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## PERFORMANCE OF ADVANCED POTATO CLONE FOR TUBER YIELD AND YIELD ATTRIBUTES WITH NUTRITIONAL PARAMETERS SUITABLE FOR CULTIVATION IN EASTERN PLAINS OF INDIA

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### ABSTRACT

Potato (*Solanum tuberosum* L.) is the most important vegetable crop of the world. The varietal development includes evaluation of advanced clones, which are superior over control varieties in important parameters like tuber yield, rich in nutritional components (Zn & Fe) with high dry matter, resistance to diseases, shallow eyed and consumer preferred skin colour etc. The field and laboratory experiment were conducted at ICAR Central Potato Research Institute, Regional Centre, Patna, Bihar during the years 2019-2020, 2020-2021 and 2021-2022 to evaluate advanced potato clone PS/16-17 with 3 controls varieties viz.; popular potato varieties in confirmatory yield trials. The performance of advanced clones was evaluated with respect to the important yield characters like total tuber yield, marketable tuber yield, dry matter content, nutritional status of the tubers and late blight resistance at field level. The experiment was planted in experiment field of crop improvement section in the pattern of Randomized Block Design with 03 replications. The planting distance of potato tubers were 20 cm (Plant x Plant) and 60 cm (Row x Row) and depth of planting 4-5 cm deep in the soil on ridges. The experiment was planted in two sets i.e. 75 days & 90 days' duration crop. The Advance clone PS/16-17 were evaluated and selected on the basis of high marketable tuber yield (25.81 t/ha at 90 days' duration crop). The nutritional status of the tubers was high (48.40 ppm Fe, 24.41 ppm Zn) tuber shape ovoid to round, red color, light red flesh colour, shallow eyes and good organoleptic qualities. The dry matter content of the clone was 20.42. The aim of the experiment was to evaluate the performance of advance clone for the important yield and quality traits selected for introduction in All India Coordinated Research Project on Potato and can be released as promising potato variety.

**Key words :** Advance clones, Potato varieties, Dry matter, Total tuber yield, Marketable tuber yield.

### Introduction

Potato (*Solanum tuberosum* L.) is the most important vegetable food crop of the world. It is important vegetable crop accounted as third most important food crop after wheat and rice (Haverkort *et al.*, 2009). In India its cultivation is done in plains as well as on hills. It is available throughout the year cultivated during *rabi* season and cold stored as seed crop and table potato consumption. This is considered as main vegetable crop in most of the countries of the world. It is cultivated in India for the last more than 300 years. It is popular

vegetable in every household, provides an economic food, low-cost energy to the human diet. Potatoes are a rich source of starch, vitamins especially vitamin C and B, minerals like Zn, Cu and Fe. Its tubers contain 20.6% carbohydrates, 2.1% protein, 3% fat, 1.1% crude fibre and 0.9 % ash. This important vegetable gained popularity and spread to whole Europe as well as different parts of the world (Hawkes and Francisco Ortega, 1993; Pandey and Kaushik, 2003). Tubers also contains good amount of essential amino acids like leucine, tryptophane and isoleucine. The demand of potatoes based on the type of

