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Effect of organic and inorganic fertilizers on growth and yield of potato (*Solanum tuberosum* L.) in Northern Bihar

Amrendra Kumar, Deepak Kumar, Sunil Kumar, DK Dwivedi, Shiv Shankar Dash and Manoj Kumar

Abstract
This field experiment was conducted during the Rabi season of year 2020-21 on potato crop with variety Kufri Lalit to test the Effect of organic and inorganic fertilizers on growth and yield of potato (*Solanum tuberosum* L.)".at Research farm of TCA, Dholi (Muzaffarpur), Bihar. The treatment combination is i.e., T_1 - control, T_2 – 50% RDF, T_3 – 100% RDF, T_4 - Crop residue incorporation (Rice straw 5 t/ha) + Biofertilizer (Azotobacter, PSB, *Trichoderma viride* 5 kg/ha each), T_5 - T4 + FYM 25 t/ha, T_6 - T4 + Vermicompost 7.5 t/ha, T_7- T4 + Neem cake 5 t/ha, T_8 - T4 + Poultry manure 3 t/ha. This experiment has conducted in randomized block design and thrice replicated it. The texture of experimental site was sandy loam with slightly alkaline in reaction (pH 8.31), low in organic carbon (0.47%) and available N (254 kg/ha). However, moderate in availability of P (17.4 kg/ha) and K (129.3 kg/ha), respectively. Among all treatments, treatment T_6 - T4 + Vermicompost 7.5 t/ha recorded higher plant's height (43.10), shoot's number/plant (5.47), dry matter accumulation (84.80 g/plant), tuber yield (24.12 t/ha) and treatment T_6 also recorded statistically at par with treatment T_3, T_5. In case of economic study, the benefit cost ratio (2.77) recorded from inorganic treatment T_3 (100% RDF). Conclusively organic treatments were not comparable with inorganic RDF treatment in terms of benefit cost ratio due to higher cost of organic inputs.

Keywords: Organic, inorganic, RDF (recommended dose of fertilizer), DAS (days after sowing), rice straw, biofertilizer (azotobacter, PSB, *Trichoderma viride*), FYM, vermicompost, neem cake, poultry manure

Introduction
Potato in terms of human consumption world's third most significant food crop after wheat and rice. Potato seems to have evolved through geographical and ecological isolation. Origin place of potato is the high Andean hills of South America and first time introduced in Europe near the 16th century. Potato originally brought to India by 'Portuguese or British missionaries' merchants in the early 17th century. Optimum temperature for growth and development of potato ranges between 15-250C. Minimum night temperature is of great significance for tuberization, and 170C is most favourable for tuber formation. At night temperature >180C, tuberization and yield are reduced, by this reason the tropical area considered unsuitable for profitable potato cultivation.

Potato gets their nutrients mostly from chemical fertilisers. Continuous use of chemical fertilisers produces imbalance in nutrients present in soil as well as recorded negative impacts on soil's physical, chemical, and biological characteristics.

Organic nutrient's sources generally maintain the balance of nutrients in soil and improving soil's physical, chemical, and biological characteristics. In India, variability in crop production generates a large quantity of agricultural waste, which is eventually burned despite its high economic worth. The burning of residue is a well-known source to spoil environment and soil quality. To address this issue, incorporating crop residue into the soil and inoculating it with cellulolytic microorganisms such as Trichoderma may be a viable and environmentally acceptable option for appropriate farm waste recycling. Trichoderma increases decomposition rate by digesting complex residue components such as cellulose, hemicelluloses, and lignin, and improves soil health (Devika *et al*., 2019) [13].

Azotobacter and PSB application may have boosted nutrient (mainly N and P) availability in the soil, resulting in improved nutrient absorption and production. Azotobacter had a number of beneficial characteristics, including fixation of nitrogen, excretion of ammonia, and the

synthesis of plant-promoting chemicals. Azotobacter also has ability to synthesize antibiotic-like metabolites. PSB, on the other hand, solubilizes phosphorus in the soil and make it accessible to the plant. Seed inoculation with PSB resulted in substantial improvements in production of big tubers recorded by several workers, including Singh (2002a) [14].

