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Performance of Red Skin and Nutrient Rich Advanced Potato Clones under North-central Conditions of India

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ABSTRACT

The experiment was conducted at ICAR-CPRI-RS, Gwalior (M.P.) from 2022–2023 to 2024–2025 with three red skinned advanced clones namely MS/13-527, MS/14-1381 and MS/17-848 along with eight control varieties namely Kufri Lalit, Kufri Lohit, Kufri Lalima (red skin), Kufri Neelkanth and Kufri Jamunia (purple skin nutrient-rich), and Kufri Khyati, Kufri Pukhraj, and Kufri Mohan (white or yellow skin) for growth, tuber yield, tuber and haulm dry matter parameters under the Gwalior conditions of North-Central conditions of India in 3 replications of RBD. The emergence percentage among all genotypes exceeded 85%. Kufri Lalima (74.2 cm), Kufri Neelkanth (67.2) and MS/13-527 (78.7) exhibited significantly the highest plant height, stem count, and number of compound leaves per plant, respectively. The nutrient-rich clone MS/17-848 demonstrated comparable marketable yields (31.94 and 36.52 t ha^{-1}) and total tuber yields (34.35 and 38.86 t ha^{-1}) at 75 and 90 days, respectively, with nutrient-superior varieties Kufri Jamunia and Kufri Neelkanth. The red-skinned advanced clone MS/14-1381 and the control cultivar Kufri Lohit achieved significantly higher marketable and total tuber yields compared to other white-skinned and coloured control varieties. The Kufri Lalima (red skin) variety (19.45% and 20.27% at 75 and 90 days), followed by the Kufri Neelkanth (nutrient-rich) variety (18.99% and 20.87% at 75 and 90 days), recorded significantly high dry matter. Therefore, the red-skinned hybrid MS/14-1381 (now released as Kufri Ratan) and the Kufri Lohit cultivar were identified as the best performers under the North-Central conditions of India.

KEYWORDS: Coloured potatoes, red skin, nutrient-rich, tuber yield, dry matter

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Data Availability Statement: Legal restrictions are imposed on the public sharing of raw data. However, author have full right to transfer or share the data in raw form upon request subject to either meeting the conditions of the original consents and the original research study. Further, access of data needs to meet whether the user complies with the ethical and legal obligations as data controllers to allow for secondary use of the data outside of the original study.

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1. INTRODUCTION

The potato, recognized as a hidden treasure (Anonymous, 2008), serves as a significant source nutrients (Dalamu et al., 2017). It is particularly abundant in vitamin C and B vitamins such as B1, B3, and B6, as well as minerals and trace elements, while containing a low amount of fat. According to its nutritional profile, potatoes are a rich source of carbohydrates, proteins, vitamins (including vitamin C and B6), and minerals such as iron, zinc, and folate (Luthra et al., 2001; Burgos et al., 2007; Duroy et al., 2019), along with carotenoids, antioxidants, dietary fibers, and protein (Maria et al., 2017; Beal, 2019; Burgos et al., 2020). The breeder's task is to pick superior genotypes by eliminating undesirable ones as quickly and efficiently as possible, without losing the one in a million that may become a potential new variety (Luthra et al., 2025). Coloured potato varieties attract attention due to their enhanced nutrient-rich compounds, such as anthocyanins and carotenoids. The anthocyanin pigments impart an appealing skin or flesh colour to the potatoes. These pigments can be red, purple, pink, dark purple, blue, or reddish purple, among others. Carotenoids, on the other hand, provide color to the flesh of the potato. The flesh color can range from white, light yellow, dark yellow, red, pink, purple, to dark purple (Burgos et al., 2007). Red potatoes derive their skin color from the anthocyanin pigments found in the tuber periderm and peripheral cortex (Andersen et al., 2002; Brown, 2005; Lewis, 1996). The red and purple potato cultivars contain the highest levels of phenolic and anthocyanin compounds, which demonstrate greater antioxidant activity when compared to white potato cultivars (Hamouz, 2011). The antioxidant capacity of red or blue-colored potatoes is 2–3 times greater than that of potatoes with white or yellow flesh (Lachman and Hamouz, 2005). The color of potato tubers is a significant factor that affects consumer preferences. Traditionally, red-skinned potatoes have been in higher demand in Eastern India, and this trend is now also observed in the North Western and West Central plains. (Luthra et al., 2006; Kankar et al., 2022; Luthra and Kumar, 2024). Furthermore, these varieties are favored in neighboring countries such as Bangladesh, Bhutan, Nepal, Pakistan, and the Philippines (Pandey et al., 2000). In India, the West Central and Eastern plains account for approximately 75% of the country's red potato production. Two red-skinned potato varieties, Kufri Lalima and Kufri Sindhuri, were developed in the 1960s but did not continue to thrive due to susceptibility to late blight. However, there is now an increased market demand for red-skinned potatoes due to their nutritional benefits (Luthra et al., 2006). To date, nine red skin varieties have been developed by CPRI, namely Kufri Red, Kufri Sindhuri, Kufri Lalima, Kufri Kanchan, Kufri Arun, Kufri Lalit, Kufri Manik (which is rich in iron and zinc), Kufri Lohit, and Kufri Uday. The new variety, Kufri Neelkanth, which is rich in antioxidants, produces visually appealing purple ovoid tubers with yellow flesh (Luthra and Kumar, 2024; Yadav et al., 2024). Kufri Jamunia is the first purples skin/fleshed high-yielding, and nutritious table potato variety from India released in 2024, characterized by abundant antioxidants such as vitamin C, carotenoids. Considering the current market demand for red-skinned and nutritionally rich potatoes, it is essential to develop new high-yielding clones of red-skinned and nutrient-rich varieties, in addition to the existing red-skinned and nutritionally superior cultivars.

