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**Tohid Ahmad Khan**
M.Sc. Student, Department of Agronomy, School of Agriculture, ITM University, Gwalior, Madhya Pradesh, India

**Jaidev Sharma**
Assistant Professor, Department of Agronomy, School of Agriculture, ITM University, Gwalior, Madhya Pradesh, India

**Vikash Kumar Sah**
M.Sc. Student, Department of Agronomy, School of Agriculture, ITM University, Gwalior, Madhya Pradesh, India

**Corresponding Author:**
**Tohid Ahmad Khan**
M.Sc. Student, Department of Agronomy, School of Agriculture, ITM University, Gwalior, Madhya Pradesh, India

# Effect of different nitrogen levels on the growth, yield and quality of potato (*Solanum tuberosum* L.) varieties

**Tohid Ahmad Khan, Jaidev Sharma and Vikash Kumar Sah**

**Abstract**
A field experiment on Effect of different Nitrogen levels on the growth, yield and quality of potato (*Solanum tuberosum* L.) Varieties was conducted during *rabi* season 2022 at the Poly house, School of Agriculture, ITM University Gwalior (M.P.). The experiment was laid out in a Factorial randomized block design with 12 treatment combinations, which includes four Nitrogen Levels (*viz*., $N_1$-0 kg N $ha^{-1}$, $N_2$-100 kg N $ha^{-1}$, $N_3$-140 kg N $ha^{-1}$ and $N_4$-180 kg N $ha^{-1}$), three different varieties (*viz*., $V_1$-Kufri Pushkar, $V_2$-Kufri Jyoti $V_3$-Pushkar) and each treatment were replicated thrice. The soil of the experimental field was Sandy loam in texture with a medium in available Nitrogen (198.6), low in available Phosphorous (15.85) and High in available Potassium (229.6) and low in Organic Carbon (0.44). The result of the experiment revealed that an increase in the application of Nitrogen and varieties had significantly increased the growth, yield and economics of *viz*., plant population, plant height (cm), No. of leaves per plant, No. of haulms, Fresh weight of haulms (g), Dry weight of haulms, Tuber yield, Grade wise number of tubers (small, medium and large), and economics of potato, the application of 180 kg N $ha^{-1}$ with Pushkar varieties was *at par* on application of 140 kg N $ha^{-1}$ with Kufri Jyoti and application of 0 kg N $ha^{-1}$ and with Kufri Pushkar were found significant with this treatment. Economics *viz*., Total cost of cultivation, Gross return, Net return and B:C Ratio were significantly higher with nitrogen (140 kg $ha^{-1}$) with Kufri Jyoti.

**Keywords:** Nitrogen, Kufri Pushkar, Kufri Jyoti and Pushkar

## Introduction
Potato, scientifically known as *Solanum tuberosum*, is an incredibly versatile and widely consumed vegetable worldwide. It is native to the Andean region of South America and has been cultivated for thousands of years. Potatoes are a staple food in many cuisines and are valued for their nutritional content, adaptability to various climates, and ability to be stored for extended periods. The potato plant belongs to the nightshade family (*Solanaceae*) and is characterized by its starchy tuberous underground stems, commonly referred to as potatoes. These tubers come in a variety of shapes, sizes, and colours, including white, yellow, red, and even purple. The potato is a crop with a large number of wild relatives, a group of more than 100 tuber bearing Solanum species. It originated in the high Andean hills of South America. Potato is believed to have been introduced in India from Europe in early 17th century AD. The potato is ranked by FAO of United Nations as the world's 4th most important food crop after rice, wheat and maize. Potato is among one of the most diverse and nutritious crops on the earth.

Potato is an ingredient in many dishes and salads. It is a non-fattening, nutritious, and wholesome food that supplies many important nutrients to the diet. It contains approximately 78% water, 22% dry matter (specific gravity) and less than 1% fat. About 82% of dry matter is carbohydrate, mainly starch with some dietary fibre and have better nutritional quality than cereals. Potato contains at least 12 essential amino-acid, minerals and is also source of vitamin C, thiamine (B6), iron and folic acid.

India is one of the leading producers of potatoes in the world. The country has a favorable climate and diverse agro-climatic regions that allow for the cultivation of potatoes across different states. Here is some information on potato production in India. According to the latest available data from the Government of India's Ministry of Agriculture and Farmers Welfare, during the agricultural year 2019-2020, India produced approximately 52 million metric tons of potatoes. Several states in India contribute significantly to potato production. The top potato-producing states in India include Uttar Pradesh, West Bengal, Bihar, Gujarat, and Punjab. Uttar Pradesh is the largest potato-producing state in the country.