usage like processing industries, table purpose and several industrial purposes such as for the production of starch and alcohol etc (Chhidda Singh, 2001). As a food product itself, potatoes are converted into dried products such as 'potato chips', 'sliced' or 'shredded potatoes'. The probable centre of origin of potato is in South America in the Central Andean region. Evidences indicate that potatoes were cultivated for centuries by South American Indians and the tubers were used as a common article of food. The Spanish people brought potato from Peru to Spain in 1565. They were probably brought to England about 1586 by Sir Francis Drake, following its introduction into European agriculture, potato became an important food crop of Italy, France and Ireland. Potato was introduced to India from Europe in the beginning of the seventeenth century, probably by the Portuguese, who were the first to open trade routes to the East. Potato is one of the important food crops of the world, cultivated over an area of 18.6 million hectares with a total production of 284 million tones (1979). The important potato growing countries are Russia, Poland, USA, China, India, Germany (Democratic Republic) and Spain. In India it is cultivated in 2.16 million hectares. The global potato production is 371.14 million tones. India contributes 13% of global potato acreage with 48.56 million tons of production and second largest producer after China. (FAOSTAT, 2020). It yields higher nutrition food per unit space and time under favourable climatic conditions as compare to the other major food crops (Dalamu *et al.*, 2019, 2020). Its dry matter, protein and energy make it extra ordinary as compared to other vegetables (Kabira and Lemaga, 2003). In eastern Indo-Gangetic plains of India the duration of potato crop ranges from 75-100 days and it includes early, medium and late maturing varieties. The red skinned varieties are more preferred in this region over white skinned potato varieties. The crop is grown during *Rabi* season. The most preferred temperature for the growth of potato crop is 15-20°C with short photo period 10 to 12 hours a day from October to February. The potato produces more energy and food per unit area than other important food crops. It is also a healthy food free from fats (Lutaladio and Castaldi, 2009).

There is a need of a time to develop nutrient rich varieties in order to fight with the hunger and malnutrition. As we know that potato is a staple vegetable crop in our country. A number of varieties, e.g. Kufri Neelkanth, Kufri Lohit, Kufri Manik were released and they are rich in Anthocyanin, ascorbic acid, carotenoids and zinc and Iron. The advance clones of potato, which are nutrient rich developed through conventional breeding, hybridization followed by phenotypic selection from F<sub>1</sub> to F<sub>1</sub>C<sub>5</sub>. The

aim of the study was to evaluate advance potato clones, which are superior over control varieties in different parameters like tuber yield, nutritionally rich (Zn & Fe) with high dry matter, resistance to diseases, shallow eyed and with red skin colour preferred in Eastern Indo-Gangetic plains.

## Materials and Methods

### Planting materials

The materials in this study were advance clones of potato PS/16-17 along with three control potato varieties Kufri Lalit, Kufri Manik and Kufri Neelkanth.

### Location of experiment

The experiment was conducted at experimental fields of crop improvement section of ICAR-CRPI RS Patna during the year 2019-20, 2020-21 & 2021-22. The advance clones were planted as per the standard experimental design during *Rabi* season. The cropping season starts from November and ends during last week of February with the harvesting of the crop.

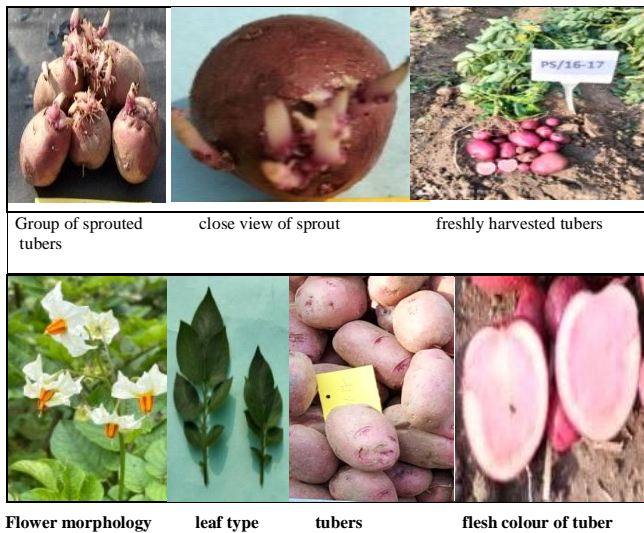
### Experimental design and planting details

The design of the experiment was Completely Randomized Block design and the planting details are given below:

Planting details:	Crop Year 2019-20	Crop Year 2020-21	Crop Year 2021-22
Experiment Name	: PYT	CYT-1	CYT-2
Date of planting	: 10/11/2020	15/11/2021	13/11/2022
Date of harvesting	: 22/02/2020-24/11/2020	23/02/2022-25/02/2022	21/02/2023-22/02/2023
No. of total entries	: 17	8	6
No. of selected hybrids	: 8	6	2
Duration	: 75 & 90 Days	75 & 90 Days	75 & 90 Days
Plot size	: 7.2 m <sup>2</sup>	7.2 m <sup>2</sup>	7.2m <sup>2</sup>
Reps.	: 3	3	3
Controls	: 7	5	7

