



# Evaluation of Red Skinned Advance Potato (*Solanum tuberosum* L.) Clones for Tuber Yield and Yield Parameters in Eastern Indo-gangetic Plains of India

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## Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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## ABSTRACT

Potato is a very important tuber crop used as staple vegetable in almost every household. India ranks second in potato production after China. The production of potato increased significantly during last six decades. There is remarkable increase in potato yield and production during last decade 1.10 and 5.98% per annum respectively at national level (Rani & Prasoon, 2013). The important yield and yield attributing traits are plant emergence (%), number of tubers/plots, tuber yield/plot and tuber dry matter (%). The present experiment was conducted at experimental field of ICAR- Central Potato Research Institute Regional Station Patna, Bihar. In this experiment data were recorded for plant emergence (%), seed wt (t/ha), foliage senescence (%), total and

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marketable tuber yield (t/ha), dry matter content in percentage (tuber), late blight (%), leaf spot disease (%) during 75- and 90-days crop. The trial was conducted in randomized block design with three replications to evaluate nine advance clones namely MS/11-664, MS/13-527, MS/14-1381, MSP/16-307, MSP/16-375, PS/11-47, PS/13-45, CP-4409 and Memphis along with seven potato varieties Kufri Khyati, Kufri Lalima, Kufri Lalit, Kufri Manik, Kufri Mohan, Kufri Pukhraj and K Neelkanth as controls during 2020-21 & 2021-22. The advance clones PS/13-45 (36.97t/ha), PS/11-47 (35.87t/ha), MS/11-664 (35.39t/ha) were good candidates for future new potato varieties in Eastern Indo Gangetic plains of India.

**Keywords:** Potato, advance clones; tuber yield; dry matter content; Potato varieties.

## 1. INTRODUCTION

Potato (*Solanum tuberosum* L.) is an important tuberous vegetable crop ranked fourth worldwide after maize, wheat and rice. The global annual production is about 371.14 million metric tonnes with an area of about 17.3 million hectares of land. The average productivity is about 20.9 tons/ha at world level [1]. It is grown for family food security and income generation. It is cultivated all over India, during rabi season in northern states and during kharif season in most of the southern states. India ranked second after China, shares 13.08% (48.56 million tonnes) of world production [1]. The main challenges causing this low potato productivity include small and fragmented land holdings, poor linkage of potato producers and markets, poor financial condition of farmers, post-harvest losses and limited supply of quality seeds, pest and disease incidence, limited number of improved, high yielding potato varieties [2-4]. The potato varieties Kufri Jyoti, Kufri Pukhraj, Kufri Arun, and Kufri Sindhuri were developed based on that time; nowadays nutritionally superior potato varieties are in demand. As food fortification is the prime objective of the government and potato processing industries require the potato varieties with high dry matter content, low reducing sugar content, good tuber colour & shape and shallow eyes [5]. Potato tubers provide raw materials to industries producing chips, crisps, starch, spirits and alcohol [6]. The enhancement in potato

production will depend on the availability of new adopted varieties resistant or tolerance to major viral diseases with high nutritional status. As red skinned are preferred over white skinned varieties in eastern Indo-Gangetic plains, these advance potato clones are able to meet the needs of the region. The present study was aimed at identifying the potential of advance clones for their yield performance and adoptability under Eastern Indo-Gangetic plains of India.

Potatoes can provide more nutritious food per unit of land and time, even when planted under unfavourable conditions, compared to other staple crops like maize, wheat, and rice." It is highly efficient crop, converts natural resources into a high-quality food, with high yield and with good response to agricultural inputs [7]. Potatoes are very rich in various nutrients such as carbohydrate, amino acid, vitamins, minerals, anti-oxidant, dietary fibers, and protein [8,9]. It is consumed in different ways such as boiled, roasted, French fries, chips and ready to eat foods. It is important source of food for many low-income people in both urban and rural areas [10]. It is fat free vegetable with no cholesterol [11,12]. Potato bears high value in terms of production favours adoption by farmers and dissemination by governmental agriculture agencies. In eastern Indo-Gangetic plains, potato is an important crop grown for family food security and income generation.