Potato is very sensitive crop to nitrogen fertilization. Excess nitrogen may prolong the vegetative phase and thus, interfere with the initiation of tuberization, decreasing yield and dry matter accumulation in the tubers. Hand hoeing is common with small farm holders while mechanization is preferred by large farmers. Because of decreasing availability of labour and/or family members at cheaper rate until recent past hiring people for hoeing is getting more and more difficult and expensive. Hoeing has been still an important practice for not only weed control but also other management requirements. Bartova *et al.* (2012) [9] reported that 100 kg N $ha^{-1}$ is sufficient for production of potato tubers with high content of both crude protein and starch, especially in production areas with higher altitude. Fandika *et al.* (2016) [3] and Chongtham *et al.* (2015) [2]. Reported that application of more than 80 kg N $ha^{-1}$ decreased yield in potato. Application of 150 kg N $ha^{-1}$ improved tuber yield and crop productivity with higher remuneration and efficient use of phosphorus, potassium, and water. However agronomic use efficiency of nitrogen decreased with subsequent increase in nitrogen levels.

Farmers of Madhya Pradesh grow potato in rabi season. The productivity of potato in this region is low as compared to some states. Nutrients have major influence on yield and quality of crop in different ways among which nitrogen is one of the key nutrients and influences the early crop development and tuber initiation, tuber size, tuber specific gravity and protein content. Kumar *et al.* (2013) [4] found that the plant height, number of tubers, dry matter accumulation both in haulm and tuber was significantly increased by application of recommended dose of fertilizers (RDF).

A suitable combination of major and secondary nutrient is by and large the most important factor affects the growth, yield and quality of potato. On the other hand, if the hybrids are fertilized with optimum level of nutrients, soil available nutrient may be greatly depleted apart from resulting in good yield. Hence, this experiment was conducted to the study the response of potato to varying levels of nitrogen and different varieties combinations during *rabi* season in sandy loam.

## Materials and Methods

During the *rabi* season of 2022-2023, a field experiment titled "Effect of different Nitrogen levels on the growth, yield and quality of potato (*Solanum tuberosum* L.) Varieties" was conducted at Poly house, School of Agriculture, ITM University Gwalior (M.P.). The research farm is situated at latitude of 26.1378° N and a longitude of 78.2082° E, with an elevation of 197 meters above the mean sea level. The region experiences an annual rainfall ranging up to 764.4 mm. Gwalior receives maximum rainfall during southwest monsoon period i.e., October to January. The experimental design employed a Factorial Randomized Block Design with twelve treatment combinations, comprising three four of Nitrogen includes four Nitrogen Levels (*viz*., $N_1$-80 kg N $ha^{-1}$, $N_2$-100 kg N $ha^{-1}$, $N_3$-140 kg N $ha^{-1}$ and $N_4$-180 kg N $ha^{-1}$), three different varieties (*viz*., $V_1$-Kufri Pushkar, $V_2$-Kufri Jyoti $V_3$-Pushkar). Each treatment was replicated thrice. The potato was sown using the dibbling method.

A standardized Recommended doses of phosphorus, potassium and different doses of nitrogen as per treatment were applied in each plot. Nutrients *viz*., nitrogen and potassium were provided through Urea, SSP and Muriate of Potash. The full quantity of phosphorus (80 kg $ha^{-1}$), potash (120 kg $ha^{-1}$) and half dose of nitrogen were applied as basal in furrows at the time of planting. While the remaining quantity of nitrogen was applied in two split doses, 1st at first earthing-up and 2nd at second earthing-up (25 and 45 days after planting, respectively).

The cost of cultivation for each treatment was calculated by summing up all the expenses incurred from land preparation to crop harvesting. To determine the gross realization, the prevailing market price of fodder at the time of harvest was considered. Net returns were obtained by subtracting the cost of cultivation from the gross returns. The benefit-cost ratio was computed using the following formula.

$$\text{B: C Ratio} = \frac{\text{Net Return } (₹\ ha^{-1})}{\text{Cost of Cultivation } (₹\ ha^{-1})}$$

Data related to the fodder pearl millet were meticulously recorded and then subjected to analysis of variance (ANOVA) using a Factorial Randomized Block Design, as per the methods described by Snedecor and Cochran (1994). To determine the significance of differences between treatment means, a critical difference at the 5% level of probability was employed for comparisons.

