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Comparative Assessment of Initial and Post-Harvest Soil Chemical Properties under Different Organic Sources and Graded Levels of Potassium in Maize (*Zea mays* L.)

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***Abstract*— *A field experiment entitled was conducted during the Kharif season of 2025 at Agronomy Instructional Farm, Rajasthan College of Agriculture, Udaipur. The experiment was laid out in Factorial Randomized Block Design (FRBD) with twelve treatment combinations comprising four potassium levels viz., K_0 (Control), K_1 (75% RDK), K_2 (100% RDK) andK_3 (125% RDK) and three organic sources viz., O_0 (Control), O_1 (FYM @ 10 t ha^{-1})and O_2 (Vermicompost @ 5 t ha^{-1}), replicated four times. The initial soil was slightly alkaline (pH 8.11), non-saline (EC 0.59 dS m^{-1}), with medium organic carbon (0.60%) and available nitrogen, phosphorus and potassium content of 230.00, 19.10and 402.00 kg ha^{-1}, respectively. After harvest, soil pH and EC remained unaffected by both potassium levels and organic sources. Potassium application significantly increased residual available potassium, with the highest value recorded under 125% RDK (K_3), which remained at par with 100% RDK (K_2). Organic sources significantly improved soil organic carbon and available nitrogen, phosphorus and potassium status. Vermicompost @ 5 t ha^{-1} (O_2) recorded the highest values of organic carbon (0.676%), available nitrogen (267.08 kg ha^{-1}), available phosphorus (22.61 kg ha^{-1}) and available potassium (455.35 kg ha^{-1}).The study concluded that organic nutrient sources, particularly vermicompost, were more effective in improving post-harvest soil fertility compared to potassium levels alone. The combined application of vermicompost @ 5 t ha^{-1} with 125% RDK (K_3O_2) proved beneficial for maintaining soil nutrient status and improving soil health under maize cultivation.**

Keywords*— Soil properties, potassium levels, organic sources, initial and after harvest soil properties, available nutrients, pH, EC & OC.

I. INTRODUCTION

Maize (*Zea mays* L.) belongs to the family Gramineae (Poaceae) and is believed to have originated in Mexico or Central America. It was introduced to West Africa by early European traders during the 16th century (Tweneboah, 2000). Today, maize is one of the most important cereal crops worldwide and plays a vital role in the agricultural economy of both the world and India (Nuss and Tanumihardia, 2010). Owing to its wide adaptability and diverse uses, it is regarded as a multipurpose crop. It serves as a staple food for humans, a valuable feed for livestock and poultry and a nutritious fodder crop. In addition, maize is an important industrial raw material and is extensively utilized in the production of cornstarch, dextrose, corn syrup, corn flakes, ethanol and several other value-added products (Gul *et al*., 2021).

In India, maize is the third most important food grain after rice and wheat, contributing significantly to the country's food and nutritional security. More than half of the nation's total maize production is concentrated in four major states Madhya Pradesh, Andhra Pradesh, Karnataka and Rajasthan (Murdia *et al*., 2016). According to the latest estimates, maize is cultivated over an area of approximately 12.1 million hectares in India, with a total production of 42.3 million tonnes and an average productivity of 3,580 kg ha^{-1} (Anonymous, 2025). Maize is cultivated across approximately 205–210 million hectares worldwide under a wide range of climatic conditions, with a global production of about 1,224.9 million tonnes (Anonymous, 2025). In India, maize occupies an area of 10.88 million hectares, producing 42.3 million tonnes with an average productivity of 3,740 kg ha^{-1} (Anonymous, 2024). Among the maize-growing states, Rajasthan ranks second in terms of cultivated area, with approximately 0.86 million hectares under maize cultivation. However, despite its large cultivation area, the state records a comparatively lower production of 1.92 million tonnes and an average productivity of only 2,229 kg ha^{-1} (Anonymous, 2024), indicating considerable scope for improving maize productivity through the adoption of improved production technologies and management practices.

Soil chemical properties are important indicators of soil fertility and play a vital role in nutrient availability and sustainable crop production. Potassium (K) is one of the essential macronutrients required in large quantities by plants and is involved in several physiological processes, including enzyme activation, photosynthesis, assimilate transport and water regulation (Pettigrew, 2008; Sardans and Penuelas, 2021). Although a major portion of soil potassium exists in mineral forms, only a small fraction is readily available for plant uptake, making efficient potassium management essential for maintaining soil fertility (Rehm and Schmitt, 2002).

