PLANT SCIENCE TODAY
Vol 12(sp4): 01–09
https://doi.org/10.14719/pst.10131

eISSN 2348-1900

RESEARCH ARTICLE

Morphological and yield performance of potato (*Solanum tuberosum* L.) varieties under organic farming in the North Eastern Hill Region of India

P Janani[1], S Rawal[2], N Sailo[1*], C Challam[1], P Mankar[2] & Y A Lyngdoh[1]

[1]Indian Council of Agricultural Research (ICAR)-Central Potato Research Institute, Regional Station, 5th Mile, Upper Shillong 793 009, Meghalaya, India
[2]Indian Council of Agricultural Research (ICAR)- Central Potato Research Institute, Regional Station, Modipuram, Meerut 250 110, Uttar Pradesh, India

*Correspondence email - ngura.sailo23@gmail.com

Received: 19 June 2025; Accepted: 19 September 2025; Available online: Version 1.0: 16 December 2025

Cite this article: Janani P, Rawal S, Sailo N, Challam C, Mankar P, Lyngdoh YA. Morphological and yield performance of potato (*Solanum tuberosum* L.) varieties under organic farming in the North Eastern Hill Region of India. Plant Science Today. 2025;12(sp4):01–09. https:/doi.org/10.14719/pst.10131

Abstract

Raising awareness about the benefits of organic food has spurred consumer demand and organic farming practices. However, organic farming often criticized for its lower productivity than conventional farming. Poorly adapted varieties are partially responsible for the lower yields in organic farming. Therefore, it's crucial to identify suitable varieties for organic farming to minimize the yield gap between organic and conventional farming practices. To address this, a field experiment was conducted at Indian Council of Agricultural Research (ICAR)-Central Potato Research Institute (CPRI), Regional Station, Shillong, during the kharif seasons of 2020 to 2022. The study evaluated the performance of six potato varieties viz., Kufri Jyoti, Kufri Megha, Kufri Giriraj, Kufri Kanchan, Kufri Himalini and Kufri Girdhari under organic farming. The findings indicated that Kufri Himalini is suitable for organic cultivation, exhibiting the highest total tuber yield (14.44 t ha^{-1}) combined with marketable tuber yield (10.89 t ha^{-1}). This variety has moderate resistant to late blight and medium tuber dormancy. Storage behaviour varied among the varieties. Tubers of Kufri Girdhari and Kufri Kanchan were exhibited excellent keeping quality with long tuber dormancy and minimum storage losses, indicating their suitability for low-cost country storage for six months.

Keywords: growth; organic farming; potato varieties; storage; suitability; yield

Introduction

India's Northeastern Hill Region (NEHR) has vast opportunities to emerge as a major supplier of organic products with the increasing global demand for organic food (1). The hilly ecosystems of the Northeastern region offer numerous advantages for organic farming, including low use of synthetic fertilizers (< 12.0 kg ha^{-1}) and chemicals, availability of 47 mt of organic manures (including 37 mt from animal excreta and 9 mt from crop residues) and high soil organic carbon content (15.0 g kg^{-1} - 35.0 g kg^{-1}) (2, 3). Potato is the third most consumed crop in the world, after wheat and rice. Potatoes are highly valued for its adaptability to diverse environments, high productivity per unit area, culinary versatility and nutritional richness (4). In 2022-23, India produced 60 mt from a 2.3 mha area with an average yield of 25 t ha^{-1} (5). In the NEHR, potatoes are grown throughout the year due to their adaptability to diverse climatic conditions, altitudes and farming methods including rainfed, monocropping and mixed cropping practices in upland and jhum lands (6). Despite this, the region contributes only 6.1 % of India's total potato area, with a productivity of 8.56 t ha^{-1} far below the national average of 25 t ha^{-1}. The low potato productivity in the NEH region is mainly due to the cultivation of local varieties, poor plant nutrition and lack of quality seeds. Farmers often rely on farms saved seeds cultivated over several generations or disease-infected seeds from local markets (7). Since potatoes are heavy feeders and highly responsive to nutrient inputs, proper nutrient management is critical for maximizing production (8). However, organic farming which differs fundamentally from conventional farming in soil fertility and pest management practices, presents additional challenges. Most commercially available potato varieties in India have been bred for high yields under conventional, high-input farming systems, which may not perform well in organic farming systems (9). The yield performance of conventional varieties under organic farming revealed that different varieties exhibit different responses across locations and years, due to interactions between the genotype and environment (10). Therefore, identification of suitable varieties that are well-adapted to organic farming is a key factor for improving productivity in organic potato farming (11). The Indian Council of Agricultural Research (ICAR)-Central Potato Research Institute (CPRI) has developed and introduced suitable potato varieties for this region, which are widely adopted under diverse ecosystems due to their high yield under intensive cultivation practices. In this context, the present study was conducted to assess the performance of different potato varieties under organic farming conditions in the NEHR.

Materials and Methods

Description of the study area

To assess the suitability of potato varieties for organic farming, a field trial was conducted in the NEHR of India. Six high-yielding varieties (HYVs) of potato were assessed over three consecutive Kharif seasons, from 2020 to 2022 at ICAR - CPRI, Regional Station, Upper Shillong, Meghalaya (25°54' N latitude and 91°84' E longitude, 1739 m mean sea level).

Description of experimental materials

This experiment included six potato varieties (Table 1). The seeds (tubers) of all six potato varieties were sourced from seed farm at ICAR-CPRI, Regional Station, Shillong. The experimental design was randomized complete block design (RCBD) with four replications.

The experiment was carried out under organic farming conditions, following the recommended package of practices for potato cultivation in the NEHR of India (12). The field was thoroughly prepared with two ploughings followed by harrowing and planking to make the soil suitable for potato planting. The first ploughing was done one month before planting, allowing the soil to be exposed to sunlight. This practice helps to reduce soil-borne pests and pathogens. A seed rate of 2.5 t ha^{-1} was used and the crop was sown last week of February from 2020 to 2022 using the ridges and furrow method of planting. A spacing of 60 cm between rows and plant-to-plant spacing of 20 cm was maintained. To meet the nutrient requirement of 140 kg of nitrogen (N), 120 kg of phosphorous (P_2O_5) and 60 kg of potassium (K_2O) per hectare, 14 t of well-decomposed farmyard manure (FYM) and 4 t of vermicompost were applied per hectare. On average, well decomposed FYM contains 0.5 % N, 0.2 % P_2O_5, 0.6 % K_2O, while vermicompost contains 1.72 % N, 0.65 % P_2O_5, 0.78 % K_2O. Although this region receives approximately 1800 mm of rainfall from February to July, supplemental irrigation was provided during dry spells. Intercultural operations, such as weeding and earthing up, were carried out at 45 days after planting (DAP). Only disease-free tubers were used for planting. Copper oxychloride (0.2 % at 2 g L^{-1} of water) was sprayed at six-day intervals from canopy closure to control late blight disease. The crop matured in approximately 120 - 140 days, depending on the varieties.

