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# Effect of Organic Manures and Biofertilizers on Growth and Yield of Potato (*Solanum tuberosum* L.)

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**Abstract** A field experiment was conducted during the *rabi* season of the year 2013-2014 and 2014-2015 with a view to study the effect of organic manures and biofertilizers on growth and yield of potato (*Solanum tuberosum* L.). The treatments comprised of three replications and eight treatments. The treatment consisted of different levels of Farm Yard Manure, vermicompost, enriched compost and biofertilizers viz., Farm Yard Manure @ 20 t/ha ($T_1$), Vermicompost @ 5 t/ha ($T_2$), Enriched compost @ 5 t/ha ($T_3$), Vermicompost @ 5 t/ha + Biofertilizers (consortia) @ 8 kg/ha ($T_4$), Vermicompost @ 2.5 t/ha + Biofertilizers (consortia) @ 8 kg/ha ($T_5$), Farm Yard Manure @ 10 t/ha + Biofertilizers (consortia) @ 8 kg/ha ($T_6$), Farm Yard Manure @ 5 t/ha + Enriched compost @ 2.5 t/ha ($T_7$) and Control ($T_8$). The two years experimental findings revealed that application of FYM @ 20 t/ha recorded highest tuber yields 17.59 and 18.62 t/ha during both years. This is closely followed by tuber yields 15.59 t/ha and 16.28 t/ha at $T_7$ (FYM @ 5 t/ha + EC @ 2.5 t/ha) during both the years. Soil organic carbon, pH, available N, P and K status of the soil after two years of experimentation were favorably influenced when due to application of organic manures either alone or in their combination. Among the different treatments $T_1$ (FYM @ 20 t/ha) recorded the highest net return and B: C ratio followed by $T_6$ during both the years of experimentation. The lowest was observed in $T_3$.

**Keywords** Growth, Organic manure, Biofertilizers, Nutrient uptake, Soil health.

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## Introduction

Potato (*Solanum tuberosum* L.) is consumed by more than one billion people the world over and has emerged as fourth most important food crop in the world after rice, wheat and maize. Nutritionally, potato is a whole some food and deserves to be promoted as a potential high quality vegetable cum food

**Table 1.** Effect of organic manures and biofertilizers on plant height, number of shoots per plants and total tuber yield.

| Treatments | Plant height (cm) | | No. of shoots/plant | | Total tuber yield (t/ha) | |
|---|---|---|---|---|---|---|
| | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 |
| $T_1$ | 36.43 | 47.36 | 4.23 | 4.33 | 17.59 | 18.62 |
| $T_2$ | 25.43 | 33.59 | 3.90 | 3.67 | 10.62 | 11.38 |
| $T_3$ | 28.56 | 32.89 | 4.23 | 3.63 | 12.50 | 13.00 |
| $T_4$ | 23.89 | 38.96 | 4.23 | 3.63 | 10.92 | 11.21 |
| $T_5$ | 23.66 | 29.36 | 4.20 | 3.77 | 8.88 | 9.40 |
| $T_6$ | 30.56 | 41.46 | 4.10 | 3.73 | 14.85 | 15.18 |
| $T_7$ | 28.13 | 40.69 | 3.97 | 4.30 | 15.59 | 16.28 |
| $T_8$ | 21.89 | 29.29 | 3.20 | 3.27 | 7.29 | 7.92 |
| SEm(±) | 2.09 | 2.70 | 0.35 | 0.19 | 1.35 | 1.17 |
| CD ($p$=0.05) | 6.35 | 8.20 | NS | 0.58 | 4.10 | 3.56 |

crop and it may prove useful to achieve the nutritional security of the nation. Over the last few decades demand for healthier food and government policies on environmentally sustainable agricultural systems have promoted a rapid expansion of organic farming. Potato represents a major food crop in many countries where the demand for organic products is gradually increasing [1]. According to Kopke [2] a potential advantage of organic agriculture in producing healthy foods is based on higher concentration of beneficial secondary plant substances in organically growtn crops compared to inorganically grown crops. Profitability of organic farming is accomplished by premium on organically produced food products. Moreover, potato cultivation fits well in organic agriculture in Assam state with enormous potential for domestic and export markets. Information available on organic production of potato crop in India is scanty. Therefore, present study was conducted with the aim to study the effect of organic manures and biofertilizers on growth and yield of potato.

