

EFFECT OF TILLAGE METHODS ON GROWTH AND YIELD OF POTATO (*SOLANUM TUBEROSUM* L.) VARIETIES IN JHAPA, NEPAL

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ABSTRACT: An experiment was conducted on the year 2025 to evaluate the effects of varieties (Kufri Jyoti, Khumal Ujjwal, and IPY-8) and tillage methods (zero tillage, minimum tillage, and conventional tillage) on the growth and yield performance of potato in Jhapa, Nepal. Parameters including sprout number, plant height, leaf number, canopy spread, tuber yield, individual tuber weight, tuber diameter, total tuber number, and number of green tubers were recorded. Among the tested varieties, Khumal Ujjwal performed significantly better, recording the highest plant height (73.4 cm), canopy spread (72.97 cm), tuber yield (15.4 t ha⁻¹), individual tuber weight (74.6 g), and tuber diameter (5.26 cm). Although Kufri Jyoti produced the highest number of tubers, a greater proportion of them were green and therefore less marketable. Tillage methods had no significant effect on the most of the growth and yield parameters, implying tedious and cost consuming process of tillage can be skipped for potato cultivation, if the the number of green tubers could be controlled. Similarly, the interaction between variety and tillage method showed no significant influence on plant height, canopy spread, sprout number, tuber yield, tuber weight, and tuber diameter. These findings indicated that varietal selection even on non-tilled lands plays an important role in determining potato productivity under the agro ecological conditions of Jhapa, with Khumal Ujjwal emerging as the most promising variety for cultivation.

KEYWORDS: Growth; Potato; Tillage; Variety; Yield

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of the most important food crops in Nepal, contributing significantly to food security, income generation and agricultural sustainability (Bhattarai, 2025). It is widely consumed throughout the country in various forms, including as a staple food, vegetable, pickle and snack. In Nepal, the crop occupies approximately 197,037 ha of cultivated area, with a total production of 2,586,287 metric tons and an average productivity of 13.13 metric tons ha⁻¹ (Chauhan *et al.*, 2022).

Owing to its adaptability, high productivity, and market demand, potato is a priority crop for Nepalese farmers (Sapkota and Bajracharya, 2018). Among the factors influencing potato production variety and tillage practices play crucial roles in determining growth, yield and tuber quality. Tillage enhances crop productivity by modifying soil physical conditions, reducing compaction, improving infiltration and aeration, and suppressing weeds, thereby creating a more favorable soil environment for crop growth (Verma *et al.*, 2023).

The selection of suitable high-yielding varieties adapted to local agroecological

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conditions is essential for improving productivity (Gairhe *et al.*, 2017). Likewise, proper tillage management is particularly important for potato because root and tuber crops are highly sensitive to soil compaction, which can restrict root development and tuber expansion (Howeler *et al.*, 1993). Although conventional tillage is commonly practiced in potato cultivation, it is energy-intensive and increases the risk of soil erosion (Boliłowa and Gleń, 2003). Moreover, intensive tillage can contribute to soil degradation, nutrient losses through nitrate leaching, and accelerated erosion, ultimately threatening the long-term sustainability of potato production systems (Begum *et al.*, 2024). In addition, the genetic makeup of potato varieties strongly influences yield potential and quality traits, highlighting the importance of evaluating varietal performance under different tillage regimes (Filipović *et al.*, 2025).

Potato varieties differ considerably in their growth, yield and quality characteristics, including plant height, leaf number, maturity period, tuber size, tuber yield, disease resistance and resilience to changing climatic conditions. In Nepal, commonly cultivated potato varieties include Janakdev, Desiree, Myagdi Local, Mustang Local, Kufri Jyoti and Khumal Ujjwal (Neupane *et al.*, 2019). The performance of these varieties varies across agroecological regions, highlighting the need for location-specific evaluation and selection. To address this need within the lowland plains, this study specifically evaluated two major hill-adapted cultivars (Kufri Jyoti and Khumal Ujjwal) alongside a specialized Terai-released variety (IPY-8) to determine their site-specific suitability under the winter climate of Jhapa.