Seed inoculation with bio-fertilizer resulted in a substantial increase in production of big size tubers, according to Singh (2002 b) [14], Rajput *et al*., (2011) [15]. Farm yard manure (FYM) is traditionally produced by storing cow dung, water, and agricultural wastes in a particularly constructed pit in the backyard of each Indian home. Improvement in crop yields, soil physical characteristics, availability of nutrients, microbial activity, and residual advantages to subsequent crops recorded from the use of FYM (Mukund and Prabhakarasetty 2006) [16].

Application of vermicompost improves the Physico-chemical features of soil in potato cultivation. Organic matter, such as vermicompost, improves phosphorus bioavailability in the soil, which affects plant development. The nitrogen mineralization process in soil has also been affected by the use of vermicompost (Abdullah Adil Ansari 2008) [17]. Neem cake is an environmentally friendly and bio-degradable nutrients source that provides both macro and micro nutrients to the plants and soil.

Neem cake also facilitates elimination of bacteria responsible for denitrification of the soil N, idyllic for cash and cereal crops, rises yield of crop, with aids in the reduction of fertiliser usage and has an antifeedant possessions. Neem seed cake serves as a soil enricher, inhibits the development of soil's harmful bacteria and pests, supplies macro nutrients necessary for growth of plants, and helps to improve plant output for the long term, as well as serving as a great soil conditioner.

Poultry manure increased organic matter content in soil and successively, released out the plant nutrients in an accessible form for utilization by the crops. Poultry manure supply macro and micronutrients in an available form to the growing plants (Magkos *et al*., 2003) [18]. Poultry manure increases the soil's water holding capacity, improve drainage, increase soil aeration and add some organic acids which dissolve soil nutrients and also act as amelioration. Study on the solitary application impacts of inorganic nutrient's sources, crop residue incorporation (Rice straw 5 t/ha) + biofertilizer (Azotobacter, PSB, *Trichoderma viride* 5kg/ha each), FYM, vermicompost, neem cake and poultry manure on the Potato cultivar is sufficient available. However, integrated application impacts of distinct organic manures (FYM, vermicompost, neem cake and poultry manure) with crop residue incorporation (Rice straw 5 t/ha) + Biofertilizer (Azotobacter, PSB, *Trichoderma viride* 5kg/ha each) on growth and yield of potato is extremely lacking. So, keeping the above facts this investigation conducted at TCA's Dholi research farm, Dr. RPCAU Pusa, Samastipur (Bihar).

Materials and Methods

Experimental Site: The current research trial investigated in plot number 13 at TCA Farm, Dholi, Muzaffarpur, Dr. RPCAU, Pusa (Samastipur), Bihar, during the Rabi period of 2020-2021. The experimental site situated at 25o98' North (N) latitude and 85o60' East (E) longitude on the southern bank of the river Burhi Gandak, at an elevation 52.2 m above mean sea level.

Edaphic conditions

The experimental plot's soil was calcareous-alluvium and somewhat alkaline in response,

owing to sediment deposition by the Burhi Gandak River. In general, Gandak's sediment includes a large quantity of free $CaCO_3$, extending from 10 - 45 percent, which was dispersed across the deepness of profile of soil. Presence of $CaCo_3$ also affects the properties of soil such as physical and chemical. Before laying out the experiment, a representative composite sample of soil from the top 0 to 30 cm sheet was obtained from various casually nominated places from each plot and thoroughly mixed to examine the initial Physical, chemical characteristics and nutrients status of the research plots. Laboratory analysis revealed that experimental site was sandy loam in texture with slightly alkaline in reaction (pH 8.31), low in organic carbon (0.47%) and available N (254 kg/ha). However, moderate in availability of P (17.4 kg/ha) and K (129.3 kg/ha), respectively.