**Photo 1. Planting of initial clonal generation**



**Photo 2. Potato crop planted on ridges**



**Photo 3. Selection of the advance clones**

## 2. MATERIALS AND METHODS

Potato is a cool season crop. It performs best in cool seasons with sufficient moisture and fertile soil. A well-prepared field is required for conducting a successful experiment. It performs well if soil temperature range is between 17-19°C because this temperature favours the tuber development. Potato can be grown on a wide range of soils from sandy loam, silt loam and clayey soils. A well-drained field is required for conducting the experiment as well for growing of the crop. The soil pH range from 5.0-6.5 are suitable for potato crop cultivation [13].

### 2.1 Planting Materials

The material in this study were 9 advance clones of potato namely MS/11-664, MS/13-527, MS/14-1381, MSP/16-307, MSP/16-375, PS/11-47, PS/13-45, CP-4409 and Memphis along and seven control potato varieties Kufri Khyati, Kufri Lalima, Kufri Lalit, Kufri Manik, Kufri Mohan, Kufri Pukhraj and K Neelkanth.

### 2.2 Location of Experiment

The experiment was conducted at experimental field of ICAR-CRPI RS Patna during the year 2020-21 & 2021-22. The advance clones were planted as per the approved technical programme of All India Coordinated Research Project on Potato from November 10-15, 2020-21 & November 8-12, 2021-22 during *Rabi* season. The cropping season starts from November and ends during last week of February with the harvesting of the crop.

### 2.3 Experimental Design

The design of the experiment was Randomized Block Design with three replications in two sets i.e. experiment harvested with 75 days after planting and 90 days after planting. All advance clones along with check varieties were planted in 5 rows of 12 tubers (3.0 m x 2.4 m) with the area 7.8 m<sup>2</sup>.

### 2.4 Field Preparation

A well-prepared field is required for good stand of the potato crop. Field is prepared by deep ploughing (20-25 cm deep) with soil turning plough, after that 2-3 cross harrowing followed by 2-3 shallow ploughed followed by leveling is required for good tuberization of the potato crop. Planking also plays an important role for leveling of the field and retention of the available moisture in the field, which plays important role at the time of sowing [13].

### 2.5 Seed Size, Seed Rate and Spacing

Tubers with 30 to 50 g weight are most suitable for conducting the experiment. In this experiment, whole tubers of above-mentioned size were planted on the ridges. The plant-to-plant distance 20 cm and row to row distance was 60 cm. After planting of the crop, light irrigation was given in the field provided in order to get even germination of the tubers.

### 2.6 Manure and Fertilizers

Potato crop is a heavy feeder crop, it requires high doses of fertilizers i.e. 180:60:80 (N: P: K). Along with these fertilizers 22-25 tones/ha well decomposed farmyard manure was applied for getting better tuber yield. At the time of land preparation half doses of Nitrogen with full dose of Potassium & Phosphorous were applied as basal. A good potato crop yields about 35 to 40 tonnes tubers per hectare [13].

### 2.7 Method of Planting

The ridges were made after land preparation with the help of tractor driven ridge-maker. Bed cutting as per layout of the experiment was done (3m x 60cm x 5 lines). The planting of potato tubers were done with the help of *khurpi* at the depth of 7-8 cm and after that tubers were covered with soil. Light irrigation just after planting was given to get the even germination of experimental material.

