Response of integrated nutrient management practices on growth and tuber yield of potato crop (Solanum tuberosum L.) in clay soils of Punjab

Ankushdeep Sharma, Kamalesh Kumar and Pradeep Kumar

DOI: [https://doi.org/10.22271/chemi.2020.v8.i4x.9956](https://doi.org/10.22271/chemi.2020.v8.i4x.9956)

Abstract

To investigate the response of integrated nutrient management (INM) practices on growth and tuber yield of potato crop (Solanum tuberosum L.) in clay soils of Punjab was conducted during *rabi* season of 2017-18 at the Campus for Agricultural Research and Advanced Studies Dhablian of the G.S.S.D.G.S. Khalsa College Patiala, Punjab. The field experiment was laid out in randomized block design with 13 different treatments with 3 replications. Integrated nutrient management significantly influenced the growth and tuber yield of potato crop. All the growth parameters like plant height (cm), number of branches plant⁻¹, fresh weight plant⁻¹ and tuber yield (200.26 q ha⁻¹) was significantly higher in treatment T₈ with 100% RDF + 2 t Poultry manure ha⁻¹ + 20 kg S ha⁻¹ + 20 kg ZnSO₄ ha⁻¹ + 1 t vermicompost ha⁻¹ + *Azotobacter* which was followed by treatment T₉ with 100% RDF + 2 t Poultry manure ha⁻¹ + 20 kg S ha⁻¹ + 20 kg ZnSO₄ ha⁻¹ + 1 t vermicompost ha⁻¹.

Keywords: Potato, integrated nutrient management, vermicompost and *Azotobacter*

Introduction

Potato (*Solanum tuberosum* L.) is one of the superior tuber crop belongs to family Solanaceae. It is the fourth important food crop after Rice, Wheat and Maize. It is also known as king of vegetables and poor man’s friend. It is an economical food and they provide a source of low cost energy to the human diet. It is rich source of minerals, vitamin B, C, and starch. It contains 2.15% proteins, 20.6% carbohydrates, 1.1% crude fiber, 18-20% starch content, 0.3% fat and 0.9% ash. It also contains a good amount of essential amino acids like leucine, isoleucine and tryptophane (Khurana and Naik 2003) [10]. The origin of potato is South America (Peru). Evidences indicate that potato was cultivated for centuries by South American Indians. According to Food and Agriculture Organization Corporate Statistical Database (FAOSTAT), in 2016-17, the total worldwide production is 388.19 million tonnes from 19.30 million hectares. In India, Potato is cultivated in about 1.5 million hectares with total production of 26.1 million tonnes. It is cultivated on a large scale in U.P., West Bengal, Bihar and Punjab. In Punjab, potato is cultivated in an area of 94 thousand hectares with production of 2.2 million tonnes (Anonymous 2016) [14]. The rising need for integrated nutrient management system due to minimize the requirement of inorganic fertilizers, to restore organic matter in soil, to increase nutrient use efficiency, to improve the soil heath and enhance the crop productivity. Plant nutrition plays an important role for increasing growth and yield in potato. Addition of organic matter through FYM have great significance for enhancing the potato yield as it exerts significant influence an physical, chemical and biological properties of soil. It has been found more effective in supplying N to potato crop and maintain soil fertility status over 100% RDF (Yadav *et al*. 2014) [17].

Materials and Methods

The field experiment was laid out in randomized block design with 13 different treatments with 3 replications. The soil of experimental field was clay, soil pH 7.3, medium in organic carbon (0.52%), low in available nitrogen (262 kg ha⁻¹), medium in available phosphorus (22.6 kg ha⁻¹) and potassium (129 kg ha⁻¹). All the nutrients were applied in basal dose at one day before sowing. The plant material comprised of potato var.

Corresponding Author:
Ankushdeep Sharma
General Shivdev Singh Diwan
Gurbachan Singh, Khalsa
College, Patiala, Punjab, India
Kufri Jyoti as per treatment was sown on 11 November, 2017 and harvested at 16February, 2018. The crop was planted maintaining a distance of 60 cm and 20 cm between the row and plants respectively. Five representative sample plants were randomly selected from each of the plots plant height was recorded in cm. The numbers of branches per plant were counted from the five randomly selected sample plants and the values of these were summed up and averaged. To study the fresh and dry weight of five plants were collected from the sampling rows of each plot at 30 days interval from sowing till harvest of the crop. The plant samples were then weighted to record the average fresh weight. The produce was separated into 3 grades of tubers and weight and number of tubers were recorded separately for each grade. The tubers of each plot the border and sampling row was weighed in kilogram.

