ha in plateau regions.

KEYWORDS: Kufri Ratan, potato, red skin, high yield, late blight resistance, keeping quality, North Indian plains, plateau regions.

INTRODUCTION

In India, consumers, particularly in the eastern regions of the country, including eastern Uttar Pradesh, Bihar, Jharkhand, West Bengal, and Orissa, as well as in Jammu & Kashmir, exhibit a preference for red-skinned potatoes. In Bihar, red-skinned potatoes are favored over white-skinned varieties due to culinary practices that utilize potato varieties suitable for “bhujia” (fried sabzi) preparation (Yadav *et al.*, 2024). The preference for red-skinned potatoes is expanding to other regions, driven by increased awareness and the influence of the migrant population from eastern states who favor red-skinned tubers. Market supply chain dynamics are also prompting potato growers in various regions to cultivate red-skinned varieties. Farmers in Kannauj (UP) are cultivating red-skinned potatoes to meet the demand of local markets and neighboring countries such as Nepal. Similarly, in the district of Bareilly (UP), the

local cultivar Bareilly Red is highly favored among consumers in this area due to its dark red tubers with variegated flesh colour and waxy texture (Luthra *et al.*, 2023). Some local potato varieties with purple-black or purple skin, although possessing low yield potential, are cultivated and consumed in several pockets of the North-Western hills and the North-Eastern region. These locally adapted varieties remain popular due to their slow rate of degeneration and unique taste appreciated by the local population (Luthra *et al.*, 2015). As consumers become increasingly health-conscious and aware of the superior nutritional value of food, coloured potatoes are likely to be preferred due to their higher antioxidant potential (Luthra *et al.*, 2018). ICAR- Central Potato Research Institute (CPRI) has developed ten indigenous varieties with red skin and white or white-cream flesh colour, as well as two purple-skinned varieties: Kufri Neelkanth with yellow flesh

*Corresponding author; email: skluthra@hotmail.com

¹ICAR-Central Potato Research Institute, Regional Station, Modipuram, Meerut - 250110, Uttar Pradesh, India

²ICAR-Central Potato Research Institute, Kufri-Fagu Unit, Shimla -171012, Himachal Pradesh, India

³ICAR-Central Potato Research Institute, Shimla - 171 001, Himachal Pradesh, India

colour (Luthra *et al.*, 2020b) and Kufri Jamunia with purple skin tubers and purple flesh (Luthra *et al.*, 2025). Breeders are persistently working to create enhanced genotypes in this area to satisfy the increasing needs of potato farmers and consumers. This work has led to the development of a new high-yielding, late blight-resistant potato variety named Kufri Ratan, which produces red ovoid tubers with shallow-medium eyes and yellow flesh. This variety possesses excellent keeping quality and taste with a mealy texture, providing farmers with new opportunities for higher profits and offering consumers a wider array of choices in their food basket.

BACKGROUND

Advanced clone MS/14-1381 released as a table purpose potato variety, Kufri Ratan was bred and selected at Modipuram (Uttar Pradesh), a regional station of ICAR-Central Potato Research Institute, Shimla (Himachal Pradesh), following breeding protocols (Luthra *et al.*, 2020a). The clone was derived from a cross between CP3391 × Kufri Sutlej made in the year 2012 at Kufri (Himachal Pradesh). Female parent CP3391 is an exotic variety Cardinal produces pink ovoid tubers with shallow eyes and cream flesh colour. Male parent Kufri Sutlej is a medium maturing indigenous variety released in 1996 for the North Indian plains. The male parent produces white-cream ovoid tubers with shallow eyes and cream flesh and is moderately resistant to late blight. The pedigree of Kufri Ratan is described in Fig.1. The clone was in the seedling stage (2013-14), five-hill plots (2014-15), 30 hill plots (2015-16) and multiple row trials (2016-17). It was evaluated in one preliminary (2017-18) and two confirmatory yield trials (2018-19 and 2019-20) at Modipuram. Advanced clone MS/14-1381 was introduced in the All India Coordinated Research Project on Potato (AICRP on Potato) in 2019 for multi-location evaluation across the country.

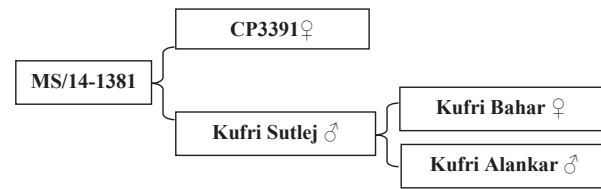


Fig.1. Pedigree of Kufri Ratan

The advanced clone MS/14-1381 was evaluated in multi-location replicated trials under AICRP on Potato during 2021-22, 2022-23 and 2023-24 in North Indian plains (17 locations) comprising northern, central and eastern plains and in plateau regions (3 locations). It showed wider adaptability and higher yield than the controls. The data was analyzed following standard statistical procedures using the online statistical software OPSTAT, CCS HAU, Hisar, Haryana (Sheoran *et al.*, 1998). Based on its performance, the clone was recommended for release as table purpose potato variety by the 42nd AICRP (Potato) Group Meeting, 22-24 September 2024, ANDUAT, Kumarganj, Ayodhya for the North Indian plains and Plateau regions. Advanced clone MS/14-1381 has been released and notified as variety in the name of Kufri Ratan in the 32nd meeting held on 04.04.2025 by the Central Sub-Committee on Crop Standards Notification and Release of Varieties for Horticultural Crops, Ministry of Agriculture, Department of Agriculture and Co-operation, Government of India, New Delhi vide F.No. No. 3-77/2025-SD-IV dated 15th April, 2025..

VARIETAL DESCRIPTION

Plants: Morphological characteristics of the variety Kufri Ratan (leaf, flower, tuber and sprouts) have been depicted in Figure 2.

