



Assessment of Physico-chemical Properties of Soil, Growth and Yield of Potato (*Solanum tuberosum* L.) as Influenced by Integrated Nutrient Management at Prayagraj District

Ravindra Pal Singh^{a++*}, Ram Bharose^{a#},
Tarence Thomas^{a†}, Arun Alfred David^{a‡},
Rajendra Yadav^{a++} and Himanshu Gaden^{a++}

^a Department of Soil Science and Agricultural Chemistry, (NAI),
Sam Higginbottom Institute of Agriculture, Technology and Sciences, Prayagraj – 211077 (U.P), India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i173203

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/102270>

Original Research Article

Received: 27/04/2023
Accepted: 30/06/2023
Published: 06/07/2023

ABSTRACT

An experiment was conducted on "Assessment of Physico-chemical Properties of Soil, Growth and Yield of Potato (*Solanum tuberosum* L.) as Influenced by Integrated Nutrient Management at Prayagraj District." during Rabi season 2022-2023 at the Research farm Department of Soil

⁺⁺Research Scholar;

[#]Assistant Professor;

[†]Associate Professor;

[‡]Professor;

*Corresponding author: E-mail: ravindrapals567@gmail.com, 21msassac033@shiats.edu.in;

science and Agricultural chemistry, NAINI, SHUATS, Prayagraj. The design applied was 3x3 RBD having three levels of Poultry manure @0t,4t,8t h⁻¹ and recommended dose of fertilizer NPK @ 0, 50 and 100%. The variety of potato is kufri jyoti was taken for research trial. Bulk density (Mg m⁻³), Particle density and pH was maximum in T₁ - [Absolute control], soil pore space, water holding capacity, EC, organic carbon, nitrogen, phosphorus and potassium were recorded maximum in T₉ - [NPK@100%+PM@8t ha⁻¹] respectively. In treatment T₉ the highest tuber yield of potato 37.31 q ha⁻¹ was obtained with C:B ratio of 1:1.92. Use of T₉ - [NPK@100%+PM@8t ha⁻¹] on crop and analysing the effect of T₉ treatment on soil physical as well as chemical properties of soil. It was also revealed that the application with organic manures was excellent source for fertilization than fertilizers.

Keywords: Potato; poultry manure; NPK; soil; etc.

1. INTRODUCTION

Soil plays a key role in many ecological processes, including nutrient cycling, water infiltration, carbon sequestration, and habitat creation. Soil quality is influenced by various factors such as climate, topography, vegetation, and human activities. Degradation of soil quality can lead to reduced crop productivity, loss of biodiversity, and increased susceptibility to erosion and desertification Lal (2014). Soil plays a vital role in potato cultivation, as it provides the necessary nutrients and support for the plant's growth and development. potato requires well-drained soil that is rich in organic matter and nutrients such as nitrogen, phosphorus, and potassium [1,2]. Soil also affects the water holding capacity and pH level, which can impact the plant's growth and yield. Additionally, soil health is crucial for the prevention of diseases and pests that can damage the potato plant [3,4]. Therefore, it is important to maintain soil fertility and quality through proper management practices such as crop rotation, composting, and appropriate irrigation. In summary, soil is a critical component in the successful cultivation of potato and must be managed carefully to ensure optimal plant growth and yield Kumar et al., [5]. "Potato (*Solanum tuberosum* L) native to tropical South America and one of the most efficient food crops which produces more dry matter, dietary fiber, quality protein, minerals, vitamins and richest source of energy. The area and production of potato in the country is estimated around 20.85 lakhs hectares and 480 96 lakh million tonnes, respectively with the productivity of 23.07 tonnes per hectare" Anon, (2015). "In order of importance for food production in comparison to other major food crops on the fresh weight basis, potato ranks 6th in developing countries, 4th in developed countries and 3rd in India" (Khurana and Naik, 2003). "The protein in potato is of good quality with regard to

