# Efficacy of Grace Hume-L and Nitro Bloomor-NB on Growth and Yield Parameters of Potato

**Abstract**

Efficacy of Grace Hume-L and Nitro Bloomor-NB was studied for their potentiality to enhance yield and productivity of potato (*Solanum tuberosum L.*) cv. Kufri Jyoti during 2012-13 at Lohagarh, Binuria and Bahadurpur village of Bolpur-Sriniketan Block under red and lateritic agro-climatic zone of West Bengal (India). Seven different commercial formulations of plant growth regulators (PGRs) and one untreated control were taken into account with three replicates. Growth regulators showed a significant effect on improving the entire growth and yield variables of the crop. The treatment $T_5$ (Nitro Bloomor-NB + Grace Hume-L) appeared best that influenced greatly all the growth and yield attributes of potato. The second best treatment was $T_2$ (Nitro Bloomor-NB + Paushak) followed by $T_6$ (Nitro Bloomor-NB) and $T_7$ (Grace Hume-L). The percentage increased in terms of tuber yield of $T_5$ and $T_2$ treatment over control ($T_8$) was 59.77 and 47.81, respectively. These combinations of growth regulators can be recommended for cultivating potato successfully with higher yield.

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**Keywords:** Growth regulator, Grace Hume-L, Nitro Bloomor-NB, PGR, Potato, Yield.

## Introduction

The potato is the third most important food crop in the world after rice and wheat which is consumed by more than a billion people worldwide. India is the second largest potato producer in the world after China; with the highest potato productivity among the top four potato producers in the world. It is an economical food, as it provides a source of low cost energy to human diet. Potato is rich source of starch, vitamins specially C and $B_1$ and minerals. It possesses 20.6% carbohydrates, 2.1% of protein, 0.3% fat, 1.1% crude fibre and 0.9% ash. It also contains a good amount of essential amino acids. The crop is grown almost all the states and union territories of India. Besides, the crop is used for several industrial purposes. Market price of the potato is increasing in trend due to its huge national and international demand. Therefore, a stabilized production is required to meet up the same. Apart from balanced doses of fertilizers growth regulators play an important role in stabilizing the crop health resulting in higher productivity (Meena *et al.,* 2012). Keeping this view in mind, the present investigation was conducted to study the effect of different plant growth regulators (PGRs) on growth and yield attributes of the crop.

## Materials and Methods

### General Information and Treatment Details

The field experiment on potato (cv. Kufri Jyoti) was conducted at the farmers' fields situated at Lohagarh, Binuria and Bahadurpur village of Bolpur-Sriniketan Block under red and lateritic agro-climatic zone of West Bengal (India) adjacent to the Agricultural Farm of Palli-Siksha Bhavana (Institute of Agriculture), Visva- Bharati, Sriniketan during 2012-2013 to study the effect of different plant growth regulators (PGRs) on growth and yield of potato. The experimental site are situated at 23°39´N latitude and 87°42´E longitude with an average altitude of 58.9 m above msl. The soil of the experimental plots was sandy loam in texture. Standard agronomic management practices were followed to raise the crop. Well decomposed FYM at 10 t/ha was applied before ploughing of the field and mixed thoroughly with the soil by ploughing. The fertilizers (N:P:K:S=200:150:150:20 kg/ha) were applied at basal as 10:26:26 and subsequent split applications was made as urea. Sulphur (20kg/ha) was applied as elemental sulphur in the plots during final land preparation. Only urea was top dressed at 25 days after planting (DAP). Two sprays of each chelated boron (2g/l) and zinc (0.5g/l) were also applied in the field at 20 and 40 DAP. The seed tubers were treated with *Trichoderma viride* (Trichovin powder, Grace Bio-care Pvt. Ltd.) at 10g/kg seed before planting to avoid seed and soil borne diseases primarily. The crop was planted during last week of December, 2012 with a seed rate of 25q/ha, and 20cm × 50cm spacing was provided for the crop. There were 8 treatments and 3 replications. Randomized Block Design was used with an individual plot size of 3m × 4m. The treatments used for the study were $T_1$=Bipul (1.0 ml/l), $T_2$= Nitro Bloomor-NB (2.0 ml/l) + Paushak (0.5 ml/l), $T_3$=Paushak (0.5 ml/l), $T_4$=Parag (0.4 ml/l), $T_5$= Nitro Bloomor-NB (2.0 ml/l) + Grace Hume-L (2.0 ml/l), $T_6$= Nitro Bloomor-NB (2.0 ml/l), $T_7$=Grace Hume-L (2.0 ml/l), $T_8$= Untreated control. In case of $T_1$, $T_3$, $T_4$, $T_6$, $T_7$ the single growth regulator specified above was applied two times in the field; at 20 and 40 days after planting (DAP). Whereas in the case of $T_2$ and $T_5$ the growth regulators Nitro Bloomor-NB was applied at 20 DAP followed by Poushak and Grace Hume-L at 40 DAP respectively. No growth regulator was applied in control plot ($T_8$).

