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# Effect of inorganic fertilizers and biofertilizers on growth, yield and quality of potato

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**Abstract**
The present experiment was conducted at the, Department of Horticulture, College of Agriculture, RVSKVV, Gwalior (M.P.) during the *Rabi* season of two consecutive years 2017-18 and 2018-19, to study the response of growth and yield parameters potato processing cultivar Kufri chipsona-1 under different levels of inorganic fertilizers and biofertilizers. The experiment was laid out in Randomized Completely Block Design (RCBD) with three replications. Growth parameters under study were plant height, shoots per plant, leaf area ($cm^2$), diameter of stem (cm), fresh weight of shoots and roots per plant. The findings of present study revealed that due to the effect of inorganic fertilizers good response of growth and yield parameters was observed with the advancement in levels of NPK from 50% upto 100% NPK. Highest marketable yield (19.9 t/ha) and total yield of (21.1 t/ha) was recorded under treatment 100%NPK. Whereas due to the effect of biofertilizer treatments, highest total yield (18.8t/ha), highest starch% (25.1%), dry matter% (23.1%) was obtained with treatment dose (Azotobacter 2.5 kg/ha + PSB 2.5kg/ha).

**Keywords:** Inorganic fertilizers, biofertilizers, growth, yield, quality, potato

## Introduction
Potato (*Solanum tuberosum* L.) is a herbaceous annual dicotyledonous plant and belongs to the family Solanaceae, and grown for its edible tubers. Originally it is a temperate crop, but well adopted for sub-tropical conditions. The average composition of a potato tuber consists of dry matter (20%), starch (13-17%), total sugars (0-2%), protein (2.2%), fibre (0.7%), lipids (0.13%), fat (0.3%), vitamin C (32 mg/ 100 g fresh weight), minerals (trace), ash (1-1.5%). Potato, being a heavy feeder crop, requires high amount of nitrogen, phosphorus and potassium fertilizers. However, continuous application of chemical fertilizers leads to nutritional imbalance and causes damage to soils health. Therefore it is necessary to incorporate combined use inorganic fertilizers and bio fertilizers to obtain sustainability in the yields. Biofertilizers are natural fertilizers containing microorganisms which help in enhancing the production by biological nitrogen fixation, solubilization of insoluble phosphate or other elements, vitamins and other growth regulators required for plant growth (Bhattacharya, 2000) [1]. The bio fertilizers like Azotobacter and Phosphate solubilising bacteria (PSB) can fix and mobilise the available elements into soluble forms for plants. Therefore the present experiment was carried out to study the response of growth, yield and quality parameters of potato crop due to the effects of inorganic fertilizers and bio fertilizers treatments.

## Materials and methods
The experiment was conducted at the, Horticulture research area, College of Agriculture, Rajmata Vijayaraje Scindia Krishi Vishwa Vidyalaya, Gwalior (M.P.) during the *Rabi* season of two consecutive years 2017-18 and 2018-19. The Experimental site College of Agriculture, Gwalior is situated at 26° 13 N latitude and 78° 14' E longitudes at an altitude of 211.5 m from mean sea level in central part of Madhya pradesh and it has a semi-arid subtropical climate. The soil of the experimental field was clay in texture with uniform topography. The treatments comprised of three levels of inorganic fertilizers viz., (100% NPK), (75%NPK) and (50%NPK) and three levels of biofertilizers (Azotobacter 5 kg/ha), (PSB 5kg/ha) and (Azotobacter 2.5 kg/ha + PSB 2.5kg/ha) tested on potato processing cultivar Kufri chipsona-1. The experiment was laid out in Randomized Completely Block Design (RCBD) with three replications. Nitrogen was given in the form of urea. Phophorus and potassium were applied through single super phosphate and muriate of potash, respectively.