essential amino acids in human nutrition. It also has the substantial number of vitamins, minerals and traces of other nutrients" Bugarcic, (2000). With all these characters, potato undoubtedly a very important crop for countries with the high human population density like India where adequate protein and calories can be supplied cheaply for the nutritional needs calling it as "Poor man's crop". Bugarcic, (2000). "Potato is an important crop for solving food and nutritional security problems of growing population of India with its high potential for the growth and yield. Potato is the fourth most important food crop after rice, wheat and maize in the North-East plains of India. India is the second largest potato producing country in the world after China, with annual production of 42.48 million tonnes from area of 1.93 million hectare, while in Uttar Pradesh area, production and productivity of potato is 0.55 m ha, 13.57 m tonnes and 24.67 tonnes ha⁻¹, respectively" Anon, (2022). "Potassium is one of the three major nutrient elements (N, P and K) required by plants. Potassium imparts pest and disease resistance to the plant and plays an important role in crop productivity" [6-8]. Potassium contributes to stem growth, tuber growth and the synthesis of protein as described by Ginindza et al., (2015). "It is always involved in the movement of carbohydrates, therefore accumulation of carbohydrates and soluble nitrogen compound points to diminish protein synthesis in case of potassium deficiency. In the event of luxury consumption during the process. It is also regulating the transpiration process through opening and closing the stomata by affecting the activities of guard cells. In these organelles potassium activates the fat produces enzyme and enhances the oil content" Singh et al., (2013). "Chemical fertilizers are not only in limited supply but also expensive in developing countries like India. The potato use of chemical fertilizer is increasing day by day, moreover, the

continuous use of these fertilizers adversely affects the soil health, which is a major concern for farmers. Integrated supply of nutrients through organic, inorganic and bio fertilizers are the need of the hour for sustainable productivity and to maintain better soil health” Jagadeesh et al., (1994). “To increase the production and quality of potato, judicious combination of organic sources of nutrients along with inorganic and biofertilizers (Azotobacter and phosphor bacteria) receive the good response” (Nag, 2006). “Phosphate solubilizing Bacteria (PSB) are capable of hydrolyzing organic and inorganic phosphorus from insoluble compounds and PSB produce phosphatase like phytase that hydrolyze organic forms of phosphate compounds efficiently. Biofertilizers are living organisms used in the fertilization of soil and are useful in supplementing the usual application of chemical fertilizers and help in enriching the soil” Nag, (2006).

2. MATERIALS AND METHODS

The investigation on “Assessment of Physico-chemical Properties of Soil, Growth and Yield of Potato (*Solanum tuberosum* L.) as Influenced by Integrated Nutrient Management Prayagraj District.” comprise of a field experiment which was carried out at the Soil Science Research Farm, Sam Higginbottom University of Agriculture Technology, Prayagraj during Rabi season 2022. The details about the experiment

site, soil and climate are described in this chapter together with the experimental design, layout plan, cultural practice, particulars of treatments, planting material and techniques employed for the parameters.

The experiment was conducted at research Farm of Soil Science at Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, the area is situated on the south of Prayagraj on the right side of the river Yamuna on the South of Rewa Road at a distance of about 6 km from Prayagraj city. It is situated at 25°57' N latitude, 81°59' E longitude and at the altitude of 98 meter above the sea level, comes under subtropical belt in the South east of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46°C – 48°C and seldom falls as low as 4°C – 5°C. The relative humidity ranged between 20 to 94 percent. The average rainfall in this area is around 1100 mm annually.

The soil samples will be randomly collected from one site in the experiment plot prior to tillage operation from a depth of 0-15 cm and 15-30 cm. The volume of the soil sample will be reduced by coning and quartering the composites soil sample will be air dried and passed through a 2 mm sieve by way of preparing the sample for physical and chemical analyses.

Table 1. Physical parameters

Particulars	Method
Soil Colour	Munsell, 1971
Soil Texture (Sandy loam)	Bouyoucous, 1927
Bulk density(Mg m ⁻³)	Muthuaval et al. 1992
Particle density(Mg m ⁻³)	Muthuaval et al. 1992
Water Holding Capacity (%)	Muthuaval et al. 1992
Pore Space (%)	Muthuaval et al. 1992

Table 2. Chemical parameters

Particulars	Methods
Soil pH (1:2)	Jackson, 1967
EC (dS m ⁻¹)	Wilcox, 1950
Organic carbon (%)	Walkley and Black, 1947
Available Nitrogen (kg ha ⁻¹)	Subbaih and Asija, 1956
Available Phosphorus(kg ha ⁻¹)	Olsen et al., 1954
Available Potassium (kg ha ⁻¹)	Toth and Prince, 1949

Table 3. Treatment combination of potato

Treatments	Treatment combinations
T ₁	Absolute control
T ₂	(NPK@0%+PM@4t ha ⁻¹)
T ₃	(NPK@0%+PM@8t ha ⁻¹)
T ₄	(NPK@50%+PM@0t ha ⁻¹)
T ₅	(NPK@50%+PM@4t ha ⁻¹)
T ₆	(NPK@50%+PM@8t ha ⁻¹)
T ₇	(NPK@100%+PM@0t ha ⁻¹)
T ₈	(NPK@100%+PM@4t ha ⁻¹)
T ₉	(NPK@100%+PM@8t ha ⁻¹)