**Methods of Recording Observation**

An area of each plot was ear-marked for destructive sampling and the rest of the plot was used for yield estimation. From the ear-marked area various growth data were recorded at different growth stages of the crop. The following growth and yield parameters were recorded from each plot of three different locations at different stages of the crop and their average values were used for statistical analysis and presentation.

**Plant Height**

Ten plants were selected randomly from each plot and their height was measured at 25 DAP, 45 DAP and 75 DAP. Average height was recorded from each plot.

**Dry Matter Accumulation (g/m$^2$)**

The plant sample was cut at ground level at 45 DAP and 75 DAP from each plot. The plant samples of each plot were then separated into green leaves, stem, branches, tubers and put into the brown paper packets for drying. The dry weights of the plant parts were recorded separately after drying in a hot air oven at 70ºC for about 72 hours till constant weights were obtained, before the tubers were put into the hot air oven for drying, they were chopped into small pieces. The dry weights recorded were used to determine dry matter accumulated in g/m.

**Leaf Area Index (LAI)**

The representative green leaves lamina were taken from the five plants uprooted at 45 DAP and 75 DAP from each plot and their leaf area was determined by leaf area meter. The leaves were then dried in a hot air oven at 70$^0$C for 48 hours till constant weights were obtained. The dry weights of those leaves were recorded and the ratio of area/weight of the leaves was used for determining the leaf area index (Kemp, 1960). The LAI was obtained by multiplying the ratio with dry weight of green leaves per unit land surface (Watson, 1952).

**Number of shoots/plant**

Number of shoots was counted from 10 randomly selected plants from each plot at 75 DAP and the average number of shoots/plant was determined from each plot.

**Number of tubers/plant**

Before harvesting, five plants were uprooted from each plot and the tubers were graded into A, B and C. Grade A comprised of tubers weighing more than 100g, grade B consisted of tubers weighing 50-100 g and grade C tubers were less than 50g.

**Tuber weight/plant**

Weights of tubers/plant (g) were taken from five plants in each plot at maturity. Then weight of tubers/plant was estimated.

**Yield**

After harvest, the tubers were graded into A, B and C grade. Then the weights of the different grades of tubers were recorded from each plot for yield estimation and also total weight of tubers were found out from the weights of the three grades.

***Methods of statistical analysis***

The data recorded on various parameters were subjected to statistical analysis following Panse and Sukhatme (1978). The significance of different sources of variations was tested by error mean square of Fisher and Snedecor's 'F' test at probability level 0.05. Fisher and Yate's tables were consulted for the determination of critical difference at 5% level of significance. The value standard error of mean (SEm±) and the critical difference (CD) to compare the difference between the treatment means and the co-efficient of variation (CV %) have been provided in the tables. Statistical analysis was made using the M stat.

**Results and Discussion**

**Plant Height**

The results (Table 1) showed that the height of the potato plant increased progressively upto 75 DAP when it attained about 10.08-46.51 cm height. It indicated that the plant height at different growth stages was significantly influenced by the different PGRs. The maximum plant height of 17.18 cm at 25 DAP, 44.37 cm at 45 DAP and 46.51 cm of 75 DAP was obtained from the potato plant receiving $T_5$ treatment. The second best treatment was $T_2$ in respect of plant height. $T_2$ and $T_5$ treatments showed better growth of the plant. That might be due to application PGRs towards the crop growth. The dwarf most plants of 10.08 cm at 25 DAP, 30.15 cm at 45DAP and 35.24 cm at 75DAP were obtained from the plots having no growth regulators ($T_8$). The result showed vital role of PGRs on increasing height of the potato.

