

## Evaluation of red & purple skinned advance clones suitable for Eastern Indo-Gangetic plains of India

### ABSTRACT

An experiment was conducted at ICAR Central Potato Research Institute, Regional Centre, Patna, Bihar during the year 2021-2022 and 2022-2023 to evaluate 04 red skinned and 02 purple skinned advance potato clones with 05 controls as popular potato varieties in confirmatory yield trials. The performance of advance clones was evaluated with respect to their yield and yield attributing traits, dry matter, nutritional status of the tubers. The experiment was planted Randomized Block design with 03 replications, plant to plant distance was 20 cm and row to row distance 60 cm with three replications. The experiment was planted in two sets i.e. 75 days & 90 days duration crop. The potato clones PS/16-02 & PS/16-17 were selected on the basis of their remarkable high marketable tuber yield (26.29 and 22.45 t/ha in 75 days duration and 30.16 t/ha & 25.81 t/ha at 90 days duration crop respectively). The nutritional status of the tubers was high, tuber shape ovoid to round, colour purple (PS/16-02) & red (PS/16-17), shallow eyes and good organoleptic qualities. The dry matter content of these selected clones was 20.17 & 20.42 respectively. The aim of the experiment was to evaluate the performance of advance clones for the above-mentioned traits and to select suitable advance clones for introduction in All India Coordinated Research Project on Potato.

**KEYWORDS:** Advance clones, control varieties, dry matter, confirmatory yield trial, tuber yield, nutrients.

### INTRODUCTION

Potato (*Solanum tuberosum* L) is starchy vegetable crop grown throughout the world. It is important vegetable crop accounted as third most important food crop after wheat and rice (Haverkort *et al.*, 2009) important constituent of our diet. Potatoes were introduced in Europe during 1570s within a short span of time. 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). It yields higher nutritious food per unit space and time under favourable climatic conditions as compare to the other major food crops (Dalamu *et al.*, 2019). That is very good source of carbohydrate, fibre, vitamins B6, C and minerals like iron, zinc, potassium, magnesium etc. Its tuber 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 preference is due to the food habit having potato varieties suitable for 'bhujia' making. 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 (Hirdesh Kumar *et al.*, 2023). The potato produces more energy and healthy food free from fats per unit area than other important food crops (Lutaladio and Castaldi, 2009). This crop is decorated with most of the nutrients like carbohydrate, proteins, vitamins, minerals, and dietary fibre (Mulatu *et al.*, 2005). Potato is cultivated throughout India under diverse Agro climatic conditions varying from temperate high hills to subtropical plains. It was introduced in our country during the beginning of 17th century by Portuguese traders as it was staple vegetable crop in the Europe. Nowadays, it occupies the rank of staple food crop in India and become a common household item. It is economic in price, good source of energy available throughout the year. The crop is versatile in nature and able to fight with hunger and malnutrition. The year 2008 was declared as 'International Year of Potato' by United Nations to highlight the importance of potatoes in global food security and poverty eradication (<https://www.un.org>, 2021). In potato on weight basis, 80% is water, 2% is protein 18% is starch and minerals. The global potato production was 371.14 million tonnes. India approximately contributes 13% of global potato acreage with 48.56 million tonnes of production (FAOSTAT, 2022).

There is a need of time to develop nutrient rich varieties in order to fight with the hunger and malnutrition in human population especially children and lactating mothers. 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 work of developing advance potato clones which are nutrient rich through conventional breeding,

hybridization followed by phenotypic selection from  $F_1$  to  $F_1C_5$ . 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, shallow eyed and with coloured skin rich in anthocyanins etc.

## MATERIALS AND METHODS

### 1. Planting materials

The material in this study were 6 advance clones of potato namely PS/16-02, PS/16-17, PS/16-19, PS/16-20, PS/16-22 and PS/16-34 along and five control potato varieties KufriKeshar, Kufri Lalit, KufriLohit, KufriManik and Kufri Neelkanth.