Plant: Medium, plant canopy compact, stem medium thick, predominantly green, secondary stem colour red brown throughout lightly scattered, wings poorly developed and straight.

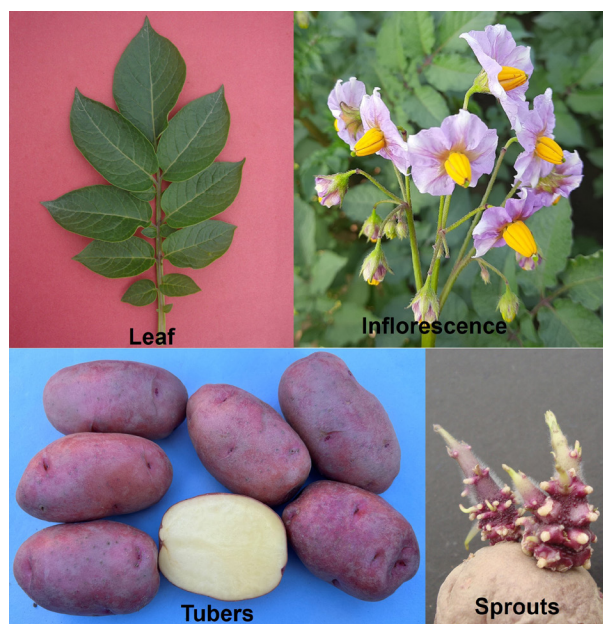


Fig. 2. Morphological characteristics of Kufri Ratan: Leaf, flower, tuber and sprouts

Foliage: Grey green, leaves intermediate, leaf width medium, leaflets lanceolate, leaflet coalescence absent, rachis coloured, midrib green.

Inflorescence

Flowering: Flowering profuse, inflorescence medium, floral stalk weakly coloured, floral

stalk-pedicle articulation clearly visible and located above the middle, calyx light red brown, corolla blue violet, corolla shape semi-stellate, anther orange, anther cone normally developed, stylar length longer than stamen column and stigma round and uni-lobed.

Tubers

Size: Medium to large, 8-10 tubers per plant; **Shape:** Ovoid; **Skin:** Smooth and red; **Eyes:** shallow-medium, predominantly apical; **Eyebrows:** Normal; **Flesh:** yellow with mealy texture.

Sprout

Red purple, conical, pubescence at sprout base is weak, sprout tip closed, length of apical sprout is medium (2-5 cm).

YIELD PERFORMANCE

Station trials

In station trials at Modipuram during 2017-18, 2018-19 and 2019-2020, advanced clone MS/14-1381 (36.94 t/ha) yielded 20 and 23 % higher total tuber yield over the control varieties Kufri Lalima (30.81 t/ha) and Kufri Lalit (29.93 t/ha) at 75 days (Table

Table 1. Yield Performance of advanced clone MS/14-1381at Modipuram during 2017-2020

Genotypes	Total tuber yield (t/ha)								Yield increase (%) over controls	
	2017-18		2018-19		2019-20		Mean		75 days	90 days
	75 days*	90 days	75 days	90 days	75 days	90 days	75 days	90 days		
MS/14-1381	40.20	49.69	35.73	46.31	34.87	41.53	36.94	45.84		
Kufri Lalima	35.00	37.83	28.57	37.71	28.89	34.25	30.81	36.60	19.88	25.27
Kufri Lalit	35.10	40.85	26.23	39.39	28.51	37.95	29.93	39.40	23.42	16.36
CD (0.05)	1.38	2.17	1.61	1.67	2.26	1.96				
	Marketable tuber yield (t/ha)									
MS/14-1381	37.60	46.46	32.95	43.23	31.56	39.96	34.04	43.22		
Kufri Lalima	32.21	35.67	26.02	35.52	25.63	32.15	27.95	34.45	21.76	25.46
Kufri Lalit	33.00	38.91	24.36	37.25	25.32	36.03	27.56	37.40	23.50	15.56
CD (0.05)	1.76	2.54	1.75	2.06	3.01	1.9				

*Days after planting

1). The MS/14-1381 produced nearly 92% marketable tuber yield, which was at par with Kufri Lalima and Kufri Lalit. The advanced Clone MS/14-1381 (45.84 t/ha) yielded 25 and 16 % higher total tuber yield over Kufri Lalima (36.60 t/ha) and Kufri Lalit (39.40 t/ha) at 90 days. The MS/14-1381 produced nearly 94% marketable tuber yield, which was at par with both Kufri Lalima and Kufri Lalit.

Multi-location evaluation under AICRP (Potato)

The replicated yield trials with controls were conducted at 75 & 90 days during 2021-22, 2022-23 and 2023-24 in North Indian plains (17 locations, Table 2) comprising northern, central and eastern plains during *rabi* season and three locations in plateau regions (Table 3, 4, 5, 6, 7) during *rabi/kharif* season.

Table 2. Yield performance of advanced clone MS/14-1381 in AICRP (Potato) replicated yield trials (pooled over 2021-22, 2022-23 & 2023-24) at 75 and 90 days (t/ha)