Data collection

Data were collected from six randomly selected plants per plot for plant height (cm), number of stems per plant, number of leaves per plant at 60 DAP. Tuber numbers and yield (t ha^{-1}) were recorded during harvesting. The tuber weights were graded into two grades: <25 g (non-marketable) and >25 g (marketable) at harvest.

Storage behaviour

An experiment was conducted over two consecutive years, from August to December 2021 and 2022, to evaluate the storage behaviour of six potato varieties under ambient conditions in a country store. Five kilograms of skin-cured, healthy and uniform-sized cleaned tubers of each variety were stored in gunny bags at room temperature with four replications. Minimum, maximum temperatures and relative humidity (RH) were recorded throughout the storage period. Data on sprouting percentage, dormancy and number of rotten tubers were recorded at 60, 90 and 120 days of storage. Physiological loss of weight (PLW) was determined by weighing five randomly selected tubers from each replication at the start of storage and again after 120 days of storage. Total weight loss (TWL) was determined at the end of the experiment.

Determination of tuber dry matter content

To determine the tuber dry matter content, 100 g of fresh chopped tubers were dried at 80 °C until a constant weight was achieved and the following formula was used to calculate tuber dry matter (13):

$$\text{Tuber dry matter (\%)} = (\text{Dry weight} / \text{Fresh weight}) \times 100$$

Economic analysis

The gross return was calculated based on the current market selling price of potatoes and expressed in ₹ ha^{-1}. Net return was calculated from the difference between gross return and total cost of cultivation and expressed in ₹ ha^{-1}. The benefit-cost ratio (BCR) was also calculated to identify the most profitable varieties under organic farming.

Statistical analysis

The data collected over three years were pooled and analysed using IBM SPSS Statistics. The treatment means were compared using the least significant difference (LSD) with a probability level of 0.05 (14). Mean values were assessed using the Duncan Multiple Range Test (DMRT) in IBM SPSS Statistics. Pearson correlation analysis was used to determine relationships between different storage parameters.

Results and Discussion

Soil characteristics and weather parameters of the study area

The experimental soil was classified as sandy loam and contained 1.3 % of organic carbon. The available nutrient content in the soil included 235 kg ha^{-1} of N, 21 kg ha^{-1} of phosphorus (P), 255 kg ha^{-1} of potassium (K) with a pH of 4.9. During the cropping period, the maximum temperatures range from 18.34 °C to 25.30 °C from February to October, while minimum temperatures range from 5.71 °C to 10.61 °C from November to January. This area received a total rainfall of 2700 mm, with peak rainfall occurring from April to

Table 1. Agronomic characteristics and yield performance of potato varieties used in this study

Varieties	Year of release	Duration (days)	Average yield (q/ha)	Agronomic characteristics
Kufri Jyoti	1968	100–120	250–300	Wider adaptability, early bulker and susceptible to late blight disease
Kufri Megha	1989	120–140	250–300	Wider adaptability in Meghalaya, moderately resistant to late blight disease
Kufri Giriraj	1998	100–120	200–250	Early bulker and susceptible to late blight disease
Kufri Kanchan	1999	120–140	250–300	Red skin, moderately resistant to late blight disease
Kufri Himalini	2006	100–120	300–350	High-yielding, moderately resistant to late blight disease
Kufri Girdhari	2008	120–140	300–350	High-yielding, highly resistant to late blight disease

October. The maximum RH ranged from 45.43 % to 77.68 % (Fig. 1).

Growth parameters of potato as influenced by varieties

Plant height

The pooled analysis of plant height revealed that significant differences were recorded among the varieties (Fig. 2a). The tallest and statistically similar plant heights were recorded in Kufri Girdhari (47.56 cm) and Kufri Himalini (42.89 cm) varieties. Kufri Giriraj exhibited the shortest plant height of 34.59 cm, which was statistically similar to the remaining varieties. Similar findings regarding the variation in plant height of potato varieties have been reported (15-18). The variations in plant height might be attributed to food reserves for early growth of seed tuber as well as genotype variations, genetic makeup and genotype-environmental interaction (19, 20).

Number of leaves per plant

The pooled analysis of variance showed that the mean number of leaves per plant varied significantly among the potato varieties. Kufri Girdhari recorded the highest mean number of leaves (42.39 leaves per plant) followed by Kufri Megha (38.80 leaves per plant) and Kufri Himalini (37.26 leaves per plant). In contrast, Kufri Kanchan had the lowest leaves per plant (33.33). These results are in line with previous studies indicating that variations in the number of leaves in potato varieties were influenced by genetic variability and environmental adaptability (15, 17). Furthermore, leaf number plays a vital role in crop productivity, as it directly influences plant growth and carbohydrate synthesis, which promotes the tuber development (21).

Number of stems per plant

The number of stems in a potato plant is a key factor influencing its yield potential. In this study, Kufri Jyoti had the highest mean number of stems per plant (4.04) followed by Kufri Megha (3.80) and Kufri Giriraj (3.69) (Fig. 2b). However, the Kufri Kanchan had the lowest mean number of stems per plant (3.17), which was on par with Kufri Girdhari (3.35) and Kufri Himalini (3.28). These findings are consistent with earlier reports (15-18), which also observed variations in number of stems per plant. The genetic diversity of potato varieties affects the number of tuber sprouts, which subsequently affects the number of stems (22). Factors such as variety, tuber size, sprouting behaviour, physiological age of the seed tuber and storage environment also influence the number of stems (23). A higher number of stems are advantageous, as it promotes early soil cover, improve photosynthesis and tuber yield of potato (16).