Pre-planting seed treatment was done with Mancozeb 0.2% solution. The tubers of uniform size were sown in plots of size 3 x 3 m at a spacing distance of 60 x 20 cm. The observations for plant growth parameters like plant height, number of shoots per plant, number of leaves per plant, leaf area ($cm^2$), diameter of stem (cm), fresh weight of shoots per plant, fresh weight of roots per plant (g), were recorded on five randomly selected plants from each plot of each replication separately. Simmillarly, observations for yield parameters were taken at the time of harvest to obtain the viz., grade wise yield of tubers(kg/plot), Processing grade tuber yield (T/ha), Marketable tuber yield and Total yield (T/ha) of potato tubers. The grade wise yield of tubers was obtained by sorting out total yield into four grades. The grading was done based on weight basis *viz*., A (>75 g), B (50-75 g), C (25-50g) and unmarketable tubers (<-25 g) and tubers of each grade were weighed separately and graded yield was expressed in kilograms (kg/plot). Processing grade tuber yield (T/ha) was obtained by taking weight of tubers weighing (above 75 g). Where, Marketable tuber yield (T/ha)(A'+'B+'C grade tubers) was obtained by adding yield of "A (>75 g), "B (50-75 g) and "C (25-50g) grade tubers and total yield (T/ha) was obtained as a sum total of all tuber yield obtained from each treatment and each replication at the time of harvest. The starch content and ascorbic acid content of potato tubers was determined by gelatinization and titration methods respectively. Whereas, the dry matter content of tubers was determined by oven drying method.

The data recorded under the study were subjected to statistical analysis as per standard procedure as suggested by Panse and Sukhatme (1985) [9].

## Results and Discussion:

### Effects of NPK

Growth of the potato plant (Table-1) and (Table-2) was studied with respect to plant height(cm), leaves per plant, Per cent emergence, number of shoots per plant, diameter of the stem (cm), leaf area per plant ($cm^2$), fresh weight of shoot and root per plant (g), days to haulm cutting and days to harvest. There was significant effect of inorganic fertilizers on all the growth parameters. Plant height and number of leaves per plant were increased with advancement of levels of inorganic fertilizers from 50% upto 100% NPK at 30, 60 and 90 days after sowing. The above results are in close proximity with the findings of Raghav *et. al* (2008), Gavit *et al.* (2010) and Marthha *et al*. (2017) [10, 2, 8]. Maximum fresh weight of shoot and root per plant (g) and shoots per plant was also observed under the treatment (100% NPK) while the lowest was recorded in the treatment (50% NPK). This may be due to higher uptake of nutrients at higher dose of NPK which may have resulted in increased vegetative growth of plants and increased shoots and root weight per plant, whereas increased leaf area per plant ($cm^2$) caused more photosynthetic absorptions, simmillar findings were reported by Kumar *et al.* (2015) [6] and Jatav *et al*. (2017) [4].

**Yield parameters:** Maximum marketable tuber yield (A'+'B+'C grade tubers), and highest yield total tuber yield of tubers (Table-3). was observed in the treatment (100% NPK) followed by treatment (75% NPK). Response of high processing grade tubers at high fertilizer rates in this study may be due the good tuber bulking efficiency at this level of. Whereas, treatment (50% NPK) had resulted in more unmarketable tubers (0-25 g) and gave less yield of large sized tubers per plot as compared to other treatments (100% NPK) and treatment (75% NPK). Which could be due to low availability of nutrients and hence tubers could not have bulked properly. These findings are in close association with findings made by Singh *et al.* (2007) [11] who reported that there was significant increase in production of large sized tubers under fertility level (150 N:150 P:100 K kg/ha), and more number of medium size tubers were obtained from medium fertility level (100 N:100 P: 50 K kg/ha). Kumar *et al.* (2011) [5] also disclosed that the crop receiving 100% NPK was the best treatment capable of affecting yield of different grades (A, B and C) of tubers. Kumar *et al.* (2015) [6] obtained highest chips grade tubers from potato chipping variety Kufri Chipsona-4 under fertilizer treatment of (100%NPK). Kumar *et al.* (2017) [7] obtained the highest marketable tubers yield of (20.8 kg/plot) and total tuber yield (21.0 kg/plot) with the application of 100%NPK/ha. Simmillarly, Swaroop *et al*. (2018) [12] also concluded that with the application of 100% NPK a yield of (24.1.t/ha) was obtained in potato.

Significant results were obtained for all the quality parameters due to effect of levels of inorganic fertilizers (table-4). Highest protein% (2.02%), starch% (26.61%), dry matter% (23.7%) was obtained with the treatment dose (100%NPK). It is evident that protein content increases with increase in nitrogen doses, simmillar findings were also reported by Kumar *et al.* (2015) [6] and Jatav *et al*. (2017) [4].