2. MATERIALS AND METHODS

The experiment was conducted in the experimental area of ICAR-CPRI-RS, located in Gwalior (M.P.), during the *rabi* seasons spanning from 2022–2023 to 2024–2025. The soil in the experimental field was classified as silt clay loam, exhibiting good drainage properties.

The materials used for this study included three red skin advanced clones namely MS/13-527, MS14-1381 and MS/17-848 along with eight varieties namely Kufri Lalit, Kufri Lohit, Kufri Lalima (red skin), Kufri Neelkanth and Kufri Jamunia (nutrient-rich) and Kufri Khyati, Kufri Pukhraj and Kufri Mohan (white or yellow skin or flesh). The experimental design was structured as a randomized block design with three replications for each treatment. Healthy, uniform, medium-sized tubers weighing 40-50 g were utilized at a planting rate of 35 q ha^{-1}, arranged in a spacing of 60×20 cm^2 within a plot size of 3×3 m^2. The standard recommended practices were adhered to in order to cultivate a healthy crop. Nitrogen, phosphorus, and potassium were supplied through ammonium sulfate and urea, single super phosphate, and muriate of potash, respectively. A consistent application of 180 kg N ha^{-1}, 80 kg P ha^{-1}, and 120 kg K ha^{-1} was administered across all plots. The haulm uprooting of the potato crop occurred at 75 DAP and 90 DAP, followed by tuber digging approximately 10–12 days post-haulm uprooting, executed manually using a spade. Various morphological and yield parameters were assessed throughout the experiment. Five randomly selected tubers of each genotype were used for the estimation of dry matter. Standard procedure was followed as described by Luthra et al. (2003; 2013). Chopped tuber pieces were mixed thoroughly, and a 100 g sample of each genotype in three replications was used for oven drying at 80°C for 72 h. Then the dry matter was estimated when the weight of the sample reached a constant level.

The percentages of dry matter and haulm dry weight were calculated using the prescribed formulas.

Tuber dry matter %=(Wt.of sliced potatoes after 72 hrs oven drying/Wt.of fresh harvest potatoes)×100

Haulm dry weight %=(Wt.of dried haulm after 72 hrs oven drying/Wt.of fresh haulm)×100

The analysis of variance was performed according to the methods proposed by Panse and Sukhatme (1967).

3. RESULTS AND DISCUSSION

3.1. Growth parameters

The emergence rate among advanced clones and control varieties exceeded 85%, ranging from 85.78% to 92.67%, with no significant differences observed among them. Gupta et al. (2003) noted that the mean maximum emergence percentage for cv. Kufri Lalima was 98.53%, while the minimum was recorded in Desiree at 81.33%. Variability was noted in plant height, the number of stems, and the number of compound leaves per plant among hybrids and controls. Specifically, Kufri Lalima (74.2 cm), K Neelkanth (67.2), and MS/13-527 (78.7) exhibited significantly higher plant height, stem number, and compound leaves per plant, respectively, compared to other clones and controls (Table 1). A significant difference was found between genotypes regarding mean plant height, with cv. Kufri Kanchan achieved the maximum height of 76.12 cm at 75 days after planting (DAP), whereas cv. Kufri Jyoti recorded the minimum height of 58.25 cm (Gupta et al., 2013). Among all treatments, the red potato variety Kufri Uday achieved the highest per cent emergence (100%), the number of compound leaves (10.05) at 45 DAP, and the number of stems per plant (3.16). The highest plant height was recorded in Kufri Manik, measuring 65.28 cm and 77.72 cm at 45 and 60 DAP, respectively (Meghna and Johari,