**Results and Discussion**

Integrated nutrient management has significantly effect on growth and tuber yield of potato crop. The result of present study found that the plant height increased significantly with increase in fertilizer combinations. The application of integrated nutrients management with the 100% RDF gave the significantly maximum plant height. The maximum plant height (29.42, 46.00 and 52.88 cm) was recorded under the treatment T7 with 100% RDF + 2t Poultry manure ha⁻¹ + 20kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ + 1t vermicompost ha⁻¹ + Azotobacter. The favourable response of integrated nutrient management on highest plant height was also delineated by Mondal et al. (2005) [12], Alam et al. (2007) [3], Najm et al. (2010) [13], Yourtchi et al. (2013) [18] and Getie et al. (2015) [6]. The result of the present study indicates that the number of branches and fresh weight (g) was significantly enhanced with increase the integrated nutrient management. The highest number of branches (5.15, 7.03 and 9.63) and fresh weight plant⁻¹ (g) (20.81, 33.48 and 43.17) was obtained in the treatment T7 with 100% RDF + 2t Poultry manure ha⁻¹ + 20kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ + 1t vermicompost ha⁻¹ + Azotobacter. A similar result on number of branches and fresh weight (g) was also found by Yourtchi et al. (2013) [18], Ratna et al. (2016) [13] and Shubha et al. (2018) [16].

Potato tuber yield in q/ha also responded to the application integrated fertilizers. Treatment T7 was significantly enhance the tuber yield and commodity value of potato. The maximum tuber yield (200.26 q/ha) was recorded the treatment T7 with 100% RDF + 2t Poultry manure ha⁻¹ + 20kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ + 1t vermicompost ha⁻¹ + Azotobacter. Application of INM provides better nutrition to potato which resulted in higher tuber yield. This similar finding was also reported by Khan et al. (2010) [9], Jaipaul et al. (2011) [8], Balemi (2012) [3], Islam et al. (2013) [7], Narayan et al. (2013) [14], Ahmed et al. (2015) [11], Mama et al. (2016), Ahmed et al. (2017) [3] and Shubha et al. (2018) [16].

### Table 1: Response of integrated nutrient management on plant height (cm) at different growth stages of potato

| Treatments          | Plant height (cm) |
|---------------------|-------------------|
|                     | 30 DAS | 60 DAS | At harvest |
| T0, Control         | 18.70  | 34.52  | 39.98      |
| T1, 100% RDF        | 19.66  | 36.33  | 40.98      |
| T2, 100% RDF + 2t Poultry manure ha⁻¹ | 21.43  | 37.67  | 42.96      |
| T3, 100% RDF + 2t Poultry manure ha⁻¹ + 20kg S ha⁻¹ | 22.21  | 39.00  | 45.75      |
| T4, 100% RDF + 2t Poultry manure ha⁻¹ + 20kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ | 23.00  | 40.83  | 48.36      |
| T5, 100% RDF + 2t Poultry manure ha⁻¹ + 20kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ + 1t vermicompost ha⁻¹ | 27.74  | 43.63  | 50.95      |
| T6, 100% RDF + 2t Poultry manure ha⁻¹ + 20kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ + 1t vermicompost ha⁻¹ + Azotobacter (Seed treatment) | 29.42  | 46.00  | 52.88      |
| T7, 50% RDF         | 18.88  | 34.57  | 40.88      |
| T8, 50% RDF + 2t Poultry manure ha⁻¹ | 20.73  | 36.28  | 42.82      |
| T9, 50% RDF + 2t Poultry manure ha⁻¹ + 20kg S ha⁻¹ | 21.77  | 38.65  | 44.85      |
| T10, 50% RDF + 2t Poultry manure ha⁻¹ + 20 kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ | 22.55  | 39.32  | 46.76      |
| T11, 50% RDF + 2t Poultry manure ha⁻¹ + 20 kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ + 1t vermicompost ha⁻¹ | 23.33  | 40.85  | 48.40      |
| T12, 50% RDF + 2t Poultry manure ha⁻¹ + 20kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ + 1t vermicompost ha⁻¹ + Azotobacter (Seed treatment) | 26.55  | 42.73  | 49.47      |
| T13, 50% RDF + 2t Poultry manure ha⁻¹ + 20 kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ + 1t vermicompost ha⁻¹ + Azotobacter | 3.02   | 1.47   | 1.46       |
| SE (d)               | 2.31   | 3.32   | 3.31       |