## Results and Discussion

### Growth parameters and yield attributes

Effect of nitrogen levels on potato varieties had significantly influenced on the plant height growth, yield and yield attributes and economics, whereas the interaction effect between nitrogen levels and varieties was found to be non-significant at all stages of the crop growth period. Crop fertilized with 180 kg N $ha^{-1}$ produced significantly taller plants (62.35 cm) at harvest. The growth parameters *viz*., number of leaves $plant^{-1}$ (54.83), Number of haulms (4.33), Fresh weight of haulms (293.84) and Dry weight of haulms (54.29) linearly increased with each incremental level of nitrogen and were significantly higher with application of 180 kg N $ha^{-1}$, while it was *at par* with the application of 140 kg N $ha^{-1}$ and significantly over corresponding lower doses (0 and 100 kg N $ha^{-1}$). The yield and attributes *viz*., Tuber yield (289.10 q $ha^{-1}$), Grade wise number of tubers (small (16.00), medium (42.89) and large (21.85)) were significantly higher with application of 180 kg N $ha^{-1}$, while it was *at par* with the application of 140 kg N $ha^{-1}$ and significantly over corresponding lower doses (0 and 100 kg N $ha^{-1}$). The similar result was given by Yang *et al.*, (2017) [8].

Effect of nitrogen levels on potato varieties had significantly influenced on the plant height growth, yield and yield attributes and economics, whereas the interaction effect between nitrogen levels and varieties was found to be non-significant at all stages of the crop growth period. Growth (Plant height) and Yield attributing analysis, the highest plant height (55.47 cm) was recorded with Pushkar variety (55.47 cm) *viz*., number of leaves $plant^{-1}$ (49.29) , Number of haulms (3.85), Fresh weight of haulms (262.84) and Dry weight of haulms (49.52) which was significantly superior as compare to other two varieties during at 30, 45, 60 DAS and at harvest stages, whereas there was no significant difference in terms of plant height at 15 DAS, the differences in the plant height was mainly because of the genetic makeup of the individual variety, similar results were reported by Vijaylakshman Again, Pushkar variety exhibited significantly maximum Tuber yield (244.03 q $ha^{-1}$), Grade wise number of tubers (small (13.51), medium (36.21) and large (18.41)) over Kufri

Jyoti and Kufri Pushkar varieties. This might be linked to the genetic potentiality of each variety which were in conformity with Sandhu *et al.*, (2010) [6].

**Economics**

Economic analysis (Table 1), depict those economic plays an important role in determining the feasibility of new research in the public domain. The application of nitrogen at 140 kg ha$^{-1}$ along with the Kufri Jyoti variety combination were demonstrated with maximum gross returns, (567592.72 ₹ ha$^{-1}$) higher net returns, (436443.02 ₹ ha$^{-1}$) profitable B:C ratio (3.33) as compared to the Pushkar and Kufri Pushkar varieties as well as with lower nitrogen levels (0, 100, and 180 kg ha$^{-1}$). The similar result was given by Verma *et al.*, (2011) [7] and Singh *et al.*, (2008) [8].

**Table 1:** Growth and yield and yield attribute of soyabean at different stages as influenced by different levels of nitrogen and different varieties.

