

## Short Communication

### Storage behavior of potato cultivars under ambient conditions in the Nilgiris

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#### ABSTRACT

Storage behavior of different potato cultivars viz., Kufri Swarna, Kufri Girdhari, Kufri Jyoti, Kufri Neelima and Kufri Himalini was assessed for post harvest loss under ambient storage conditions of Nilgiri region. The study was carried out in three different seasons (Spring, Summer and Autumn) during 2013-2015. All the cultivars showed dormancy period of more than six weeks in all the three seasons. Cultivars varied widely in their weight loss, sprouting behavior and cooking quality. Among the varieties Kufri Girdhari found to possess good storage qualities while Kufri Swarna showed poor keeping quality in all the three seasons. All the cultivars recorded less total weight loss during autumn season. The study indicated that importance should be given to the storage behavior of the cultivars along with yield in order to have better keeping quality for regular supply of tubers for table as well as seed purpose.

**Key Words:** Potato cultivars, storage behavior, dormancy, total weight loss and keeping quality.

#### INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the unique and most potential crops having high productivity, supplementing major food requirement in the world. It is rich in carbohydrates, proteins, phosphorus, calcium, vitamin C,  $\beta$ -carotene and has high protein calorie ratio. Amongst the world's important food crops, potato is the fourth important food crop after wheat, rice and maize because of its' great yield potential and high nutritive value. India ranks third in area and second in production with two million hectares and 46 million tons of production. The Nilgiri hills, situated at an elevation of 1500 - 2600 meters above mean sea level at 11° 24' North latitude and 74° 4' East longitude is one of the oldest places where the potato crop was introduced by the foreign invaders long ago. Here, the potato crop can be cultivated throughout the year due to its better geographical location making possible to receive rainfall evenly, round the year. The average annual rainfall of the region is 1400mm in about 100 rainy days and the mean maximum and minimum temperatures are 22.2°C and 17.5°C respectively. In the Nilgiris, potato can be grown under three distinct seasons namely, summer, autumn and winter. Summer is the main season (April/May to August/September) followed by

autumn (August/September to December/January). Potato crop is grown under rainfed conditions during both summer and autumn seasons. A meager area is grown under irrigation during January/February to May/June as winter crop. Knowledge of storage characteristics of potato cultivars is valuable information for planning for next season in areas like Nilgiris where the potato can be grown throughout the year and also storage is necessary for regular supply of potatoes to the consumers during off seasons. Here the seed requirement of main crop is to be met from the autumn season harvest and for autumn it is to be met from the summer crop which has been planted little earlier than that of regular summer crop i.e. during mid March as the irrigated crop is grown in a very negligible area. Hence the information on storage behavior of different cultivars in different seasons is very much important for farmers so that they can maintain their own source of seed. Previous studies on keeping quality (Kang and Gopal 1993; Singh *et al*, 2001; Patel *et al*, 2002; Pande and Luthra 2003; Das *et al*, 2004; Kumar *et al*, 2005) conducted under ambient conditions or under non refrigerated storage like heaps, pits and evaporative cooled potato stores (Kumar *et al*, 1995; Mehta and Kaul, 1997 and Mehta *et al*, 2006) were limited to a few varieties or hybrids

or regions. Pande *et al.*, (2007), conducted an extensive study on sprouting behaviour and weight loss of 37 Indian potato varieties under controlled conditions, but, consolidated information on storage behavior of location specific potato varieties under ambient conditions is lacking. Hence, the present study was carried out to evaluate the storage behavior of different varieties under different seasons at Nilgiri hills.

The study was carried out at ICAR-Central Potato Research Station, Muthorai, Udthagamandalam, The Nilgiris during 2012-13 and 2013-14 in three different potato growing seasons namely spring (January-February to April-May), summer (April- May to August-September) and Autumn (August-September to December).

The experimental material consisted of five commercial potato cultivars recommended for the Nilgiris viz., Kufri Swarna, Kufri Girdhari, Kufri Jyoti, Kufri Neelima and Kufri Himalini. Spring crop was planted during second week of January and harvested during April, summer crop was planted during 1<sup>st</sup> week of May and harvested during September and autumn crop was planted during September and harvested in December. Recommended crop management practices were followed to grow the crop. Haulms cutting were done 105 days after planting. The crop was harvested 15 days after haulm cutting to allow the tubers to attain skin firmness. Immediately after harvesting, tubers were kept in heap under shade for 15–20 days for proper curing of tuber skin and the tubers were utilized for studying the storage behavior and cooking quality.