With increasing scarcity of labor, water and other agricultural inputs, conservation-oriented soil management practices are gaining importance as sustainable approaches

to potato production (Alam *et al.*, 2017). Furthermore, inadequate access to improved varieties and limited adoption of appropriate cultivation technologies continue to constrain potato productivity, resulting in challenges related to crop growth, yield, harvesting efficiency and post-harvest quality (Schulte-Geldermann, 2025). Since production cost in potato cultivation are largely influenced by the production technology employed, the adoption of suitable and resource-efficient management practices is essential for reducing costs and enhancing farm profitability (Kalimullin *et al.*, 2019). Therefore, this study was conducted to evaluate the effects of different potato varieties and tillage methods on the growth and yield performance of potato under the agroecological conditions of Jhapa, Nepal, and to identify suitable variety–tillage combinations for improved and sustainable potato production.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at the Horticulture research field of IAAS, Gauradaha Agriculture Campus, Gauradaha, Jhapa, which is situated about 11 km south from Padajungi, Jhapa, Nepal, at latitude 26.56°N, longitude 87.72°E, and altitude 79 meters above sea level. The study area is characterized by a tropical monsoon climate, with generally warm temperatures and high humidity throughout the year.

Temperatures typically range from about 16.4°C during the cooler winter months to around 30°C in summer. Annual rainfall varies between 1500 and 2000 mm, with the majority occurring during the monsoon period from June to September. This seasonal distribution results in humid conditions with frequent cloud cover during the rainy season, followed by relatively drier and clearer weather from November to February.

Treatment details

Experiment details

The experiment was conducted using a two-factor factorial Randomized Complete Block Design (RCBD), with variety (Kufri Jyoti, Khumal Ujjwal, and IPY-8) as Factor A and tillage practice (zero, minimum, and conventional) as Factor B. The field was divided into three blocks, each containing nine plots, making a total of 27 plots. Each plot measured 3 × 1.5 m with spacing of 60 cm between rows and 30 cm between plants, accommodating five rows and 25 plants per plot. Spacing between replications and treatments was maintained at 1 m and 0.5 m, respectively, covering a total area of 192.5 m² (17.5 m × 11 m). For land preparation, conventional tillage plots were thoroughly ploughed and prepared before planting. In minimum tillage plots, soil disturbance was limited to digging planting spots only, while in zero tillage plots, potato tubers were planted without any prior soil disturbance. Details of treatments are given in Table 1.

Crop management

Intercultural operations were carried out throughout the crop period. Mulching was done in all plots immediately after planting using rice straw to conserve moisture,

control weeds, and protect against adverse conditions, and an additional layer was added at 45 days after planting. Pre-sowing irrigation was applied lightly to maintain soil moisture, followed by irrigation at 30 days after planting and then at 15-day intervals, which was stopped two weeks before harvesting. 0.5 tons of FYM was added before planting to improve soil health. A recommended dose of 220:140:140 kg NPK/ha was applied, where nitrogen was applied in two splits (half dose at planting and remaining half dose at 45 days after planting) and full dose of phosphorus and potassium was applied at planting (AITC, 2024). Weed management included first weeding at 30 days after planting, followed by weekly hand weeding and regular removal of weeds from bunds and surrounding areas. Insect incidence was negligible, so no control measures were taken. However, early symptoms of late blight were observed and controlled by spraying copper oxychloride 50% WP at 3 g/L. Manual harvesting was done at 98 days after planting by removing mulch and carefully lifting the plants. Samples were then evaluated for tuber weight, diameter, yield, green tuber number and total tuber number.

Data collection

Data were recorded from five randomly selected plants per plot, excluding border plants. Sample plants were tagged for repeated observations. Data on sprout number, plant height, canopy spread and leaf number were taken at the interval of 15 days starting from 45 days after planting. Canopy spread was measured in two directions (north-south and east-west), and the mean canopy spread was calculated. Tuber diameter was measured using vernier calipers. Tuber weight was measured using a weighing balance. For green tubers, those with more than 50% greening were classified as green.

Table 1. Details of treatments used in the study at Jhapa

S.N.	Notation	Treatment Detail
1	T1	Kufri Jyoti × Zero Tillage
2	T2	Kufri Jyoti × Minimum Tillage
3	T3	Kufri Jyoti × Conventional Tillage
4	T4	Khumal Ujjwal × Zero Tillage
5	T5	Khumal Ujjwal × Minimum Tillage
6	T6	Khumal Ujjwal × Conventional Tillage
7	T7	IPY-8 × Zero Tillage
8	T8	IPY-8 × Minimum Tillage
9	T9	IPY-8 × Conventional Tillage

Post-harvest data included yield, tuber weight, tuber diameter, total tuber number, and number of green tubers.