**Table 1:** Effect of Inorganic fertilizers and biofertilizers on growth of potato

| Treatment | Plant emergence % | Plant height (cm) | | | Number of leaves per plant | | | Shoots per plant | | Diameter of stems (cm) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 30 DAS | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS | 60 DAS | 90 DAS | 60 DAS | 90 DAS |
| 50%NPK | 85.41 | 19.23 | 40.71 | 52.27 | 20.15 | 42.28 | 65.83 | 3.62 | 4.76 | 1.52 | 3.86 |
| 75%NPK | 86.33 | 21.92 | 40.7 | 58.93 | 22.1 | 45.09 | 68.04 | 3.8 | 5.31 | 1.58 | 4.07 |
| 100%NPK | 88.4 | 23.09 | 45.1 | 58.9 | 23.09 | 43.38 | 72.16 | 4.02 | 5.33 | 1.66 | 4.24 |
| SE(m) | 0.779 | 0.280 | 0.448 | 0.656 | 0.228 | 0.556 | 0.807 | 0.104 | 0.074 | 0.039 | 0.052 |
| CD at 5% | 2.199 | 0.790 | 1.264 | NS | 0.812 | 0.589 | 0.671 | 0.212 | 0.210 | 0.110 | 0.145 |
| Azotobctr | 86.04 | 21.7 | 41.94 | 57.7 | 21.46 | 45.07 | 68.45 | 3.89 | 5.10 | 1.53 | 4.01 |
| PSB | 86.48 | 21.8 | 41.8 | 58.7 | 21.8 | 45.06 | 68.40 | 3.71 | 5.10 | 1.60 | 4.02 |
| Azto+PSB | 87.63 | 21.9 | 42.7 | 58.6 | 21.90 | 45.64 | 69.18 | 3.92 | 5.15 | 1.64 | 4.13 |
| SE(m) | 0.779 | 0.280 | 0.448 | 0.656 | 0.228 | 0.556 | 0.807 | 0.104 | 0.074 | 0.039 | 0.052 |
| CD at 5% | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS | NS |

(DAS-days after sowing, NPK-Nitrogen, Phosphorus, Potassium, PSB- Phosphate solubilising bacteria, Azotobctr- Azotobacter, Azto + PSB - Azotobacter + PSB)

**Table 2:** Effect of Inorganic fertilizers and biofertilizers on growth of potato

| Treatment | Days to Harvest | Leaf area per plant($cm^2$) | | | Average fresh weight of roots | | | Average Fresh weight of Shoots | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS | 30 DAS | 60 DAS | 90 DAS |
| 50%NPK | 118.4 | 140.3 | 321.1 | 405.5 | 3.92 | 7.9 | 12.11 | 82.93 | 155.6 | 182.8 |
| 75%NPK | 118.5 | 145.4 | 316.1 | 414.0 | 4.40 | 9.07 | 13.56 | 85.75 | 155.4 | 191.2 |
| 100%NPK | 117.8 | 148.6 | 343.0 | 418.2 | 4.83 | 9.22 | 15.21 | 88.9 | 166.61.607 | 197.03 |
| SE(m) | 0.373 | 1.35 | 3.118 | 4.04 | 0.077 | 0.114 | 0.166 | 0.904 | NS | 1.971 |
| CD at 5% | NS | 0.312 | 0.259 | NS | 0.217 | 0.323 | 0.469 | 7.142 | | 5.561 |
| Azotobctr | 118.25 | 143.1 | 329.7 | 410.4 | 4.36 | 8.58 | 13.1 | 85.10 | 158.8 | 188.6 |
| PSB | 118.03 | 144.9 | 326.3 | 414.0 | 4.34 | 8.68 | 13.7 | 85.76 | 160.8 | 191.7 |
| Azto+PSB | 118.5 | 146.4 | 324.3 | 413 | 4.44 | 9.00 | 13.9 | 86.7 | 160.9 | 190.7 |
| SE(m) | 0.373 | 1.358 | 3.118 | 4.04 | 0.077 | 0.114 | 0.166 | 0.904 | 1.607 | 1.971 |
| CD at 5% | NS | NS | NS | NS | NS | 0.323 | 0.469 | NS | NS | NS |

(DAS- days after sowing, NPK-Nitrogen, Phosphorus, Potassium, PSB- Phosphate solubilising bacteria, Azotobctr- Azotobacter, Azto + PSB - Azotobacter + PSB)