Organic sources such as farmyard manure (FYM) and vermicompost improve soil chemical properties by increasing soil organic matter, enhancing nutrient availability and improving cation exchange capacity and microbial activity. Their gradual nutrient release helps maintain soil fertility and supports sustainable crop production (Gao *et al*., 2023; Kumar *et al*., 2024). Long-term application of FYM along with balanced fertilization has been reported to improve soil fertility and crop productivity in maize-based cropping systems (Kumar *et al*., 2022), while vermicompost enriches the soil with nutrients and beneficial microorganisms, thereby improving soil health (Adhikary, 2012; Roychowdhury *et al*., 2017).Therefore, the combined application of organic sources and graded levels of potassium is considered an effective approach for maintaining soil chemical properties and ensuring sustainable maize production. Therefore, the current investigation was conducted to assessment of initial and post-harvest soil chemical properties under different organic sources and graded levels of potassium in maize (*Zea mays* l.)

II. MATERIALS AND METHODS

The experiment was carried out at the field block B2 of Agronomy Instructional Farm, Rajasthan College of Agriculture, Udaipur, which is located in the southeast of Rajasthan at an elevation of 582.2 m above mean sea level, at latitude 24°35' N and longitude 73°42' E. The area is located in Rajasthan's agroclimatic zone IV A, which includes the Sub-Humid Southern Plain and Aravalli Hills.

For analysis of initial soil properties, samples were taken at random from 0–15 cm soil depths in different parts of the experimental area in order to ascertain the chemical characteristics of the soil. This sample collection was performed before sowing and after harvest. A representative composite sample was then submitted to distinct chemical analyses. Recommended doses of fertilizers were applied.

The experiment comprised 12 treatment combinations involving maize crop variety DHM 121 and was laid out in a Factorial Randomized Block Design (FRBD). Each treatment was replicated four times to minimize experimental error and to obtain reliable and precise results.The experiment comprised two factors. Factor I consisted of four potassium levels: K_0 (Control), K_1 (75% RDK), K_2 (100% RDK), and K_3 (125% RDK). Factor II included three organic source levels: O_0 (Control), O_1 [Farmyard Manure (FYM) @ 10 t ha^{-1}] andO_2 [Vermicompost @ 5 t ha^{-1}].

Table: Methods of analysis of soil chemical properties

Sr. No.	Determination	Methods followed	Reference
Soil analysis			
Chemical determinations			
(a)	Available nitrogen	By alkaline permanganate method	Subbiah and Asija (1956)
(b)	Available Phosphorus	Extraction of soil with 0.5 M $NaHCO_3$ at pH 8.5 and development of blue colour with $SnCl_2$ and measurement through calorimetrically	Olsen *et al.* (1954)
(c)	Available potassium	Extraction done with 1 N neutral ammonium acetate at pH 7.0 and will be determined by flame photometer	Richards (1954)
(f)	Organic carbon	Walkley and Black's rapid titration method	Walkley and Black (1934)
(g)	Soil reaction (pH)	Using pH meter in 1:2 soil water suspension as per method of USDA, Hand book No. 60	Richards (1954)
(h)	Electrical conductivity (1:2 soil water suspension)	ECmeasured with the help of "Solubridge" in soil saturation extract as per method 4b, USDA, Hand book No. 60	Richards (1954)

Statistical Analysis

The experimental data were subjected to analysis of variance (ANOVA) following the procedure of Fisher and Yates (1949). Treatment means were compared using the critical difference (C.D.) test at the 5% level of significance wherever the F-test was found significant. The results are presented with S.Em. (±) and C.D. (P = 0.05) and the analysis of variance is provided in the Appendix. Appropriate tables and figures have been used to present the results.

III. RESULTS AND DISCUSSION

Soil chemical properties of the experimental soil before sowing

The pre-sowing soil analysis indicated that the experimental soil was slightly alkaline in reaction with a pH of 8.11 and had low electrical conductivity (0.59 dS m^{-1}), indicating non-saline conditions. The soil contained 0.60% organic carbon, suggesting a moderate organic matter status. The available nutrient content showed 230.00 kg ha^{-1} nitrogen, 19.10 kg ha^{-1} phosphorus and 402.00 kg ha^{-1} potassium, indicating low to medium available nitrogen, medium available phosphorus and high available potassium. Overall, the experimental soil was non-saline, slightly alkaline and moderately fertile, providing suitable conditions for conducting the experiment.