### Field preparation

A well-prepared field is pre-requisite for conducting an experiment. In case of potato a well-prepared field obtained by deep ploughing (20-25 cm deep) with soil turning plough followed by 2-3 cross harrowing and leveling. It plays very important role in obtaining good tuberization in the crop. Leveling helps in moisture retention in the field obtained from the retreating rainfall. If the retreating monsoon is weak then the crop can be sown by giving by pre-sowing irrigation which promotes even and quick germination.



**Plate 1 :** Morphological traits of red skinned advance clone PS/16-17.

### 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. The experiment was planted in 3 replications, 4 rows each of 3m length (plot size 7.2m<sup>2</sup>). A shallow irrigation was given for even germination of the crop.

### Manure and fertilizers

Potato crop requires 180:60:80 (N: P: K) doses for good tuberization and better yield. Half doses of Nitrogen with full dose of Potassium and Phosphorous were applied at during land preparation as a basal dose. To maintain the texture of soil 25-30 tones/ha of well decomposed farmyard manure/compost is required in this crop. A healthy timely sown crop produces about 35 to 40 tonnes tubers per hectare (Chhidda Singh, 2001).

### Method of planting

The experiment was planted as per the layout. Tubers were planted on the ridges, made with the help of tractor driven ridge-maker. The planting of potato tubers was done manually with the help of *khurpi* at a depth of 7-8 cm followed by covering with the soil and light irrigation.

### Inter culture operations

Inter culture operations play important role in this crop, timely operations help better tuberization in the crop. Early-stage weeds are controlled by weedicide Oxyfluorfen 23.5% EC (500 ml/ha) spray during pre-emergence stage. Hand weeding was done 25 days after planting followed by remaining half dose of Nitrogen in the form of urea in side of the furrows. Earthing up operation was done after application of urea in order to

get better tuberization in the crop. In this crop 4-5 irrigations 10-15 days interval were given as per the requirement. To control the incidence of late-blight during month of December and January one prophylactic spray of Mancozeb 75WP followed by 2 sprays of Cymoxanil 8% + Mancozeb 64% WP were done. As sucking pest like aphids and white flies are the prime vectors for spread of viral diseases in this crop, were controlled by spray of Imidacloprid 17.8% SL 45-50 days after planting.

### Data collection and recording

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 was recorded time to time as per their appearance. 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 tubers haulms weight (%) & tuber dry matter (%) were estimated within a week after harvesting in both 75 & 90 duration crops.

### Formulas

$$\text{Total tuber yield (t/ha)} = \frac{\text{Tubers harvested per plot (kg)}}{\text{Plot size (m}^2\text{)}} \times 10$$

$$\text{Marketable tuber yield (t/ha)} = \frac{\text{Total weight of harvested tubers(kg) - weight of very small tubers (kg)}}{\text{Plot size (m}^2\text{)}} \times 10$$

$$\text{Tuber dry matter (\%)} = \frac{\text{Final weight of sliced oven dried for 72 hrs (g)}}{\text{Initial weight 200 g of freshly harvested potatoes}} \times 100$$

To determine the marketable yield, very small tubers were sorted out from the total tuber yield. The marketable tuber yield consists of Big ( $\leq 80$ g) medium (79-50g) and small (49-25g) tubers.

## Results and Discussion

**Total Tuber yield :** The pooled mean total tuber yield of PS/16-17 at 75 days (27.99 t/ha) across crop years 2019-20, 2020-21, and 2021-22 showed a 9.7 to 16.3% higher yield than control varieties K. Lalit, K.