Detail of treatments and design

The 8 treatments combination of organic and inorganic sources of nutrients studies on potato

crop. The trial was laid out in a randomized-block-design with three replications.

Table 1: The treat mental details of experiment

Sl. No.	
1	T1 Control
2	T2 50% RDF
3	T3 100% RDF
4	T4 Crop residue incorporation (Rice straw 5 t/ha) + Biofertilizer (Azotobacter, PSB *Trichoderma viride* 5 kg/ha each)
5	T5 Crop residue incorporation (Rice straw 5 t/ha) + Biofertilizer (Azotobacter, PSB *Trichoderma viride* 5 kg/ha each) + FYM 25 t/ha
6	T6 Crop residue incorporation (Rice straw 5 t/ha) + Biofertilizer (Azotobacter, PSB *Trichoderma viride* 5 kg/ha each) + Vermicompost 7.5 t/ha
7	T7 Crop residue incorporation (Rice straw 5 t/ha) + Biofertilizer (Azotobacter, PSB *Trichoderma viride* 5 kg/ha each) + Neem cake 5.0 t/ha
8	T8 Crop residue incorporation (Rice straw 5 t/ha) + Biofertilizer (Azotobacter, PSB *Trichoderma viride* 5 kg/ha each) + Poultry 3.0 t/ha

Crop Husbandry

Potato planting was done with the variety Kufri Lalit in specified planting configurations as per treatments in the winter season (13 November) of 2020-21. For planting, uniform-sized tubers weighing 30-40 g were selected. Tuber planting was done with row to row 60 cm spacing and plant to plant 20 cm spacing on the line directly close to the fertilizer line. During crop growth 3 irrigations at different growth

stages of plant were given. Intercultural operations such as earthing and Dehaulming also did before harvesting. Potato depleted a high amount of nutrients; it required a lot of nutrients to create a healthy crop canopy. The primary nutrients that impacted crop growth and development were nitrogen, phosphorus, and potassium. Fertilizer doses of 150-90-100 kg N: P: K/ha were recommended. The entire recommended dose of P and K, as well as half of the required dose of N, were provided as a basal application, while the rest half dose of N given at 40-45 DAP, espectively. Nitrogen was applied via urea, phosphorous was applied via di-ammonium phosphate, and potash was applied via muriate of potash, respectively. The nutrients concentration in rice straw 5 t/ha (0.56% N, 0.11%P, 1.18% K), farm yard manure 25 tonnes/hectare (N-0.5%, P-0.2%, K-0.5%), vermicompost 7.5 tonnes/hectare (N-1.8%, P-1.5%, K-1.2%), neem cake 5 tonnes/hectare (N-5.2%, P- 1.0%, K-1.4%) and in poultry manure poultry manure 3 t/ha (2.63% N, 2.04% P, 1.35% K). The potato crop harvested during the first fortnight of March (5) month of 2021. Days to emergence and other phenological stages were recorded from each plot when approximately 50% of the plants reached that particular stage. After physiological maturity, a net area of 3.6 × 3.6 m2 from each plot harvested manually. Yield attributes such as tuber's yield and haulm's yield were recorded at harvest. Biomass yield was determined by taking the weight of both tuber and haulm. The tuber yield after harvesting obtained from each plot expressed in t/ha. 2.5 Calculation of growth indices The growth indices such as plant height, number of leaves per plant, dry matter accumulation, tuber bulking rate, tuber yield, haulm yield and biological yield was calculated.

Plant height

5 plants selected at random from every plot, and height of every plant were determined from
the ground level to the plant's neck at 75 DAP and at harvest. The height was measured (cm) and then averaged.

Shoot's number/plant

The potato's shoots number/plant calculated at an interval of two weeks commencing at 45, 60, and 75 DAP and at harvest from the net plot area of each plot.