Regions	Locations	75 days					90 days				
		MS/14-1381	Kufri Manik	Kufri Lohit	Kufri Lalit	Kufri Lalima	MS/14-1381	Kufri Manik	Kufri Lohit	Kufri Lalit	Kufri Lalima
Northern plains	Hisar	28.99	30.26	30.15	29.64	29.03	32.64	34.34	34.69	35.06	32.86
	Jalandhar	36.48	34.75	39.39	36.05	32.59	47.55	42.74	50.74	46.73	40.06
	Modipuram	31.22	28.77	32.64	29.51	28.77	41.43	33.82	40.51	35.17	34.34
	Pantnagar	47.05	36.64	41.14	37.23	36.92	50.90	41.18	44.15	42.09	40.45
	Mean	35.93	32.60	35.83	33.11	31.83	43.13	38.02	42.52	39.76	36.93
	% Yield ±		10.21	0.29	8.53	12.90		13.45	1.43	8.47	16.79
Central plains	Chhindwara	31.49	25.72	30.57	34.45	33.24	35.08	28.97	34.81	37.90	37.92
	Deesa	42.00	35.60	41.30	37.10	35.17	56.14	42.19	51.43	47.11	41.17
	Gwalior	44.06	40.82	38.18	40.23	35.47	52.02	45.89	43.16	43.16	40.08
	Kanpur	33.76	20.95	34.99	30.01	27.90	46.07	27.73	39.31	36.08	32.93
	Kota	35.16	27.00	26.67	28.70	30.72	43.41	31.89	32.39	36.17	40.60
	Raipur	34.10	28.17	38.70	26.19	33.05	40.00	31.11	41.39	30.74	37.19
	Mean	36.76	29.71	35.07	32.78	32.59	45.45	34.63	40.41	38.53	38.32
	% Yield ±		23.73	4.83	12.14	12.79		31.25	12.47	17.97	18.62
Eastern plains	Ayodhya	34.08	30.60	33.13	34.84	25.51	37.36	32.61	35.68	37.75	31.05
	Bhubaneswar	20.30	14.42	21.56	22.71	20.02	23.77	16.48	25.28	23.04	22.57
	Dholi	27.44	17.00	26.36	17.46	18.26	36.38	18.87	29.34	19.95	21.71
	Jorhat	19.20	16.42	16.89	16.49	19.25	18.79	18.73	19.01	16.94	18.01
	Kalyani	31.37	24.00	28.22	27.53	26.87	34.56	27.03	32.41	30.31	30.32
	Patna	28.41	26.18	31.42	31.70	26.27	37.74	29.63	38.83	35.06	31.57
	Pasighat	17.71	13.81	17.89	15.50	17.09	22.58	16.83	25.76	18.75	21.67
	Mean	25.50	20.35	25.07	23.75	21.90	30.17	22.88	29.47	25.97	25.27
	% Yield ±		25.34	1.73	7.38	16.46		31.84	2.36	16.17	19.38
	Overall	Mean	31.93	26.54	31.13	29.14	28.01	38.61	30.59	36.40	33.65
% Yield ±		20.33	2.57	9.58	14.00		26.23	6.07	14.75	18.38	
CD (0.05)	Genotype: 0.48; Location × Genotype:1.94					Genotype:0.52; Location × Genotype:2.09					

Performance in North Indian Plains

75 days: Advanced clone MS/14-1381 (35.93 t/ha) yielded 10, 9 and 13% higher total tuber yield over Kufri Manik (32.60 t/ha), Kufri Lalit (33.11 t/ha) and Kufri Lalima (31.83 t/ha) in northern plains (4 locations: Hisar, Jalandhar, Modipuram and Pantnagar). The performance of MS/14-1381 (36.76 t/ha) was 24, 5, 12 and 13% superior to Kufri Manik (29.71 t/ha), Kufri Lohit (35.07 t/ha), Kufri Lalit (32.78 t/ha) and Kufri Lalima (32.59 t/ha) in central plains (5 locations, Chhindwara, Deesa, Gwalior, Kanpur, Kota and Raipur). However, in eastern plains (7 locations: Ayodhya, Bhubaneshwar, Dholi, Jorhat, Kalyani, Patna and Pasighat), MS/14-1381 (25.50 t/ha) out yielded the control Kufri Manik (20.35 t/ha), Kufri Lohit (25.07 t/ha), Kufri Lalit (23.75 t/ha) and Kufri Lalima (21.90 t/ha) by margin of 25, 2, 7 and 16% respectively (Table 2).

90 days: Advanced clone MS/14-1381 (43.13 t/ha) yielded 13, 1, 8, and 17% higher total tuber yield over Kufri Manik (38.02 t/ha), Kufri Lohit (42.52 t/ha), Kufri Lalit (39.76 t/ha) and Kufri Lalima (36.93 t/ha) in northern plains (4 locations: Hisar, Jalandhar, Modipuram and Pantnagar). The performance of MS/14-1381 (45.45 t/ha) was 31, 12, 18 and 19% superior to Kufri Manik (34.63 t/ha), Kufri Lohit (40.41 t/ha), Kufri Lalit (38.53 t/ha) and Kufri Lalima (38.32 t/ha) in central plains (5 locations: Chhindwara, Deesa, Gwalior, Kanpur, Kota and Raipur). However, in eastern plains (7 locations: Ayodhya, Bhubaneshwar, Dholi, Jorhat, Kalyani, Patna and Pasighat), MS/14-1381 (30.17 t/ha) out yielded the control Kufri Manik (22.88 t/ha), Kufri Lohit (29.47 t/ha), Kufri Lalit (25.97 t/ha) and Kufri Lalima (25.27 t/ha) by margin of 32, 2, 16 and 19% respectively (Table 2).

Overall performance in North Indian Plains: At 75 days, MS/14-1381 (31.93 t/ha) produced 20, 3, 10, and 14% higher total tuber yield over Kufri Manik (26.54 t/ha), Kufri Lohit (31.13),

Kufri Lalit (29.14 t/ha) and Kufri Lalima (28.01 t/ha). The advanced clone produced nearly 91% marketable tuber yield, which was at par with Kufri Manik, Kufri Lalima (90%), Kufri Lohit (91%), and Kufri Lalit (92%). However, at 90 days, MS/14-1381 (38.61 t/ha) produced 26, 6, 15, and 18% higher total tuber yield over Kufri Manik (30.59 t/ha), Kufri Lohit (36.40), Kufri Lalit (33.65 t/ha) and Kufri Lalima (32.62 t/ha). The advanced clone produced nearly 93% marketable tuber yield, which was at par with Kufri Manik, Kufri Lohit (93%), and Kufri Lalit and Kufri Lalima (92%).