### Storage behaviour

For studying storage behaviour, 5 kg healthy clean uniform size tubers of each genotype from the harvest of 120 days crop were kept in gunny bags under ambient conditions in country store. This formed one replication. Three such replications were kept in the first week of May for spring crop, last week of September for summer crop, first week of January for autumn crop. The number of tubers in each bag was recorded at the beginning of experiment. The bags containing tuber material were stored for 90 days allowing sufficient space for air movement between bags at ambient room temperatures. The maximum and minimum temperatures and relative humidity were recorded every day. Percent sprouting of tubers (as

calculated from tubers having one or more sprouts above 2 mm long) and number and weight of healthy and rotted tubers were recorded at 60 and 90 days of storage. The physiological weight loss was calculated by weighing five randomly marked tubers from each replication both at the start and at the end of storage, while per cent total weight loss was calculated by weighing the stored tubers at the end of experiment.

### Tuber dry matter content

Samples of five randomly drawn tubers of each variety were used for dry matter estimation. The tubers were cut horizontally and half part was chopped into small pieces. The chopped pieces were mixed properly and 50 g sample of each variety in three replications were kept in oven at 80° C for 72 h (Luthra *et al.*, 2003). The final dry content of the sample was estimated when the weight of the sample reached to a constant level.

### Cooking quality

Internal colour, texture and flavour of boiled/cooked tubers were carried out after one month of harvesting with panel consisting of 12 persons. Precaution was taken to wash the mouth before testing the sample (Meitei and Barooah, 1980) and the final decision about each organoleptic characteristic was taken on consensus. The texture was adjudged in four major categories i.e. 1) extremely mealy–floury, 2) medium to slightly mealy/granular-Mealy, 3) gummy/pasty”waxy and 4) watery or translucent”soggy. Similarly, flavor (a combination of feel of taste, texture and aroma) of the baked potatoes was examined in four categories i.e. 1) Excellent, 2) Very Good, 3) Good and 4) Average (Gupta *et al.*, 2014).

### Statistical analysis

The data obtained during the two years of experimentation were pooled and analyzed with standard statistical procedure (Panse and Sukathme 1967).

The maximum and minimum temperatures ranged between 12.6-24 °C to 5.9-12.4 °C during the period of spring, 14.75 - 22.5 °C to 6.95-8.88°C during summer and 15-21°C to 2.8 – 6.3°C during autumn storage. The relative humidity ranged from 60-82 % during spring, 69-90% during summer and 64-97.5% during autumn. The results on different storage

parameters and cooking quality of potato varieties are described below.

### Dormancy

Based on the dormancy duration from the date of harvesting, Indian potato cultivars can be divided into three categories namely short dormancy (< 71 days), medium dormancy (71-80 days) and long dormancy (>80 days). In the present study, all the test cultivars exhibited a dormancy period of more than six

weeks in all the seasons and per cent of sprouting was below its critical limit (80%) on 60 days after storage and falls under the category of medium dormancy. In cultivar Kufri Swarna, per cent of sprouting reached its critical limit (80%) on 60 days after storage in all the seasons (**Table 1**). Hence, it falls under the category of short dormancy variety. Such variation in tuber dormancy among genotypes under test is in agreement with earlier report (Van Ittersum, 1992; Das *et al.*, 2004 and Gupta *et al.*, 2015).

**Table 1. Dormancy, sprouting per cent and per cent loss due to sprouting of potato cultivars under ambient conditions in different seasons**