Table 1: Growth, yield and quality parameters in advanced potato clones and cultivars

Genotypes	Growth parameters				Tuber yield (t ha^{-1})				Quality parameters (%)			
	Emergence %	Plant height (cm)	No. of stems $plant^{-1}$	No. of compound leaves $plant^{-1}$	Total yield		Marketable yield		Tuber dry matter		Haulm dry weight	
					75 days	90 days	75 days	90 days	75 days	90 days	75 days	90 days
MS/17-848 (Red skin Nutrient- rich)	88.22	43.7	5.8	60.7	34.35	38.86	31.94	36.52	16.17	19.10	11.19	11.34
MS/13-527 (Red skin)	88.44	67.0	5.2	78.7	31.67	35.65	28.86	32.64	16.80	18.59	8.82	11.13
MS/14-1381 (Red skin) K. Ratan	87.11	61.2	5.0	65.3	42.31	51.76	39.91	48.48	15.37	17.86	8.63	10.55
K. Lohit (Red skin)	90.00	65.5	4.5	71.5	45.07	50.32	43.09	47.43	15.81	18.39	9.36	10.68
K. Lalit (Red skin)	88.89	63.8	4.7	54.0	34.02	37.35	32.16	35.44	17.57	19.20	9.58	10.75
K. Lalima (Red skin)	86.22	74.2	5.3	65.3	29.41	34.21	25.39	29.99	19.45	20.27	9.86	10.47
K. Neelkanth (Nutrient rich)	85.78	67.2	6.7	71.5	36.38	44.32	34.19	40.62	18.99	20.87	9.99	10.66
K. Jamunia (Nutrient- rich)	87.56	46.2	6.0	55.8	33.48	36.24	32.60	35.86	17.90	18.76	9.07	10.02
K. Mohan (White skin)	87.56	61.5	5.5	67.7	36.11	42.10	33.85	39.72	15.91	17.05	8.68	11.02
K. Khyati (White skin)	89.11	61.3	5.0	66.3	35.60	38.23	33.50	36.19	16.48	18.60	8.95	10.40
K. Pukhraj (yellow skin)	92.67	58.8	6.3	69.0	36.65	41.43	34.52	39.23	15.07	17.05	9.21	10.47
SEm±	1.83	2.0	0.5	3.5	0.89	0.95	0.90	0.87	0.45	0.41	0.30	0.39
CD (p=0.05)	NS	5.9	1.4	10.2	2.62	2.80	2.64	2.56	1.34	1.21	0.87	1.14

2025). Variability in emergence % at 30 DAP and in plant height, stem number, stem diameter, and compound leaves at 45 DAP was reported when five advanced clones and six cultivars were evaluated under red skin evaluation trials in the North Central region of India (Kankar et al., 2022). Similar variability was also reported by Gupta et al. (2013).