Performance in Plateau regions

The MS/14-1381 was evaluated at Pune (*Rabi/Kharif* season) and Dharwad and Hassan (*Kharif* season).

Pune (*Rabi* season): At 75 days, MS/14-1381 (20.29 t/ha) showed 16 and 22% total tuber yield increase over Kufri Lohit (17.13 t/ha) and Kufri Lalit (16.67 t/ha), respectively. However, at 90 days, MS/14-1381 (22.69 t/ha) exhibited a 19% higher total tuber yield over Kufri Lohit (19.05 t/ha) and Kufri Lalit (19.07 t/ha). The tuber dry matter content in MS/14-1381 was 19% at 75 days and 20% at 90 days (Table 3).

Pune (*Kharif* season): At 75 days, MS/14-1381 (19.38 t/ha) exhibited 12 and 13% superiority in total tuber yield over the control Kufri Lohit (17.26 t/ha) and Kufri Lalit (17.10 t/ha). However, at 90 days, MS/14-1381 (21.61 t/ha) showed 14 and 10% total tuber yield superiority over the control Kufri Lohit (19.02 t/ha) and Kufri Lalit (19.61 t/ha), respectively. The tuber dry matter content in MS/14-1381 was 19% at 75 days and 20% at 90 days (Table 4).

Dharwad (*Kharif* Season): At 75 days, MS/14-1381 (15.19 t/ha) exhibited 26, 13, and 8% total tuber yield superiority over Kufri Lohit (12.05 t/ha), Kufri Lalit (13.47 t/ha) and Kufri Lalima (14.13 t/ha), respectively. However, at 90 days, MS/14-1381 (17.21 t/ha) exhibited 21,

10 and 8% total tuber yield superiority over Kufri Lohit (14.26 t/ha), Kufri Lalit (15.60 t/ha) and Kufri Lalima (15.92 t/ha), respectively. The tuber dry matter content in MS/14-1381 was 19% at 75 days and 90 days (Table 5).

Hassan (Kharif Season): At 75 days, MS/14-1381 (19.12 t/ha) exhibited 16, 24 and 12% higher total tuber yield compared to Kufri Lohit (16.52 t/ha), Kufri Lalit (14.44 t/ha) and Kufri Lalima (17.01 t/ha), respectively. However, at 90 days, MS/14-1381 (24.10 t/ha) exhibited 11, 28 and 14% total tuber yield superiority over Kufri Lohit (21.63 t/

ha), Kufri Lalit (18.81 t/ha) and Kufri Lalima (21.10 t/ha), respectively. The tuber dry matter content in MS/14-1381 was 18% at 75 days and 19% at 90 days (Table 6).

Overall performance of MS/14-1381 in plateau regions over Rabi/Kharif seasons: At 75 days, MS/14-1381 (18.50 t/ha) recorded 18 and 20% higher total tuber yield than Kufri Lohit (15.74 t/ha) and Kufri Lalit (15.42 t/ha), respectively. However, at 90 days, MS/14-1381 (21.40 t/ha) exhibited 16 and 17% total tuber yield superiority over Kufri Lohit (18.49 t/ha) and Kufri Lalit (18.27 t/ha), respectively. The tuber

Table 3. Performance of MS/14-1381 in AICRP replicated yield trials at Pune (Rabi Season, Mean of 2021-22, 2022-23 and 2023-24)

Genotypes	75 days			90 days		
	Tuber yield (t/ha)		Dry matter (%)	Tuber yield (t/ha)		Dry matter (%)
	Total	Marketable		Total	Marketable	
MS/14-1381	20.29	19.52	18.66	22.69	21.58	19.93
Kufri Lohit	17.13	16.00	18.38	19.05	17.54	19.26
Kufri Lalit*	16.67	15.38	17.03	19.07	17.25	18.58
CD (0.05)	0.19	0.19	0.12	0.27	0.24	0.13

*Kufri Pukhraj in place of Kufri Lalit (2021-22)

Table 4. Performance of MS/14-1381 in AICRP replicated yield trials at Pune (Kharif Season, Mean of 2021-22, 2022-23 and 2023-24)

Genotypes	75 days			90 days		
	Tuber yield (t/ha)		Dry matter (%)	Tuber yield (t/ha)		Dry matter (%)
	Total	Marketable		Total	Marketable	
MS/14-1381	19.38	18.60	18.98	21.61	20.50	20.41
Kufri Lohit *	17.26	16.21	18.43	19.02	17.63	19.77
Kufri Lalit**	17.10	15.68	17.24	19.61	17.62	19.09
CD (0.05):	0.15	0.14	0.07	0.20	0.17	0.13

*Kufri Neelkanth in place of K Lohit (2022-23), **Kufri Pukhraj in place of Kufri Lalit (2021-22 & 2022-23)

Table 5. Performance of MS/14-1381 in AICRP replicated yield trials at Dharwad (Kharif Season, Mean of 2022-23 and 2023-24)

Genotypes	75 days			90 days		
	Tuber yield (t/ha)		Dry matter (%)	Tuber yield (t/ha)		Dry matter (%)
	Total	Marketable		Total	Marketable	
MS/14-1381	15.19	12.82	18.84	17.21	14.65	19.15
Kufri Lohit	12.05	10.05	17.77	14.26	12.00	18.89
Kufri Lalit	13.47	11.68	19.89	15.60	13.16	20.81
Kufri Lalima	14.13	12.16	17.82	15.92	13.79	19.38
CD (0.05)	1.64	1.39	0.97	1.19	1.18	1.10

dry matter content was 19% at 75 days and 20% at 90 days in the plateau regions (Table 7).