### 2.8 Inter Culture Operations

After planting of the crop, weedicide Oxflurofen 23.5% SC (500 ml/ha) was sprayed at pre-emergence stage. All inter culture operations like weeding, earthing up etc. were done manually as per requirement of the crop. After hoeing remaining half dose of Nitrogen in the form of urea was applied in side of the furrows and then earthing up was done in order to get better tuberization in the crop. In potato crop 4-5 irrigations at an interval of 15 days were given, the interval may vary as per requirement. Late blight of potato is very serious disease in this crop and the control can be done by one prophylactic spray of Mancozeb 75WP followed by 2 sprays of Cymoxanil 8% + Mancozeb 64% WP at an interval of 15 days. For control of aphids and pest such as potato leaf cutters, cutworms etc Imidacloprid 17.8% SL was sprayed in 45 days crop.



**Planting of potato on ridges**



**Healthy experimental crop**



**Earthing up in the crop**



**Recording of observations**



**Selected red-skinned potato clone**



**Harvesting of tubers**

**Photos 4-9. Important agronomical practices in potato crop**

### 3. DATA COLLECTION AND RECORDING OF OBSERVATIONS

The important observations were recorded for plant emergence (%), foliage maturity (%), total tuber yield (t/ha), marketable tuber yield (t/ha), dry matter (%) and disease reaction (%) were recorded at different physiological stages of the crop. The primary observations before planting of the crop were counting of tuber numbers required per plot were done. Then seed wt. per plot (in kg) was calculated at planting. Plant emergence (%) at 30 days after planting by

counting of total number of tubers germinated per plot, incidence of major viral diseases were recorded time to time as per their appearance in the field.. Foliage senescence data was recorded from 60 days after planting to 90 days after planting at interval of 10 days. At the time of harvesting of the crop tuber rottage (kg) per plot was recorded. Total & marketable tuber yield (kg/plot) with marketable tuber yield consisting big, medium and small tubers & tuber dry matter (%) were estimated within a week after harvesting in both 75 & 90 days duration crops.

#### Formulas:

1. Plant emergence (%) =  $\frac{\text{No. of germinated plants per plot}}{\text{Total no. of plants planted per plot}} \times 100$
2. Seed wt. (t/ha) =  $\frac{\text{Wt. of seed tubers per plot (kg)}}{\text{Plot size (m}^2\text{)}} \times \frac{10000}{1000}$
3. Foliage senescence (%) =  $\frac{\text{No. of plants with 75\% foliage maturity per plot}}{\text{Total no. of plants per plot}} \times 100$
4. Total tuber yield (t/ha) =  $\frac{\text{Total wt. (kg) of all sized tubers per plot}}{\text{Plot size (m}^2\text{)}} \times \frac{10000}{1000}$
5. Marketable tuber yield (t/ha) =  $\frac{\text{Total wt. (kg) of large, medium small sized tubers per plot}}{\text{Plot size (m}^2\text{)}} \times \frac{10000}{1000}$
6. Tuber dry matter (%) =  $\frac{\text{Wt. of sliced potatoes after 72 hrs oven drying}}{\text{Wt. of fresh harvest potatoes}} \times 100$

**Table 1. Plant emergence (%), seed wt. (t/ha), total & marketable tuber yield (t/ha) & tuber dry matter (%) in 75 days crop (pooled data 2020-21 & 2021-22)**

Hybrid/ Variety	Emergence (%)	Seed wt.(t/ha)	Foliage senescence (%)	Yield (t/ha)		Dry matter (%)
				Total	Mkt.	Tuber
CP-4409	97.78	3.98	30.00	32.45	22.09	15.40
Memphis	95.55	4.03	51.67	27.39	21.24	11.40
MS/11-664	95.56	4.07	58.33	30.47	22.55	14.95
MS/13-527	96.67	4.03	16.67	30.20	23.26	14.25
MS/14-1381	98.33	4.12	20.22	24.49	21.92	13.50
MSP/16-307	78.89	3.83	25.33	21.92	18.55	14.83
MSP/16-375	73.89	3.93	20.67	16.55	14.53	11.67
PS/11-47	94.45	4.00	16.67	34.78	29.88	16.07
PS/13-45	97.22	3.68	50.33	36.19	33.02	15.67
K Khyati	96.95	3.99	31.67	35.00	28.28	14.59
K Lalima	96.67	4.12	41.67	26.00	25.49	16.90
K Lalit	97.23	3.99	51.67	27.20	21.28	15.79
K Manik	96.00	3.96	35.00	27.25	25.53	13.73
K Mohan	96.95	4.00	31.67	27.33	21.43	13.00
K Pukhraj	97.78	4.14	51.67	32.99	27.62	15.24
K Neelkanth	96.11	3.87	35.33	25.60	21.45	17.17
SEd	1.78	0.16	2.34	1.68	1.29	0.48
CD (0.05)	4.28	NS	4.92	3.49	2.68	1.00
CV (%)	2.30	4.79	7.58	7.03	6.58	3.96