Hybrids	Dormancy (Weeks)			Sprouting						% loss due to sprouting (%)		
	Spring	Summer	Autumn	Spring	Summer	Autumn	Spring	Summer	Autumn	Spring	Summer	Autumn
				At 60 days	At 90 days	At 60 days	At 90 days	At 60 days	At 90 days			
Kufri Neelima	> 6 weeks	> 6 weeks	> 6 weeks	76.5(65.1)	95.8(78.4)	66.3(53.0)	88.7(78.6)	52.0(45.6)	76.7(66.1)	0.4(3.8)	1.0(5.6)	0.5(3.9)
Kufri Swarna	> 6 weeks	> 6 weeks	> 6 weeks	82.2(78.0)	98.5(84.3)	81.5(77.5)	98.5(84.3)	79.0(68.0)	96.9(79.4)	1.8(7.8)	2.1(8.0)	0(0.6)
Kufri Jyoti	> 6 weeks	> 6 weeks	> 6 weeks	75.4(65.1)	94.0(78.8)	68.5(56.3)	89.3(79.2)	70.4(57.1)	90.7(80.5)	0.7(4.5)	1.3(6.4)	0(0.6)
Kufri Girdhari	> 6 weeks	> 6 weeks	> 6 weeks	54.6(47.7)	79.3(68.1)	35.7(26.5)	59.9(50.8)	5.0(0.8)	14.0(6.0)	0.4(3.8)	0.5(3.9)	0(0.6)
Kufri Himalini	> 6 weeks	> 6 weeks	> 6 weeks	78.2(67.0)	97.0(83.5)	77.4(66.8)	95.7(78.4)	73.5(60.2)	92.5(75.4)	1.3(6.4)	1.4(6.8)	0(0.6)
SEd				0.35	0.53	0.92	1.41	2.10	3.20	0.03	0.04	0.05
CD ( <i>P</i> = 0.05)				0.70	1.07	1.86	2.84	4.23	6.47	0.07	0.08	0.10

Values in parentheses are transformed values

In general, dormancy is considered to be the varietal character that might get influenced by the soil and environmental conditions during crop growth and storage environment (Ezekiel and Singh, 2003).

### Per cent of sprouting

Significant variations were recorded with respect to sprouting among the cultivars in different seasons. During spring season, the results on sprouting (**Table 1**) revealed that cultivars Kufri Girdhari, Kufri Neelima, Kufri Jyoti and Kufri Himalini showed more than 50% tuber dormancy but it was below the critical limit (80%). Cultivar Kufri Swarna attained 82.2% sprouting at 60 days storage. At 90 days, all the cultivars except Kufri Girdhari attained the critical level (80 %) of sprouting. Kufri Girdhari recorded 59.9% of sprouting at 90 days after harvest.

During summer season, percent sprouting was minimum in Kufri Girdhari (35.7%), Kufri Neelima (66.3%), Kufri Jyoti (68.5%) and Kufri Himalini (77.4%) at 60 days after storage whereas, Kufri Swarna crossed the critical level (81.5%). At 90 days after storage, all the varieties crossed the critical limit of sprouting except Kufri Girdhari (79.3%). During

autumn season also the same trend was observed as summer season but the percent sprouting was lower than summer crop. At 60 days, Kufri Swarna (79.0), Kufri Himalini (73.5%) and Kufri Jyoti (70.4%) recorded a highest sprouting per cent. At the end of storage, Kufri Girdhari recorded 14% sprouting and Kufri Neelima recorded 76.7% sprouting whereas other varieties reached the critical limit. Such variations in sprouting were also observed by Kang *et al* (2001) in indigenous varieties and hybrids.

Soil and environmental conditions during crop growth have a strong influence on the dormancy duration. Cold and wet weather is known to increase the dormancy duration while dry and warm weather reduces it. Season to season variation in the duration of dormancy can also be considerable due to variation in the environmental conditions during crop growth. Storage temperature has a strong influence on the dormancy duration. Higher storage temperature hastens dormancy release, while storage at a temperature of 4°C and below prolongs dormancy by preventing sprout growth (Singh, 2013). Wiltshire and Cobb (1996) also reported that, temperature is considered to be most important physical factors affecting dormancy and it

is reported that within the range of 3–20° C, tubers stored at lower temperature have a longer period of innate dormancy than those stored at higher temperatures. In the present study, average storage temperature during the spring harvested tubers (May – July) was 13.75°C whereas the storage temperature during summer harvested crop is 13.27°C while in autumn harvested crop was 11.3°C. Hence, the per cent sprouting was more in spring season crop than other two seasons and it was minimum in autumn season crop in all the varieties.