### 2. Location of Experiment

The experiment was conducted at experimental field of ICAR-CRPI RS Patna during the year 2021-22 & 2022-23. The advance clones were planted as per the standard experimental design during Rabi season. The cropping season starts from planting during first fort night of November and ends during last week of February with the harvesting of the crop.

### 3. Experimental Design & Planting details

The design of the experiment was completely randomized plot design and the planting details are given below –

List 1: .Planting details

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

### 4. 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 (*palava*).

### 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 was 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 is required for even germination of the crop just after planting of the tubers on the ridges.

### 6. Manure and fertilizers

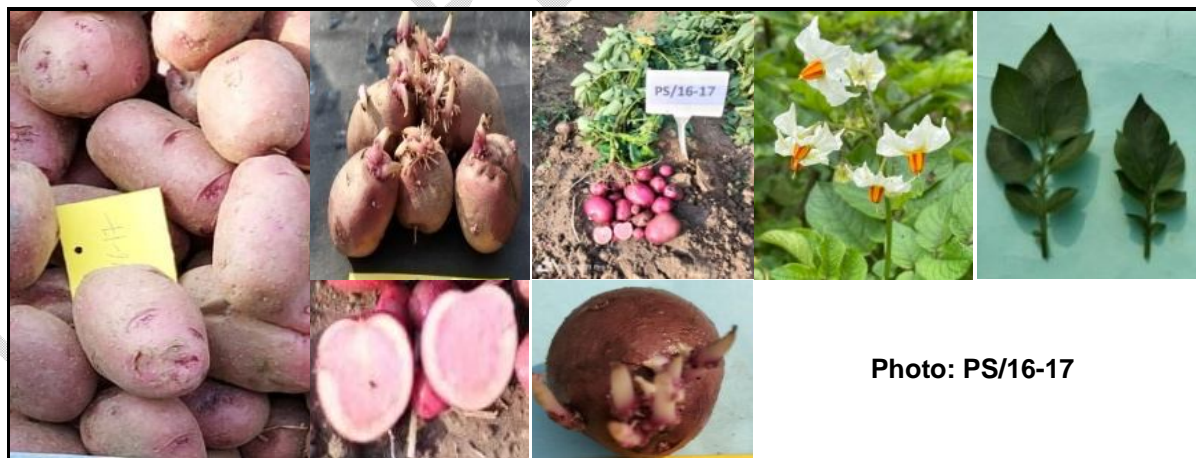
Potato crop requires 180: 80:100 (N: P: K) doses for good tuberization and better yield. Half doses of Nitrogen with full dose of Potassium & Phosphorous were applied during land preparation as a basal dose. To maintain the level of micro fauna in the soil 22-25 tonnes/ha of well decomposed farmyard manure/compost is required in this crop. A healthy timely sown crop produces about 35 to 40 tonnes tubers per hectare (*Chhidda Singh, 2001*).

### 7. Method of planting

The experiment was planted as per the layout. Tubers were planted on the ridges, made with the help of manual labours or 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 followed by light irrigation.

### 8. Inter culture operations

Inter culture operations play important role in this crop, timely operations help better tuberization in the crop. In this crop early stage weeds can be controlled by weedicide Oxflurofen 23.5% EC (500 ml/ha) spray during pre-emergence stage. Hand weeding was done 25 days after planting followed by application of 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 at 10-15 days interval were given as per the requirement. To control the incidence of late-blight during month of December & 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.