**Table 1:**
**Effect of different PGRs on plant height**

| Treatment | Plant height (cm) | | |
|---|---|---|---|
| | 25 DAP | 45 DAP | 75 DAP |
| T1 | 11.87 | 33.73 | 37.20 |
| T2 | 14.71 | 40.67 | 43.12 |
| T3 | 13.75 | 37.33 | 41.25 |

| | | | |
|---|---|---|---|
| T4 | 12.15 | 34.29 | 38.51 |
| T5 | 17.18 | 44.37 | 46.51 |
| T6 | 14.52 | 39.63 | 42.17 |
| T7 | 14.43 | 38.81 | 41.27 |
| T8 | 10.08 | 30.15 | 35.24 |
| SEM (±) | 0.69 | 1.28 | 1.48 |
| CD (p=0.5) | 2.08 | 3.88 | 4.50 |

**Leaf Area Index (LAI)**

Different PGRs exerted significant effect on increasing LAI of potato. The maximum LAI of 2.26 at 45 DAP and 4.08 at 75 DAP was recorded in crop receiving the $T_5$ treatment. The second best treatment was $T_2$. The crop without growth regulators produced the lowest LAI values (0.95 and 1.51) as compared to others (Table 2).

**Dry Matter Accumulation (DMA)**

Total dry matter production per plant and its accumulation in different parts is the manifestation of the magnitude and persistence of photosynthetic capacity of the plant and its translocation to different parts; hence biomass production is directly related to crop productivity. The highest aerial biomass of 313.33 g/m$^2$ at 45 DAP and 622.67 g/m$^2$ at 75 DAP of crop was obtained with the $T_5$ treatment over the other treatments.

**Table 2**
**Effect of PGRs on leaf area index and dry matter accumulation**

| Treatment | LAI | | DMA | |
|---|---|---|---|---|
| | 45 DAP | 75 DAP | 45 DAP | 75 DAP |
| T1 | 1.19 | 2.52 | 219.00 | 533.33 |
| T2 | 1.90 | 3.64 | 268.00 | 594.33 |
| T3 | 1.40 | 3.10 | 227.67 | 495.33 |
| T4 | 1.33 | 3.10 | 217.00 | 537.33 |
| T5 | 2.26 | 4.08 | 313.33 | 622.67 |
| T6 | 1.79 | 3.07 | 234.00 | 564.00 |
| T7 | 1.59 | 2.61 | 229.33 | 566.00 |
| T8 | 1.05 | 1.95 | 200.33 | 488.00 |
| SEM (±) | 0.08 | 0.12 | 9.80 | 29.11 |
| CD (p=0.5) | 0.26 | 0.37 | 29.74 | 88.28 |

The lowest highest aerial biomasses of 200.33 g/m$^2$ at 45 DAP and 488.00 g/m$^2$ at 75 DAP of crop was obtained the treatment receiving no growth regulators. In respect to aerial biomass production, the second best treatment was $T_2$ (Table 2). Increased aerial biomass of crop by using of PGRs might be due to better development of root systems resulting in tapping larger volume of bound soil water and nutrients which plays a significant role in several physiological and biochemical plant activities like photosynthesis, transformation of sugar to starch, and transporting of the genetic traits.

**Number of Shoots Plant/Plant**

The numbers of shoots/plant was significantly influenced by the PGRs (Table 3). The maximum numbers of shoots/plant was recorded on $T_5$ (4.33) followed by $T_2$ (3.85). The lowest (2.68) numbers of shoots/plant was observed in $T_8$ which was control plot. Application of Nitro Bloomor-NB alternating with Grace Hume-L has an important role for increasing numbers of shoots/plant.

**Table 3.**
**Effect of PGRs on number of shoots and tubers/plant**

| Treatment | Data as on 75 DAP | |
|---|---|---|
| | No. of shoots/plant | No. of tubers/plant |
| T1 | 2.95 | 3.57 |
| T2 | 3.85 | 5.33 |
| T3 | 3.28 | 4.13 |
| T4 | 3.17 | 4.37 |
| T5 | 4.33 | 6.33 |
| T6 | 3.70 | 4.78 |
| T7 | 3.67 | 4.69 |
| T8 | 2.68 | 3.12 |
| SEM (±) | 0.18 | 0.21 |
| CD (p=0.5) | 0.45 | 0.54 |

**Number of Tubers/Plant**

The maximum (6.33) numbers of tubers/plant was recorded in $T_5$. The second best treatment was $T_2$ which produced 5.33 numbers of tubers/plant. The lowest (3.12) numbers of tubers/plant was observed in $T_8$ which was control plot. From this study, it was found that application of PGRs have an important role for increasing numbers of tubers/plant significantly (Table 3).

