

## A Study on Growth, Yield, and Quality Traits of Potato (*Solanum tuberosum* L.) Varieties under the Agro-Climatic Conditions of Nagaland, India

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### ABSTRACT

A field experiment was conducted during the *rabi* season of 2024 at the experimental farm of the Department of Agronomy, School of Agricultural Sciences, Nagaland University, Medziphema campus. The objective of the study was to assess the growth, yield, and quality of seven different potato varieties under the agro climatic conditions of Nagaland. The experiment was conducted in Randomized Block Design with three replications. The results of the experiment indicated the significant variations in emergence percentages among the potato varieties. Tuber weight did not correlate positively with yield, as the heaviest tuber weight was observed in V<sub>3</sub> Kufri

Khyati, amounting to 76.00 g for fresh weight and 15.80 g for dry weight. Conversely, V<sub>6</sub> Kufri Lalima exhibited the lowest tuber weight, recorded at 37.39 g for fresh and 9.50 g for dry weight. The harvest index varied significantly among the varieties, with the highest value recorded for V<sub>4</sub> Kufri Jyoti. Moisture content encompassed a range of 70% to 79%, with V<sub>3</sub> Kufri Khyati attaining the highest moisture level at 79.77%, comparable to V<sub>2</sub> Kufri Nilkantha at 70%. In terms of dry matter percentage, V<sub>6</sub> Kufri Lalima exhibited the highest dry matter content at 29.56%, followed by V<sub>5</sub> Kufri Uday at 28.22%. Kurfi Uday recorded the highest yield (7.36 t ha<sup>-1</sup>) followed by Kurfi Khyati (6 t ha<sup>-1</sup>). This study provided an insights into the performance of various potato varieties in the agricultural landscape of Nagaland, contributing to enhanced understanding and potential improvement in potato cultivation practices.

**Keywords** Potato, Varieties, Growth, Yield, Quality.

### INTRODUCTION

Potatoes (*Solanum tuberosum* L.) are a non-grain food product and rank among the top crops produced worldwide. They are considered one of the most important tuber vegetables after rice and wheat. In developing countries, potatoes play a crucial role in food security, contributing to 50% of the world's food energy needs alongside rice, wheat, and maize

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(Wijesinha-Bettoni and Mouillé 2019). Potatoes are a nutritious food source, providing a significant amount of carbohydrates, primarily in the form of starch. Additionally, they are rich in protein, essential amino acids, potassium, and vitamin C, all of which are vital nutrients for the human body.

Since the introduction of the potato in the 17<sup>th</sup> century, its cultivation has played an integral role in India's market and economy, establishing the country as a major exporter in the global potato market. Consequently, India has become the second-largest producer of potatoes, following China, with 2.33 million hectares dedicated to cultivation and a production of 60.14 million tonnes. While potatoes are cultivated throughout the country, the northeastern and eastern regions are recognized as the centers of potato production. States such as Uttar Pradesh, West Bengal, Bihar, Assam, and Himachal Pradesh are particularly known for their commercial potato cultivation (Das *et al.* 2025). The sub-Himalayan plains are an important potato-growing region, with Nagaland being part of eastern Himalayan region, is grown over an area of 5,273 hectares, contributing to a production of 58912 metric tonnes (Anonymous 2023). Potato is an important vegetable food crop prevalent in the mid hill to high hill mountain region of Nagaland.

Potatoes are considered not only a good staple diet but plays a significant role for producing high-quality value-added products. However, it is important to note that with the increasing demand for the processing of quality potatoes, the availability of suitable raw material for the processing industry is scant making it a challenge rapid for a cost-effective quality assessment, and so the predictability of the yields of genotypes with high yielding performances suitable for a range of environmental condition needs to be properly assured in order to protect the interest of the farmers (Das *et al.* 2021).

Despite leading second in area and production, India ranks 53<sup>rd</sup> worldwide in potato yields, which average about 25,789.53 kg per hectare (Anonymous 2023). This discrepancy indicates a significant yield gap due to various challenges. Various constraints in potato productivity have been linked to several factors

such as improper planting date, prevalence of pests and diseases, low soil fertility variability in climatic patterns, shortage of water, shortage of agricultural input, and poor post-harvest handling practices (Tefaye *et al.* 2011, Menza *et al.* 2014 ).

The genetic architecture of potato plants significantly influences both yield and quality, presenting an opportunity for improvement in this vital crop. A variety of potato cultivars has been developed, each offering unique advantages in terms of yield potential and quality traits. Additionally, these varieties demonstrate diverse responses under various agro-climatic conditions (Jatav *et al.* 2017). As such, identifying potato varieties that maximize production while maintaining adaptability is essential to meet the evolving challenges of the market and production landscape. Considering the better scope of potato in north-eastern states of India, this experiment was conducted in Nagaland to evaluate seven potato genotypes with an objective to study their growth performance, yield and quality responses.