Accumulation of dry matter (g/plant)

Measurements of accumulated dry matter (g/plant) were recorded at 75 DAS and at harvest.
Three plants were plucked at casual from every plot of each treatment's net plot area. The weight of the entire plant (tuber and shoots) was measured and averaged. The plants were then cut into bits, and 100 g of the total (homogenous samples) were stored in paper bags and air-dried before being oven dried at 700 degrees Celsius in hot air oven till a consistent mass was achieved. As a result, the dry weight/plant/treatment ratio was calculated.

Yield of tubers (t/ha)

All tubers collected from each plot's net plot area were shade dried, and tuber weights were
calculated by using an electronic balance. The resulting yield was translated into t/ha.
2.5.8 Yield of haulms (t/ha) Ten plants casually selected from each plot's net plot area were removed and properly washed, and the mass of the vines was documented in kg/plot, then changed into unit tonnes/hectare.

Statistical analysis

The data is analysed for statistical purposes. The data for each character was analysed
using the “analysis of variance” approach. As indicated by Cochran and Cox (1957) [19], overall
differences were evaluated using the "F" test of significance at a 5% level of significance. For comparing treatments, critical differences at a 5% level of probability were computed.

Results and Discussion

Growth parameters

A close examination of data given in table – 1. The data on plant's height, shoots number/plant, dry matter accumulation (g/plant) at harvest and no. of tubers/ plants showed a substantial variation in plant's growth parameters across various treatments. plant significantly occurred in treatment T_6- T_4 + Vermicompost 7.5 t/ha (T_4 - Crop residue incorporation (Rice straw 5 t/ha) + Biofertilizer (*Azotobacter*, PSB, *Trichoderma viride* 5kg/ha each)) and minimum recorded under T_1– Control.

(The maximum plant's height, may be related to increased nutritional absorption, with good soil health and efficient work of soil microbes during the growth spell, results in increased cell's size, extension, and augmentation in division of cells which eventually rise the plant's height. The inorganic sources make easy availability of nutrients to plants results in plants get increment in plant hight. The increment in plant height with submission of organic nutrient's sources to the soil significantly boosted nutrient availability and improved soil physical, chemical, and biological property leading to a beneficial impact on the growth and crop's development as indicated by Yourtchi *et al*. (2013) [12].
The maximum shoots number/plant, This was mainly owing to the submission of a advanced dosage of nutrients from different sources that would have encouraged the adjustment of bio-logical compound and protein which could have been resulted in higher shoot growth and taller plants. The findings of Patel (2013) [9] also supported the findings. Dry matter accumulation (g/plant) at harvest The dry matter accumulation in the plants increased largely because of a higher number of leaves/plants which enhances the rate of photosynthesis and movement of photosynthetic product from source to sink. The addition of organic manures in soil has probably improved the soil's physical, chemical, and biological conditions and increased the availability of macro-nutrients and micro-nutrients. The inorganic sources easily supplied nutrients to plants which play a key role in efficient photosynthesis and dry matter accumulation. These outcomes of investigation recorded same with the research conclusions of Kushwah *et al*. (2005) [5], Alam *et al*. (2007) [1], Lal and Khurana (2007) [6] and Patel (2013) [9]. No. of tubers/ plants This may be owing to increased vegetative growth and division of cells, which collected enough Sun's energy, results in greater buildup of photosynthates and their sectionalization to boost initiation of tuber's number. This finding also confirms by Kumar *et al*. (2008) [3] and Patel (2013) [9].

Yield and yield attributing character

A close examination of data given in table – 2. The maximum tubers yield, haulm yield recorded under treatment T_6- T_4 + Vermicompost 7.5 t/ha, (T_4 - Crop residue incorporation (Rice

straw 5 t/ha). Marketable yield, harvest index significantly recorded maximum in treatment T_6- T_4 + Vermicompost 7.5 t/ha, (T_4 - Crop residue incorporation (Rice straw 5 t/ha) and T_7- T_4 (T_4 - Crop residue incorporation (Rice straw 5 t/ha))+ Neem Cake 5 t/ha. Highest benefit cost ratio was observed under treatment T_3- 100% RDF. The data on tubers yield, This result may be owing to submission distinct nutrient's sources facilitated easy availability and absorption of nutrients by the crop (Raghav and Kamal, 2009) [10]. However, submission of distinct nutrient's sources in the soil ameliorates nutrients mineralization, plant absorption of phosphorus by promoting carbonic acid production. The current research finding conform to findings of Kushwah *et al.* (2005) [5], Yourtchi *et al.*, (2013) [12], Patel (2013) [9], and Kumar *et al*. (2017) [4].