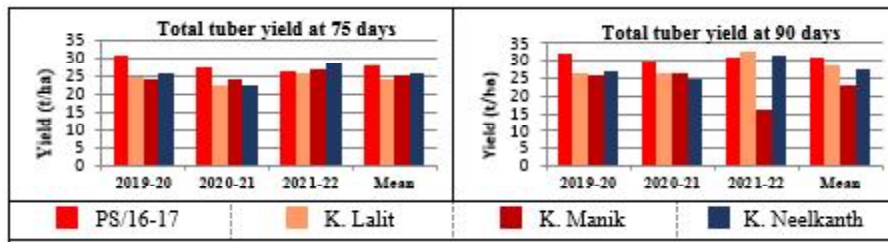


Fig. 1 : Total Tuber Yield of PS/16-17 over controls.

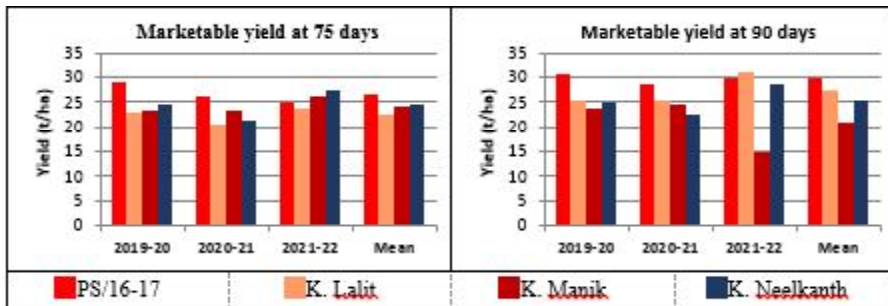


Fig. 2 : Marketable Tuber Yield of PS/16-17 over controls.

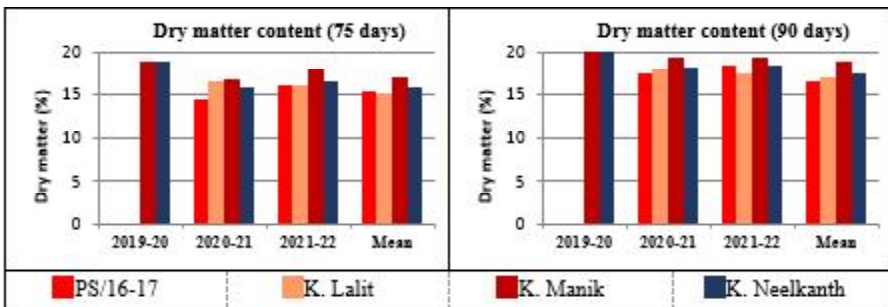


Fig. 3 : Dry Matter content of PS/16-17 over controls.

Manik, and K. Neelkanth. At 90 days the pooled mean data of PS/16–17 (30.82 t/ha) showed an 8.2 to 35.8% increase in total tuber yield at 90 days compared to K. Lalit, K. Manik, and K. Neelkanth control varieties (Table 1 and Fig. 1).

**Marketable Tuber yield :** The pooled mean for marketable tuber yield of PS/16-17 at 75 days (26.68 t/ha) across crop years 2019-20, 2020-21 and 2021-22 showed a 9.1 to 18.7% higher yield than control varieties K. Lalit, K. Manik, and K. Neelkanth. The pooled mean for marketable yield data of PS/16–17 (29.58 t/ha) showed an 8.7 to 41.0% increase in marketable tuber yield at 90 days compared to K. Lalit, K. Manik, and K. Neelkanth control varieties (Table 2 and Fig. 2).

**Dry matter :** The pooled mean dry matter of PS/16-17 (75 days produce) was 18.95 % across crop years 2019-20, 2020-21 and 2021-22 which showed a 13.9 to 19.3% higher dry matter content than control varieties K. Lalit, K. Manik, and K. Neelkanth. At 90 days the pooled

Table 1 : Total Tuber Yield of PS/16-17 over controls.