### Table 2: Response of integrated nutrient management on number of branches plant⁻¹ at different growth stages of potato

| Treatments          | Number of branches plant⁻¹ |
|---------------------|-----------------------------|
|                     | 30 DAS | 60 DAS | At harvest |
| T0, Control         | 1.94   | 3.05   | 4.70       |
| T1, 100% RDF        | 2.11   | 3.48   | 5.11       |
| T2, 100% RDF + 2t Poultry manure ha⁻¹ | 3.00   | 3.63   | 5.44       |
| T3, 100% RDF + 2t Poultry manure ha⁻¹ + 20kg S ha⁻¹ | 3.40   | 4.88   | 6.11       |
| T4, 100% RDF + 2t Poultry manure ha⁻¹ + 20kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ | 4.04   | 5.22   | 6.77       |
| T5, 100% RDF + 2t Poultry manure ha⁻¹ + 20kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ + 1t vermicompost ha⁻¹ | 4.92   | 6.23   | 8.32       |
| T6, 50% RDF         | 5.15   | 7.03   | 9.63       |
| T7, 50% RDF + 2t Poultry manure ha⁻¹ | 1.99   | 3.11   | 5.02       |
| T8, 50% RDF + 2t Poultry manure ha⁻¹ | 2.76   | 3.51   | 5.39       |
| T9, 50% RDF + 2t Poultry manure ha⁻¹ + 20 kg S ha⁻¹ | 3.14   | 3.84   | 5.58       |
| T10, 50% RDF + 2t Poultry manure ha⁻¹ + 20 kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ | 3.87   | 4.91   | 6.21       |
| T11, 50% RDF + 2t Poultry manure ha⁻¹ + 20 kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ + 1t vermicompost ha⁻¹ | 4.10   | 5.39   | 7.12       |
| T12, 50% RDF + 2t Poultry manure ha⁻¹ + 20kg S ha⁻¹ + 20kg ZnSO₄ ha⁻¹ + 1t vermicompost ha⁻¹ + Azotobacter (Seed treatment) | 4.32   | 5.63   | 8.18       |
| SE (d)               | 0.19   | 0.47   | 0.39       |
| CD (0.50)            | 0.44   | 1.07   | 0.88       |
### Table 3: Response of integrated nutrient management on Fresh weight plant\(^{-1}\) (g) at different growth stages of potato

| Treatments | Fresh weight plant\(^{-1}\) (g) | 30 DAS | 60DAS | At harvest |
|------------|---------------------------------|--------|-------|------------|
| T\(_1\). Control | 12.70                           | 22.37  | 35.05 |
| T\(_2\).100% RDF | 13.50                           | 23.07  | 36.04 |
| T\(_3\). 100% RDF + 2t Poultry manure ha\(^{-1}\) | 14.96                           | 23.98  | 37.18 |
| T\(_4\).100% RDF + 2t Poultry manure ha\(^{-1}\) + 20kg S ha\(^{-1}\) | 15.68                           | 24.72  | 37.87 |
| T\(_5\).100% RDF + 2t Poultry manure ha\(^{-1}\) + 20kg S ha\(^{-1}\) + 20kg ZnSO\(_4\) ha\(^{-1}\) | 17.46                           | 26.23  | 39.04 |
| T\(_6\). 100% RDF + 2t Poultry manure ha\(^{-1}\) + 20kg S ha\(^{-1}\) + 20kg ZnSO\(_4\) ha\(^{-1}\) + 1t vermicompost ha\(^{-1}\) | 19.67                           | 31.09  | 41.08 |
| T\(_7\).100% RDF + 2t Poultry manure ha\(^{-1}\) + 20kg S ha\(^{-1}\) + 20kg ZnSO\(_4\) ha\(^{-1}\) + 1t vermicompost ha\(^{-1}\) + Azotobacter (Seed treatment) | 20.81                           | 33.48  | 43.17 |
| T\(_8\). 50% RDF | 13.42                           | 22.55  | 35.87 |
| T\(_9\). 50% RDF + 2t Poultry manure ha\(^{-1}\) | 14.71                           | 23.76  | 36.22 |
| T\(_10\). 50% RDF + 2t Poultry manure ha\(^{-1}\) + 20 kg S ha\(^{-1}\) | 15.64                           | 24.43  | 37.28 |
| T\(_11\). 50% RDF + 2t Poultry manure ha\(^{-1}\) + 20 kg S ha\(^{-1}\) + 20kg ZnSO\(_4\) ha\(^{-1}\) | 16.93                           | 25.77  | 38.12 |
| T\(_12\). 50% RDF + 2t Poultry manure ha\(^{-1}\) + 20 kg S ha\(^{-1}\) + 20kg ZnSO\(_4\) ha\(^{-1}\) + 1t vermicompost ha\(^{-1}\) | 17.75                           | 27.39  | 39.14 |
| T\(_13\). 50% RDF + 2t Poultry manure ha\(^{-1}\) + 20 kg S ha\(^{-1}\) + 20kg ZnSO\(_4\) ha\(^{-1}\) + 1t vermicompost ha\(^{-1}\) + Azotobacter (Seed treatment) | 18.22                           | 29.63  | 40.43 |