## Materials and Methods

The experiment was carried out during the *rabi* season of 2013-14 and 2014-15 in the Instructional-cum Research Farm of Assam Agricultural University, Jorhat, Assam, India which is situated at 26°47´N latitude and 94°12´E longitude and at the elevation of 86.6 meters above mean sea level (MSL). The soils of experimental site sandy loam in nature, acidic (5.56) in reaction, low in organic carbon (0.25%), available N (161.61 kg/ha) and P (17.75), medium in available K (137.77 kg/ha). The experiment was laid out in randomized block design with three replications and eight treatments. The treatment consisted of different levels of farmyard manure, vermicompost, enriched compost and biofertilizers viz., Farm Yard Manure @ 20 t/ha ($T_1$), Vermicompost @ 5 t/ha ($T_2$), Enriched compost @ 5 t/ha ($T_3$), Vermicompost @ 5 t/ha + Biofertilizers (consortia) @ 8 kg/ha ($T_4$), Vermicompost @ 2.5 t/ha + Biofertilizers (consortia) @ 8 kg/ha ($T_5$), Farm Yard Manure @ 10 t/ha + Biofertilizers (consortia) @ 8 kg/ha ($T_6$), Farm Yard Manure @ 5 t/ha + Enriched compost @ 2.5 t/ha ($T_7$) and Control ($T_8$).FYM alone @ 20 t/ha ($T_1$), FYM @ 10 t/ha + Biofertilizers @ 8 kg/ha ($T_6$) and FYM @ 5 t/ha + Enriched compost @ 2.5 t/ha ($T_7$) were applied 15

**Table 2.** Effect of organic manures and biofertilizers on grade wise tuber yield.

| Treatments | Grade wise tuber yield (t/ha) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | <25 g | | 25 g–50 g | | 50 g–75 g | | >75 g | |
| | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 |
| $T_1$ | 4.43 | 4.70 | 4.58 | 5.10 | 4.41 | 4.96 | 4.17 | 3.87 |
| $T_2$ | 2.66 | 2.89 | 2.64 | 3.13 | 2.58 | 2.59 | 2.73 | 2.76 |
| $T_3$ | 3.12 | 3.18 | 3.05 | 3.12 | 3.25 | 3.30 | 3.08 | 3.50 |
| $T_4$ | 2.73 | 3.03 | 2.58 | 2.93 | 2.87 | 2.90 | 2.74 | 2.34 |
| $T_5$ | 2.22 | 2.63 | 2.29 | 2.37 | 2.27 | 2.32 | 2.10 | 2.08 |
| $T_6$ | 3.71 | 3.90 | 3.49 | 3.77 | 4.29 | 3.90 | 3.36 | 3.71 |
| $T_7$ | 3.90 | 4.14 | 3.87 | 4.20 | 3.98 | 4.10 | 3.85 | 3.85 |
| $T_8$ | 1.82 | 1.99 | 1.65 | 2.01 | 1.98 | 2.01 | 1.84 | 1.91 |
| SEM (±) | 0.33 | 0.30 | 0.37 | 0.48 | 0.37 | 0.29 | 0.36 | 0.29 |
| CD ($p$-=0.05) | 1.00 | 0.92 | 1.11 | 1.44 | 1.12 | 0.89 | 1.10 | 0.87 |