Foliage maturity was recorded at 60 days after planting and continues up to 90 days after planting. The data on this parameter was recorded at an interval of 10 days. To determine the marketable yield, very small tubers were sorted out from the total tuber yield. The marketable tuber yield consists of Big ( $\geq 80g$ ) medium (79-50g) and small (49-25g) tubers.

### 3.1 Data Interpretation and Analysis

Data recorded and collected from the experiment on various aspects such as plant emergence, foliage maturity, total tuber yield, marketable tuber yield, tuber dry matter, haulm dry matter, disease reaction etc. The recorded data were analyzed by using OPSTAT (HAU, Hissar, 2022).

## 4. RESULTS AND DISCUSSION

The performance of studied advance clones are shown in the Table 3.

### 4.1 Plant Emergence

The plant emergence ranged from 98.33 to 73.89. Highest emergence was observed in the advance clone MS/14-1381 (98.33) followed by CP-4409 (97.78). The plant emergence is positively correlated with the yield performance of the advance clone. (Tables 1, 2 and Fig.1).

### 4.2 Yield Performance

Among the tested advanced potato clones, the highest yield was recorded in PS/13-45 (36.19 t/ha) and it is significantly superior to the planted control varieties followed by the advance clone PS/11-47 (34.78 t/ha) which was at par with controls. Also both these advance clones showed significantly superior marketable tuber yield over controls (Tables 1, 2 and Figs. 2,3).

**Table 2. Plant emergence (%), seed wt. (t/ha), total & marketable tuber yield (t/ha) & tuber dry matter (%) in 90 days crop (pooled data 2020-21 & 2021-22)**

Hybrid/ Variety	Emergence (%)	Seed wt.(t/ha)	Foliage senescence (%)	Yield (t/ha)		Dry matter (%)
				Total	Mkt.	Tuber
CP-4409	96.67	4.13	88.33	34.91	23.86	16.93
Memphis	91.67	3.99	86.67	28.10	25.31	16.77

Hybrid/ Variety	Emergence (%)	Seed wt.(t/ha)	Foliage senescence (%)	Yield (t/ha)		Dry matter (%)
				Total	Mkt.	Tuber
MS/11-664	96.39	4.00	90.00	35.39	27.75	18.04
MS/13-527	95.06	4.05	90.00	31.21	24.20	17.10
MS/14-1381	98.33	4.29	80.67	34.17	30.78	18.50
MSP/16-307	77.22	4.08	83.33	26.72	20.43	18.33
MSP/16-375	71.11	4.22	88.33	18.73	17.28	15.17
PS/11-47	97.22	4.05	83.33	35.87	31.10	19.69
PS/13-45	95.00	4.12	90.67	36.97	33.47	19.17
K Khyati	97.22	3.81	83.33	35.15	30.06	15.94
K Lalima	96.95	4.05	85.00	28.76	28.90	18.84
K Lalit	97.78	4.02	93.33	32.77	27.33	18.04
K Manik	94.84	3.80	87.33	30.67	27.46	16.60
K Mohan	95.28	3.99	93.33	40.90	34.02	16.47
K Pukhraj	97.78	4.03	88.33	32.86	29.70	17.37
K Neelkanth	96.67	4.21	90.00	29.54	24.20	20.67
SEd	49.78	0.18	2.77	2.08	1.20	0.78
CD (0.05)	5.95	-	5.82	4.35	2.50	1.30
CV (%)	3.21	5.38	3.86	7.97	5.44	5.50

