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Effect of organic manures and potassium on yield of potato (*Solanum tuberosum* L.) and physico-chemical properties of soil

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Abstract

A field experiment entitled “Effect of Organic Manures and Potassium on Yield of Potato (*Solanum tuberosum* L.) and Physico-Chemical Properties of Soil” conducted during *Rabi* season of 2025-26 at Agricultural Research Farm, Department of Soil Science, School of Agriculture Suresh Gyan Vihar University, Jaipur (Rajasthan). Among the organic manure treatments, vermicompost @ 7.5 t ha⁻¹ (O₃) recorded the highest number of tubers per plant (13.65), average tuber weight (37.63 g), tuber yield per plot (38.52 kg) and tuber yield (42.80 t ha⁻¹). Similarly, among the potassium levels, 125 kg K₂O ha⁻¹ (K₃) recorded the maximum plant height (56.78 cm), number of tubers per plant (12.88), average tuber weight (42.65 g), tuber yield per plot (37.92 kg) and tuber yield (42.13 t ha⁻¹), which remained statistically at par with 100 kg K₂O ha⁻¹ for most of the parameters. The post-harvest soil analysis indicated that soil pH and electrical conductivity were not significantly influenced by the treatments. However, application of organic manures significantly improved soil organic carbon and available nutrient status. The highest organic carbon (0.40%), available nitrogen (184.65 kg ha⁻¹), available phosphorus (17.42 kg ha⁻¹), available potassium (188.32 kg ha⁻¹) and available sulphur (10.25 kg ha⁻¹) were recorded with vermicompost @ 7.5 t ha⁻¹. Among potassium levels, 125 kg K₂O ha⁻¹ recorded the highest available nitrogen (177.36 kg ha⁻¹), available phosphorus (15.45 kg ha⁻¹), available potassium (210.96 kg ha⁻¹) and available sulphur (9.92 kg ha⁻¹), indicating improvement in soil fertility through balanced nutrient management. Economic analysis revealed that although vermicompost and higher potassium levels increased the cost of cultivation, they produced substantially higher economic returns due to increased tuber yield. Based on the findings of the present investigation, it may be concluded that the application of vermicompost @ 7.5 t ha⁻¹ along with potassium @ 125 kg K₂O ha⁻¹ is an effective nutrient management strategy for potato cultivation.

Keywords: Vermicompost, potato, soil properties, sustainable agriculture

1. Introduction

Potato (*Solanum tuberosum* L.), belonging to the family Solanaceae, is one of the most important food and vegetable crops worldwide and is popularly known as the “King of Vegetables” and “Poor Man’s Friend.” The edible tuber is a modified underground stem rich in carbohydrates, protein, minerals, vitamins and dietary fibre. Owing to its high productivity, nutritional value and diverse uses in food and processing industries, potato plays an important role in global food and nutritional security.

The intensive use of chemical fertilizers has undoubtedly increased crop productivity; however, their continuous and imbalanced application may cause nutrient imbalance, deterioration of soil health, reduction in organic matter and environmental pollution. Therefore, the integrated use of organic manures and inorganic fertilizers is essential for maintaining soil fertility, improving nutrient availability and sustaining crop productivity. Organic sources such as FYM and vermicompost supply nutrients and provide favourable conditions for microbial activity, thereby improving soil quality and nutrient-use efficiency.

Potassium (K) is a major nutrient required in large quantities by potato and plays an important role in enzyme activation, stomatal regulation, water relations and translocation of photosynthates from leaves to developing tubers. Adequate K nutrition enhances tuber development, size, dry

matter accumulation, storage quality and processing characteristics. Integrated application of potassium with organic manures can further improve K availability and nutrient-use efficiency by enhancing soil physical and chemical properties (Kumar and Maurya, 2024) ^[2]. Hence, balanced potassium fertilization combined with organic nutrient sources is an important approach for improving potato productivity, tuber quality and long-term soil fertility.

2. Materials and Methods

A field experiment was conducted during the Rabi season of 2025–26 at the Agricultural Research Farm, Department of Soil Science, School of Agriculture, Suresh Gyan Vihar University, Jaipur, Rajasthan, to assess the Effect of Organic Manures and Potassium on Yield of Potato (*Solanum tuberosum* L.) and Physico-Chemical Properties of Soil. The experimental site is located in a semi-arid, subtropical climate characterized by extreme temperature variations, with hot and dry summers (maximum temperature up to 45 °C) and cold winters (minimum temperature as low as 2.8 °C). The area receives an average annual rainfall of 500–800 mm, mostly concentrated during the monsoon season. The soil of the experimental field was sandy loam in texture, saline in reaction, with the following initial characteristics: Soil of the experimental field was sandy loam in texture, saline in reaction with a pH value of 7.62, EC (0.48 dSm⁻¹), poor in organic carbon (0.34%), low in available nitrogen (134.25 kg/ha), phosphorus (13.25 kg/ha) and (178.15 kg/ha) but medium in available potassium (320 kg/ha). The factorial randomized block design with three replications. The collected data were statistically analysed using analysis of variance (ANOVA) appropriate for the RBD design to determine the significance of treatment effects.