Yield and yield-related parameters

Total, marketable and non-marketable tuber yield

Different potato varieties had a significant effect on yield attributes of potato under organic farming (Table 2). Kufri Himalini recorded the highest total tuber yield (14.44 t ha^{-1}), followed by Kufri Griraj (12.28 t ha^{-1}), Kufri Girdhari (11.79 t ha^{-1}) and Kufri Megha (11.80 t ha^{-1}). The lowest tuber yield of 10.13 t ha^{-1} was recorded in Kufri Kanchan. Although Kufri Jyoti produced higher number of stems per plant, but its tuber yield was lower (11.16 t ha^{-1}), probably due to lower weight of individual tuber. Similarly, Kufri Ashoka also had more stems

Table 2. Yield and production economics of various potato cultivars (estimation from three years' pooled data)

Varieties	Tuber yield (t ha^{-1})	Marketable yield (t ha^{-1})	Non-marketable tuber yield (t ha^{-1})	Net return (₹ ha^{-1})	BCR
Kufri Jyoti	11.16^{bc*}	6.94^{cd}	4.42^{b}	272899	0.96
Kufri Megha	11.80^{b}	6.65^{cd}	5.15^{a}	304815	1.07
Kufri Giriraj	12.48^{b}	8.75^{b}	3.73^{b}	340972	1.20
Kufri Kanchan	10.13^{c}	5.94^{d}	4.18^{b}	221357	0.78
Kufri Himalini	14.44^{a}	10.31^{a}	4.13^{b}	436914	1.53
Kufri Girdhari	11.79^{b}	7.49^{bc}	4.30^{b}	311114	1.12

*Values in a column with different letter(s) are significantly different at $p < 0.05$ applying LSD test

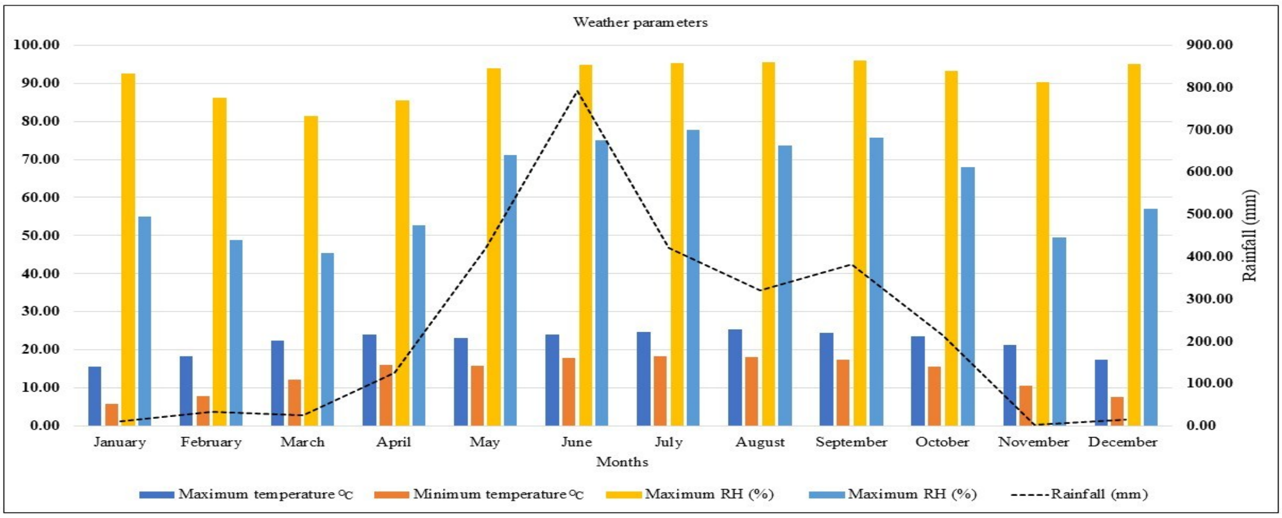

Fig. 1. Average monthly weather parameters (pooled mean of 2020-2022) of experimental site (Upper Shillong, Meghalaya).

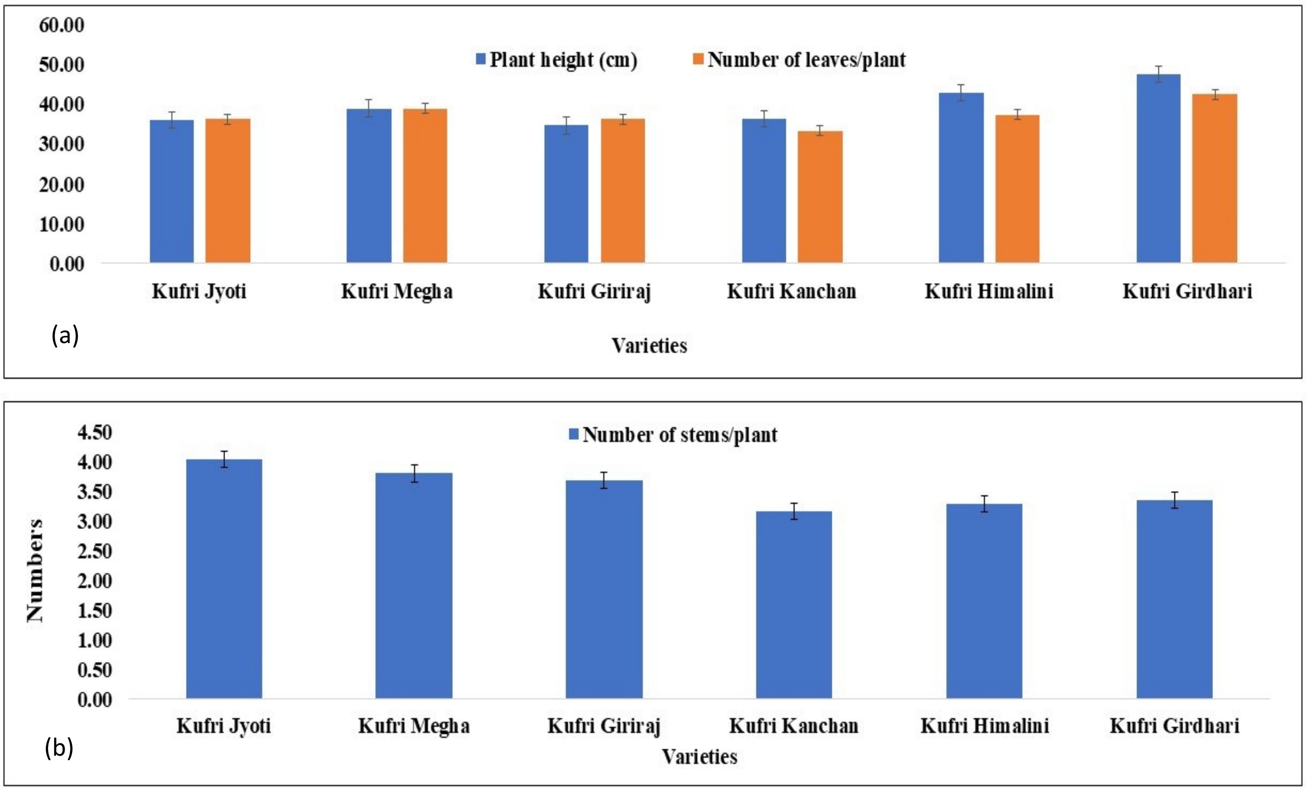

Fig. 2. Plant growth parameters of different potato varieties (three years pooled data): (a) Plant height and number of leaves per plant, (b) Number of stems per plant.