**Table 3. Range of various parameters**

Parameters	Range			
	75 DAP		90 DAP	
Plant Emergence (%)	73.89 - 98.33		71.11 - 98.33	
	Highest -	MS/14-1381 (98.33)	Highest -	MS/14-1381 (98.33)
	Lowest -	MSP/16-375 (73.89)	Lowest -	MSP/16-375 (71.11)
Seed wt.(t/ha)	3.68 - 4.14		3.8 - 4.29	
	Highest -	MS/14-1381 (4.12)	Highest -	MS/14-1381 (4.29)
	Lowest -	PS/13-45 (3.68)	Lowest -	Memphis (3.99)
Foliage senescence (%)	16.67 - 58.33		80.67 - 93.33	
	Highest -	MS/11-664 (58.33)	Highest -	PS/13-45 (90.67)
	Lowest -	PS/11-47 (16.67)	Lowest -	MS/14-1381 (80.67)
Total tuber yield (t/ha)	16.55 - 36.19		18.73 - 40.9	
	Highest -	PS/13-45 (36.19)	Highest -	PS/13-45 (36.97)
	Lowest -	MSP/16-375 (16.55)	Lowest -	MSP/16-375 (18.73)
Market tuber yield (t/ha)	14.53 - 33.02		17.28 - 34.02	
	Highest -	PS/13-45 (33.02)	Highest -	PS/13-45 (33.47)
	Lowest -	MSP/16-375 (14.53)	Lowest -	MSP/16-375 (17.28)
Tuber dry matter (%)	11.4 - 17.17		15.17 - 20.67	
	Highest -	PS/11-47 (16.07)	Highest -	PS/11-47 (19.69)
	Lowest -	Memphis (11.4)	Lowest -	MSP/16-375 (15.17)

• DAP- Days after planting

### 4.3 Dry Matter Content

The highest dry matter was observed in the advance clone PS/11-47 (16.07 %), followed by the clone PS/13-45 (15.67 %) which are at par to

the control varieties. The dry matter is positively correlated with the processing qualities of the tubers. High dry matter content is desirable for the processing industries associated in making chips, French fries etc. (Tables 1, 2 and Fig. 4).