**Tuber Weight/Plant**

The data recorded on tuber weight/plant at 75 DAP and at harvest was presented in Table 4. Application of PGRs significantly influenced the tuber weight/plant. The highest tuber weight/plant (199.50 g) was recorded in crop receiving $T_5$ treatment. The second best treatment was $T_2$ (184.43 g) in respect of tuber weight/plant. The lowest (112.07 g) tuber weight/plant was observed in $T_8$ i.e. control plot. Similarly, the highest tuber weight/plant (289.44 g) at harvest was recorded in crop receiving $T_5$ treatment. The second best treatment was $T_2$ (258.24 g). The lowest (158.43 g) tuber weight/plant was observed in $T_8$ i.e. control plot. PGRs increased tuber formation which was primarily responsible for higher tuber weight/plant.

**Table 4**
**Effect of PGRs On Tuber Weight/Plant**

| Treatment | Tuber weight/plant | |
|---|---|---|
| | 75 DAP (g) | At harvest (g) |
| T1 | 125.40 | 186.31 |
| T2 | 184.43 | 258.24 |
| T3 | 157.30 | 209.73 |
| T4 | 155.28 | 208.04 |
| T5 | 199.50 | 289.44 |
| T6 | 170.56 | 236.75 |
| T7 | 169.95 | 231.82 |
| T8 | 112.07 | 158.43 |
| SEM (±) | 5.70 | 7.99 |
| CD (p=0.5) | 13.27 | 21.25 |

**Grade Wise Tuber Yield (t/ha)**

The results of Table 5 showed a marked influence of PGRs on grade wise total tuber yield particularly of large and medium size tubers. The highest tuber yield of Grade A, B and C was recorded in crop receiving $T_5$ treatment. The lowest total tuber yield was observed in crop receiving $T_8$ treatment i.e. control plot. The results clearly indicated the need of PGRs for increasing the large and medium size tubers which ultimately led to high productivity of the crop.

**Tuber Yield (t/ha)**

The tuber yield comprising of all grades recorded at maturity during the year of experimentation has been statistically analyzed and presented in table 5. The increased yield due to application of PGRs was contributed mainly by large and medium sized tubers. The crop that received $T_5$ treatment produced maximum (21.92 t/ha) tuber yield. The second best treatment was $T_2$ which produced 20.28 t/ha of tuber yield. The percentage increased in terms of tuber yield of $T_5$ and $T_2$ treatment over control ($T_8$) was 59.77 and 47.81, respectively. The result clearly indicated that application of plant growth regulators has an important role for increasing tuber yield of potato. The lowest tuber yield of 13.72 t/ha was obtained from crop receiving control treatment i.e. $T_{8.}$

**Table:5**
**Effect of Pgrs On Grade Wise Tuber and Total Tuber Yield**

| Treatment | Grade wise tuber yield (t/ha) | | | Total tuber Yield(t/ha) |
|---|---|---|---|---|
| | A | B | C | |
| T1 | 6.18 | 6.33 | 2.69 | 15.2 |
| T2 | 8.12 | 8.61 | 3.55 | 20.28 |
| T3 | 7.19 | 7.57 | 3.06 | 17.82 |
| T4 | 6.31 | 6.43 | 2.76 | 15.5 |
| T5 | 8.75 | 9.29 | 3.88 | 21.92 |
| T6 | 7.83 | 7.98 | 3.26 | 19.07 |
| T7 | 7.29 | 7.63 | 3.16 | 18.08 |
| T8 | 5.65 | 5.83 | 2.24 | 13.72 |
| SEM (±) | 0.27 | 0.34 | 0.09 | 0.38 |
| CD (p=0.5) | 0.81 | 1.04 | 0.28 | 1.16 |

A =100 g or above, B=50-99 g and C=below 50 g

**Conclusion**

PGRs showed a significant effect on improving the entire growth variables recorded under the study. Plant height, number of shoots/plant, leaf area index, and dry matter accumulation increased markedly due to the application of $T_5$ treatment (Nitro Bloomer NB + Grace Hume-L) over the other treatments. Number of tubers/plant, grade wise yield of tubers/plant and total tuber yield were greatly influenced by the growth regulators treatment. The highest amount of large and medium size tubers and also the total tuber yield was obtained from the crop receiving $T_5$ treatment. The second best treatment was $T_2$ (Nitro Bloomer NB + Paushak) followed by $T_6$ (Nitro Bloomer NB) and $T_7$ (Grace Hume-L).

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