### Physiological weight loss and weight loss due to sprout

Reduction in weight of tubers due to evaporative losses from the tuber surface (skin) is considered as physiological weight loss. Excessive evaporative losses

not only reduce weight but also cause shrinkage on the tuber skin and consequently affect the market value of tubers. Physiological weight loss in all the varieties ranged from 11% (Kufri Himalini) to 18.9% (Kufri Neelima) during spring season. The range was 9.3% (Kufri Girdhari) to 22.9% (Kufri Jyoti) during summer season whereas 5.7% (Kufri Girdhari) to 9.5% (Kufri Neelima) during autumn season. Among the seasons, autumn season exhibited lower mean physiological weight loss (<9.5 %) (**Table 2**). This could be attributed to low temperatures (minimum and maximum) and relative humidity during the storage of autumn season compared to spring and summer crop. Ezekiel *et al* (2004) also reported based on studies in unspouted tubers of 11 varieties that weight loss in potato during storage is related with the periderm thickness, number of cell layers in the periderm and also with the number of lenticels on the tuber surface.

**Table 2. Per cent loss due to rottage, physiological loss of weight and total weight loss of potato cultivars under ambient conditions in different seasons**

Hybrids	% loss due to rottage			Physiological loss of weight (%)			Total weight loss (%)		
	Spring	Summer	Autumn	Spring	Summer	Autumn	Spring	Summer	Autumn
Kufri Neelima	3.7(10.4)	2.0(6.8)	0(1.6)	18.9(26.0)	17.0(24.5)	9.5(18.2)	23(28.9)	20.0(26.5)	10.0(18.4)
Kufri Swarna	8.4(14.2)	0.9(4.7)	0(1.6)	15.8(23.5)	22.0(27.0)	8.4(16.7)	26(30.6)	25.0(29.6)	8.4(16.7)
Kufri Jyoti	1.3(5.9)	0.7(4.1)	0(1.6)	18.0(25.1)	22.9(27.6)	6.4(14.2)	20(26.5)	24.9(29.4)	6.4(14.2)
Kufri Girdhari	0(1.6)	0(1.6)	0(1.6)	14.6(22.0)	9.3(16.1)	5.7(13.4)	15(22.5)	9.8(17.9)	5.7(13.4)
Kufri Himalini	6.7(11.4)	2.8(8.1)	0(1.6)	11.0(18.5)	21.7(27.9)	8.3(16.5)	19(25.4)	25.9(30.6)	8.3(16.5)
SEd	0.69	0.34	0.20	0.42	0.51	1.14	0.64	0.78	1.74
CD ( $P= 0.05$ )	1.39	0.70	0.41	0.85	1.03	2.29	1.30	1.57	3.51

Values in parentheses are transformed values

In general, sprouted potato tubers loose much more weight than un-sprouted potatoes since the permeability of the surface of the sprout is higher than periderm layer of the tubers. In the present study, among the varieties tested, percent weight loss due to sprouts was in higher range in cultivars, Kufri Swarna (1.8% at 90 days of storage) whereas it was minimum in Kufri Neelima and Kufri Girdhari (0.4%) during spring season. In summer season, maximum sprout loss was recorded in Kufri Swarna (2.1%) and it was minimum in Kufri Girdhari (0.5%) whereas in autumn, minimum weight loss due to sprouting was observed in all the varieties except Kufri Neelima (0.5%). Such variations in loss due to sprouting was observed by Kang *et al* (2001), Das *et al* (2004) and Gupta *et al* (2015).

### Tuber rottage

Rottage makes the tuber unfit for consumption and also induces the infection in the adjacent tubers kept for storage. The mean percent rottage by weight was maximum in Kufri Swarna (8.4%) while no rottage was observed in Kufri Girdhari during spring season. During summer also no rottage was observed in Kufri Girdhari whereas, Kufri Himalini recorded a maximum rottage of 2.8%. During autumn, no rottage was observed in all the varieties (**Table 2**). The variable response of different genotypes, prevailing temperature and humidity and response of the cultivar might have attributed to variable rottage percentage during different seasons of experiment. Raghav and Singh (2003) in an experiment involving 12 potato varieties under room temperature, found maximum rottage in Kufri Jawahar

followed by Kufri Safed. However, Mehta *et al* (2006) reported highest rottage in Kufri Arun at 105 days of storage.

### Total weight loss

Total weight loss in potato varieties determines the longevity of their storage and also their keeping quality. Total weight loss (including evaporative and respiratory weight loss of tubers and sprouts and weight loss due to rottage) at 90 days of storage showed large variation between varieties in the study (Table 2).