Evaluation of MS/14-1381 under natural farming production system at Modipuram:

The trial was conducted during 2021-22, 2022-23 and 2023-24 on a plot fixed for a natural farming system and nutrition equivalent to inorganic doses of 180-80-100 N-P₂O₅-K₂O kg/ha was applied through FYM, Green manuring, vermi-compost and bio-fertilizers. The selection parameters under the natural farming system were yield, tuber shape, size, skin colour, texture etc. MS/14-1381 (27.6 t/ha) showed 23 and 33% superiority for total tuber yield (Table 8) over Kufri Lohit (22.4

t/ha) and Kufri Jamunia (20.8 t/ha). MS/14-1381 produced 78% marketable tuber yield than Kufri Lohit (79%) and Kufri Jamunia (74%) under the natural farming system. The tuber dry matter (21%) was toward the high side in MS/14-1381 as compared to Kufri Lohit (20%) and Kufri Jamunia (18%).

Evaluation of MS/14-1381 for export oriented production at Modipuram:

The trial for export oriented production was conducted during 2021-22, 2022-23 and 2023-24 by applying nutrition through inorganic doses of 180-80-100 N-P₂O₅-K₂O kg/ha. The selection parameters included tuber shape (oblong, round), Size (>40 mm), tuber dry matter

Table 6. Performance of MS/14-1381 in AICRP replicated yield trials at Hassan (Kharif, Mean of 2021-22, 2022-23 and 2023-24)

Genotypes	75 days			90 days		
	Tuber yield (t/ha)		Dry matter (%)	Tuber yield (t/ha)		Dry matter (%)
	Total	Marketable		Total	Marketable	
MS/14-1381	19.12	16.49	17.69	24.10	21.21	19.18
Kufri Lohit	16.52	13.91	18.49	21.63	19.06	20.11
Kufri Lalit	14.44	11.82	20.95	18.81	15.93	21.61
Kufri Lalima*	17.01	13.74	18.09	21.10	18.23	19.14
CD (0.05)	2.23	2.10	0.75	2.52	2.38	0.72

*Kufri Manik in place of Kufri Lalima (2021-22)

Table 7. Overall performance of MS/14-381 in plateau regions* at 75 and 90 days

Genotypes	75 days			90 days		
	Tuber yield (t/ha)		Dry matter (%)	Tuber yield (t/ha)		Dry matter (%)
	Total	Marketable		Total	Marketable	
MS/14-1381	18.50	16.85	18.54	21.40	19.49	19.67
Kufri Lohit	15.74 (18%)	14.04 (20%)	18.27	18.49 (16%)	16.56 (18%)	19.51
Kufri Lalit	15.42 (20%)	13.64 (24%)	18.78	18.27 (17%)	15.99 (22%)	20.02

Value in parenthesis-yield enhancement over respective control; *Means of Pune (Rabi & Kharif), Dharwad and Hassan (Kharif)

Table 8. Evaluation of MS/14-1381 under natural farming production system at Modipuram.

Genotypes	Tuber yield (t/ha)		Yield increase (%)		Tuber dry matter (%)	Tuber dry matter yield (t/ha)
	Marketable	Total	Marketable	Total		
MS/14-1381	21.5	27.6			20.7	5.71
Kufri. Lohit	17.8	22.4	20.79	23.21	19.8	4.44
Kufri Jamunia	15.4	20.8	39.61	32.69	18.4	3.81
CD (0.05)	2.65	3.54			1.56	0.83

(>18%), cosmetic value skin colour, shine, texture etc). MS/14-1381 (36.9 t/ha) showed 6 and 19% superiority for exportable tuber yield (Table 9) as compared to Kufri Lohit (34.6 t/ha) and Kufri Jamunia (31.0 t/ha). MS/14-1381 produced a 90% marketable tuber yield than Kufri Lohit (85%) and Kufri Jamunia (84%). MS/14-1381 possessed 19% tuber dry matter as compared to Kufri Lohit (18%) and Kufri Jamunia (19%).

Tuber dry matter content

Advanced clone MS/14-1381 possessed comparable mean tuber dry matter content of 17% and 18% at 75 and 90 days crop duration, respectively in comparison to controls Kufri Manik (17 and 18%), Kufri Lohit (17 and 18%), Kufri Lalit (18 and 19%) and Kufri Lalima (19 and 21%) in multi-location AICRP (Potato) trials during 2021-22, 2022-23 and 2023-24 (Table 10).

Table 9. Evaluation of MS/14-1381 for export oriented production at Modipuram

Genotypes	Tuber yield (t/ha)		Yield increase (%)		Tuber dry matter (%)	Tuber dry matter yield (t/ha)
	Exportable	Total	Exportable	Total		
MS/14-1381	36.9	41.0			18.7	7.67
Kufri Lohit	34.9	41.0	5.73	0.00	17.8	7.28
Kufri Jamunia	31.0	37.0	19.03	10.81	18.7	6.89
CD (0.05)	4.02	3.8			1.36	0.68

Table 10. Tuber dry matter (%) content in AICRP trials (Mean of 2021-22, 2022-23 and 2023-24) at 75 days and 90 days