## MATERIALS AND METHODS

A field experiment was executed during the *rabi* seasons of 2024 at the Experimental Research Farm of the School of Agricultural Sciences at Nagaland University, located on the Medziphema Campus. The experimental site is strategically situated at a latitude of 25°45/43//N and a longitude of 95°53/04//E, at an elevation of 310 meters above sea level. This region typically experiences mean temperatures ranging from 21°C to 23°C in summer, with winter temperatures rarely dipping below 8°C due to the high atmospheric humidity. The average annual rainfall in the area falls between 1500 mm and 2000 mm. The experimental soil site was well-drained and sandy loam with high organic carbon content and a pH level of around 4.5. The soil available nitrogen was low with medium level of phosphorus and available potassium. The field experiment was conducted in Randomized Block Design with three replications under rainfed conditions. The treatment consisted of seven treatments. These treatments included seven potato varieties: V<sub>1</sub> Kufri Pukhraj, V<sub>2</sub> Kufri Nilkantha, V<sub>3</sub> Kufri Khyati, V<sub>4</sub> Kufri Jyoti, V<sub>5</sub> Kufri Uday, V<sub>6</sub> Kufri Lalima, and V<sub>7</sub> Kufri Megha.

The tubers were planted with a spacing of 50 × 20 cm on November 09, 2024, and harvested on February 13, 2025. Well-decomposed farmyard manure (FYM) at a rate of 10 tons hectare<sup>-1</sup> was applied, along with the recommended fertilizer doses of 60 kg of nitrogen (N), 120 kg of phosphorus (P<sub>2</sub>O<sub>5</sub>), and 60 kg of potassium (K<sub>2</sub>O) per hectare. The full quantities of phosphorus, potassium, and half of the nitrogen were applied as a basal application in furrows at the time of planting. The remaining nitrogen was applied during the first earthing-up. Earthing up was done when the crop attained a height of 10-15 cm. While Intercultural operations/weeding was carried out just prior to earthing up and as per requirement and intensity. For each observation five tagged plants were chosen from each plot and observations were recorded at various successive growth stages. Chlorophyll content was recorded using a SPAD-502 chlorophyll meter (SPAD-502, Minolta, Japan) to obtain readings estimating leaf chlorophyll concentration (SPAD value). The readings were recorded at different growth stages at intervals of 30, 50, and 75 DAP.

Yield was calculated based on the net plot area and expressed in kg ha<sup>-1</sup> and harvest index was determined. Dry matter was recorded after harvesting the crop. Samples of 100 g were dried in a hot air oven at 90 degrees celsius for sixteen hours. The fresh samples were weighed using an electronic balance, and the dried samples were weighed again after the drying process. The percentage of dry matter was calculated using the formula:

$$\text{Dry matter (\%)} = \frac{\text{Oven dry weight}}{\text{Initial fresh weight}} \times 100$$

**Table 1.** Growth attributes of different potato cultivars days after planting (DAP).

Treatments	Emergence % at 25	Plant height (cm)			No. of leaves plant <sup>-1</sup>			No. of shoot plant <sup>-1</sup>			Chlorophyll content (µmol/m <sup>2</sup> )		
		30	50	75	30	50	75	30	50	75	30	50	75
V <sub>1</sub> Kufri Pukhraj	54.32	26.60	30.00	34.60	34.67	55.33	52.33	4.00	5.67	5.00	42.57	42.87	36.52
V <sub>2</sub> Kufri Nilkantha	32.67	33.67	42.77	44.27	23.00	47.67	43.67	3.00	4.00	3.67	37.54	38.62	27.43
V <sub>3</sub> Kufri Khyati	74.69	19.60	28.67	31.67	42.67	60.33	55.33	5.33	6.00	5.67	43.10	47.07	36.83
V <sub>4</sub> Kufri Jyoti	49.38	17.60	26.60	28.63	32.00	52.33	47.67	5.00	5.67	4.67	42.09	42.09	31.93
V <sub>5</sub> Kufri Uday	69.63	17.53	24.67	25.73	53.33	65.33	57.33	5.67	6.33	6.00	43.17	49.50	38.56
V <sub>6</sub> Kufri Lalima	72.47	16.60	25.20	28.00	35.33	57.67	53.67	5.00	5.67	5.33	42.57	44.47	33.33
V <sub>7</sub> Kufri Megha	47.04	14.20	23.80	25.47	22.33	41.67	39.00	1.00	3.33	3.00	25.57	37.48	24.86
SEm±	4.00	2.44	2.65	2.18	7.77	1.57	2.55	0.82	0.38	0.41	3.85	3.72	3.33
CD (p=0.05)	12.32	7.51	8.17	6.73	16.94	4.82	7.85	2.51	1.18	1.28	11.86	11.46	10.26
CV (%)	16.16	28.97	22.76	17.33	39.13	4.82	12.65	47.60	18.07	21.56	24.19	21.33	25.14

## Statistical analysis

The statistical analysis of various observations was performed using Fisher's analysis of variance method (Fisher 1950). The critical difference (CD) for comparing treatments was calculated whenever the variance ratio (F test) showed significance at the 5% level.