Table 1: Soil chemical properties of the experimental soil before sowing

Sr. No.	Soil Property	Values
1.	pH (1:2 soil: water)	8.11
2.	EC (dS m^{-1})	0.59
3.	Organic carbon (%)	0.60
4.	Available Nitrogen (kg ha^{-1})	230.00
5.	Available Phosphorus (kg ha^{-1})	19.10
6.	Available Potassium (kg ha^{-1})	402.00

Soil properties with application of potassium levels and organics after harvest

Soil pH and EC

Potassium levels:

An examination of the data presented in Table 2 reveals that different potassium levels failed to exert any significant influence on soil pH and EC after harvest of maize.

Organic levels:

The data further indicate that application of different organic sources did not significantly affect soil pH and EC after harvest of maize.

Organic carbon (%)

Potassium levels:

A close scrutiny of the data presented in Table 2 reveals that organic carbon content of soil after harvest of maize was not influenced by application of potassium levels.

Organic levels:

The data further indicate that application of different organic sources significantly affected soil organic carbon content after harvest of maize. The highest organic carbon content (0.676%) was recorded under vermicompost @ 5 t/ha (O2), which was significantly higher by 4.81 and 11.18 per cent over FYM @ 10 t/ha (O1) and control (O0), respectively.

Both soil pH and electrical conductivity (EC) remained statistically unaffected by different potassium levels, indicating that potassium application did not cause any appreciable change in soil reaction or soluble salt concentration during the experimental period. The non-significant effect of potassium levels on soil pH and EC observed in the present investigation is in agreement with the findings of Singh Brar *et al.* (2015), who also reported only marginal changes in soil pH and no significant variation in soil EC following potassium application.

Application of organic sources increased soil organic carbon due to the addition of organic matter and enhanced microbial activity. Vermicompost @ 5 t ha^{-1} recorded the highest organic carbon content after harvest owing to its stable organic fractions and gradual decomposition. However, soil pH and EC remained statistically unaffected by the organic treatments. These findings are in agreement with Angelova *et al*. (2013), who also reported increased soil organic matter with only slight changes in soil pH and EC following the application of vermicompost and compost.

Available nutrients

Available nitrogen (kg/ha)

Potassium levels:

An examination of the data presented in Table 2a reveals that different potassium levels failed to exert any significant influence on available nitrogen status of soil after harvest of maize.

Organic levels:

The data further indicate that application of different organic sources significantly influenced available nitrogen content of soil after harvest of maize. The highest available nitrogen (267.08 kg/ha) was recorded under vermicompost @ 5 t/ha (O_2), which was significantly higher by 3.21 and 10.19 per cent over FYM @ 10 t/ha (O_1) and control (O_0), respectively.

Available phosphorus (kg/ha)

Potassium levels:

Data presented in Table 2a indicate that different potassium levels did not significantly affect available phosphorus status of soil after harvest of maize.

Organic levels:

Application of different organic sources significantly influenced available phosphorus content of soil. The highest available phosphorus (22.61 kg/ha) was recorded under vermicompost @ 5 t/ha (O_2), which was significantly higher by 5.02 and 13.28 per cent over FYM @ 10 t/ha (O_1) and control (O_0), respectively.

Available potassium (kg/ha)

Potassium levels:

A close scrutiny of the data presented in Table 2a reveals that available potassium status of soil after harvest of maize was significantly influenced by potassium levels. The highest available potassium (453.37 kg/ha) was recorded under application of 125% RDK (K_3), which remained statistically at par with 100% RDK (K_2) and was significantly higher by 4.69 and 11.57 per cent over 75% RDK (K_1) and control (K_0), respectively.

Organic levels:

The data further indicate that application of different organic sources significantly affected available potassium content of soil after harvest of maize. The highest available potassium (455.34 kg/ha) was recorded under vermicompost @ 5 t/ha (O_2), which was significantly higher by 4.95 and 10.42 per cent over FYM @ 10 t/ha (O_1) and control (O_0), respectively.