3. Results and Discussion

3.1 Growth attributes

The application of organic manures and potassium significantly improved the growth of potato. Among the organic manure treatments, vermicompost @ 7.5 t ha⁻¹ (O₃) recorded the maximum plant height (58.75 cm), whereas the minimum (48.52 cm) was recorded under control. Similarly, among potassium treatments, 125 kg K ha⁻¹ (K₃) resulted in the maximum plant height (56.78 cm) compared with 50.85 cm under K₀. The improvement in growth with vermicompost may be attributed to the gradual release of nutrients, enhanced microbial activity and improvement in soil physical conditions, which collectively promote root development and nutrient absorption. Similar beneficial effects of integrated organic and inorganic nutrient management on potato growth have been reported by Mohanty *et al.* (2014) ^[4] and Tiwari *et al.* (2021) ^[10].

The favourable response to potassium may be associated with its important role in enzyme activation, photosynthesis, osmotic regulation and translocation of assimilates from leaves to developing tubers. Potassium deficiency can restrict root development, nutrient uptake and photosynthetic product transport, thereby reducing plant growth and tuber formation. A recent meta-analysis also demonstrated that potassium application significantly improved potato yield and K uptake, confirming the importance of adequate K nutrition in potato production. Similar increases in plant growth and tuber productivity with increasing potassium supply have been reported by Singh and Lal (2012) ^[9].

3.2 Yield attributes and tuber yield

The application of organic manure and potassium considerably enhanced the yield attributes of potato. The maximum number of

tubers (13.65 plant⁻¹) was recorded with vermicompost @ 7.5 t ha⁻¹, while potassium application at 125 kg K ha⁻¹ resulted in 12.88 tubers plant⁻¹. The maximum average tuber weight (42.65 g) was also recorded with 125 kg K ha⁻¹. The increase in tuber number and weight under improved nutrient supply may be attributed to better vegetative growth, enhanced photosynthetic activity and greater translocation of assimilates to the tubers.

The maximum tuber yield among organic manure treatments was obtained with vermicompost @ 7.5 t ha⁻¹ (42.80 t ha⁻¹) compared with 20.31 t ha⁻¹ under control. Similarly, 125 kg K ha⁻¹ produced the maximum tuber yield (42.13 t ha⁻¹) compared with 24.61 t ha⁻¹ under K₀. The positive effect of potassium on tuber yield is in agreement with Singh and Lal (2012) ^[9], who reported that increasing K application enhanced tuber yield, nutrient uptake and the production of large and medium-sized tubers. More recently, a meta-analysis based on 192 publications and 2,165 observations reported an average 19.24% increase in potato yield with K application and a 40.49% increase in K uptake.

The interaction between organic manure and potassium was also important. The highest tuber yield (42.98 t ha⁻¹) was obtained with O₃K₃ (vermicompost @ 7.5 t ha⁻¹ + 125 kg K ha⁻¹). The superiority of this combination may be due to the complementary effects of organic manure and mineral potassium. Vermicompost supplies nutrients gradually and improves nutrient retention and microbial activity, whereas potassium provides readily available K during the period of tuber initiation and bulking. Similar improvements in potato yield and soil health under integrated application of FYM, vermicompost and inorganic fertilizers were reported by Mohanty *et al.* (2014) ^[4].

The present findings are further supported by studies showing that K nutrition improves not only potato yield but also tuber quality. Potassium application has been reported to increase starch, crude protein and vitamin C while reducing reducing-sugar concentration under suitable growing conditions. However, the response to K can vary with soil K status, fertilizer source, rate and environmental conditions, indicating the importance of site-specific potassium management.

3.3 Soil physico-chemical properties

Organic manure and potassium treatments did not significantly influence soil bulk density, pH and electrical conductivity after potato harvest. The absence of significant changes in these properties may be attributed to the relatively short duration of the experiment, as substantial changes in stable soil properties such as bulk density and pH generally require repeated application of organic amendments (Westermann, 2005) ^[11].

In contrast, nutrient availability was improved considerably by organic manure application. Vermicompost @ 7.5 t ha⁻¹ recorded the highest available N (184.65 kg ha⁻¹) and P (17.42 kg ha⁻¹) compared with 170.22 and 13.25 kg ha⁻¹, respectively, under control. The higher availability of nutrients may be attributed to mineralization of organic residues, release of nutrients from vermicompost and enhanced microbial activity. Similar improvements in available N, P and K following integrated nutrient management in potato have been reported by Mohanty *et al.* (2014) ^[4].

The maximum available sulphur (10.25 kg ha⁻¹) was recorded with vermicompost @ 7.5 t ha⁻¹ compared with 8.25 kg ha⁻¹ under control. Among potassium treatments, available sulphur increased from 8.95 kg ha⁻¹ under K₀ to 9.92 kg ha⁻¹ under K₃. This improvement may be associated with greater nutrient cycling and improved soil biological activity following organic matter addition. The increase in available nutrients under integrated nutrient management indicates that organic amendments can complement mineral fertilizers by improving nutrient retention

and cycling. (Singh *et al.* 2017) [8].