RDF for Potato = 120: 240: 120 kg ha⁻¹ Source: Handbook of ICAR, 2016
 Seeds are treated with PSB @10 ml kg⁻¹

3. RESULTS AND DISCUSSION

3.1 Soil Parameters

The maximum Bulk density 1.43 and 1.46 Mg m⁻³ of soil after crop harvest was recorded in application of T₁ Control and minimum 1.33 and 1.30 Mg m⁻³ in T₉. The maximum particle density of soil was recorded in T₁ control 2.54 and 2.56 Mg m⁻³ and minimum 2.36 and 2.40 Mg m⁻³ in T₉. The maximum pH of soil was recorded in T₁ control 7.47 and 7.65 and minimum 7.21 and 7.28 T₉. The composition of NPK and Poultry manure have significant increase on the soil parameters. The increase of EC, pore space %, water holding capacity %, organic

carbon, available nitrogen, phosphorus and potassium with the improvement of soil parameters, In treatment T₁ lowest data observed, Ec 0.18 and 0.16, pore space 40.55 and 39.21%, water holding capacity 35.55 and 34.21%, organic carbon 0.36 and 0.34%, nitrogen 219.30 and 204.30 kg ha⁻¹, phosphorus 21.02 and 18.62 kg ha⁻¹, potassium 152.54 and 150.21 kg ha⁻¹ and T₉ shows the highest Ec 0.37 and 0.28 pore space 47.57 and 47.24%, water holding capacity 42.57 and 42.24%, organic carbon 0.44 and 0.42%, nitrogen 278.49 and 256.66 kg ha⁻¹, phosphorus 31.26 and 29.93 kg ha⁻¹ and potassium 208.58 and 202.18 kg ha⁻¹, respectively in 0-15cm and 15-30cm depth of soil.

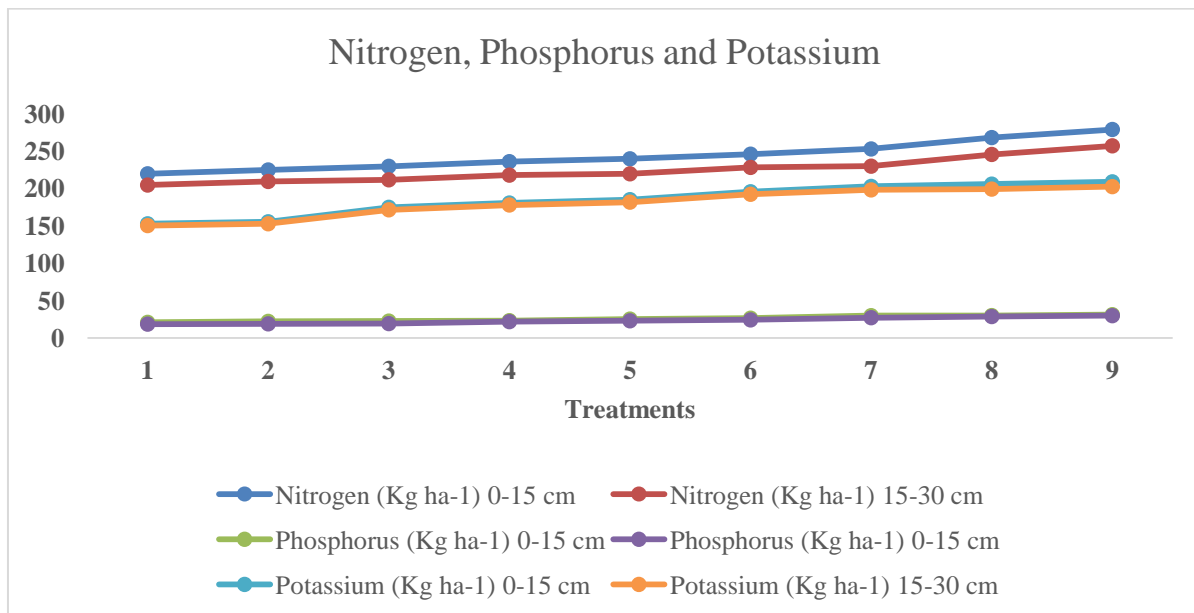


Fig. 1. Effect of different levels of NPK and poultry manure on nitrogen, phosphorus and potassium

Table 4. Effect of different levels of NPK and poultry manure on physical-chemical properties of soil