| Treatment | At harvest | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Plant height (cm) | No of leaves plant$^{-1}$ | Number of haulms | Fresh weight of haulms | Dry weight of haulms | Tuber yield (q ha$^{-1}$) | Grade wise number of tubers | | | Total number of tubers |
| | | | | | | | Small | Medium | Large | |
| **Nitrogen (kg ha$^{-1}$)** | | | | | | | | | | |
| 0 | 31.46 | 28.07 | 2.18 | 154.06 | 32.30 | 117.23 | 6.49 | 17.39 | 8.86 | 32.74 |
| 100 | 53.89 | 48.08 | 3.73 | 253.95 | 46.91 | 228.47 | 12.65 | 33.89 | 17.26 | 63.79 |
| 140 | 59.84 | 53.40 | 4.15 | 282.00 | 52.11 | 275.06 | 15.23 | 40.81 | 20.80 | 76.84 |
| 180 | 62.35 | 54.83 | 4.33 | 293.84 | 54.29 | 289.10 | 16.00 | 42.89 | 21.85 | 80.75 |
| S.E(m) ± | 1.40 | 1.27 | 0.10 | 6.63 | 1.25 | 6.08 | 0.34 | 0.93 | 0.50 | 1.78 |
| C.D (P=0.05) | 4.09 | 3.73 | 0.29 | 19.43 | 3.68 | 17.83 | 1.01 | 2.74 | 1.47 | 5.22 |
| **Varieties** | | | | | | | | | | |
| Kufri Pushkar | 47.92 | 42.55 | 3.32 | 227.29 | 42.95 | 209.15 | 11.58 | 31.02 | 15.80 | 58.40 |
| Kufri Jyoti | 52.27 | 46.43 | 3.62 | 247.76 | 46.74 | 229.21 | 12.69 | 34.01 | 17.33 | 64.02 |
| Pushkar | 55.47 | 49.29 | 3.85 | 262.84 | 49.52 | 244.03 | 13.51 | 36.21 | 18.45 | 68.16 |
| S.E(m+) | 1.21 | 1.10 | 0.09 | 5.74 | 1.09 | 5.27 | 0.30 | 0.81 | 0.43 | 1.54 |
| C.D (P=0.05) | 3.55 | 3.23 | 0.26 | 16.83 | 3.19 | 15.45 | 0.88 | 2.37 | 1.27 | 4.52 |
| **Interaction** | | | | | | | | | | |
| S.E(m+) | 2.42 | 2.20 | 0.17 | 11.48 | 2.17 | 10.53 | 0.60 | 1.62 | 0.87 | 3.08 |
| C.D (P=0.05) | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

Effect of different Nitrogen levels on the economics of potato Varieties

| Treatments | Common cost | Treatment cost | Total cost of cultivation | Gross return | Net return | B:C ratio |
|---|---|---|---|---|---|---|
| N1V1 | 68837.78 | 75000 | 143837.78 | 213383.92 | 69546.14 | 0.48 |
| N1V2 | 68837.78 | 60000.00 | 128837.78 | 222810.26 | 93972.48 | 0.73 |
| N1V3 | 68837.78 | 75000.00 | 143837.78 | 267197.81 | 123360.03 | 0.86 |
| N2V1 | 68837.78 | 76651.37 | 145489.15 | 407988.07 | 262498.92 | 1.80 |
| N2V2 | 68837.78 | 61651.37 | 130489.15 | 479489.76 | 349000.61 | 2.67 |
| N2V3 | 68837.78 | 76651.37 | 145489.15 | 483314.01 | 337824.86 | 2.32 |
| N3V1 | 68837.78 | 77311.92 | 146149.698 | 505058.59 | 358908.89 | 2.46 |
| N3V2 | 68837.78 | 62311.92 | 131149.698 | 567592.72 | 436443.02 | 3.33 |
| N3V3 | 68837.78 | 77311.92 | 146149.698 | 577695.19 | 431545.49 | 2.95 |
| N2V1 | 68837.78 | 77972.47 | 146810.246 | 546790.38 | 399980.13 | 2.72 |
| N2V2 | 68837.78 | 62972.47 | 131810.246 | 563773.74 | 431963.49 | 3.28 |
| N3V3 | 68837.78 | 77972.466 | 146810.246 | 624022.5573 | 477212.31 | 3.25 |

**Conclusion**

Based on the present experimental findings it can be presumed that, the optimum level of nitrogen application at 180 kg ha$^{-1}$ resulted in superior outcome concerning with plant growth (height) yield and yield attributes and economic value as compared to lower nitrogen levels (0, 100, and 140 kg ha$^{-1}$). Among the different varieties tested, the Pushkar variety displayed favorable responses and proved to be well-suited for enhancing the all parameters of the crop. However, the combination of Pushkar variety along with nitrogen application at 180 kg ha$^{-1}$ emerged as the most suitable treatment combination for significantly improving the crop production and to maximize the profitability."

Remarkably, the combined treatment of nitrogen at 120 kg ha$^{-1}$ along with sulphur at 60 kg ha$^{-1}$ proved to be the most suitable combination for significantly improving crop production and maximizing profitability. It is important to note that these findings are based on a single-season study, and further experimentation is required to validate and recommend these results with certainty.

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