**Table 3.** Effect of organic manures and biofertilizers on nutrient uptake (kg/ha) by haulm and tuber.

| | Haulm | | | | | | Tuber | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | | P | | K | | N | | P | | K | |
| Treatments | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 |
| $T_1$ | 19.65 | 20.67 | 16.38 | 17.12 | 19.65 | 20.47 | 75.66 | 77.94 | 15.51 | 15.62 | 73.99 | 74.77 |
| $T_2$ | 14.61 | 15.64 | 12.08 | 12.63 | 15.73 | 16.54 | 46.85 | 51.46 | 8.39 | 9.62 | 45.96 | 49.54 |
| $T_3$ | 16.83 | 17.86 | 14.52 | 14.77 | 18.81 | 19.93 | 56.80 | 58.93 | 9.46 | 10.36 | 54.70 | 56.74 |
| $T_4$ | 14.45 | 15.11 | 11.84 | 12.14 | 15.89 | 16.29 | 53.28 | 56.91 | 9.60 | 10.67 | 51.36 | 53.36 |
| $T_5$ | 11.80 | 12.42 | 9.44 | 9.93 | 12.74 | 13.66 | 42.94 | 43.67 | 7.77 | 7.82 | 43.76 | 42.02 |
| $T_6$ | 18.55 | 18.66 | 15.85 | 15.65 | 18.95 | 17.87 | 72.21 | 74.49 | 13.80 | 14.16 | 70.14 | 73.08 |
| $T_7$ | 18.74 | 19.63 | 15.51 | 16.60 | 19.13 | 19.60 | 74.10 | 75.47 | 14.85 | 14.79 | 71.98 | 74.00 |
| $T_8$ | 9.87 | 10.04 | 8.19 | 7.95 | 10.50 | 10.25 | 33.16 | 36.05 | 5.79 | 6.18 | 33.16 | 35.71 |
| SEm (±) | 0.17 | 0.55 | 0.43 | 0.69 | 1.60 | 0.56 | 1.57 | 1.51 | 0.17 | 0.57 | 2.42 | 3.59 |
| CD ($p$=0.05) | 0.51 | 1.68 | 1.30 | 2.09 | 4.84 | 1.69 | 4.77 | 4.59 | 0.50 | 1.47 | 7.35 | 10.88 |

days prior to planting. The FYM were mixed thoroughly with the soil after application. The healthy tubers were selected one day prior to planting and biofertilizers (consortia) were inoculated by thoroughly mixing the inoculum with the tubers using gum arabica. Vermicompost alone @ 5 t/ha ($T_2$), V. C @ 5 /ha + Biofertilizers (consortia) @ 8 kg/ha ($T_4$) and V. C @ 2.5 t/ha + Biofertilizers (consortia) @ 8 kg/ha were applied 2 days prior to planting. Vermicompost were mixed thoroughly with the soil after application. The healthy tubers were selected one day prior to planting and biofertilizers (consortia) were applied as a tuber inoculation. The compost was enriched with rock phosphate. Enriched compost alone @ 5 t/ha and FYM @ 5/ha + Enriched compost @ 2.5 t/ha were applied 2 days prior to planting. Enriched compost was mixed thoroughly with the soil after application. Potato tubers were planted manually on 15th and 10th November during the seasons of 2013-14 and 2014-15 respectively. Expenditure and total returns were worked out on hectare basis for each treatment by taking into account the cultural operations, prevailing prices of inputs and outputs.

The gross return (Rs/ha), net return and B:C ratio were calculated out as follows:

Gross return (Rs/ha) = Value of tuber

Net return (Rs/ha)=Gross return - Total cost of cultivation

$$\text{Benefit: Cost ratio (B:C)} = \frac{\text{Net return}}{\text{Cost of cultivation}}$$

## Results and Discussion

### Plant height and number of shoots per plant

Table 1 showed that there was significant effect on plant height at 50 DAP during both the years. Application of organic manures alone and in combination with biofertilizers at different doses improved the plant height as compared to control. However, maximum plant height was attain at $T_1$ (FYM @ 20 t/ha) during both the years.

Table 1 reveal that there was no significant effect on number of shoots per plant during the 2013-14. Number of shoots per plant also increased due to application of organic manures and biofertilizers either alone or in combination, but significant improvement was observed during the second year of experimentation and highest number of shoots per plant was recorded at in the plot fertilized with FYM @ 20 t/ha ($T_1$) during both the years. The increased in plant height and number of shoots per plant could be due to adequate supply of nutrients during plant growth and ideal moisture condition prevailed due to application of organic manures. Similar results were also observed by Jaipual et al. [3].