**Photo1: Red & purple skinned advance stage hybrids introduced in AICRP (P) trials**

### 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 were 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 rotting (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:

1. Plant emergence (%) =  $\frac{\text{No. of germinated plants per plot}}{\text{Total no. of plants per plot}} \times 100$
2. Foliage senescence (%) =  $\frac{\text{No. of plants with 75\% foliage maturity per plot}}{\text{Total no. of plants per plot}} \times 100$
3. Total tuber yield (t/ha) =  $\frac{\text{Total wt. (kg) of all sized tubers per plot}}{\text{Plot size (m}^2\text{)}} \times 10$
4. Marketable tuber yield (t/ha) =  $\frac{\text{Total wt. (kg) of large to medium sized tubers per plot}}{\text{Plot size (m}^2\text{)}} \times 10$
5. Tuber dry matter (%) =  $\frac{\text{Wt. of sliced potatoes after 72 hrs oven dried followed by shade drying}}{\text{Wt. of fresh harvest potatoes}} \times 100$

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 ( $\geq 80\text{g}$ ) medium (79-50g) and small (49-25g) tubers.

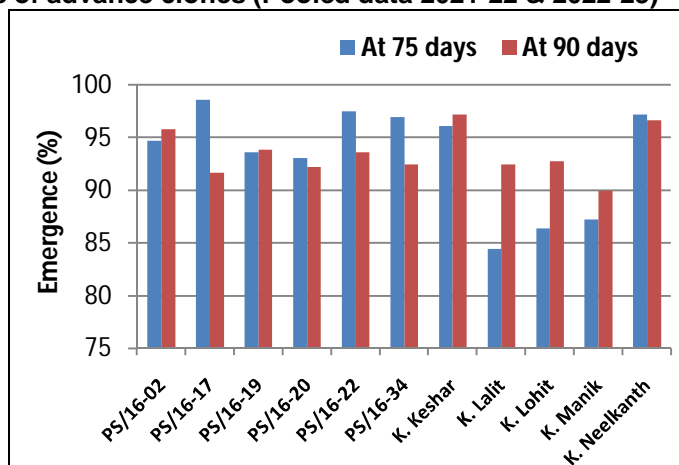
## RESULT AND DISCUSSION

1. **Plant Emergence:** Data were recorded for plant emergence, 25 days after planting (Table-1). The plant emergence ranged from 98.61% (PS/16-17) to 84.45% (K.Lalit) in 75 days crop. In the experiment planted for evaluation in 90 days crop the range was 97.23% (K.Keshar) to 90.00% (K.Manik). The results are given in Table 1 and fig 1.

**Table 1: Advance clones/Varieties and Emergency (%)**

**Fig.1: Bar graph showing Plant Emergence of advance clones (Pooled data 2021-22 & 2022-23)**

Advance clones /Varieties	Emergence (%)	
	At 75 days	At 90 days
PS/16-02	94.73	95.83
PS/16-17	98.61	91.67
PS/16-19	93.61	93.89
PS/16-20	93.06	92.22
PS/16-22	97.50	93.62
PS/16-34	96.95	92.50
K. Kesar	96.11	97.23
K. Lalit	84.45	92.50
K. Lohit	86.39	92.78
K. Manik	87.23	90.00
K. Neelkanth	97.22	96.67