Total weight loss was lowest in cultivar Kufri Girdhari (15 %) whereas it was high in Kufri Swarna (26%) during spring season whereas, in summer, Kufri Himalini recorded highest total weight loss (25.9%) which was on par with Kufri Swarna (25%) and Kufri Jyoti (24.9%) and Kufri Girdhari recorded lowest weight loss of 9.8%. During autumn, Kufri Girdhari recorded lowest total weight loss (5.7%) which was on par with other varieties *viz.*, Kufri Swarna (8.4%), Kufri Himalini (6.4%) and Kufri Jyoti (8.3%) whereas Kufri Neelima recorded highest total weight loss of 10%. The keeping quality of Indian potato varieties based on total weight loss can be grouped as excellent (<10 % total weight loss), very good (10–12 %), good (12–15 %), average (15–20 %) and poor keeper (>20 % weight loss) (Gupta *et al*, 2015). Based on the results of the three seasons, Kufri Girdhari was the good keeper in spring season and excellent in summer and autumn seasons whereas, other varieties were poor keeper in spring and summer seasons while excellent keeper in autumn season.

### Tuber dry matter content

Tuber dry matter is important parameter for considering the suitability of potatoes for different

purposes. It ranged from 16.1 % to 24.2 % in Indian varieties (Gupta *et al.*, 2015). During spring and summer season, highest percent tuber dry matter (Table 3) was observed in variety Kufri Girdhari (19.24 % and 20.61%) followed by Kufri Himalini (17.58% and 19.35%). During autumn season, highest tuber dry matter was recorded in Kufri Girdhari (20.07%) followed by Kufri Swarna (18.30%).

### Cooking quality and potato flavour

Out of five cultivars evaluated, four varieties were adjudged as waxy and one as floury (Kufri Swarna) (Table 3). Similarly, three of them had cream and two light yellow flesh colour after peeling. Floury textured Kufri Swarna possessed moderately high mean dry matter content (18.83 %). Jansky (2008), Leung *et al* (1983), Van Dijk *et al* (2002) and Mosley and Chase (1993) also observed association of mealiness with high tuber dry matter content. However, average tuber dry matter content of waxy varieties varies from 16.57% (Kufri Jyoti) to 19.97% (Kufri Girdhari). Besides dry matter, texture is also influenced by cultivars having varying cell wall density and the degree of solubilization of the middle lamella and cell walls (Van Marle *et al*, 1997). In general floury texture is preferred for processing purposes whereas, waxy texture is liked for boiling and canning (Mosley and Chase, 1993).

On the basis of consensus of panel tasters, all the varieties were adjudged as good flavor (Table 3). The reason for varying flavours includes plant genotype, production and storage environment and the enzymes that react with them to produce flavour compounds (Jansky, 2010).

**Table 3. Cooking quality, flavour and dry matter content of potato cultivars under ambient conditions in different seasons**

Hybrids	Dry matter content (%)			Texture	Flavour	Flesh colour
	Spring	Summer	Autumn			
Kufri Neelima	17.40	17.24	17.14	Waxy	Good	Light yellow
Kufri Swarna	17.15	17.75	18.30	Floury	Good	Cream
Kufri Jyoti	16.17	15.86	17.69	Waxy	Good	Cream
Kufri Girdhari	19.24	20.61	20.07	Waxy	Good	Cream
Kufri Himalini	17.58	19.35	17.44	Waxy	Good	Light yellow
SEd	0.47	0.52	0.35			
CD ( <i>P</i> = 0.05)	0.95	1.04	0.70			

Values in parentheses are transformed values

Potato is a semi-perishable crop and storage is necessary for a regular supply to the consumers for table purpose. In areas like Nilgiris, since round the year production is possible, there is a regular demand for seed potatoes too. Hence, knowledge of storage behavior of different varieties which can withstand ambient temperatures at least for 60–75 days is very important. In the current study, Kufri Girdhari presented the best overall performance accounting for longer dormancy period, slower sprout growth, low total weight loss and high dry matter content in all the three seasons. Hence it can be used as a seed for

next year i.e summer harvested tubers can be used as a seed for next summer. Kufri Swarna proved inferior mainly in terms of its shorter dormancy and faster sprout growth, hence it can be used for alternate seasons i.e spring harvested potatoes can be utilized for autumn season, same way other varieties viz., Kufri Himalini, Kufri Jyoti and Kufri Neelima can be used for planting of alternate seasons. The current study can help the Nilgiris farmers to choose and cultivate the potato varieties according to the nature of the demand.

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