**Table 4.** Effect of organic manures and biofertilizers on physico-chemical properties of soil at harvest.

| Treatments | pH | | Organic carbon (%) | | N (kg/ha) | | P (kg/ha) | | K (kg/ha) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 | 2013-14 | 2014-15 |
| $T_1$ | 5.62 | 5.66 | 0.50 | 0.52 | 234.62 | 238.75 | 23.93 | 24.02 | 184.57 | 184.91 |
| $T_2$ | 5.56 | 5.57 | 0.48 | 0.48 | 230.58 | 232.87 | 22.20 | 22.53 | 144.57 | 144.40 |
| $T_3$ | 5.57 | 5.59 | 0.50 | 0.51 | 225.67 | 229.89 | 20.98 | 21.46 | 171.22 | 171.37 |
| $T_4$ | 5.56 | 5.57 | 0.49 | 0.50 | 223.08 | 228.82 | 22.74 | 23.07 | 170.15 | 170.20 |
| $T_5$ | 5.59 | 5.60 | 0.48 | 0.59 | 222.66 | 225.38 | 19.86 | 20.20 | 159.33 | 159.55 |
| $T_6$ | 5.60 | 5.61 | 0.50 | 0.50 | 228.40 | 233.01 | 23.58 | 23.76 | 152.16 | 152.29 |
| $T_7$ | 5.61 | 5.62 | 0.49 | 0.50 | 230.45 | 233.16 | 23.05 | 23.20 | 131.35 | 151.52 |
| $T_8$ | 5.55 | 5.54 | 0.46 | 0.46 | 190.18 | 189.93 | 18.68 | 18.71 | 129.64 | 129.76 |
| SEm (±) | 0.05 | 0.04 | 0.01 | 0.02 | 6.04 | 7.51 | 1.60 | 1.21 | 13.92 | 13.86 |
| CD ($p$=0.05) | NS | NS | NS | NS | 18.32 | 22.77 | NS | NS | NS | NS |

Grade wise tuber yield

Tuber yields under different grades (Table 2) was found to be significantly influenced due to application of organic manures either alone and biofertilizers or in combination during both the years. $T_1$ (FYM @ 20 t/ha) produced highest yield of 4.43 and 4.70 t/ha under <25 g grade tuber during both the years. This was closely followed by $T_7$ (FYM @ 5 t/ha + EC @ 2.5 t/ha) and $T_6$ (FYM @ 10 t/ha + Biofertilizer @ 8 kg/ha). Similar trend in tuber yields under 25–50, 50–75, and >75 g grade tuber was noticed during both the years. However, tuber yields were lowest in $T_8$ (Absolute control). The increase in grade wise tuber yield could possibly be due to soil mineralization, synergistic effect of biofertilizers with FYM, in availability of N, P and K that are essential for tuber initiation and tuber enlargement. These results are conformity with results earlier [4, 5].

Total tuber yield

Table 1 showed that the highest total tuber yield (17.59 t/ha and 18.62 t/ha) was observed in $T_1$ (FYM @ 20 t/ha) during both the years of experimentation. This was closely followed by $T_7$ and $T_6$, which were statistically at par. However, lowest tuber yield (7.29 t/ha and 7.92 t/ha) was recorded at $T_8$ (control) during both the years. The increase in total tuber yield is mainly due to inxcrease in grade wise tuber yield. Application of FYM @ 20 t/ha could meet the recommended dose of N for potato i.e. 120.00 kg/ha which adequate to produce higher yields due to improved growth and there by higher interception of light. Beneficial effect of FYM, compost and biofertilizers has also been reported by Raghav and Kamal [6].

N, P and K uptake by the haulm and tuber

Table 3 it is evident that N, P and K uptake by haulm and tuber at harvest was found significant during both the years. However, highest N, P and K uptake by haulm and tuber was observed in $T_1$ (FYM @ 20 t/ha) during both years of experimentation. Highest total N, P and K uptake by potato crop was observed in $T_1$ (FYM @ 20 t/ha) during both the years. However, lowest nutrient uptake was recorded at $T_8$ (Control). It might be due to application of organic manures and biofertilizers that increases the nutrient availability in soil. In acid soil, biofertilizers act as a major role for releasing the unavailable form of nutrients to available form in the soil. Releasing sufficient nutrients in soil solution around root zone [7]. Therefore, the nutrient uptake by tubers and haulm was found closely linked with productivity and their concentration in plant [8—10].