Regions	Locations	MS/14-1381	Kufri Manik	Kufri Lohit	Kufri Lalit	Kufri Lalima	MS/14-1381	Kufri Manik	Kufri Lohit	Kufri Lalit	Kufri Lalima
Northern plains	Hisar	17.48	16.93	15.55	16.49	17.81	18.43	17.89	16.60	17.48	18.71
	Jalandhar	14.08	15.16	14.63	16.42	17.58	14.79	15.54	15.31	17.46	18.99
	Modipuram	13.50	15.54	13.71	15.26	16.92	14.44	16.11	14.39	17.82	19.12
	Mean	15.02	15.88	14.63	16.06	17.44	15.89	16.51	15.43	17.59	18.94
Central plains	Chhindwara	17.43	18.28	18.63	18.03	18.33	18.30	18.98	18.86	18.84	33.38
	Deesa	16.48	17.63	17.28	17.64	19.08	17.76	18.74	18.37	18.68	21.57
	Gwalior	15.34	15.12	15.76	16.74	20.04	16.72	16.28	16.95	18.41	19.80
	Kanpur	14.66	14.99	14.42	15.31	15.66	18.03	16.46	15.78	17.18	17.58
	Kota	18.46	17.60	18.21	18.71	18.33	19.53	18.70	18.86	19.65	20.09
	Raipur	18.70	19.13	18.79	17.81	18.84	20.11	19.94	20.35	19.43	19.88
	Mean	16.84	17.12	17.18	17.37	18.38	18.41	18.18	18.19	18.70	22.05
	Eastern plains	Ayodhya	17.59	17.56	17.65	17.41	17.51	18.55	18.26	18.41	18.37
Bhubaneswar	17.74	18.58	18.22	17.56	18.98	18.59	19.34	18.66	18.61	19.62	
Dholi	18.02	17.95	16.59	18.63	20.66	18.51	18.48	17.43	19.53	21.38	
Jorhat	22.32	22.36	22.43	22.33	22.39	22.22	22.44	22.25	22.26	21.90	
Kalyani	18.51	16.55	15.14	17.79	18.52	19.28	17.80	17.89	19.73	19.61	
Patna	14.00	14.89	14.56	14.89	16.28	15.83	16.06	16.39	16.06	17.17	
Pasighat	16.64	18.00	20.18	20.20	20.54	18.65	19.85	20.25	23.91	22.94	
Mean	18.03	17.98	17.43	18.10	19.06	18.83	18.73	18.50	19.09	19.67	
Overall	Mean	16.93	17.27	16.98	17.57	18.59	18.11	18.18	17.92	18.96	20.63
CD(0.05)	Genotype:0.14; Location × Genotype:0.53						Genotype:1.12; Location × Genotype:1.94				

Keeping quality

Advanced clone MS/14-1381 adjudged to be of very good keeper as it exhibited medium tuber dormancy (6-8 weeks), comparatively less total weight loss (<10%), rottage, sprout weight and firm tuber appearance after 75 days of on-farm storage in station trials (Table 11). In AICRP (Potato) trials (Table 12), the advanced clone showed lower total weight loss (18.25%) along with Kufri Lalima (17.57%) which was lower than other controls Kufri Manik (23.93%), Kufri Lalit (20.71%) and Kufri Lohit (20.40%). Medium tuber dormancy (6-8 weeks) and very good keeping quality of the variety will help farmers to store produce under ambient conditions for up to two months to tide over glut situations in the market.

Nutritional quality: MS/14-1381 possessed medium anthocyanins (6.32 mg/100 G FW), low carotenoids (26.13 µg/100 g FW), medium ascorbic Acid (33.3 mg/100 g FW), high zinc (27.68 ppm) and medium iron (41.78 ppm) in tuber flesh

Usage

Kufri Ratan is suitable for table purpose with attractive red coloured ovoid tubers having shallow-medium eyes, which leads to less peeling losses in comparison to Kufri Lalima and Kufri Sindhuri as both have round shaped tubers with deep eyes and their peeling losses are high (Luthra *et al.*, 2006 and Kumar *et al.*, 2014). Tubers of this clone seldom exhibit external/internal defects

and are not susceptible to skin damage at harvest. The tubers are easy to cook (15-20 minutes) and cooked/boiled tubers are free from any kind of discolouration. The new variety possesses pleasant flavour, mealy texture and good organoleptic taste. Thus, the desirable tuber characters, very good keeping and culinary quality of this clone will favour its acceptance.

Disease resistance

Advanced clone MS/14-1381 has field resistance to late blight (AUDPC: 412) as compared to the red-skinned varieties like Kufri Lalima (AUDPC: 827), Kufri Lalit (754), Kufri Manik (1019) and Kufri Lohit (722)

Table 12. Keeping quality (Total weight loss %) of MS/14-1381 in AICRP Locations (Mean of 2021-22, 2022-23 and 2023-24; *one year, **2 year, *3 year)**

Locations	MS/14-1381	Kufri Manik	Kufri Lalit	Kufri Lohit	Kufri Lalima
Ayodhya***	14.47	15.27	14.53	14.50	15.03
Bhubaneshwar**	20.38	11.75	31.35	19.67	19.62
Deesa**	20.11	26.73	30.32	42.24	19.13
Dholi*	18.05	20.58	17.60	18.73	12.10
Hisar***	17.30	16.00	21.90	21.60	18.70
Kanpur**	33.00	17.70	28.75	29.60	21.10
Modipuram***	11.97	15.47	14.35	13.73	9.60
Pasighat***	17.86	16.05	15.51	13.01	15.80
Pune (Rabi)**	9.64	-	10.83	11.78	-
Raipur**	27.85	64.57	27.89	25.23	27.59
Dharwad **	16.24	35.00	30.13	27.07	18.38
Hassan**	20.37	13.09	14.79	18.82	16.18
Pune (Kharif)*	10.05	-	11.23	9.21	-
Mean	18.25	22.93	20.71	20.40	17.57

Table 11. Keeping quality of MS/14-1381 (Mean of 2017-18, 2018-19, 2019-20) at Modipuram

Genotypes	Dormancy (<or> than 6 weeks)	Sprouting (%)		Weight loss (%) after 75 days of storage				Tuber appearance at 75 days
		At 6 weeks	At 75 days	Rottage	Sprouting	Physiological	Total	
MS/14-1381	6-8 weeks	49.69	96.48	0.79	0.59	6.83	8.21	4.63
Kufri Lalima	>10 weeks	2.41	42.85	0.96	0.17	5.47	6.59	4.77
Kufri Lalit	>10 weeks	18.47	65.61	2.67	0.18	5.70	8.56	4.79

under field conditions. (Table 13). In AICRP (Potato) trials (Table 14), the variety showed comparatively less late blight infection (7%) as compared to Kufri Manik and Kufri Lalit (12%), Kufri Lohit (11%) and Kufri Lalima (22%).