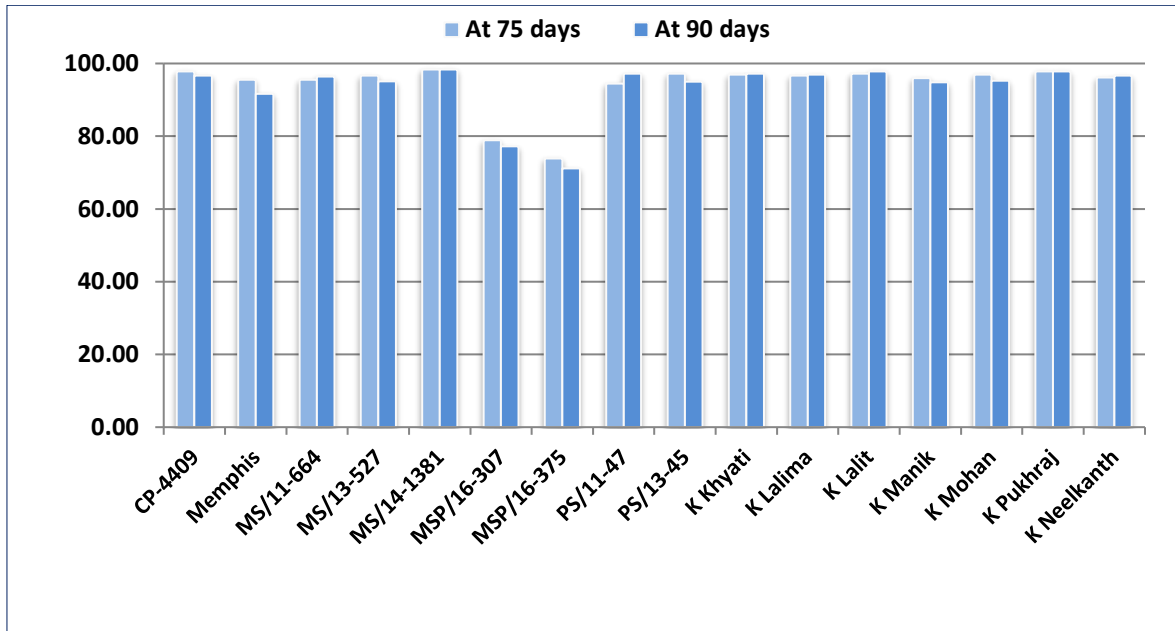


Fig. 1. Plant Emergence at 75 & 90 days

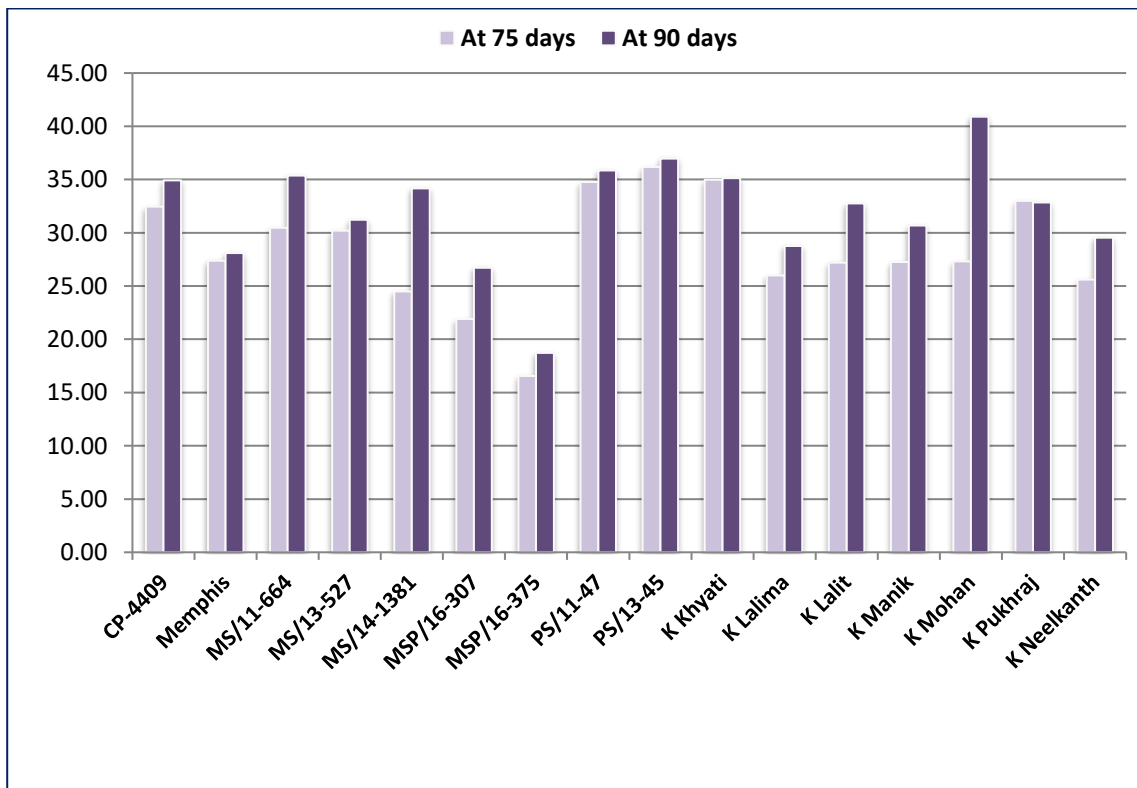


Fig. 2. Total tuber yield (t/ha)