but yielded only 24.54 t ha^{-1}, for the same reason (16). These observations align with earlier findings indicated a positive correlation between the number of stems and tuber number, but a negative correlation between stem number and individual tuber weight (24). Overall, the variation in tuber yield among the potato varieties under organic farming systems have been documented in previous studies (25). Additionally, factors like genotype, soil properties, climate and agronomic management have been identified as key factor in yield and productivity of potato. Marketable tuber yield is the most important parameter in potato production and directly influences the economics. The highest marketable tuber yield was also recorded from Kufri Himalini (10.31 t ha^{-1}) followed by Kufri Giriraj (8.75 t ha^{-1}), Kufri Girdhari (7.49 t ha^{-1}) and Kufri Jyoti (6. 94 t ha^{-1}). Kufri Kanchan had the lowest marketable yield of 5.94 t ha^{-1}. Variation in marketable tuber yield among different varieties was influenced by several factors, including genetic variability, agronomic practices and agro-ecological conditions (15, 17, 18, 26). The Kufri Kanchan exhibited lower total and marketable tuber yields compared to other varieties, probably due to its limited adaptability to organic farming in the northeastern region. In terms of non-marketable tuber yield, Kufri Megha had the highest yield of 5.15 t ha^{-1}. In contrast, the lowest non-marketable tuber yield was recorded in Kufri Giriraj (3.73 t ha^{-1}), Kufri Himalini (4.13 t ha^{-1}), Kufri Kanchan (4.18 t ha^{-1}) and Kufri Jyoti (4.22 t ha^{-1}) respectively. The non-marketable tuber yield of potatoes varied significantly among different genotypes and varieties across different locations and climatic conditions (15, 27). From this three-year study, Kufri Himalini variety consistently performed better in total and marketable tuber yield as compared to other varieties under organic farming.

Number of total, marketable and non-marketable tubers

Among the varieties evaluated for tuber numbers, Kufri Himalini produced the highest total number of tubers, 591.81 thousand ha^{-1}, indicating its superior performance under the current agro-ecological conditions. On the other hand, Kufri Giriraj produced the lowest total tubers (464.30 thousand ha^{-1}) followed by Kufri Girdhari (478.97 thousand ha^{-1}) (Fig. 3). These variations in tuber number among the varieties are attributed to several factors, including genetic variability (28–31), vegetative vigour, number of stems per plant (29), environmental conditions and cultivation practices (32). In terms of marketable tubers, Kufri Himalini again outperformed other varieties, producing 274.74 thousand ha^{-1}. In contrast, Kufri Kanchan produced the lowest number of marketable tubers (162.42 thousand ha^{-1}), followed by Kufri Megha (180.75 thousand ha^{-1}). These differences are influenced by the genetic characteristics of each variety (29, 33). Regarding non-marketable tubers, Kufri Megha produced the highest number of undersized (non-marketable) tubers (364.51 thousand ha^{-1}), which was statistically on par with Kufri Kanchan (357.77 thousand ha^{-1}). On the other hand, Kufri Giriraj exhibited the fewest undersized tubers (235.34 thousand ha^{-1}), followed by Kufri Girdhari (264.25 thousand ha^{-1}). A high proportion of undersized tubers may result from excessive vegetative growth, delayed physiological maturity (34), varietal characteristics and adaptability (35). From a farmer's perspective, varieties that yield a higher proportion of medium to large-sized marketable tubers are more profitable, as they fetch better prices in the market and ensure higher economic returns. Therefore, cultivars like Kufri Himalini, which exhibit both high total and marketable tuber numbers, offer significant potential for

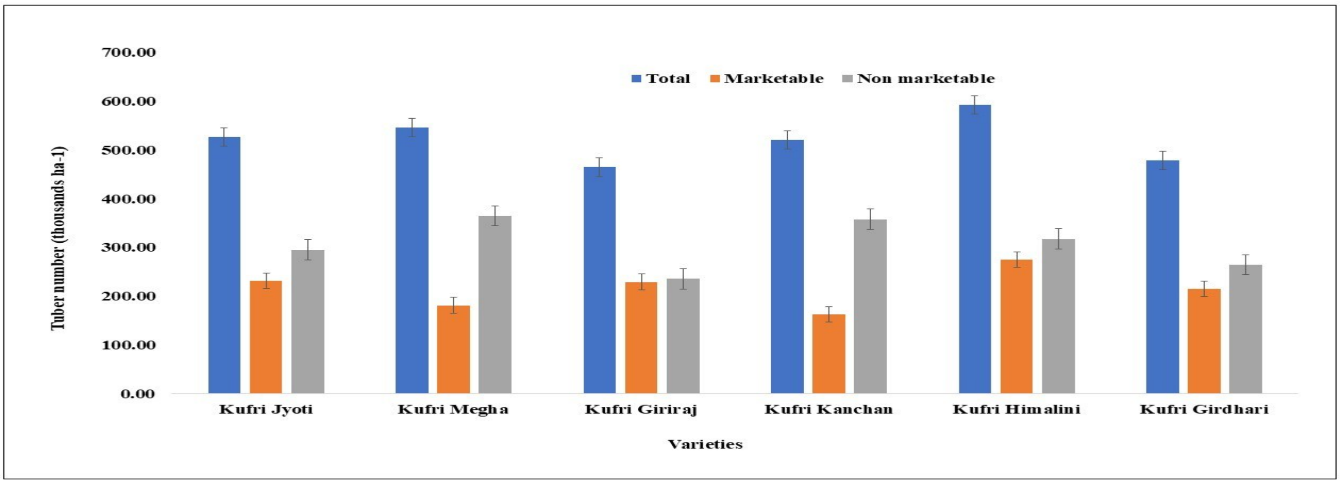

Fig. 3. Effect of different potato varieties on the number of tubers per 1000 ha^{-1} (three years pooled data).

adoption in commercial organic potato farming systems.