Soil pH, organic carbon and available NPK

Table 4 indicate that the effect of organic manures and biofertilizers on soil pH, organic carbon and available P and K contents were not significant during

both the years of experimentation. However, there was significant effect on available N during both the years. Organic carbon, available P and K in soil were also improved due to application of organic manures and biofertilizers. Similar trend was also observed by Shambhavi and Sharma [11].

Economics

The cost of production was highest for enriched compost (5 t/ha) treatment (Rs 155,530/ha) and lowest (Rs 555,30/ha) for control. The highest net profit (Rs 196,320/ha and Rs 211,770/ha) was obtained in $T_1$ followed by $T_6$ (Rs 160,620/ha and Rs 165,570/ha) during both the years. The B:C ratio was found highest (2.90 and 3.13) under the treatment using Farm Yard Manure (20 t/ha) followed by Farm Yard Manure (10 t/ha) + Biofertilizers (8 kg/ha) treatment (2.58) and (2.66) during both the years.

## Conclusion

Based on the results of two years experimentation, it can be concluded that the application of Farm Yard Manure alone or combined with enriched compost and biofertilizers increased plant height, number of shoots per plant and also increased tuber yield as compared to the control.

The highest potato yield was observed where Farm Yard Manure was applied @ 20 t/ha ($T_1$). This was followed by application of Farm Yard Manure @ 5 t/ha + Enriched compost @ 2.5 t/ha ($T_7$) and $T_6$ (Farm Yard Manure @ 10 t/ha + Biofertilizer @ 8 kg/ha). Among the different treatments $T_1$ proved in respect of yield, gross return and B:C ratio. Application of organic manures alone or combined with biofertilizers improved soil characters like pH, organic carbon, available N, P and K. However, there is need for further research to generate more useful information on organic management of potato.

### References


1. Maggio A, Corillo P, Bulmetti GS, Fuggi A, Barbieri G, Pascale SD (2008) Potato yield and metabolic profiling under conventional and organic farming. Eur J Agro 28 : 343—350.
2. Kopke U (2005) Organic foods: Do they have a role in diet diversification and health promotion. Forum Nutr. Elmadfa I (ed), Basel, Karger AG 57 : 62—72.
3. Jaipual J, Sharma S, Sharma AK (2013) Effect of organic fertilizers on growth yield and quality of potato under rainfed conditions of central Himalayan region of Uttarakhand. Potato J 38 : 11.
4. Kumar M, Jadav MK, Trehan SP (2008) Contributing of organic sources to potato nutrition at varying nitrogen levels. In: Proc Global Potato Conf, 9—12 Dec 2008, New Delhi, India.
5. Das PP, Sarkar A, Zamen A (2009) Response of organic and inorganic sources of nutrients on growth and yield of potato in gangetic alluvials plains of West Bengal. In: Proc 96th Ind Sci Cong 3—7 Jan 2009, NEHU, Shillong, Meghalaya, India, pp 58.
6. Raghav M, Kamal S (2008) Organic farming technology for higher and eco-friendly potato production in tarai region of Uttarakhand. Proc Global Potato Conf,9—12 Dec 2008, New Delhi, India.
7. Anonymous (2008) Annual Scientific Report, Central Potato Res Inst, Shimla, pp 144.
8. Haase T, Schuler C, Heb J (2007) The effect of different N and K sources on tuber nutrient uptake, total and graded yield of potatoes (*Solanum tuberosum* L.) for processing. Euro J Agron 26 : 187—197.
9. Baishya LK (2009) Response of potato vatieties to organic and inorganic sources of nutrients. PhD thesis. Visva Bharati Univ, Santiniketan, West Bengal, pp 99—102.
10. Shaheen AM, Rizk FA, El-Samad EHA, El-Ashry SM (2013) Effect of nitrogen fertilizer and soil condition on the productivity of potato plants grown under sandy soil conditions. J Appl Sci Res 9 : 1774—1781.
11. Shambhavi S, Sharma RP (2008) Effect of integrated use of vermicompost and chemical fertilizers on quality of potato on acid Alfisols. In: Proc Nat Sem on Integrated Nutrient Management A Key to Sustain Soil Quality and Crop Productivity 10–11 Apr 2008, CSKHPKV, Palampur, HP.