## RESULTS AND DISCUSSION

### Plant emergence

Emergence percent at 25 DAP responded significantly due to different varieties. The highest emergence at 25 DAP was recorded in V<sub>3</sub> Kufri Khyati (74.69 %), followed by V<sub>6</sub> Kufri Lalima (72.47%) Table 1). The increased emergence percentage may be due to favorable climatic conditions, particularly temperature (Thongam *et al.* 2017, Kumar and Bhatia 2019). V<sub>2</sub> Kufri Nilkantha recorded the lowest emergence percent at 32.67 %. The response on plant emergence rate also depended on potato cultivars (Park *et al.* 2021). The different performances of these varieties are attributed to their genetic and environmental conditions. This investigation is supported by various research findings by Sati *et al.* (2018), Kumar *et al.* (2022), Giri *et al.* (2023).

### Growth attributes

The growth characteristics of the potato plant were examined and evaluated (Table1). Plant height increased in the following order: Kufri Nilkantha > Kufri

Pukhraj and Kufri Khyati. The highest plant height was recorded in V<sub>2</sub> Kufri Nilkantha at 30 (33.67 cm), 60 (42.77 cm) and 90 (44.27 cm) DAP respectively, with the lowest recorded in V<sub>7</sub> Kufri Megha at 30 (14.20 cm), 60 (23.80 cm) and 90 (25.73 cm) DAP which was at par with V<sub>4</sub> Kufri Jyoti. The variation in plant height among different potato cultivars may be due to genetic and inherent characteristics of cultivars/ hybrids of potato, which is in accordance with the findings of Banjade *et al.* (2019), and Sadawarti *et al.* (2018).

The number of leaves plant<sup>-1</sup>, the number of shoots plant<sup>-1</sup>, and the chlorophyll content all exhibited an upward trend until 60 days (Table 1) followed by a gradual decrease at 90 DAP, which may be due to commencement of maturity and the ageing of the plant (Chakraborty and Arora 2003, Jatav *et al.* 2017).

Among different cultivars, an increased number of leaves, shoot plant<sup>-1</sup> and chlorophyll content at 30, 60 and 90 DAP was registered by V<sub>5</sub> Kufri Uday followed by V<sub>3</sub> Kufri Khyati. Lowest was recorded in V<sub>7</sub> Kufri Megha (Table 1). Varieties with a greater number of stems tend to exhibit more vegetative growth, resulting in a higher number of leaves (Zezelew *et al.* 2016), which led to an increased photosynthetic activity. This characteristic is desirable for early soil coverage and results in higher fresh and dry weights due to the accumulation of food materials. Similar findings have been reported by Jatav *et al.* (2017) and Das *et al.* (2021).

## Yield attributes

Yield parameters of different potato cultivar has been presented in Table 2. The highest tuber yield and Haulm fresh and dry weight was recorded in V<sub>5</sub> Kufri Uday (7357.00 kg ha<sup>-1</sup>, 32000 kg ha<sup>-1</sup>), 8963 kg ha<sup>-1</sup> followed by V<sub>3</sub> Kufri Khyati (6037.00 kg ha<sup>-1</sup>, 23,443 kg ha<sup>-1</sup>, 4918 kg ha<sup>-1</sup>) and V<sub>6</sub> Kufri Lalima (2224 kg ha<sup>-1</sup>, 5807 kg ha<sup>-1</sup>, 1748 kg ha<sup>-1</sup>) whereas as the lowest yield among the variety was recorded in V<sub>7</sub> Kufri Megha (1999.67 kg ha<sup>-1</sup>, 444, 977 kg ha<sup>-1</sup> and 977 kg ha<sup>-1</sup> respectively). The increase in yield has been attributed to the maximum increase in growth parameters. While it can differ from one cultivar to another, having more stems per plant also contributes to an increased quantity of tubers for each plant, increasing yield (Knowles and Knowles 2006). Another probable reason may be due to the genetic makeup and environmental interactions. These findings are in agreement with Kaushik *et al.* (2006) and Kumar *et al.* (2022).