Economic feasibility of the tested varieties

The economic analysis revealed that Kufri Himalini offered the highest net returns and BCR of ₹ 436914 ha^{-1} and 1.53 respectively (Table 2). Following this, Kufri Giriraj yielding net returns of ₹ 340972 ha^{-1} along with a BCR of 1.20. Kufri Girdhari generated net returns of ₹ 311114 per hectare, resulting in a BCR of 1.12. Kufri Megha produced net returns of ₹ 304815 per hectare, with a BCR of 1.07. Conversely, Kufri Kanchan and Kufri Jyoti exhibited the lowest net returns and BCR values. This economic analysis of this experiment highlights the importance of varietal selection for achieving profitable organic potato production.

Storage behaviour

The data on sprouting, PLW, tuber rottage and TWL during storage at room temperature were shown in Tables 3 and 4. During the storage period, the average maximum and minimum temperatures ranged from 15.65 °C to 24.61 °C and 4.59 °C to 16.76 °C respectively. Meanwhile, the average maximum and minimum RH ranged from 91.06 % to 94.67 % and 52.07 to 73.12 % respectively.

Dormancy period and sprouting

Sprouting of potatoes significantly affects the post-harvest quality and marketability of potato tubers. Significant differences in sprouting percentage were observed among the potato varieties and across storage durations of 60, 90 and 120 days. Indian potato varieties were categorized based on dormancy period: short (<70 days), medium (71-80 days) and long (>80 days) (36). Kufri Giriraj and Kufri Jyoti reached 80 % sprouting within 60 days of storage, indicating short dormancy. Early sprouting affects the potato quality under non-refrigerated storage (37). Varieties with short dormancy periods are advantageous, as they allow the summer crop to be used for autumn planting within the same year (38). After 90 days of storage, Kufri Himalini (84.85 %) and Kufri Megha (93.03 %) surpassed the 80 % sprouting threshold, classifying them as medium dormancy. In contrast, Kufri Girdhari (22.34 %) and Kufri Kanchan (20.43 %) exhibited less than 80 % sprouting even after 90 days of storage, indicating longer dormancy period for

Table 4. Percent rottage by number, PWL and TWL of potato varieties under ambient storage conditions

Varieties	% Rottage (number)	PLW (%)	TWL (%)
Kufri Jyoti	5.36^{bc} (2.31)*	18.42^{ab} (4.28)	23.78^{a} (4.87)
Kufri Megha	4.17 ^{bc} (2.00)	17.96^{ab} (4.10)	22.13^{ab} (4.58)
Kufri Giriraj	6.02 ^{b} (2.32)	23.46^{a} (4.80)	29.48^{a} (5.42)
Kufri Kanchan	3.33^{bc} (1.82)	10.30^{bc} (3.15)	13.63^{bc} (3.65)
Kufri Himalini	9.11^{a} (3.01)	19.02^{ab} (4.34)	28.13^{a} (5.29)
Kufri Girdhari	2.97^{c} (1.70)	7.53^{c} (4.80)	10.50^{c} (3.23)

*Data in parenthesis are mean of the square-root transformed percentage. Values in a column with different letter(s) are significantly different at $p < 0.05$ applying LSD test.

Table 3. Dormancy period and sprouting (%) of potato varieties under ambient storage conditions

Varieties	Dormancy (weeks)	Sprouting (%)		
		At 60 days after storage	At 90 days after storage	At 120 days after storage
Kufri Jyoti	>6 weeks	80.23^{b} (64.04)*	100.00^{a} (90)	100.00^{a} (90.00)
Kufri Megha	>6 weeks	74.00^{b} (59.39)	93.03^{a} (74.88)	100.00^{a} (90.00)
Kufri Giriraj	>6 weeks	91.38^{a} (73.00)	100.00^{a} (90.00)	100.00^{a} (90.00)
Kufri Kanchan	>6 weeks	4.05^{d} (11.42)	20.43^{c} (26.51)	65.31^{c} (53.93)
Kufri Himalini	>6 weeks	51.24^{c} (45.72)	84.85^{b} (67.41)	93.06^{b} (75.28)
Kufri Girdhari	>6 weeks	5.31^{d} (12.97)	22.34^{c} (28.10)	48.78^{d} (44.30)

* Data in parenthesis are arcsine transformed values of percentages. Values in a column with different letter(s) are significantly different at $p < 0.05$ applying LSD test.

these varieties. Even after 120 days of storage, sprouting for Kufri Girdhari (48.78 %) and Kufri Kanchan (65.31 %) remained below 80 %, indicating these varieties are suitable for extended non-refrigerated storage to minimize market losses. These findings align with findings reported in earlier studies (39-42). The variation in the sprouting behaviour of different potato varieties could be influenced by factors such as variety (43), season (41), storage temperature and RH (42).

Physiological loss of weight

Excessive evaporation from the tuber surface causes weight reduction and skin shrinkage, which adversely affects tuber quality and reduce its market value. In this investigation, the PLW of potato varieties varied between 7.53 % in Kufri Girdhari to 23.46 % in Kufri Giriraj after 120 days of storage. Kufri Girdhari and Kufri Kanchan exhibited lower weight loss (7.53 % and 10.30 %) due to their lower sprouting rates. Varieties with long dormancy generally experience the lowest PLW under non -refrigerated storage conditions. Sprouted potato tubers lose more weight than unsprouted tubers (44). Several factors influence PLW, including periderm thickness, number of cell layers and lenticel count (45). Potatoes also lose moisture through respiration during storage, especially under high temperatures and low humidity conditions (46). These results confirmed the findings of (39-42) which also highlighted the effect of environmental factors on PLW in stored potatoes.

Tuber rotting

Tuber rotting makes the tuber unsuitable for consumption and can spread infection to adjacent tubers during storage. Deterioration of freshly harvested potatoes was caused by moisture loss, respiratory loss, microbial spoilage and biochemical changes. The mean percent rot (by number) was highest in Kufri Himalini (9.11 %) and Kufri Giriraj (6.67 %), while Kufri Girdhari (2.97 %) and Kufri Kanchan (3.33 %) exhibited the lowest tuber rottage. The highest tuber rottage in Kufri Himalini (2.8 %) under ambient storage in the Nilgiris has been previously reported (41), which the current results are consistent with. The rotting of tubers in different varieties was influenced by growing conditions, storage environments and varietal responses (41, 47).