Treatments	Depth (cm)	BD (Mg m ⁻³)	PD (Mg m ⁻³)	Pore Space (%)	WHC (%)	pH	EC (dS m ⁻¹)	OC (%)	N (kg ha ⁻¹)	P (kg ha ⁻¹)	K (kg ha ⁻¹)
T ₁	0-15	1.43	2.54	40.55	35.55	7.47	0.18	0.36	219.30	21.02	152.54
	15-30	1.46	2.56	39.21	34.21	7.65	0.16	0.34	204.30	18.62	150.21
T ₂	0-15	1.42	2.50	42.63	37.63	7.39	0.20	0.36	224.43	22.35	155.27
	15-30	1.44	2.53	41.29	36.29	7.62	0.18	0.35	209.10	19.02	152.60
T ₃	0-15	1.40	2.44	44.46	39.46	7.37	0.20	0.37	229.31	22.70	174.58
	15-30	1.43	2.47	43.15	38.15	7.63	0.18	0.36	211.31	19.36	171.25
T ₄	0-15	1.37	2.47	44.58	39.58	7.38	0.21	0.38	235.54	23.29	180.33
	15-30	1.39	2.49	43.22	38.22	7.53	0.20	0.36	217.54	21.96	177.67
T ₅	0-15	1.38	2.43	44.64	39.64	7.36	0.24	0.38	239.31	25.40	184.81
	15-30	1.40	2.45	44.31	39.31	7.51	0.22	0.37	219.31	23.07	181.48
T ₆	0-15	1.36	2.39	45.57	40.57	7.31	0.25	0.39	245.50	26.56	195.33
	15-30	1.38	2.42	45.23	40.23	7.48	0.23	0.38	229.48	24.30	192.00
T ₇	0-15	1.35	2.40	46.49	41.49	7.29	0.31	0.41	267.66	29.96	202.51
	15-30	1.38	2.46	45.16	40.16	7.38	0.22	0.40	245.16	27.23	197.85
T ₈	0-15	1.33	2.38	46.55	41.55	7.25	0.34	0.43	278.49	30.08	205.52
	15-30	1.37	2.44	46.21	41.21	7.32	0.26	0.42	256.66	28.75	198.91
T ₉	0-15	1.33	2.36	47.57	42.57	7.21	0.37	0.44	314.22	31.26	208.58
	15-30	1.30	2.40	47.24	42.24	7.28	0.28	0.42	268.98	29.93	202.18
F-Test		NS	NS	S	S	NS	NS	S	S	S	S
		NS	NS	S	S	NS	NS	S	S	S	S
S.ED. (±)		-	-	0.26	0.46	-	-	0.01	2.21	1.53	1.35
		-	-	0.24	0.41	-	-	0.03	1.85	1.70	1.09
C.D. at 5%		-	-	0.55	0.98	-	-	0.46	4.45	3.25	2.68
		-	-	0.53	0.87	-	-	0.35	3.78	3.61	2.24

Table 5. Effect of different levels of NPK and poultry manure on growth and yield parameters of potato

Treatments	Plant height (cm)			Number of leaves (cm)			Tuber yield (q ha ⁻¹)
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	
T ₁	23.82	33.40	39.34	51.53	101.00	110.93	30.32
T ₂	25.31	37.10	42.39	57.40	103.46	117.86	31.67
T ₃	25.51	37.16	42.76	57.60	103.86	118.53	32.91
T ₄	26.40	39.30	43.21	57.60	107.13	120.46	32.06
T ₅	26.50	39.70	43.69	59.27	107.73	120.90	33.03
T ₆	26.51	40.01	43.69	59.73	108.20	122.20	34.95
T ₇	27.19	40.03	44.35	60.07	110.00	122.60	34.27
T ₈	27.66	40.30	44.83	60.80	110.60	123.08	35.20
T ₉	28.10	42.01	46.78	60.93	112.73	129.08	37.31
F-Test	S	S	S	S	S	S	S
S.ED. (±)	0.66	1.04	1.10	1.50	2.19	1.35	0.69
C.D. at 5%	2.00	3.12	3.31	4.51	6.59	4.05	2.08