Production technology

Crop management: The optimal total tuber yield of 36-38 t/ha can be achieved in the advanced clone MS/14-1381 by adhering to the recommended fertilizer doses and package of practices. In North Indian plains, the ideal planting period is from the second fortnight of October to the first fortnight of November, when the daily maximum temperature decreases to approximately 32°C. Conversely, in plateau regions, the planting period during the *rabi* season is from October

15th to November 5th, and during the *kharif* season, it occurs in June/July. For seed-sized tubers (40-60g), planting at a spacing of 20 cm within 60 cm rows yields optimal tuber production, with a seed rate of approximately 3.5-4.0 t/ha. Seed tubers should be removed from cold storage at least 10 days before planting. It is crucial to avoid exposing seed bags to direct sunlight to prevent rotting due to sudden temperature increases. Tubers should be spread in a thin layer under shade in diffused light to promote sprouting, allowing sprouts to reach a length of 0.5-1.0 cm, becoming thick and green. Transport sprouted tubers to the fields in seed trays or baskets to prevent sprout damage. At the trial site in Modipuram, Nitrogen, Phosphorus, and Potassium levels were 180, 80, and 100 kg/ha, respectively, for a 90-day crop duration of ware potatoes. For seed crops, it is recommended to apply 150 kg of nitrogen (N), 60 kg of phosphorus (P₂O₅), and 80 kg of potassium (K₂O) per hectare. Green manuring prior to potato cultivation is advantageous for crop nutrition. At planting, 10-15 t/ha of well-rotted farmyard manure (FYM) may be applied to enhance soil tilth and nutrition for the potato crop. These crop management practices can reduce nitrogen application by approximately one-third and phosphorus and potassium by half. Consequently, a half-adjusted dose of nitrogen and full-adjusted doses of P₂O₅ and K₂O should be applied at planting. The remaining half-adjusted dose of nitrogen should be administered 20-25 days post-planting, coinciding with inter-cultivation and earthing. Nutrient management may vary across different agro-ecological zones; therefore, regional recommendations should be refined and adopted to achieve optimal productivity of this clone. Pre-sowing irrigation is essential to ensure uniform emergence. In its absence, the first irrigation should occur 4-6 days after planting. Subsequent post-planting

Table 13. Late blight resistance at Modipuram (Mean of 2018-19, 2019-20, 2022-23 and 2023-24, **2 years, *3 years, ****4 years)**

Genotypes	Late blight screening under field conditions	
	AUDPC	rAUDPC
MS/14-1381****	411.61	0.21
Kufri Lalima***	826.67	0.37
Kufri Lalit***	753.60	0.40
Kufri Manik***	1019.05	0.47
Kufri Lohit **	722.00	0.29

Table 14. Late blight (%) in MS/14-1381 at AICRP locations at 90 days (Mean of 2021-22, 2022-23 and 2023-24; *one year, **2 year, *3 year)**

Locations	MS/14-1381	Kufri Manik	Kufri Lalit	Kufri Lohit	Kufri Lalima
Bhubaneswar*	6.00	15.00	10.00	18.00	20.00
Dholi**	2.50	0.00	9.00	0.00	9.00
Chhindwara*	2.20	-	3.20	2.20	3.40
Gwalior*	0.00	0.00	0.50	0.00	0.00
Kalyani***	14.28	15.10	16.73	15.85	16.70
Kanpur**	11.00	30.00	35.00	30.00	80.00
Kota**	6.50	12.50	6.50	-	-
Pune***	14.03	-	15.25	12.53	-
Mean	7.06	12.10	12.02	11.23	21.52

irrigations should be light and applied at 7-10 day intervals in sandy loam soil and 10-12 days in heavy soil. It is imperative to prevent potato ridges from submerging under water, and drainage systems should be established to manage unseasonal rains during the crop season (Rawal *et al.*, 2021).

Plant Protection Measures: For management of cutworms, white grubs, beetles and *leaf-eating* caterpillars, apply cartap hydrochloride 4G @20 kg/ha during earthing-up. It will also take care of sucking *pests* like leaf *hoppers* and aphids. For seed *crops*, place yellow sticky traps (15x30 cm² size) just above the canopy height @ 60 traps/ha at equidistance from each other for mass trapping of white flies/aphids. Seed treatment is done with imidacloprid (200SL) @ 0.04% (4 ml/10 l water) for 10 minutes before planting. The first spray of imidacloprid (200SL) @ 0.03% (3 ml/10 l water) is completed at 85% crop emergence followed by a second spray with thiamethoxam (25 WG) @ 0.05% (5 gm/10 l water) 10-15 days after the first spray. Although the variety is field resistant to late blight, however, prophylactic spray just at the time of canopy closure with mancozeb or propineb or chlorothalonil @ 0.2% (2 gm/l water) followed by *need-based* application of cymoxanil + mancozeb or dimethomorph + mancozeb or fenamidone + mancozeb @ 0.3% (3 gm/l water) is required for effective management of late blight. Insecticide sprays are not required in the case of table *crops* and integrated pest and disease management recommended by the institute should be followed (Rawal *et al.*, 2021).