Statistical analysis

Data collected from the experimental plots were organized using Microsoft Excel 2019, and all statistical analyses were performed in R (version 4.4.1). The coefficient of variation (CV), standard error of the mean (SEM), and least significant difference (LSD at 5%) were calculated. Treatment means were compared for significant differences using Duncan's Multiple Range Test (DMRT) at a 5% probability level ($p \leq 0.05$).

RESULTS AND DISCUSSION

Plant height (cm)

Table 2. depicts that plant height at 45, 60 and 75 days after plantation was

Table 2. Effect of different varieties and tillage methods on plant height (cm) of potato at Gauradaha, Nepal during the year 2025.

Treatments	Plant height (cm)		
Varieties	45 DAP	60 DAP	75 DAP
Kufri jyoti	37.64 ^b	52.91 ^b	57.36 ^b
Khumal ujjwal	49.47 ^a	66.93 ^a	73.40 ^a
IPY-8	32.73 ^b	48.53 ^b	59.73 ^b
F- test	***	***	*
LSD	5.41	5.36	7.89
Tillage			
Zero tillage	36.00 ^b	52.31 ^b	58.87 ^b
Minimum tillage	42.71 ^a	57.47 ^{ab}	64.82 ^{ab}
Conventional tillage	41.13 ^{ab}	58.60 ^a	66.80 ^a
F-test	*	*	*
LSD	5.41	5.36	7.80
Mean	39.95	56.13	63.43
SEM	2.58	2.54	3.7
CV	11.18	7.86	10.11

Source: Field test, 2025

*Significant at 5% level of significance, ** significant at 1% level of significance, ***significant at 0.1% level of significance, NS: Not significant, LSD: Least significant difference, CV: Coefficient of variation

significantly affected by varieties. Maximum plant height 49.47 cm, 66.93 cm, and 73.40 cm was observed in variety Khumal ujjwal at 45, 60, and 75 days after planting, respectively. Similar observations were reported by Shrestha *et al.* (2023) in Bajhang district, where potato varieties significantly influenced vegetative growth parameters, including sprout number, plant height, leaf number, and canopy spread.

Likewise, there was a significant difference in plant height due to different tillage methods. At 45 days after planting, maximum height (42.72 cm) was observed in Minimum tillage. Meanwhile at 60 and 75 days after planting, maximum height (58.6 and 66.8 cm respectively) was recorded in Conventional tillage. Conventional tillage improves soil aeration and creates favorable conditions for microbial activity, which can enhance nutrient mineralization and availability to plants (Subbulakshmi *et al.*, 2009). These improved soil conditions may have promoted root development and nutrient uptake, thereby supporting greater vegetative growth and plant height under conventional tillage. Minimum height (36 cm, 52.31 cm, and 58.87 cm at 45, 60, and 75 DAP respectively) was observed in zero tillage.

Number of leaves

Number of leaves at 45 and 75 days after planting was significantly affected by variety but at 60 days after planting it was not significantly affected by variety. According to table 3. highest leaf number was recorded 37.95 in Kufri jyoti at 45 days where Variety IPY-8 showed minimum leaf number of 27.40. But at 75 days after planting, IPY-8 variety showed maximum number of leaf (115.48). Likewise, number of leaves at 45 and 60 days after planting was significantly affected by the type of tillage method adopted. Highest number of leaves (40.69) was observed in

Table 3. Effect of different varieties and tillage methods on number of leaves of potato at Gauradaha, Nepal during the year 2025.

Treatments	Number of leaves		
Varieties	45 DAP	60 DAP	75 DAP
Kufri jyoti	37.96 ^a	66.09	73.20 ^b
Khumal ujjwal	37.84 ^a	66.82	77.38 ^b
IPY-8	27.40 ^b	69.82	115.49 ^a
F test	**	NS	**
LSD	7.89	15.48	32.04
Tillage			
Zero tillage	31.73 ^b	63.80 ^{ab}	93.31
Minimum tillage	40.69 ^a	78.09 ^a	89.78
Conventional tillage	30.78 ^b	60.84 ^b	82.98
F test	**	*	NS
LSD	7.83	15.49	32.02
Mean	34.4	67.58	88.69
SEM	3.75	12.72	15.2
CV	18.87	18.86	29.72

Source: Field test, 2025

*Significant at 5% level of significance, **significant at 1% level of significance, ***significant at 0.1% level of significance, NS: Not significant, LSD: Least significant difference, CV: Coefficient of variation

Minimum tillage at 45 days and 78.08 at 60 days after plantation.