**SE (d)** 1.09 1.42 1.18
**CD (0.50)** 2.46 3.21 2.66

### Table 4: Response of integrated nutrient management on tuber yield (q ha\(^{-1}\)) of potato

| Treatments | Tuber yield (q ha\(^{-1}\)) | 104.40 |
|------------|----------------------------|--------|
| T\(_1\). Control | 104.40                           | 153.67 |
| T\(_2\).100% RDF | 153.67                           | 167.67 |
| T\(_3\). 100% RDF + 2t Poultry manure ha\(^{-1}\) | 167.67                           | 175.65 |
| T\(_4\).100% RDF + 2t Poultry manure ha\(^{-1}\) + 20 kg S ha\(^{-1}\) | 175.65                           | 185.18 |
| T\(_5\).100% RDF + 2t Poultry manure ha\(^{-1}\) + 20 kg S ha\(^{-1}\) + 20kg ZnSO\(_4\) ha\(^{-1}\) | 185.18                           | 194.37 |
| T\(_6\). 100% RDF + 2t Poultry manure ha\(^{-1}\) + 20 kg S ha\(^{-1}\) + 20kg ZnSO\(_4\) ha\(^{-1}\) + 1t vermicompost ha\(^{-1}\) | 194.37                           | 200.26 |
| T\(_7\).100% RDF + 2t Poultry manure ha\(^{-1}\) + 20 kg S ha\(^{-1}\) + 20kg ZnSO\(_4\) ha\(^{-1}\) + 1t vermicompost ha\(^{-1}\) + Azotobacter (Seed treatment) | 200.26                           | 143.25 |
| T\(_8\). 50% RDF | 143.25                           | 165.67 |
| T\(_9\). 50% RDF + 2t Poultry manure ha\(^{-1}\) | 165.67                           | 171.26 |
| T\(_10\). 50% RDF + 2t Poultry manure ha\(^{-1}\) + 20 kg S ha\(^{-1}\) | 171.26                           | 181.61 |
| T\(_11\). 50% RDF + 2t Poultry manure ha\(^{-1}\) + 20 kg S ha\(^{-1}\) + 20kg ZnSO\(_4\) ha\(^{-1}\) | 181.61                           | 192.74 |
| T\(_12\). 50% RDF + 2t Poultry manure ha\(^{-1}\) + 20 kg S ha\(^{-1}\) + 20kg ZnSO\(_4\) ha\(^{-1}\) + 1t vermicompost ha\(^{-1}\) | 192.74                           | 200.26 |
| T\(_13\). 50% RDF + 2t Poultry manure ha\(^{-1}\) + 20 kg S ha\(^{-1}\) + 20kg ZnSO\(_4\) ha\(^{-1}\) + 1t vermicompost ha\(^{-1}\) + Azotobacter (Seed treatment) | 192.74                           | 143.25 |

**SE (d)** 1.09 1.42 1.18
**CD (0.50)** 2.46 3.21 2.66

![Fig 1: Response on integrated nutrient management on plant height (cm) at different growth stages of potato](image-url)
Fig 2: Response of integrated nutrient management on number of branches plant\(^{-1}\) at different growth stages of potato

Fig 3: Response of integrated nutrient management on Fresh weight plant\(^{-1}\) (g) at different growth stages of potato

Fig 4: Response of integrated nutrient management on tuber yield (q ha\(^{-1}\)) of potato
Conclusion
On the basis of the results from the present investigation, the following conclusion has been drawn:
From the above study, I concluded that all growth parameters viz. plant height (cm), number of branches plant$^{-1}$ and fresh weight plant$^{-1}$ (g) were found to be significantly superior with the application of 100% RDF + 2t Poultry manure ha$^{-1}$ + 20kg S ha$^{-1}$ + 20kg ZnSO$_4$ ha$^{-1}$ + 1t vermicompost ha$^{-1}$ + Azotobacter.
On the basis of results obtained from the present investigation, I concluded that tuber yield (q ha$^{-1}$) was found to be significantly best with the application of 100% RDF + 2t Poultry manure ha$^{-1}$ + 20kg S ha$^{-1}$ + 20kg ZnSO$_4$ ha$^{-1}$ + 1t vermicompost ha$^{-1}$ + Azotobacter. I also concluded that the use of INM improved productivity of potato as compare to inorganic fertilizers alone.