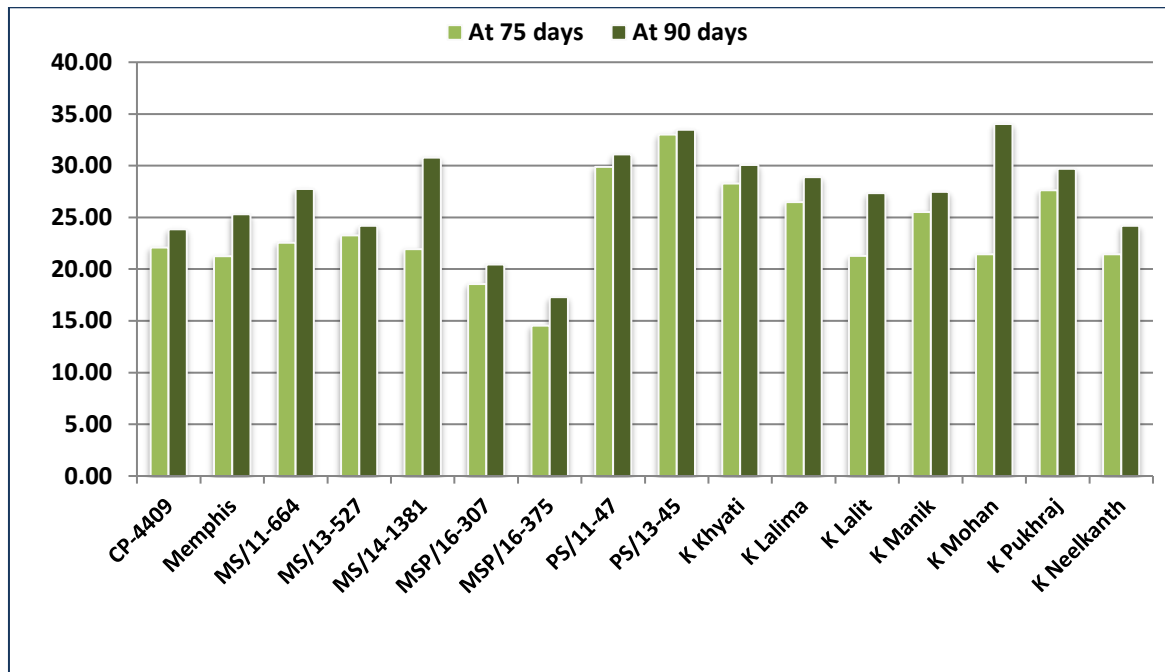


Fig. 3. Marketable tuber yield (t/ha)