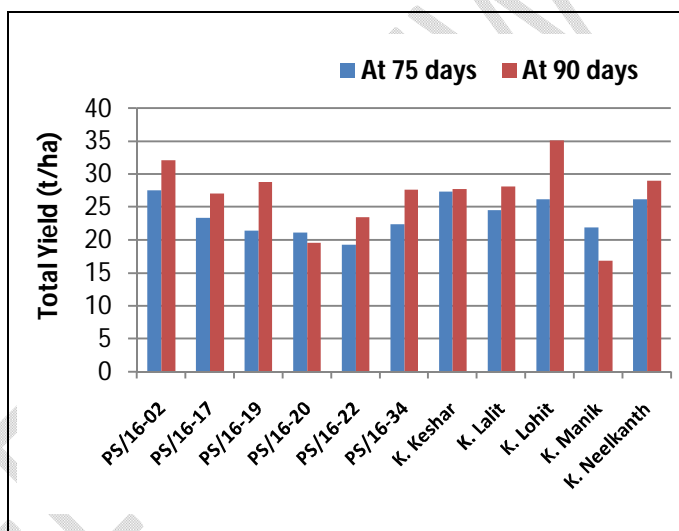
CD (0.05)	4.40	4.28	
CV (%)	2.74	2.66	

2. **Total tuber yield:** The total tuber yield was recorded maximum in PS/16-02 (27.62 t/ha) followed by K.Kesar (27.35 t/ha) in 75 days crop experiment. In the 90 days crop experiment the total tuber yield was highest in K.Lohit (35.14 t/ha) followed by PS/16-02 (32.14 t/ha) (Table-2 and fig 2).

**Table2 Advance clones /Varieties for Total tuber Yield (t/ha)**

**Fig. 2: Bar graph showing Total tuber yield of advance clones (Pooled data 2021-22 & 2022-23)**

Advance clones /Varieties	Total tuber Yield (t/ha)	
	At 75 days	At 90 days
PS/16-02	27.62	32.14
PS/16-17	23.44	27.10
PS/16-19	21.45	28.88
PS/16-20	21.19	19.63
PS/16-22	19.29	23.53
PS/16-34	22.41	27.67
K. Kesar	27.35	27.72
K. Lalit	24.61	28.15
K. Lohit	26.23	35.14
K. Manik	21.92	16.87
K. Neelkanth	26.25	29.03
CD (0.05)	3.82	5.68
CV (%)	9.52	12.59

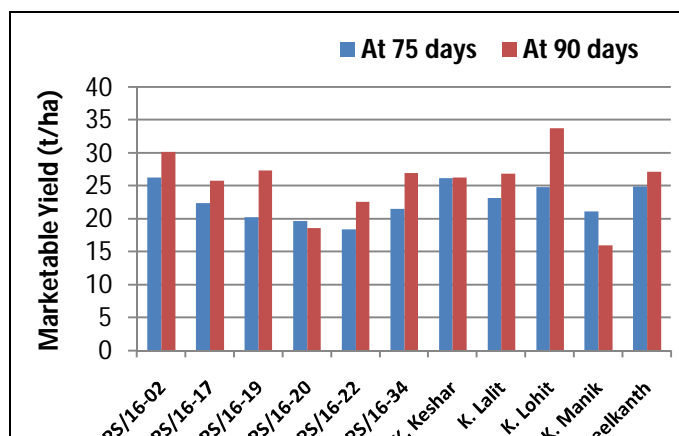


3. **Marketable tuber yield:** The marketable tuber yield was recorded after subtraction of weight of very small tubers from the total tuber yield. In 75 days crop marketable tuber yield was maximum in PS/16-02 (26.29 t/ha) significantly superior over planted control varieties. In the 90 days crop highest marketable tuber yield was recorded in PS/16-02 (31.16 t/ha) followed by PS/16-19 (27.41 t/ha), PS/16-34 (26.41 t/ha), PS/16-17 (25.81 t/ha) & PS/16-22 (22.61 t/ha), significantly at par with the most of the control varieties (Table-3 and Fig 3).

**Table 3 Advance clones/Varieties for market Yield (t/ha)**

**Fig. 3: Marketable tuber yield of advance clones (Pooled data 2021-22 & 2022-23)**

Advance clones /Varieties	Mkt. Yield (t/ha)	
	At 75 days	At 90 days
PS/16-02	26.29	30.16
PS/16-17	22.45	25.81
PS/16-19	20.30	27.41
PS/16-20	19.69	18.62
PS/16-22	18.48	22.61
PS/16-34	21.59	26.97
K. Kesar	26.21	26.28
K. Lalit	23.17	26.86
K. Lohit	24.88	33.78
K. Manik	21.19	16.04