Genotypes	Total Tuber yield (t/ha)								Yield increase (%) over controls	
	2019-20		2020-21		2021-22		Mean		75 days	90 days
	75 days	90 days	75 days	90 days	75 days	90 days	75 days	90 days		
PS/16-17	30.46	31.82	27.22	29.80	26.28	30.84	27.99	30.82	-	-
K. Lalit	24.66	26.50	22.07	26.48	25.47	32.44	24.07	28.47	16.29	8.24
K. Manik	24.07	25.82	24.20	26.40	26.95	15.87	25.07	22.70	11.62	35.79
K. Neelkanth	25.62	27.21	22.32	24.82	28.60	31.29	25.51	27.77	9.69	10.97
C.D. 5%	3.49	2.48	2.01	1.80	2.40	2.44	-	-	-	-

Table 2 : Marketable Tuber Yield of PS/16-17 over controls.

Genotypes	Marketable Tuber yield (t/ha)								Yield increase (%) over controls	
	2019-20		2020-21		2021-22		Mean		75 days	90 days
	75 days	90 days	75 days	90 days	75 days	90 days	75 days	90 days		
PS/16-17	29.03	30.54	25.95	28.60	25.05	29.60	26.68	29.58	-	-
K. Lalit	23.02	25.32	20.61	25.30	23.78	30.99	22.47	27.20	18.72	8.74
K. Manik	23.19	23.85	23.31	24.39	25.96	14.66	24.15	20.97	10.45	41.08
K. Neelkanth	24.55	24.83	21.39	22.65	27.41	28.55	24.45	25.34	9.11	16.72
C.D. 5%	2.97	1.96	1.71	1.42	2.04	1.93	-	-	-	-

**Table 3 :** Dry Matter content of PS/16-17 over controls.

Genotypes	Dry Matter Content (%)								Yield increase (%) over controls	
	2019-20		2020-21		2021-22		Mean			
	75 days	90 days	75 days	90 days	75 days	90 days	75 days	90 days	75 days	90 days
PS/16-17	18.05	20.10	18.75	21.06	18.95	20.50	18.95	20.50	-	-
K. Lalit	14.50	17.50	16.60	17.88	16.67	19.33	15.92	18.24	19.03	12.39
K. Manik	16.00	18.50	16.10	17.50	17.83	19.33	16.64	18.44	13.88	11.17
K. Neelkanth	15.50	16.50	15.14	17.05	17.00	18.83	15.88	17.46	19.33	17.41
C.D. 5%	-	-	1.40	5.25	1.14	1.41	-	-	-	-

**Table 4 :** Nutritional components in advance clone (Pooled data 2021-22 & 2022-23) and control varieties of potato.

Advance Clone/ varieties	Zn (ppm)	Fe (ppm)	Carotenoid (µg/100-gram fresh weight)	Anthocyanin (mg/100-gram fresh weight)	Vitamin C (mg/100-gram fresh weight)
PS/16-17	24.41	48.40	73.85	7.79	50.65
K. Lalit	27.48	34.85	136.90	0.94	24.12
K. Manik	26.55	44.79	79.05	0.93	31.54
K. Neelkanth	25.25	38.64	85.30	1.00	30.81

mean dry matter content of PS/16–17 of 90 days produce (20.5%) showed an 11.7 to 17.4% increase compared to K. Lalit, K. Manik, and K. Neelkanth control varieties (Table 3 and Fig. 3).

The nutritional status of different advance clone with potato varieties as control were presented in Table 4. The Fe, Anthocyanin and Vitamin C content was highest in the advance clone PS/16-17 over potato varieties taken as control. So, it can be considered as nutritionally superior advance clone.

### Conclusion

Medium maturing red skinned advanced clone PS/16-17 was suitable for table potato with attractive, red colour with light red flesh colour. The yield performance of the clone was significantly superior than planted control varieties during 75- & 90-days crop. The tubers were round in shape with shallow eyes. The organoleptic qualities of these clones were mealy texture; pleasant flavour and the colour retention of these clones were excellent after boiling of the tubers. The average cooking time of these clones were 15-18 minutes. High Anthocyanin colouration, Fe and vitamin C content increases its utility in the diet as well as able to overcome hidden hunger of these nutrients. These qualities will promote the acceptance of this clone among the consumers.

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