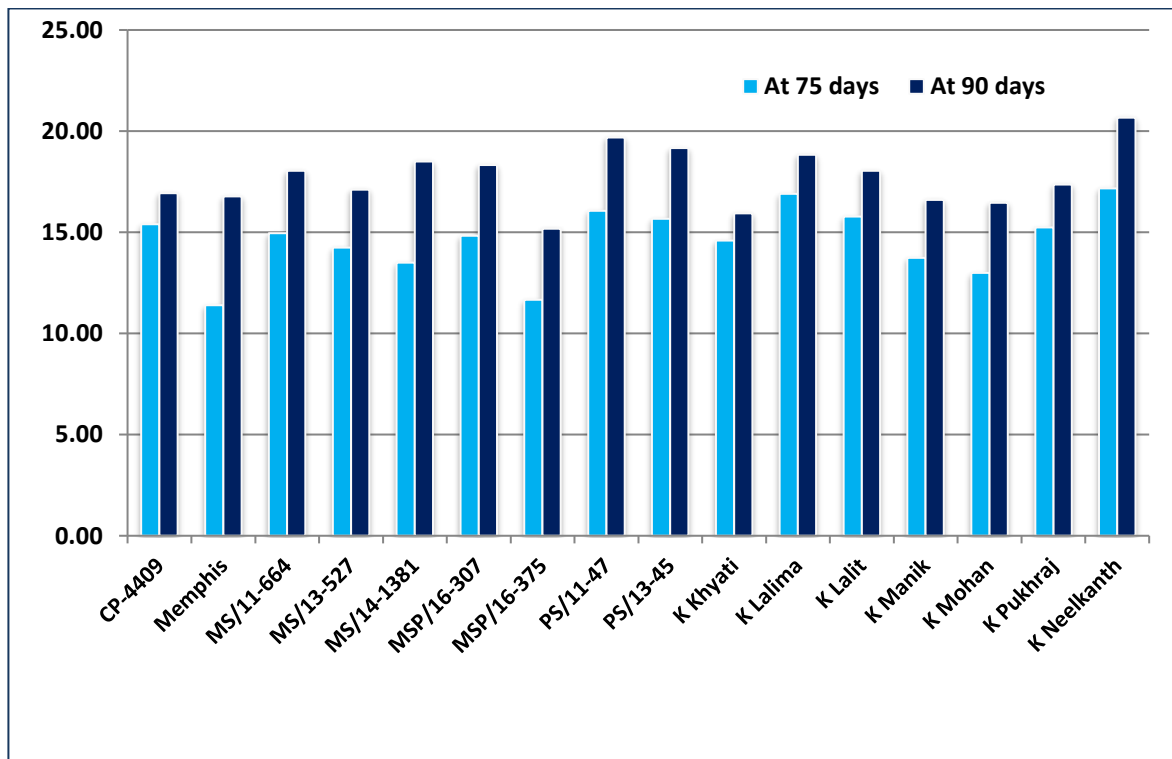


Fig. 4. Dry matter (%) during 75 & 90 days crop

Yield is very important parameter in selection and release of the potato varieties. The genetic makeup of the potato varieties expresses well under favorable environmental factors such as

fertility of the soil, surrounding temperature, water availability, pH of the soil, genotype and environmental interaction affect the crop yield in different ways [14]. This study was aimed to



determine the overall performance of nine advance potato clones along with seven controls varieties. According to Tessema et al. [15] the genotype and environment interaction has considerable influence on the quality and quantity of tubers yield. Rukundo et al. 2019, reported that the significant difference in total yield among potato genotypes is attributed to the intrinsic yield potential of genotypes, growing environment, and the interaction of genotype x environment. Superior potato genotypes have capability to utilize available soil nutrients; therefore, in the variety selection process the adaptability of tested genotypes has to be determined in order to recommend a variety to farmers with specific or broad adaptability.

## 5. CONCLUSION

Potato genotypes have significant difference with respect to the tuber yield and number of tubers per plant across of all locations. According to Patel et al. [14] and Subarta and Upadhyia [16] the variations among the genotypes for number of tubers per plant and tuber yield are associated with the inherent potential of variety which is highly influenced by growing conditions and interaction of variety by environment. This was also highlighted by Firman and Daniels [17-19] reporting that a high number of tubers per plant are influenced by varietal characteristics, adaptability and impact of the growth attributes, best clones should have a high yield with a high number of marketable tubers. The potato tubers yield ranging between 21.7 and 40.3 tons/ha was reported by Mulema et al. [20-22]. In the present study the advance clones PS/13-45 (36.97t/ha), PS/11-47 (35.87t/ha), MS/11-664 (35.39t/ha) are good candidates for future new potato varieties in Eastern Indo Gangetic plains of India.

## DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that no generative AI technologies such as large language models (chat, GPT, COPILOT etc) and text-to-image generators have been used during writing or editing of this manuscript.

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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