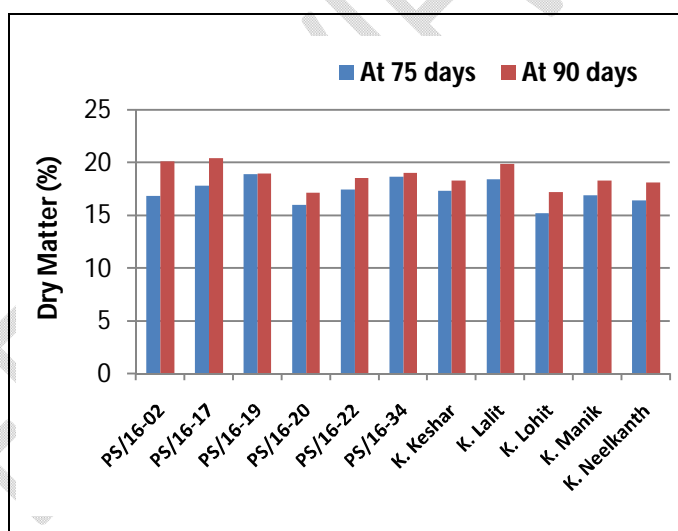
K. Neelkanth	24.98	27.17
CD (0.05)	3.62	5.29
CV (%)	9.53	12.31

4. **Dry Matter:** The dry matter content plays very important role in selection of clones. The range varies from 18.92% (PS/16-19) to 15.25% (K. Lohit). In 90 days crop it varies from 20.42 (PS/16-17) to 17.17% (PS/16-20). The dry matter performance of PS/16-17 was at par with PS/16-02 and these were significantly superior over the planted control varieties (Table 4 and Fig 4).

**Table 4 Advance clones /Varieties for Dry Matter (%)**

**Fig. 4: Bar graph showing Dry Matter content of advance clones (Pooled data 2021-22 & 2022-23)**

Advance clones /Varieties	Dry Matter(%)	
	At 75 days	At 90 days
PS/16-02	16.84	20.17
PS/16-17	17.84	20.42
PS/16-19	18.92	19.00
PS/16-20	16.00	17.17
PS/16-22	17.48	18.59
PS/16-34	18.67	19.08
K. Kesar	17.33	18.34
K. Lalit	18.42	19.92
K. Lohit	15.25	17.25
K. Manik	16.92	18.33
K. Neelkanth	16.42	18.17
CD (0.05)	0.88	1.01
CV (%)	3.02	3.22



**Table 5: Nutritional components in advance clones (Pooled data 2021-22 & 2022-23)**

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/16-02	28.71	42.57	67.10	29.38	52.67
PS/16-17	24.41	48.40	73.85	7.79	50.65
PS/16-19	25.29	49.51	67.50	11.48	43.76
PS/16-22	27.28	50.87	109.50	22.07	42.35
PS/16-34	27.65	49.13	73.70	5.75	31.64
K.Kesar	31.70	41.88	150.80	0.46	39.71
K.Lalit	27.48	34.85	136.90	0.94	24.12
K.Lohit	26.15	41.40	124.00	0.84	28.89
K.Manik	26.55	44.79	79.05	0.93	31.54
K.Neelkanth	25.25	38.64	85.30	1.00	30.81

## CONCLUSION

Medium maturing red and purple skinned advanced clones PS/16-02 and PS/16-17 were suitable for table potato with attractive, red & purple colour, with purple flesh and light red flesh colour respectively. The yield performance of PS/16-02 (27.62 t/ha) superior over best control K.Kesar (27.35 t/ha) during 75 days duration crop and or at par (32.14 t/ha) with KufriLohit (35.14 t/ha) during 90 days planted crop. The advance clone PS/16-17 was superior in dry matter (20.42 %), iron (48.40 ppm) and vitamin C (50.65) over control varieties. The tubers were round in shape with shallow eyes. The organoleptic qualities of these clones were mealy texture; pleasant flavour (PS/16-02 and PS/16-17) 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 (PS/16-02) will promote the acceptance of these clones among the consumers.