3.4 Economics

The economic analysis showed that vermicompost @ 7.5 t ha⁻¹ recorded the maximum gross return (₹3,42,433 ha⁻¹) and net return (₹2,06,433 ha⁻¹), although its cost of cultivation was also highest (₹1,36,000 ha⁻¹). Among potassium treatments, 125 kg K ha⁻¹ resulted in the highest gross return (₹3,37,024 ha⁻¹) and net return (₹2,34,524 ha⁻¹). The higher economic returns were mainly associated with increased tuber yield and improved marketable

production. (Kumar *et al.* 2018) [2].

The economic advantage of integrated nutrient management in potato has also been reported by Mohanty *et al.* (2014) [4], who observed improved productivity, nutrient uptake, soil fertility and economic returns under combined organic and inorganic nutrient sources. The present results therefore indicate that appropriate potassium management combined with organic manure can provide both agronomic and economic benefits in potato production. (Islam *et al.* 2016) [1].

Table 1: Effect of organic manures and potassium levels on growth and yield of potato

Sr. No.	Treatments	Plant height at harvest (cm)	Number of tubers per plant	Average weight of tuber (g)	Tuber yield (kg/plot)	Tuber yield (t/ha)
A.	Organic manures					
1.	O0-Control	48.52	10.02	24.32	18.28	20.31
2.	O1-FYM @ 30 t/ha	51.32	11.32	29.45	25.00	27.78
3.	O2-Poultry manures 5 t/ha	54.65	12.52	33.52	31.48	34.97
4.	O3-Vermicompost @ 7.5 t/ha	58.75	13.65	37.63	38.52	42.80
	S.Em.±	1.39	0.41	1.39	2.35	2.62
	CD	4.18	1.22	4.18	7.06	7.85
B.	Potassium levels					
1.	K0-0 kg/ha	50.85	11.22	26.32	22.15	24.61
2.	K1-75 kg/ha	53.65	11.88	31.55	28.11	31.23
3.	K2-100 kg/ha	55.25	12.33	37.65	34.82	38.69
4.	K3-125 kg/ha	56.78	12.88	42.65	37.92	42.13
	S.Em.±	1.39	0.41	1.39	2.35	2.62
	CD	4.18	1.22	4.18	7.06	7.85
A × B	Organic manures × Potassium levels					
	S.Em.±	1.78	0.82	2.78	4.72	5.24
	CD	NS	2.46	8.39	14.14	7.86

Table 2: Effect of organic manures and potassium levels on physico-chemical properties of potato

Sr. No.	Treatments	Bulk density (Mg/m ³)	Soil pH	EC (dSm ⁻¹)	Organic carbon (%)	Available nitrogen (kg/ha)	Available phosphorus (kg/ha)	Available potassium (kg/ha)	Available Sulphur (kg/ha)
A.	Organic manures								
1.	O0-Control	1.36	7.70	0.51	0.35	170.22	13.25	181.32	8.25
2.	O1-FYM @ 30 t/ha	1.34	7.65	0.48	0.37	176.65	14.52	184.65	8.88
3.	O2-Poultry manures 5 t/ha	1.33	7.62	0.46	0.38	180.25	15.65	186.45	9.65
4.	O3-Vermicompost @ 7.5 t/ha	1.31	7.60	0.45	0.40	184.65	17.42	188.32	10.25
	S.Em.±	0.02	0.03	0.02	0.01	1.48	0.60	1.82	0.21
	CD	NS	NS	NS	0.03	4.45	1.81	5.55	0.62
B.	Potassium levels								
1.	K0-0 kg/ha	1.35	7.76	0.50	0.36	172.65	13.85	183.65	8.95
2.	K1-75 kg/ha	1.35	7.74	0.49	0.37	174.52	14.32	195.32	9.35
3.	K2-100 kg/ha	1.34	7.72	0.48	0.38	175.25	15.02	205.54	9.58
4.	K3-125 kg/ha	1.33	7.70	0.46	0.39	177.36	15.45	210.96	9.92
	S.Em.±	0.02	0.03	0.02	0.01	1.48	0.60	1.82	0.21
	CD	NS	NS	NS	0.03	4.45	1.81	5.55	0.62
A × B	Organic manures × Potassium levels								
	S.Em.±	0.04	0.06	0.04	0.06	1.95	1.20	3.64	0.42
	CD	NS	NS	NS	NS	NS	NS	NS	NS

Table 3: Effect of organic manures and potassium levels on economics

Sr. No.	Treatments	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio
A.	Organic manures				
1.	O0-Control	98500	162458	63958	1.65
2.	O1-FYM @ 30 t/ha	113500	222249	108749	1.96
3.	O2-Poultry manures 5 t/ha	128500	279780	151280	2.18
4.	O3-Vermicompost @ 7.5 t/ha	136000	342433	206433	2.52
B.	Potassium levels				
1.	K0-0 kg/ha	98500	196874	98374	2.00
2.	K1-75 kg/ha	100900	249876	148976	2.48
3.	K2-100 kg/ha	101700	309483	207783	3.04
4.	K3-125 kg/ha	102500	337024	234524	3.29

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