Total weight loss

The TWL of potatoes affects their longevity and quality during storage. After 120 days of storage, Kufri Girdhari showed the lowest weight loss (10.50 %) and was classified as a "very good keeper," followed by Kufri Kanchan (13.63 %) which was classified as a “good keeper”. In contrast, Kufri Giriraj, Kufri Himalini, Kufri Jyoti and Kufri Megha had the highest losses (29.48 %, 28.13 %, 23.78 % and 22.13 % respectively) and were classified as "poor keepers". Kufri Girdhari exhibited superior performance during the summer and autumn seasons and maintained good storability in spring under the climatic conditions of the Nilgiris region (44). Sprouting contributes to TWL during storage (39–42). Based on these findings, Kufri Girdhari and Kufri Kanchan exhibited minimal TWL, maintained tuber firmness and retained market value for longer periods.

Tuber dry matter content

Significant variations were recorded in tuber dry matter content ranged from 16.8 % to 18.8 % (Fig. 4). Kufri Megha exhibited the highest dry matter content (18.8 %) followed by Kufri Himalini (18.4 %), Kufri Girdhari (18.3 %) and Kufri Kanchan (18.14 %). In contrast, Kufri Jyoti had the lowest dry matter content (16.8 %), followed by Kufri Giriraj (17.81 %). Tuber dry matter content is a key indicator of the end-use quality of potato tubers. Varieties with high dry matter content are more suitable for processing, while those with low to moderate dry matter are better suited for table consumption (48). These findings are in line with several studies on Indian potato varieties (40-42) which also emphasized the importance of dry matter content in varietal suitability for different use.

Pearson correlation matrix between different attributes of potato storage parameters

Pearson correlation analysis was used to examine the relationships between the six storage parameters of potatoes (Table 5). The sprouting percentage at 60 days of storage showed a positive correlation with the sprouting percentage at 90 days of storage (r=0.98**), 120 days of storage (r=0.94**), PLW (r=0.94**) and TWL (r=0.87*). Similarly, the sprouting at 90 days of storage was positively correlated with sprouting percentage at 120 days of storage (r=0.97**), PLW (r=0.94**) and TWL (r=0.91*) at 5 % significance level. Additionally, the sprouting percentage at 120 days positively correlated with PLW (r=0.94**) and TWL (r=0.91*). These findings align with previous studies that emphasized similar correlations between sprouting, TWL and PLW in Indian potato varieties (40, 42). Increased tuber weight loss was associated with sprouting, which expands the tuber surface area and enhances water vapour loss due to the permeability of sprout walls. Furthermore, studies show that potato sprouts are equivalent to 1 % of the surface area of potato tuber and can double the evaporation rate (49). Additionally, the percentage of tuber rotting by number positively correlated with TWL (r=0.82*). The weight loss due to rottage was positively correlated with TWL in potatoes (40). PLW showed a strong positive correlation with sprouting at 60, 90 and 120 days of storage (r= 0.94**) and TWL (r= 0.98**). However, excessive PLW, tuber rottage and TWL can adversely affect the quality of potato tubers during storage (50). Therefore, careful varietal selection is essential for successful potato cultivation and post-harvest management (42).

Table 5. Pearson correlation matrix analysis between different storage parameters

Parameters	Spr 60	Spr 90	Spr 120	RN (%)	PLW (%)	TWL (%)
Spr 60	1	0.98**	0.94**	0.47	0.94**	0.87*
Spr 90		1	0.97**	0.61	0.94**	0.91*
Spr 120			1	0.59	0.94**	0.91*
RN (%)				1	0.68	0.82*
PLW (%)					1	0.98**
TWL (%)						1

*Significant at 0.05 probability level; **highly significant at 0.01 probability level; Spr 60: Sprouting at 60 days from start of storage (%); Spr 90: Sprouting at 90 days from start of storage (%); Spr 120: Sprouting at 120 days from start of storage (%); RN: Percentage rottage by numbers (%); TWL: Total weight loss (%) at 120 days; PLW: Physiological loss of weight (%) at 120 days.

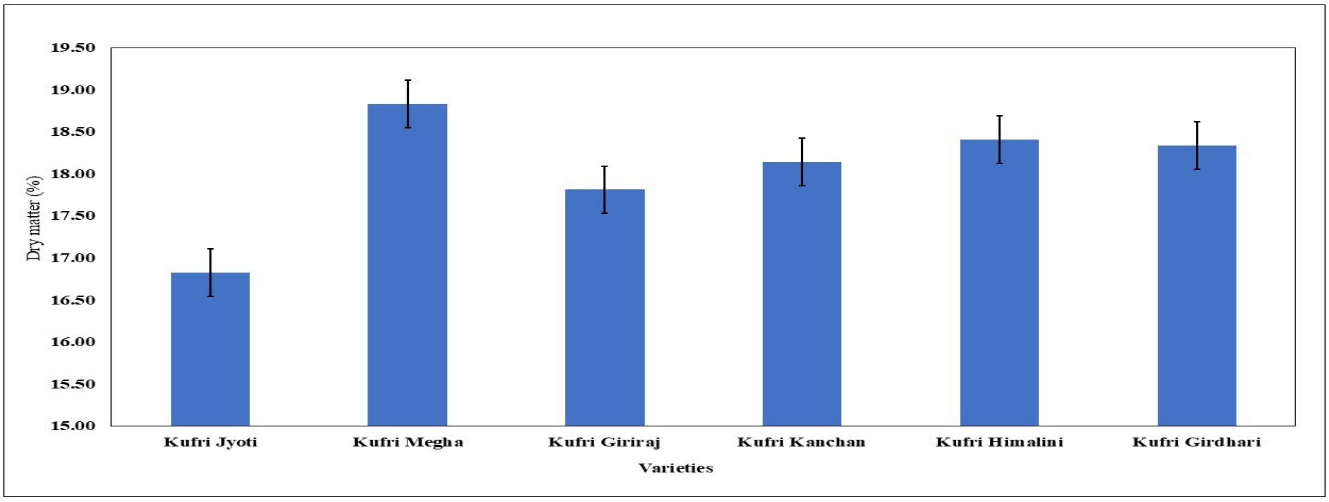

Fig. 4. Dry matter content (%) of different potato varieties (three years pooled data).