Tuber weight, however, did not show a positive relation with the yield. Despite V<sub>5</sub> Kufri Uday having the highest number of shoots resulting in the highest yield in comparison to other varieties, the tuber weight g<sup>-1</sup> was lower i.e., 46.00 g fresh tuber weight and 12.88 g dry tuber weight<sup>-1</sup> respectively. The highest tuber weight was observed in V<sub>3</sub> Kufri Khyati, i.e., 76.00 g tuber<sup>1</sup> fresh weight and 15.80 g tuber<sup>1</sup> dry weight, which also recorded second in yield followed by V<sub>2</sub> Kufri Nilkantha with a fresh and

**Table 2.** Yield attributes and quality of different potato cultivar.

Treatments	Haulm			Tuber				
	Fresh weight kg ha <sup>-1</sup>	Dry weigh kg ha <sup>-1</sup>	Yield kg ha <sup>-1</sup>	Fresh weight g tuber <sup>-1</sup>	Dry weight g tuber <sup>-1</sup>	Harvest index %	Moisture %	Dry matter %
V <sub>1</sub> Kufri Pukhraj	8,555	1,836	3057.00	49.33	10.60	78.50	78.99	20.48
V <sub>2</sub> Kufri Nilkantha	7,000	1,248	2111.00	69.00	14.46	63.57	79.00	20.75
V <sub>3</sub> Kufri Khyati	23,443	4,918	6037.00	76.00	15.80	85.70	79.77	20.79
V <sub>4</sub> Kufri Jyoti	5,000	1200	2666.33	59.06	13.37	97.74	76.78	23.23
V <sub>5</sub> Kufri Uday	32,000	8,963	7357.00	46.00	12.88	81.48	72.00	28.22
V <sub>6</sub> Kufri Lalima	5,807	1,748	2224.00	37.39	9.50	72.20	70.94	29.56
V <sub>7</sub> Kufri Megha	4,444	977	1999.67	44.00	11.83	71.97	78.42	21.72
SEm ±	675.10	198.60	158.37	1.07	0.99	1.58	3.02	1.54
CD (p=0.05)	2080.19	611.95	487.98	3.28	3.06	4.68	9.30	4.76
CV (%)	13.56	16.46	10.78	4.84	19.68	4.95	9.75	16.23

dry tuber weight of 49g and 10.6g, respectively. The lowest tuber weight was found in V<sub>6</sub> Kufri Lalima, 37.39 g and 9.50 g fresh and dry tuber weight. The number of main stems was positively correlated with tuber number and negatively correlated with individual tuber weight (Das *et al.* 2021). The differences in average tuber weight can also be attributed to the distinct genetic traits of each variety. The findings of this study are consistent with the research conducted by Yayeh *et al.* (2025), which highlights the significant variations in average tuber weight among different potato varieties. Binalfew *et al.* (2015) also indicated that tuber size in potatoes is a hereditary trait.

The harvest index presented in Table 2 reveals notable differences across the varieties. The highest index was observed in V<sub>4</sub> Kufri Jyoti at 97.74%, followed by V<sub>3</sub> Kufri Khyati at 85.70%, V<sub>5</sub> Kufri Uday at 81.48%. In contrast, the lowest harvest index was seen in V<sub>2</sub> Kufri Nilkantha, which had a value of 63.57%. This harvest index is affected by both the biomass production and the tuber yield plant<sup>-1</sup> (Debbarma *et al.* 2023).

Moisture percentage ranged from 70-79%, with the highest being recorded in V<sub>3</sub> Kufri Khyati (79.77%) which was on par with V<sub>2</sub> Kufri Nilkantha (70%). V<sub>6</sub> Kufri Lalima (70.94%) recorded the lowest among all the varieties.

Dry matter contents and specific gravity are important quality parameters influencing potato processing, influencing crispiness, hardness, flavor, color and processing efficiency (Kaaber *et al.* 2001, Das *et al.* 2021), texture and cooking quality of potatoes, varied among potato varieties and moisture conditions (Bhattacharai and Chaudhary 2024). V<sub>6</sub> Kufri Lalima exhibited higher (29.56%) dry matter content compared to other varieties. This was followed by V<sub>5</sub> Kufri Uday (28.22 %). Dry matter content in potatoes as influenced by varieties. This was in line of conformity with Kaur and Aggarwal (2014) who were in the opinion that the genotype had a direct influence on the dry matter content. Genotypes and growing conditions may affect the DM content. Cultivars with high DM have better quality characteristics as compared to their counterpart (Asmamaw *et al.* 2010).

## CONCLUSION

From this field experiment, it can be concluded that the cultivar 'Kufri Uday performed better in terms of yield and growth parameters such as number of Leaves plant<sup>-1</sup>, number of Shoot plant<sup>-1</sup> and Chlorophyll content. In terms of quality, Kufri Lalima followed by Kufri Uday exhibited higher dry matter percentage compared to other varieties, reflecting its superiority over other varieties/cultivars. Given its superior growth, yield attributes, and quality, the Kufri Uday cultivar can be recommended for the hilly conditions of Nagaland. This trait is desirable for improving productivity in the hilly state. However, these results are only indicative and require further experimentation to arrive at a more consistent and final conclusion.

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