Canopy spread

Canopy length at 45, 60 and 75 days after planting was significantly affected by variety. Table 4. Shows that maximum canopy length (42.68 cm, 60.45 cm, and 72.97 cm at 45, 60 and 75 days after planting, respectively) was observed in variety Khumal Ujjwal. At 45 and 60 days, varieties Khumal Ujjwal and Kufri jyoti were statistically similar. Meanwhile, at 75 days after plantation, Varieties Kufri jyoti and IPY-8 were statistically at par.

But there was no significant difference in canopy spread at 45, 60 and 75 days after plantation due to the type of tillage method adopted. This contradiction of results from previous findings may be due to the delayed effect of tillage, genetic control and

Table 4. Effect of different varieties and tillage methods on canopy spread (cm) of potato at Gauradaha, Nepal during the year 2025

Treatments	Variety	Canopy spread (cm)		
		45 DAP	60 DAP	75 DAP
Kufri jyoti		37.50 ^a	53.61 ^a	63.30 ^b
Khumal ujjwal		42.68 ^a	60.44 ^a	72.97 ^a
IPY-8		28.50 ^b	42.56 ^b	61.62 ^b
F test		***	***	**
LSD		6.64	7.25	8.53
Tillage				
Zero tillage		33.73	48.66	61.98
Minimum tillage		39.32	54.53	70.59
Conventional tillage		35.62	53.42	65.32
F test		NS	NS	NS
LSD		6.64	7.25	8.53
Mean		36.23	52.27	65.96
SEM		3.15	3.44	4.04
CV		15.04	11.42	10.63

Source: Field test, 2025

*Significant at 5% level of significance, ** significant at 1% level of significance, ***significant at 0.1% level of significance, NS: Not significant, LSD: Least significant difference, CV: Coefficient of variation

environmental conditions on sprout number and canopy spread (Scavo *et al.*, 2023).

Yield (ton/ha), tuber weight (g), tuber diameter (cm)

Table 5. clarifies that yield(ton/ha), individual potato weight (gm) and potato diameter (cm) were significantly affected by the variety. Highest yield (15.4 ton/ha) was observed in variety Khumal ujjwal which is statistically similar to variety Kufri jyoti (14t/ha). Lowest yield (5.7 t/ha) was seen in variety IPY-8. This aligns with the findings of Banjade *et al.* (2019), who demonstrated that the choice of potato variety directly influences yield parameters.

Likewise, Individual tuber weight and tuber diameter was recorded highest in Khumal ujjwal which was 74.60 gm and 5.26 cm respectively. Least potato weight (40.56

Table 5. Effect of different varieties and tillage methods on yield (ton/ha), tuber weight (g), and tuber diameter (cm) of potato at Gauradaha, Nepal during the year 2025.

Varieties	Yield (ton/ha)	Tuber weight (g)	Tuber diameter (cm)
Kufri jyoti	14.07 ^a	67.44 ^a	4.81 ^b
Khumal ujjwal	15.43 ^a	74.60 ^a	5.23 ^a
IPY-8	5.65 ^b	40.56 ^b	3.98 ^c
F test	***	**	***
LSD	3.49	25.81	0.36
Tillage			
Zero tillage	9.74	55.27	4.52
Minimum tillage	13.34	71.33	4.76
Conventional tillage	11.97	56	4.84
F test	NS	NS	NS
LSD	3.49	25.81	0.36
Mean	11.74	60.87	4.64
SEM	1.65	12.25	0.17
CV	24.51	34.89	6.35

Source: Field test, 2025

*Significant at 5% level of significance, ** significant at 1% level of significance, ***significant at 0.1% level of significance, NS: Not significant, LSD: Least significant difference, CV: Coefficient of variation

gm) and diameter (3.99 cm) were recorded in variety IPY-8. Meanwhile, there was no significant difference in yield (t/ha), individual potato weight (gm) and potato diameter (cm) due to method of tillage practice adopted.

Total tuber number and number of green tubers

Total number of tuber and number of green tubers were significantly affected by the variety used. Highest number of green tuber (4.78) was seen in variety Kufri jyoti and lowest number of green tuber (2.42) was observed in variety IPY-8. Likewise, maximum tuber number (8.4) was observed in variety Kufri jyoti and minimum number of tuber (5.48) were observed in variety IPY-8 according to table 6.