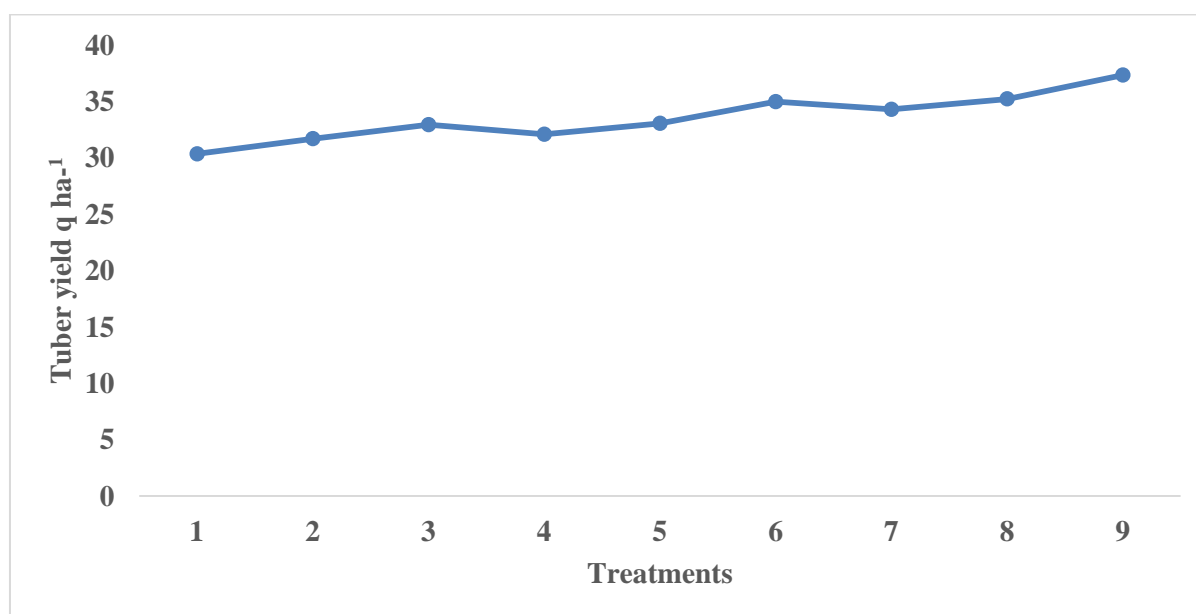


Fig. 2. Variation in tuber yield (q ha⁻¹) of potato as influenced by NPK and Poultry manure

4. CONCLUSION

The study concluded that the treatment combinations of T₉ [NPK@100%+PM@8t ha⁻¹] shows best results with respect to in comparison to other treatment combinations. It gives highest yield 37.31 q ha⁻¹. So, we can recommend farmer to apply NPK and Poultry manure for profitable production of Potato and for good soil Health.

ACKNOWLEDGEMENT

Success is the manifestation of diligence, perseverance, inspiration, motivations and innovations. It is my proud privilege to express a

deep sense of gratitude of my Advisor (Dr.) Ram Bharose, Assistant Professor, Department of Soil Science and Agricultural Chemistry, SHUATS, Prayagraj, whose generous help, untiring guidance, supervision, critical suggestions and his positive attitude towards my abilities enabled me to complete this work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Andre CM, Legay S, Iammarino C. The potato in the human diet a complex matrix

- with potential health benefits Potato Research. 2014;57(3-4):201-214.
2. Anonymous. Estimates of potato production, Directorate of Economics. Ministry of Agriculture, New Delhi; 2013.
 3. Barman KS, Kumar A, Kasera S, Ram B Integrated nutrient management in potato (*Solanum tuberosum* L) cv Kufri Ashoka. Journal of Pharmacognosy and Phytochemistry (special issue). 2018;1936: 1938.
 4. Kumar Dubey M, Baishaya LK, Ghosh DC, Gupta VK, SK, Das A, Patel, Kushwah SS, et al. Influence of different N and P levels with and without biofertilizers of N, P content, uptake and yield of potato cv Kufri Jyoti. J Indian Potato Assoc. 2010, 2003;30(3-4):321-324.
 5. Yadu D. Effect of varying levels of NPK fertilizers and size of seed tubers on growth and yield of potato (*Solanum tuberosum* L.) in Alfisol. M. Sc. (Ag) IGKVV Raipur; 2011.
 6. Nongmaithem D, Pal D. the effect of organic sources of nutrients on the growth attributes and yields of potato (*Solanum tuberosum* L.) Journal of Crop and Weed. 2011;7(2):67-69.
 7. Sharma SK, Singh SP. Effect of potassium, zinc and poultry manure on growth, yield, nutrient uptake and quality of potato (*Solanum tuberosum* L.) International Journal of Chemical Studies. 2017;5(5):818-822.
 8. Sood MC. Integrated Nutrient Supply and Management for Potato Production; 2007.

© 2023 Singh et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/102270>