Harvesting: Irrigation should be stopped 10-12 days before haulm killing and harvesting may be done 10-15 days after haulm cutting at proper soil moisture. After harvest, produce should be kept under shade in heaps covered with 30 cm thick available straw or crop residue for 10-15 days. Both of these measures

shall help in curing tuber skin. All damaged and rotten tubers are removed and graded to fetch better prices in the market. Potatoes are packed in 45-50 kg capacity gunny or leno bags and labeled either for selling in the market or storing in cold storage (Rawal *et al.*, 2021).

Adaptability

The newly developed red-skinned potato variety, Kufri Ratan, has demonstrated good performance in multi-location trials conducted under the All India Coordinated Research Project (AICRP) on Potato. Consequently, it has been recommended for cultivation in the North Indian plains (Haryana, Punjab, the plains of Uttarakhand, Uttar Pradesh, Madhya Pradesh, Rajasthan, Gujarat, Chhattisgarh, Odisha, Bihar, West Bengal, Assam, and Arunachal Pradesh) and the Plateau regions (Maharashtra (for both *Rabi* and *Kharif* crops) and Karnataka (for *Kharif* crops)). Kufri Ratan presents an advantageous option for farmers and consumers in areas where red-skinned potatoes are favoured. Furthermore, its export potential can be strategically leveraged in the future for markets such as Bangladesh, Bhutan, Nepal, Pakistan, and the Philippines, where there is a traditional preference for red-skinned tubers (Pandey *et al.*, 2000; Luthra *et al.*, 2004).

ACKNOWLEDGEMENT

We thank ICAR for financial and infrastructural support.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest

ETHICAL STATEMENT

This article does not contain any studies with human participants or animals performed by any of the authors

LITERATURE CITED

- Gomez KA and Gomez AA (1984) Statistical procedures for agricultural research. John Wiley and Sons, New York, 680p
- Kumar V, Luthra SK, Bhardwaj V and Singh BP (2014) Indian potato varieties and their salient features. *Technical Bulletin* No. 78 (Revised), ICAR-CPRI, Shimla, HP, 64p
- Luthra SK, Gupta VK, Chaudhary B, Rawal S and Lal M (2023). Kufri Lohit: A new red skin potato variety. *Potato J* 50 (1): 77-88
- Luthra SK, Gupta VK, Kumar R, Rawal S, Lal M, Kumar S, Dalamu, Tiwari JK, Raigond P, Kaundal B, Kumar V, Singh BP and Chakrabarti SK (2020b) Kufri Neelkanth: purple skin coloured specialty potato variety of India. *Potato Journal* 47(1): 1-8
- Luthra SK, Gupta VK, Srivastava AK, Gurjar MS and Singh BP (2015) Exploration of potato germplasm in Meghalaya. Newsletter No. 60, ICAR-CPRI, Shimla, HP, pp1-2
- Luthra SK, Gupta VK, Tiwari JK, Kumar V, Bhardwaj V, Sood S, Dalamu, Kaur RP, Kumar R, Vanishree G, Kumar D, Mhatre P and Chakrabarti SK (2020a) Potato breeding in India. *Technical Bulletin* No. 74 (Revised), ICAR-CPRI, Shimla, HP, 214p
- Luthra SK, Kumar V, Gupta VK, Buckseth T, Dalamu, Chaudhary B, Sood S, Mangal V, Singh RK and Singh B. 2025. Potato Varieties in Seed Chain "Revolutionising Potato Productivity in India". ICAR-Central Potato Research Institute, Shimla, Himachal Pradesh, India, 208p
- Luthra SK, Pande PC and Singh BP (2004) Perspective planning for developing potatoes for export. In: Processing & Export Potentials of Indian Potatoes (Eds. SM Paul Khurana, BP Singh, SK Luthra, NR Kumar, Devendra Kumar and Dinesh Kumar). *Proceedings of International Potato Conference & Fest-2004*, ICAR-CPRI Campus, Modipuram, Meerut, UP, India, Indian Potato Association, Shimla, pp18-27
- Luthra SK, Pandey SK, Singh BP, Kang GS, Singh SV and Pande PC (2006) Potato breeding in India. *Technical Bulletin* No. 74, ICAR-CPRI, Shimla, HP, 90p
- Luthra SK, Tiwari JK, Dalamu, Kaundal B, Raigond P, Sharma J, Singh B, Dua VK, Kumar V and Gupta VK (2018) Breeding for coloured flesh potatoes: molecular, agronomical and nutritional profiling. *Potato Journal* 45(2): 81-92
- Pandey SK, Shekhawat GS and Sarkar D (2000) Quality attributes of Indian potatoes for export: priorities and possibilities. *Potato Journal (Formerly J Indian Potato Assoc.)* 27:103-11
- Rawal S, Mankar P, Dua VK, Kumar D, Malik K, Luthra SK, Lal M, Singh S, Lekshmanan DK, Das B and Chakrabarti SK (2021) Good agricultural practices for the production of potato crop. E-book, ICAR-CPRI, Shimla, HP Website, 219p
- Sheoran OP, Tonk DS, Kaushik LS, Hasija RC and Pannu, RS (1998). Statistical Software Package for Agricultural Research Workers. In: Recent Advances in information theory, Statistics & Computer Applications (Eds. DS Hooda and RC Hasija), Department of Mathematics Statistics, CCS HAU, Hisar, pp139-143.
- Yadav S, Luthra SK, Singh RK and Singh SP (2024). Evaluation of red & purple skinned advance clones suitable for Eastern Indo-Gangetic plains of India, *Journal of advances in biology and biotechnology.* 27, 11(1): 23-32.

(MS Received : June 24, 2025; Accepted : October 30, 2025)