Conclusion

In India, potato is an important commercial tuber crop, cultivated in almost all states and adapted under wide range of agroclimatic conditions. However, challenges such as the lack of suitable varieties, several biotic and abiotic factors have hindered organic potato production. This field trial was evaluated the performance of six potato varieties under an organic farming system. Among the varieties tested, Kufri Himalini produced the highest total tuber and marketable yield of 14.44 t ha^{-1} and 10.89 t ha^{-1} respectively. This variety is characterized by early to medium maturity, high total and marketable tuber yield along with moderate resistance to late blight disease are the key traits preferred by farmers in organic farming. Based on overall performance including tuber yield, disease resistance and economics, Kufri Himalini is recommended for organic farming in Meghalaya. Additionally, farmer's perceptions for their varietal requirements can provide valuable insights for potato breeding, which will improve the adoption of new varieties in organic farming.

Acknowledgements

All authors would like to express their sincere gratitude to Indian Council of Agricultural Research - Central Potato Research Institute Shimla, India, for providing financial support and the necessary facilities for conducting the experiments.

Authors' contributions

PJ and SR conceptualized and designed the study. PJ, NS and CC carried out the fieldwork and data collection. PJ and PM performed the data analysis and visualization. PJ and YAL contributed to the interpretation of the results and the literature review. PJ, NS, CC and YAL prepared the initial draft of the manuscript. SR improved the manuscript. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interest to declare.

Ethical issues: None

References

1. Sanwal SK, Yadav RK, Singh PK. Effect of types of organic manure on growth, yield and quality parameters of ginger (*Zingiber officinale*). Indian J Agric Res. 2007;77:67–72.
2. Bujarbaruah KM. Organic farming: opportunities and challenges in northeastern region of India. In: Souvenir of international conference on organic food; ICAR (RC) for NEH region, Umiam, Meghalaya; 2004. p. 13–24.
3. Das A, Ramakrishna GI, Layek J, Babu S, Ngangom B, Suiting D. Package of practices of Meghalaya. In: Ravisankar N, Panwar AS, Kamta P, Vipin K, Bhaskar S, editors. Organic farming crop production guide. Modipuram, UP, India: ICAR IIFSR; 2017. p. 226–44.
4. FAOSTAT. Food balance sheet. 2016. Available from: http://www.fao.org/faostat/en/#data/FBS
5. Singh B, Dutt S. Seventy-five years of potato in India: an inspiring success story. Indian Farming. 2024;74(05):3–8.
6. Sailo N, Janani P, Challam C, Lyngdoh YA. Potato production technologies for northeastern region. Indian Farming. 2024;74(05):20–2.
7. Nath D, Shil S, Dey D, Chakraborty A. Bringing prosperity to potato growers through true potato seed (TPS) cultivation: a case of Khowai district of Tripura. Innovative Farming. 2017;2(1):22–5.
8. Koch M, Naumann M, Pawelzik E, Gransee A, Thiel H. The importance of nutrient management for potato production part I: plant nutrition and yield. Potato Res. 2020;63:97–119. https://doi.org/10.1007/s11540-019-09431-2
9. Murphy MK, Campbell KG, Kimberly, Lyon SR, Stephen SS. Evidence of varietal adaptation to organic farming systems. Field Crops Res. 2007;102(3):172–7. https://doi.org/10.1016/j.fcr.2007.03.011
10. Anastasi U, Corinzia SA, Cosentino SL, Scordia D. Performances of durum wheat varieties under conventional and no-chemical input management systems in a semiarid Mediterranean environment. Agronomy. 2019;9(12):788. https://doi.org/10.3390/agronomy9120788
11. van Bueren ETL, Struik PC, Jacobsen E. Ecological concepts in organic farming and their consequences for an organic crop ideotype. NJAS Wageningen J Life Sci. 2002;50:1–26. https://doi.org/10.1016/S1573-5214(02)80001-X
12. Mankar P, Rawal S, Das P, Janani P, Dua VK, SK Chakrabarti. Package of practice for organic potato cultivation in hills. Shimla, HP: ICAR-Central Potato Research Institute; 2020. p. 36.
13. Luthra SK, Gopal J, Pandey SK. Selection of superior parents and crosses in potato for developing cultivars suitable for early planting in UP. J Indian Potato Assoc. 2003;30(1–2):1–2.

14. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. New Delhi: Indian Council of Agricultural Research; 1967. p. 1–381.

15. Sadawarti M, Patel K, Samadhiya RK, Gupta PK, Singh SP, Gupta VK, et al. Evaluation of table and processing varieties of potato (*Solanum tuberosum* L) for North-Central India. Int J Chem Stud. 2018;6(4):823–33.

16. Das S, Mitra B, Luthra SK, Saha A, Hassan MM, Hossain A. Study on morphological, physiological characteristics and yields of twenty-one potato (*Solanum tuberosum* L) cultivars grown in Eastern Sub-Himalayan plains of India. Agronomy. 2021;11:335. https://doi.org/10.3390/agronomy11020335

17. Sruthi V, Suchitra V, Laxmi Narayana D, Bhagyashali H. Evaluation of potato (*Solanum tuberosum* L) varieties for growth and yield attributes under Southern Telangana agroclimatic conditions. Pharma Innov J. 2021;10(12):1459–62.

18. Shankar D, Markam PS, Siwana H, Ganjeer PK, Kujur A. Evaluation of potato varieties/genotypes in Kanker district of Chhattisgarh. Pharma Innov J. 2022;SP-11(9):3206–9.

19. Asnake D, Alemayehu M, Asredie S. Growth and tuber yield responses of potato (*Solanum tuberosum* L) varieties to seed tuber size in northwest highlands of Ethiopia. Heliyon. 2023;9(3):e14586. https://doi.org/10.1016/j.heliyon.2023.e14586

20. Eaton TE, Azad AK, Kabir H, Siddiq AB. Evaluation of six modern varieties of potatoes for yield, plant growth parameters and resistance to insects and diseases. Agric Sci. 2017;8(11):1315–26. https://doi.org/10.4236/as.2017.811095

21. Malik NJ. Potatoes in Pakistan: a handbook. Islamabad, Pakistan: Pakistan agricultural research council, Pak Swiss potato development project; 1995. p. 80–5.

22. Getie AT, Madebo MP, Abrar SA. Evaluation of growth, yield and quality of potato (*Solanum tuberosum* L) varieties at Bule, Southern Ethiopia. African J Plant Sci. 2018;12:277–83.

23. Iritani WM, Thornton R, Welter L, Leavy O. Relationship of seed size, spacing, stem numbers to yield of Russet Burbank potatoes. Am J Potato Res. 1972;40:463–79. https://doi.org/10.1007/BF02895746

24. Knowles N, Knowles L. Manipulating stem number, tuber set and yield relationships for northern- and southern-grown potato seed lots. Crop Sci. 2006;46:284–96.