3.2. Yield parameters

The nutrient-rich advanced clone MS/17-848 hybrid exhibited at par marketable yields (31.94 and 36.52 t ha^{-1}) and total tuber yields (34.35 and 38.86 t ha^{-1}) at 75 and 90 days, respectively, when compared to the nutrient-superior varieties Kufri Jamunia and Kufri Neelkanth, as well as other white and red-skinned cultivars. The red-skinned advanced clone MS/14-1381 achieved significantly higher marketable yields (39.91 and 48.48 t ha^{-1}) and total tuber yields (42.31 and 51.76 t ha^{-1}) at 75 and 90 days, respectively, compared to the control cultivar. This is owing to the better growth parameters in these tested advanced clones. Kufri Lohit recorded marketable yields of 43.09 and 47.43 t ha^{-1} and total tuber yields of 45.07 and 50.32 t ha^{-1} at 75 and 90 days, respectively. This variety outperformed other white-skinned and coloured control varieties, as shown in Table 1 and Figure 1. At both 75 and 90 days, the red-skinned clone PS/17-09 reported the highest marketable tuber yield (29.56 t ha^{-1} at 75 days and 34.96 t ha^{-1} at 90 days) compared to most control varieties (Yadav et al., 2025). Among all potato hybrids, the red-skinned Kufri Uday achieved the highest tuber yield ha^{-1} (21.69 t), which was comparable to the varieties Kufri Mohan (19.87 t) and Kufri Pukhraj (19.59 t) as noted by Meghna and Johari in 2025. The clone PS/16-02 demonstrated superior yield performance (27.62 t ha^{-1}) relation to the best control K. Kesar (27.35 t ha^{-1}) during the 75-day crop duration, and at the 90-day crop duration, PS/16-02 (32.14 t ha^{-1}) performed comparably to Kufri Lohit (35.14 t ha^{-1}) under the eastern plain's conditions of India (Yadav et al., 2024). The clone MS/92-2105 (Kufri Arun) has been identified as suitable for cultivation in the eastern plains due to its desirable tuber characteristics, high yield potential, early maturity, and superior quality traits (Sharma et al., 2003). At 75 days post-planting, the red skin advanced clone MS/14-505 (43.11 t ha^{-1}) demonstrated significantly higher yields, which were statistically comparable to MS/14-1381 and Kufri Lalit. At 90 days after planting, advanced clone MS/14-505 (52.92 t ha^{-1}) also exhibited significantly higher yields, found to be statistically similar to MS/14-1381 and the controls Kufri Mohan, Kufri Khyati, and Kufri Pukhraj under the North Central conditions of India (Kankar et al, 2022). The total yields of 'Red LaSoda' and 'LaRouge' were significantly greater than those of B0984-1 and B1145-2, yet comparable to B1758-3 and B1758-4. The highest marketable tuber yields were recorded for 'Red LaSoda', 'LaRouge', and B1758-4 under Florida conditions (Chad et al, 2003). Gupta et al. (2013) reported that among the red-skinned cultivars/hybrids, cv. Kufri Lalima (135.55 q ha^{-1}) was significantly superior to Desiree (132.90 q ha^{-1}) and cv. Kufri Kanchan (77.05 q ha^{-1}) under the conditions of Meghalaya, India. This highlights the variability in yield patterns among hybrids and varieties.

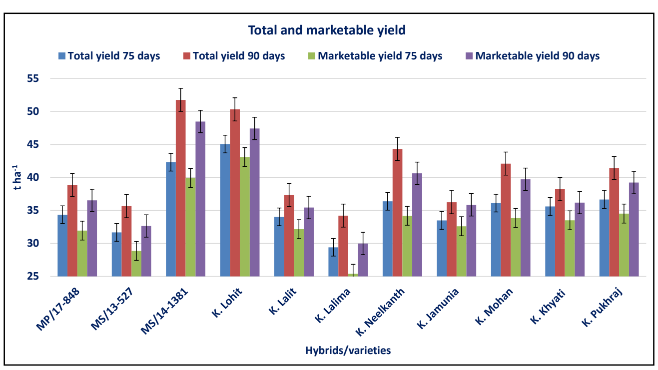

Figure 1: Total and marketable yield of different tested clones and controls at 75 and 90 days

3.3. Tuber dry matter and haulm dry weight (%)

Variability was noted in the tuber dry matter and haulm dry weight among various advanced clones and cultivars, with the Kufri Lalima (Red skin) cultivar exhibiting the highest values (19.45% and 20.27% at 75 and 90 days, respectively), followed closely by the Kufri Neelkanth (nutrient-rich) cultivar, which recorded 18.99% and 20.87%. These cultivars demonstrated significantly greater dry matter compared to other advanced clones and the control varieties. The haulm dry weight was found to be significantly highest in the nutrient-rich advanced clone MS/17-848, which recorded 11.19% and 11.34% for 75 and 90 days (Table 1). The clone PS/16-17 was superior in terms of dry matter content (20.42%), iron concentration (48.40 ppm), and vitamin C content (50.65 mg/100g fresh weight) when compared to control varieties (Yadav et al., 2024). The advanced clones PS/16-17 and PS/16-19 for the 75-day crop, as well as PS/16-02 and PS/16-17 for the 90-day crop, exhibited significantly higher dry matter levels compared to the control varieties (Yadav et al., 2025).

4. CONCLUSION

The comparative evaluation of advanced clones and eight control varieties highlighted clear genetic superiority among specific genotypes. The red-skinned advanced clone MS/14-1381 (now released as Kufri Ratan) outperformed recording significantly higher marketable and total tuber yields, on par with the elite control Kufri Lohit. Notably, Kufri Lalima and Kufri Neelkanth exhibited the highest tuber dry matter. Hence, MS/14-1381 (released as Kufri Ratan) and Kufri Lohit emerged as regionally adaptable and high-yielding promising cultivars suitable for the North-Central conditions of India.

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