References
1. Ahmed AA, Zaki MF, Shafeek MR, Helmey YI, Abd El-Baky MMH. Integrated use of Farmyard Manure and Inorganic Nitrogen Fertilizer on Growth, Yield and Quality of Potato (Solanum tuberosum L.). International Journal of Current Microbiology and Applied Sciences. 2015; 4(10):325-349.
2. Ahmed NU, Mahmud NU, Salim M, Halder SC, ULLAH H. Yield maximization of potato (Solanum tuberosum L.) through integrated nutrient management system. International Journal of Natural and Social Sciences. 2017; 4(1):49-56.
3. Alam MN, Jahan MS, Ali MK, Ashraf MA, Islam MK. Effect of vermicompost and chemical fertilizers on growth, yield and yield components of potato in barind soils of Bangladesh. Journal of Applied Sciences Research. 2007; 3(12):1879-1888.
4. Anonymous. Package of Practices for cultivation of vegetables. Punjab Agriculture University, Ludhiana, 2016, 1.
5. Balemi T. Effect of integrated use of cattle manure and inorganic fertilizers on tuber yield of potato in Ethiopia. Journal Soil Science and Plant Nutrition 2012. 12 (2): 257-265.
6. Getie AT, Dechassa N, Tana T. Response of Potato (Solanum tuberosum L.) Yield and Yield Components on Nitrogen Fertilizer and Planting Density at Harmaya, Eastern Ethiopia. Journal of Plant Sciences. 2015; 3(6):320-328.
7. Islam MM, Akhter S, Majid NM, Ferdous J, Alam MS. Integrated nutrient management for potato (Solanum tuberosum L.) in grey terrace soil. Australian Journal of Crop Science. 2013; 7(9):1235-1241.
8. Jaipaul, Sharma S, Sharma AK. Effect of organic fertilizers on growth, yield and quality of potato (Solanum tuberosum L.) under rainfed conditions of central Himalayan region of Uttarakhand. Potato Journal. 2011; 38(2):176-181.
9. Khan MZ, Akhtar ME, Safdar MN, Mahmood MM, Ahmad S, Ahmed N. Effect of source and level of potash on yield and quality of potato tubers. Pakistan Journal of Botany. 2010; 42(5):3137-3145.
10. Khurana PSM, Naik PS. The potato production and utilization in sub tropics. Mehta Publication. New Delhi, 2003, 1-14.
11. Mama A, Jeylan J, Aseffa AW. Effects of different rates of Organic and Inorganic Fertilizer on growth and yield components of potato (Solanum tuberosum L.) in Jimma Are, South West Ethiopia. International Journal of Research Granthaalayah. 2016; 4(11):115-121.
12. Mondal SS, Aharya D, Ghosh A, Bug A. Integrated nutrient management on the growth, productivity and quality of potato (Solanum tuberosum L.) in Indo-Gangetic plains of West Bengal. Potato Journal. 2005; 32(1/2):75-78.
13. Najm AA, Hadi MRHS, Fazeli F, Darzi MT, Shamorady R. Effect of utilization of organic and inorganic nitrogen sources on the potato shoots, dry matter, leaf area index and plant height during middle stage of growth. International Journal of Agricultural and Biosystems Engineering. 2012; 4(11):852-855.
14. Narayan S, Kanth RH, Narayan R, Khan FA, Singh P, Rehman SU. Effect of integrated nutrient management practices on yield of potato (Solanum tuberosum L.). Potato Journal. 2013; 40(1):84-86.
15. Ratna SA, Howlader MHK, Hasan MM, Mallick MR, Shantha UK. Effect of integrated use of manure and fertilizer on the growth and yield of potato. Progressive Agriculture. 2016, 27(4):435-443.
16. Shubha AS, Srinivasa V, Shanwaz A, Anusha RB, Sharavathi MB. Effect of integrated nutrient management on growth and yield attributes in potato (Solanum tuberosum L.). International Journal of Current Microbiology and Applied Sciences. 2018; 7(9):830-836.
17. Yadav SK, Srivastava AK, Bag TK. Effect of integrated nutrient management on production of seed tubers from true potato (Solanum tuberosum L.) seed. Indian Journal of Agronomy. 2014; 59(4):646-650.
18. Yourtchi MS, Hadi MHS, Darzi MT. Effect of nitrogen fertilizer and vermicompost on vegetative growth, yield and NPK uptake by tuber of potato (Agria CV.). International Journal of Agriculture and Crop Sciences. 2013; 5(18):2033-2040.