Haulm yield. The increase in the yield of haulm in T_3 treatment mainly due to submission of suggested dosage of N,P,K results in plants perform well their metabolic and physiological activity. The application of organic manures along with biofertilizers enhanced organic carbon content, the availability of macro and micronutrients, beneficial microorganism activity, and release of nutrients during the entire crop growth period encouraged plant's height, shoot's number/plant, leave's number/plant and total yield of haulm. The current research findings conform to the results of finding of Shambhavi and Sharma (2008) [11] and Patel (2013) [9].

Marketable yield, This may be related to the fact that thegreater photosynthetic rate during the tuberization period and partitioning of photosynthates to sink. The current research findings conform to the results of findings of Nizamuddin *et al.* (2003) [8] and Kandil *et al.* (2011) [2].

Harvest index This might be due to the higher photosynthetic rate during the tuberization period and partitioning of photosynthates to sink. This result was supported by Nag (2006) [7] and Patel (2013) [9]. and benefit cost ratio.

Table 1: The data on plant's height, shoots number/plant, dry matter accumulation (g/plant) at harvest and no. of tubers/ plants

Treatments	Plant height (cm) At harvest	No. of shoot At harvest	Dry matter At harvest	No. of tubers/ plant
T_1– Control	27.26	3.27	42.15	6.17
T_2-50%	33.27	3.83	59.06	7.42
T_3- 100% RDF	42.60	5.31	83.84	10.48
T_4- Crop residue incorporation (Rice straw 5 t/ha) + Biofertilizer (*Azotobacter*, PSB, *Trichoderma viride* 5kg/ha each)	30.26	3.43	48.96	6.68
T_5 - T_4 + FYM 25 t/ha	40.60	5.17	80.10	10.14
T_6- T_4 + Vermicompost 7.5 t/ha	43.10	5.47	84.80	10.65
T_7- T_4 + Neem Cake 5 t/ha	37.30	4.70	72.10	8.55
T_8- T_4 + Poultry manure 3 t/ha	35.30	4.17	65.41	7.84
S Em (±)	1.19	0.20	2.350	0.30
CD (*p=0.05*)	3.61	0.61	7.13	0.91

Table 2: The data on tubers yield, haulm yield. Marketable yield, harvest index and benefit cost ratio

Treatments	Tuber yield (t/ha)	Haulm yield (t/ha)	Marketable Yield (t/ha)	Harvest index (%)	B:C
T_1– Control	11.20	6.36	10.41	63.80	1.02
T_2-50%	16.55	8.06	15.40	67.20	1.78
T_3- 100% RDF	23.83	11.10	22.16	68.14	2.77
T_4- Crop residue incorporation (Rice straw 5 t/ha) + Biofertilizer (*Azotobacter*, PSB, *Trichoderma viride* 5 kg/ha each)	13.33	7.07	12.39	65.34	0.90
T_5 - T_4 + FYM 25 t/ha	22.53	10.85	20.95	67.51	1.22
T_6- T_4 + Vermicompost 7.5 t/ha	24.12	11.22	22.43	68.25	1.29
T_7- T_4 + Neem Cake 5 t/ha	20.62	9.42	19.19	68.56	0.35
T_8- T_4 + Poultry manure 3 t/ha	18.58	8.67	17.30	68.05	1.52
S Em (±)	0.91	0.36	0.85	1.38	0.12
CD (p=0.05)	2.77	1.11	2.58	NS	0.36

Conclusion

The current study demonstrates the response of organic and inorganic sources of nutrients on
growth and yield of potato. Out of the eight treatments tested during the research, treatment T6 – (Crop residue incorporation (Rice straw 5 t/ha) + Biofertilizer (Azotobacter, PSB, *Trichoderma viride* 5kg/ha each) and Vermicompost 7.5 t/ha) documented significantly superior in terms of growth metrics, yield attributes, and yield of potato. Finally, it can be concluded that treatment T6 is a greatest choice for enlightening the productivity of potato.