#### 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.

#### References

1. Bonierbale M. (2020) Procedures for standard evaluation trials of advanced potato clones. *An international cooperator's guide*. International Potato Center, Lima, Peru.
2. Chidda Singh (2010). *Modern techniques of raising field crops*. P: 449-463
3. Cutter E.G. (2018). Structure and development of the potato plant. In: Haris, P. M. *The potato crop*. Springer, Science + Business media, B.V, UK. pp. 70-152.
4. Dalamu, SK Luthra, JK Tiwari, J Sharma (2019). Mineral content of red skinned potatoes of eastern India. *J.Horti. Sci.* 14(1):79-82
5. FAO/STAT, *Food and Agriculture Organization of the United Nations, Rome, Italy. 2019, 2020, 2022*
6. Gopal J. (2015). Challenges and Way-forward in Selection of Superior Parents, Crosses and Clones in Potato Breeding. *Potato Research* 58: 165-88.
7. Hassanpanah D. and Hassanabadi H. (2014). Evaluating quantitative and qualitative traits of promising potato clones and commercial cultivars using the GGE BI- plot and AMMI models. (article in Persian with an abstract in English). *Iranian Journal of Agricultural Science*. 30: 149-164.
8. Haverkort A., Struik P., Visser R.G.F. and Jacobsen E. (2009). Applied biotechnology to combat late blight in potato caused by *Phytophthora infestans*. *Potato Research* 52: 249-64.
9. Hawkes J.G. and Francisco-Ortega J. (1993). The early history of the potato in Europe. *Euphytica* 70:1-7.
10. Jansky S. (2009). Breeding, genetics and cultivar development. *Advances in potato chemistry and technology*. Academic Press, Burlington, VT, 27-62.
11. Jozani S., Abd-Mishani G.H.R S., Hosenzadeh A.H. and Seied Tabatabaei B.E. (2003). Genetic diversity analysis of commercial potato cultivars (*Solanum tuberosum*) in Iran using RAPD-PCR technique. (article in Persian with an abstract in English) *Iranian Journal of Agricultural Science*. 34: 1021-1029.
12. Kabira, J. N. and Lemaga, B. (2003). Quality Evaluation Procedures for Research and Food Industries Applicable in East and Central Africa Kenya Agricultural Research Institute Publication.
13. Kumar Hirdesh, B Rashmi, Murlidhar J, Sushma Tiwari, Singh SP and Samad Diya RK (2023). Evaluation of potato (so tube, *L. selenium tuberosum* capital L.) hybrid and varieties for medium maturity and quality component for north central India. *Biological forum – an international journal* 15.(2); 1244–1250
14. Litaladio, N. and Castaldi, L. (2009). Potato: the hidden treasure. *Journal of Food Composition and Analysis*, 22(6), 491-493.
15. Meltzer H.V. (1992). The effect of growth regulators on the relationship between numbers of stems and tubers in potato. *Potato Research* 35: 297-303.
16. Mulatu, E., Ibrahim, O. and Bekele, E. (2005). Improving Potato Seed Tuber Quality and Producers Livelihoods in Hararge, Eastern Ethiopia. *Journal of New Seeds*, 7(3), 31–56.

17. Muthoni J., Shimelis H. and Melis R. (2014). Genetics and Reproductive Biology of Cultivated Potato (*Solanum tuberosum* L.), *Implications in Breeding*. Reproductive Biology of Plants. CRC press, Taylor & Francis group. PP. 164-194
18. Neele A.E.F. (1991). Parental choice and selection in the early generations of a potato breeding programme. *PhD. Wageningen University*, Netherlands.
19. Pandey S. and Kaushik S. (2003). Origin, evolution, history and spread of potato. In: Khurana S.M.P., Minhas J.S., Pandey S.K. *The Potato: Production and Utilization in Sub-Tropics* Mehta, New Delhi. pp. 15-24.
20. <https://www.un.org>, 2021.

UNDER PEER REVIEW