25. Ierna A, Parisi B. Crop growth and tuber yield of “early” potato crop under organic and conventional farming. Sci Hortic. 2014;165:260–5. https://doi.org/10.1016/j.scienta.2013.11.032

26. Scavo A, Mauromicale G, Ierna A. Genotype × environment interactions of potato tuber quality characteristics by AMMI and GGE biplot analysis. Sci Hortic. 2023;310:111750. https://doi.org/10.1016/j.scienta.2022.111750

27. Tessema L, Mohammed W, Abebe T. Evaluation of potato (*Solanum tuberosum* L) varieties for yield and some agronomic traits. Open Agric. 2020;5:63–74. https://doi.org/10.1515/opag-2020-0006

28. Das SK, Banerjee H, Chakraborty A, Sarkar A. Production potential of newly released potato (*Solanum tuberosum* L) cultivars under different nitrogen levels. SAARC J Agric. 2015;13(2):121–30. https://doi.org/10.3329/sja.v13i2.26573

29. Gebreselassie H, Mohamed W, Shimelis B. Evaluation of potato (*Solanum tuberosum* L) varieties for yield and yield components in eastern Ethiopia. J Biol Agric Healthc. 2016;6(5):146–54.

30. Giri RA, Bhusal Y, Upadhyay KP, Chalise B, Subedi G, Thapa B, Poudel B. Evaluation of potato genotypes under high hill conditions of Nepal. Asian J Agric Hortic Res. 2023;10(4):1–8. https://doi.org/10.9734/ajahr/2023/v10i4239

31. Thapa S, Rokaya PR, Parajuli S, Pokhrel B, Aryal Y. Evaluation of performance of different varieties of potato (*Solanum tuberosum* L.) in Bajhang, Nepal. Int J Appl Biol. 2022;6(2):115-25. https://doi.org/10.20956/ijab.v6i2.21224

32. Islam J, Choi SP, Azad OK, Kim JW, Lim YS. Evaluation of tuber yield and marketable quality of newly developed thirty-two potato varieties grown in three different ecological zones in South Korea. Agriculture. 2020;10(8):327. https://doi.org/10.3390/agriculture10080327

33. Hira Moni M, Mannan A, Yamin Kabir M. Evaluation of potato varieties in the south-western coastal region of Bangladesh. Khulna Univ Stud. 2024;21(2):39-47. https://doi.org/10.53808/KUS.2024.21.02.1222-ls

34. Sharma AK, Sarjeet S. Effect of seed tuber desprouting on potato production in Kufri Giriraj. Potato J. 2009;36(1-2):51-60.

35. Patel RN, Patel NH, Pandey SK, Kanbi VH, Patel CK. Yield performance and shelf life of some advanced potato hybrids in Gujarat. Potato J. 2006;33(3-4):149-50.

36. Pande PC, Singh SV, Pandey SK, Singh B. Dormancy sprouting behaviour and weight loss in Indian potato (*Solanum tuberosum* L.) varieties. Indian J Agric Sci. 2007;77(11):715-20.

37. Paul V, Ezekiel R. Relationship between tuber size and storage behaviour in two potato cultivars during on-farm storage. J Indian Potato Assoc. 2003;30:161-2.

38. Gupta VK, Bipul KD, Pandey SK. Performance of local potato varieties in Meghalaya hills. Potato J. 2009;36(1-2):65-7.

39. Das M, Ezekiel R, Pandey SK, Singh AN. Storage behaviour of potato varieties and advanced cultures at room temperature in Bihar. Potato J. 2004;31(1/2):71-5.

40. Gupta VK, Luthra SK, Singh BP. Storage behaviour and cooking quality of Indian potato varieties. J Food Sci Technol. 2015;52(8):4863-73. https://doi.org/10.1007/s13197-014-1608-z

41. Sudha R, Venkatasalam EP, Divya K, Bairwa A, Mhatre PH. Storage behavior of potato cultivars under ambient conditions in the Nilgiris. J Hortic Sci. 2017;12(2):186-92.

42. Gupta VK, Luthra SK. Storability and organoleptic performance of indigenous and exotic potato collections. Potato J. 2020;47(1):80-91.

43. Jaiswal RC, Singh AP, Pathak SP, Srivastava RK. Evaluation of potato hybrids/varieties for their storage behaviour. J Indian Potato Assoc. 2003;30:169-70.

44. van Es A, Hartmans KJ. Dormancy, sprouting and sprout inhibition. In: Rastovski A, van Es A, editors. Storage of potatoes: post-harvest behaviour, store design, storage, practice, handling. Wageningen, the Netherlands: Pudoc; 1987. p. 114-32.

45. Ezekiel R, Singh B, Sharma ML, Garg ID, Khurana SMP. Relationship between weight loss and periderm thickness in potatoes stored at different temperatures. Potato J. 2004;31:135-40.

46. Ezeocha CV, Ironkwe AG. Effect of storage methods and period on the physiological and nutrient components of livingstone potato (*Plectranthus esculentus*) in Abia State, Nigeria. Open Agric. 2017;2:213-9. https://doi.org/10.1515/opag-2017-0022

47. Bhutani RD, Khurana SC. Storage behaviour of potato genotypes under ambient conditions. Potato J. 2005;32(3-4):209-10.

48. Beukema HP, van der Zaag DE. Introduction to potato production. Wageningen, the Netherlands: Pudoc; 1990. p. 208.

49. Paul V, Ezekiel R, Pandey R. Sprout suppression on potato: need to look beyond CIPC for more effective and safer alternatives. J Food Sci Technol. 2016;53(1):1-18. https://doi.org/10.1007/s13197-015-1980-3

50. Pande PC, Luthra S. Performance and storability of advanced potato hybrids in West-central plains. J Indian Potato Assoc. 2003;30(1-2):21-2.

Additional information

Peer review: Publisher thanks Sectional Editor and the other anonymous reviewers for their contribution to the peer review of this work.

Reprints & permissions information is available at https://horizonepublishing.com/journals/index.php/PST/open_access_policy

Publisher's Note: Horizon e-Publishing Group remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Indexing: Plant Science Today, published by Horizon e-Publishing Group, is covered by Scopus, Web of Science, BIOSIS Previews, Clarivate Analytics, NAAS, UGC Care, etc

See https://horizonepublishing.com/journals/index.php/PST/indexing_abstracting

Publisher information: Plant Science Today is published by HORIZON e-Publishing Group with support from Empirion Publishers Private Limited, Thiruvananthapuram, India.