References

1. 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.
2. Kandil AA, Attia AN, Badawi MA, Sharief AE, Abido WAH. Effect of water stress and fertilization with inorganic nitrogen and organic chicken manure on yield and yield components of potato. Australian Journal of Basic and Applied Sciences. 2011;5(9):997-1005.
3. Kumar M, Jadav MK, Trehan SP. Contributing of organic sources to potato nutrition at varying nitrogen levels. Global potato conference, New Delhi, 2008 Dec 9-12.
4. Kumar P, Kumar A, Kumar N, Ahamad A, Verma MK. Effect of integrated nutrient management on productivity

and nutrients availability of potato. International Journal of Current Microbiology and Applied Sciences. 2017;6(3):1429-1436.
5. Kushwah VS, Singh SP, Lal SS. Effect of manures and fertilizers on potato (Solanum tuberosum) production. Potato Journal. 2005;32(3-4):157-158.
6. Lal M, Khurana SC. Effect of organic manure, biodynamic compost and biofertilizer on potato. Potato Journal. 2007;34(1-2):105-106.
7. Nag GP, Sarnaik DA, Verma Satish K, Tamrakar SK. Integrated nutrient management in potato for Chhattisgarh plains. The Orissa Journal of Horticulture. 2006;36(2):158-161.
8. Nizamuddin M, Mahmood M, Khalid F, Riaz S. Response of potato crop to various levels of NPK. Asian Journal of Plant Sciences. 2003;2(2):149-151.
9. Patel B. Effect of different levels of NPK on growth, development and yield of potato cv. Kufri Ashoka under Chhattisgarh plain condition. M. Sc. (Ag) Thesis IGKV, Raipur. 2013. p. 70-71.
10. Raghav M, Kamal S. Effect of organic sources of nutrients on potato production in Tarai region of Uttarakhand, Pantnagar Journal of Research. 2009;**7**(1):69-72.
11. Shambhavi S, Sharma RP. Influence of vermicompost on quality of potato (Solanumtuberosum) in wet temperate zone of Himachal Pradesh. Indian Journal of Plant Physiology. 2008;13:185-190.
12. 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.
13. Devika NT, Raman K. Deciphering the metabolic capabilities of Bifidobacteria using genome-scale metabolic models. Scientific Reports. 2019 Dec 3;9(1):1-9.
14. Zollo M, Reuer JJ, Singh H. Interorganizational routines and performance in strategic alliances. Organization science. 2002 Dec;13(6):701-713.
15. Mohan D, Rajput S, Singh VK, Steele PH, Pittman Jr CU. Modeling and evaluation of chromium remediation from water using low cost bio-char, a green adsorbent. Journal of hazardous materials. 2011 Apr 15;188(1-3):319-333.
16. Mukund J, Prabhakarasetty TK. Sustainability through organic farming. Xpress Graphics: Delhi, India; c2006.
17. Ansari AA. Effect of vermicompost and vermiwash on the productivity of spinach (Spinacia oleracea), onion (Allium cepa) and potato (Solanum tuberosum). World Journal of Agricultural Sciences. 2008;4(5):554-557.
18. Magkos F, Arvaniti F, Zampelas A. Organic food: nutritious food or food for thought? A review of the evidence. International journal of food sciences and nutrition. 2003 Jan 1;54(5):357-371.
19. Cochran WG. Analysis of covariance: its nature and uses. Biometrics. 1957 Sep 1;13(3):261-281.