Number of green tubers was significantly affected by the type of tillage practice, but,

Table 6. Effect of different varieties and tillage methods on total tuber number and number of green tubers of potato during the year 2025.

Varieties	Green tuber	Total tuber number
Kufri jyoti	4.78 ^a	8.40 ^a
Khumal ujjwal	3.29 ^b	6.58 ^{ab}
IPY-8	2.42 ^b	5.49 ^b
F test	***	*
LSD	1.26	2.40
Tillage		
Zero tillage	4.82 ^a	7.22
Minimum tillage	3.58 ^a	6.80 ^a
Conventional tillage	2.09 ^b	6.44
F test	***	NS
LSD	1.26	2.40
Mean	3.46	6.82
SEM	0.6	1.14
CV(%)	29.68	28.96

Source: Field test, 2025

*Significant at 5% level of significance, ** significant at 1% level of significance, ***significant at 0.1% level of significance, NS: Not significant, LSD: Least significant difference, CV: Coefficient of variation

total number of tubers was not significantly affected. Highest number of green tuber (4.82) was observed in zero tillage and lowest number of green tuber (2.08) was recorded in conventional tillage. Zero tillage and minimum tillage were statistically at par. Greening in potato is caused by accumulation of chlorophyll due to exposure of light (Tanios *et al.*, 2018). Since, in zero tillage seed potatoes were not covered by soil, light easily entered to the potato and caused greening.

Interaction effects

Table 7. depicts that there was no significant difference in plant height, sprout number, and canopy spread due to the interaction of tillage and variety. Likewise, yield parameters such as total yield(t/ha), tuber number, tuber diameter and individual tuber weight, were not significantly influenced

Table 7. Interaction effects of variety and tillage method on yield and number of green tubers during the year 2025.

Interaction	Yield	Number of green tubers
Kufri Jyoti × Zero tillage	10.80	7.40 ^a
Kufri Jyoti × Minimum tillage	12.87	4.47 ^{ab}
Kufri jyoti × conventional tillage	5.61	2.60 ^{bc}
Khumal Ujjwal × Zero tillage	14.09	3.60 ^{bc}
Khumal Ujjwal × Minimum tillage	19.26	3.73 ^{bc}
Khumal Ujjwal × Conventional tillage	6.77	3.40 ^{bc}
IPY-8 × Zero tillage	17.14	3.33 ^{bc}
IPY-8 × Minimum tillage	14.09	1.67 ^{bc}
IPY-8 × Conventional tillage	4.72	1.27 ^c
F test	NS	*
LSD	8.34	3.01
Mean	11.74	3.46
SEM	1.65	0.6
CV	24.51	29.68

Source: Field test, 2025

*Significant at 5% level of significance, **significant at 1% level of significance, ***significant at 0.1% level of significance, NS: Not significant, LSD: Least significant difference, CV: Coefficient of variation

by the interaction between variety and tillage method. OR *et al.* (2022), observed that interaction of variety and tillage has no impact on growth and yield of sweet potato varieties which aligns with our findings.

CONCLUSION

Based on the findings of this research, variety has more influence on vegetative and reproductive growth compared to the tillage method. From this research result, it can be concluded that variety Khumal Ujjwal is superior since it showed maximum height, canopy spread, maximum yield, tuber weight, and tuber diameter. Among different tillage methods, minimum tillage is best as it reduces the cost of production and highest leaf number and tuber yield was observed on it. The choice of tillage practice did not show any effect on yield parameters except number of green tubers. Highest number of

green tubers were observed on zero tillage, so to produce potato with less tedious cultural practices and low cost, thick layer of mulching should be applied in order to reduce exposure to sunlight. Combination of variety Khumal Ujjwal and minimum tillage is recommended for sustainable potato production in Jhapa, Nepal.

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CONFLICTS OF INTEREST

The author declare that there is no conflict of interest regarding the publication of this manuscript.

ETHICAL STATEMENT

This study did not involve any animal or human participant and thus ethical approval was not applicable.

AUTHOR CONTRIBUTION STATEMENT

S.B. conducted the experiment, collected and analyzed the data, and prepared the first draft of the manuscript. J.D. conceived and supervised the study, provided guidance on experimental design and data interpretation, and reviewed and edited the manuscript. Both authors read and approved the final manuscript.

DATA AVAILABILITY

The data that support the findings of this study are available on request from the corresponding author

SUPPLEMENTARY DATA

No supplementary data is available for the paper.

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