Available potassium increased significantly with increasing potassium levels due to the direct addition of potassium to the soil, resulting in higher residual available potassium after harvest. Accordingly, the highest available potassium content was recorded under 125% RDK. In contrast, available nitrogen and phosphorus were not significantly affected by potassium application, as potassium primarily influences nutrient uptake and translocation rather than directly altering soil nitrogen and phosphorus status. These findings are in agreement with Jiang *et al.* (2018), who reported enhanced potassium availability with potassium fertilization and with Kurbah and Dixit (2019), who also observed a significant improvement in soil available potassium under potassium fertilization and integrated nutrient management.

Available nitrogen and phosphorus status of soil was significantly improved by organic sources due to enhanced nutrient cycling, mineralization and microbial activity. Vermicompost @ 5 t ha^{-1} recorded the highest available nitrogen and phosphorus content after harvest owing to its efficient nutrient release and improved soil biological activity. It also enhanced available potassium status through the gradual release of potassium during decomposition. Similar findings were reported by Thomas *et al.* (2019), who observed improved nutrient availability and sustained nutrient supply with the application of organic amendments.

Table 2: Effect of different levels of potassium and organics on chemical properties of soil after harvesting of maize

Treatment	pH	EC (dS/m)	Organic carbon (%)
Potassium Levels			
K_0 - Control	8.19	0.66	0.641
K_1- 75% RDK	8.23	0.68	0.640
K_2- 100% RDK	8.18	0.68	0.644
K_3- 125% RDK	8.14	0.69	0.647
SEm$\pm$	0.12	0.02	0.007
CD (P=0.05)	NS	NS	NS
Organic Levels			
O_0- Control	8.13	0.70	0.607
O_1 - FYM (10 t/ha)	8.27	0.68	0.645
O_2- Vermicompost (5 t/ha)	8.15	0.65	0.676
SEm$\pm$	0.10	0.01	0.006
CD (P=0.05)	NS	NS	0.017

Table 2a: Effect of different levels of potassium and organics on chemical properties of soil after harvesting of maize

Treatment	Available Nitrogen (kg/ha)	Available Phosphorus (kg/ha)	Available Potassium (kg/ha)
Potassium Levels			
K_0 - Control	252.58	21.13	406.36
K_1- 75% RDK	254.87	21.41	433.06
K_2- 100% RDK	256.46	21.40	444.51
K_3- 125% RDK	260.41	21.53	453.37
SEm$\pm$	2.28	0.29	3.29
CD (P=0.05)	NS	NS	10.80
Organic Levels			
O_0-Control	242.38	19.96	412.37
O_1 – FYM (10 t/ha)	258.78	21.53	433.86
O_2- Vermicompost (5 t/ha)	267.08	22.61	455.34
SEm$\pm$	1.97	0.25	3.39
CD (P=0.05)	5.70	0.72	9.81

Comparative Assessment of Initial and Post-Harvest Soil Chemical Properties

The initial soil of the experimental field was slightly alkaline (pH 8.11), non-saline (EC 0.59 dS m^{-1}), with 0.60% organic carbon and contained 230.00, 19.10 and 402 kg ha^{-1} of available nitrogen, phosphorus and potassium, respectively. After harvest, soil pH and EC remained statistically unchanged under different potassium levels and organic sources, indicating that the treatments had no adverse effect on soil reaction or salinity. Similarly, potassium levels did not significantly influence soil organic carbon, available nitrogen, or available phosphorus. However, application of organic sources, particularly vermicompost @ 5 t ha^{-1} (O_2), significantly improved soil organic carbon, available nitrogen, available phosphorus and available potassium over FYM and control. Among potassium levels, only available potassium content was significantly enhanced, with 125% RDK (K_3) recording the highest residual available potassium, remaining at par with 100% RDK (K_2).

IV. CONCLUSION

The study indicated that the application of organic sources was more effective than potassium levels in improving post-harvest soil chemical properties. Vermicompost @ 5 t ha^{-1} (O_2) significantly enhanced soil organic carbon and the availability of nitrogen, phosphorus and potassium, while maintaining soil pH and EC within a desirable range. Potassium fertilization mainly influenced the residual available potassium status of the soil, with 125% RDK (K_3) proving superior. Based on the post-harvest soil analysis, vermicompost @ 5 t ha^{-1} (O_2) was the most effective organic source for improving soil chemical properties. Among potassium levels, 125% RDK (K_3) recorded the highest residual available potassium. Therefore, the combined application of vermicompost @ 5 t ha^{-1} along with 125% RDK (K_3O_2) may be considered the most suitable treatment for improving soil fertility and sustaining soil health under maize cultivation.

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