**Table 3:** Effect of Inorganic fertilizers and biofertilizers on yield parameters of potato

| Treatments | Processing grade tuber yield (T/ha) | Grade wise tuber yield (kg/plot) | | | | Marketable tuber yield (T/ha) | Total yield (T/ha) |
|---|---|---|---|---|---|---|---|
| | | 'A' grade | 'B' grade | 'C' grade | Unmarketable yield | | |
| 50%NPK | 4.70 | 4.25 | 4.55 | 4.29 | 1.35 | 14.60 | 16.17 |
| 75%NPK | 6.12 | 5.54 | 5.45 | 4.20 | 1.13 | 16.86 | 18.20 |
| 100%NPK | 8.20 | 7.38 | 6.73 | 3.90 | 0.84 | 19.91 | 21.02 |
| SE(m) | 0.091 | 0.081 | 0.113 | 0.075 | 0.048 | 0.165 | 0.212 |
| CD at 5% | 0.257 | 0.227 | 0.318 | 0.211 | 0.099 | 0.466 | 0.502 |
| Aztobactr | 6.07 | 5.50 | 5.46 | 4.23 | 1.09 | 16.87 | 18.19 |
| PSB | 6.27 | 5.66 | 5.4 | 4.1 | 1.16 | 16.99 | 18.31 |
| Azto+PSB | 6.69 | 6.02 | 5.78 | 4.07 | 1.07 | 17.59 | 18.80 |
| SE(m) | 0.091 | 0.081 | 0.113 | 0.075 | 0.048 | 0.165 | 0.212 |
| CD at 5% | 0.257 | 0.227 | 0.318 | NS | NS | 0.631 | NS |

(NPK-Nitrogen, Phosphorus, Potassium, PSB- Phosphate solubilising bacteria, Azotobctr- Azotobacter, Azto+PSB - Azotobacter +PSB)

**Table 4:** Effect of Inorganic fertilizers and biofertilizers on quality parameters of potato

| Treatments | Protien % | Ascorbic acid content (mg) | Starch% | Dry matter %. |
|---|---|---|---|---|
| 50%NPK | 1.65 | 19.06 | 22.9 | 22.1 |
| 75%NPK | 1.87 | 21.6 | 24.6 | 22.5 |
| 100%NPK | 2.02 | 21.9 | 26.6 | 23.7 |
| SE(m) | 0.021 | 0.219 | 0.262 | 0.245 |
| CD at 5% | 0.061 | 1.617 | 0.738 | 0.690 |
| Azotobactr | 1.8 | 20.4 | 24.4 | 22.5 |
| PSB | 1.88 | 20.6 | 24.5 | 22.8 |
| Azoto+PSB | 1.87 | 21.5 | 25.1 | 23.10 |
| SE(m) | 0.021 | 0.219 | 0.262 | 0.245 |
| CD at 5% | 0.061 | 0.617 | NS | NS |

(NPK-Nitrogen, Phosphorus, Potassium, PSB- Phosphate solubilising bacteria, Azotobctr- Azotobacter, Azto + PSB - Azotobacter + PSB)

**Effects of biofertilizers**

There was no significant differences noticed among the results shown by the three levels of biofertilizers on various growth parameters of potato (Table-1) and (Table-2), like height of the plant, leaves per plant, number of shoots per plant, diameter of the stem, leaf area and per fresh weight of root and shoot per plant at 30, 60 and 90 days after sowing. Which can be due to similar effects exerted by the different levels of biofertilizers on growth of plants. These findings are in confirmation with, results were obtained by Verma *et al*., (2013), Yadav *et al* (2016) and Kumar *et al*. (2017) [13, 14, 7].

Whereas, the yield varied among the biofertilizer treatment levels (Table-3). Highest marketable tuber yield, graded tuber yield, processing ('A' grade) yield and total yield was obtained with treatment (Azotobacter 2.5 kg/ha + PSB 2.5kg/ha) followed by treatment (Azotobacter at 5 kg/ha) and (PSB at 5kg/ha). This can be due to the fact that biofertilizers PSB and *Azotobacter* help in solubilizing the nitrogen and phosphorus which readily became available to the plants in soluble forms and also fascilitate their fast absorption leading to increase in more number of large sized tubers and thus increasing their yield. These results are in confirmation with findings of Jaipaul (2011) [3], Yadav *et al* (2016) [14] and Kumar *et al*. (2017) [7].

Significant results were obtained for quality parameters (table-4) like Protien %, ascorbic acid content (mg) due to effect of all three levels of biofertilizers. Highest starch% (25.1%), dry matter% (23.1%) was obtained with the treatment dose (Azotobacter 2.5 kg/ha + PSB 2.5kg/ha). These findings are in close proximity with results obtained by Sharma *et al.* (2011) [3] and Jaipaul (2011) [3] who also noted maximum dry matter (21.03%), starch (11.76%) in their experiment on potato.

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