Original Research Article

Effect of Cattle Urine Application and Spray Frequencies on Okra Productivity and Soil Chemical Properties

ABSTRACT

Aims: This research aimed to assess the impact of different doses of cattle urine and spraying frequencies on the growth, yield, and soil properties of okra, focusing on identifying optimal application practices.

Study Design: The experiment was conducted using a two-factor factorial randomized complete block design (RCBD) with nine treatments comprising three ratios of cattle urine to water (1:5, 1:10, 1:15) and three spraying frequencies (one spray, two sprays, and three sprays). Each treatment was replicated three times.

Place and Duration of Study: The study was carried out from April to July 2024 in Lamjung District, Nepal.

Methodology: Growth parameters such as plant height, stem diameter, number of leaves, pod diameter, pod length, and yield were recorded at 30, 45, and 60 days after sowing (DAS). Soil properties including nitrogen (N), phosphorus (P), potassium (K), pH, and organic matter content were analysed post-harvest. Statistical analysis was performed to evaluate treatment effects.

Results: The 1:5 urine-to-water ratio with three sprays significantly enhanced plant height (10.59 cm, 40.15 cm, 71.54 cm at 30, 45, and 60 DAS, respectively), stem diameter (1.4 cm, 1.71 cm, 2.61 cm), and the number of leaves (9.85, 20, 19.5). Pod diameter (1.76 cm), pod length (17.29 cm), and yield (0.98 kg/m^2) were also highest in this treatment. Soil analysis revealed the 1:5 ratio with three sprays had the highest N, P, K, and organic matter content.

Conclusion: The application of cattle urine at a 1:5 ratio with three sprays significantly improved okra growth, yield, and soil properties, making it a sustainable practice for enhancing agricultural productivity.

Keywords- Cattle urine; Okra; Nitrogen; Growth; Productivity; Nutrient enhancement

1. INTRODUCTION

Okra (*Abelmoschus esculentus L. Moench*) is an herbaceous, cross pollinated annual vegetable crop that falls in the Malvaceae family(Khan, 2009). It is originated in Africa, and is now grown in many parts of the world , mostly in tropical nations and sub-tropical countries like India, Japan , Bangladesh, Nepal , West Africa and many more (Singh *et al*). Altogether there exist about 2,283 species of okra, among them Abelmoschus esculentus L. Moench is mostly cultivated in Asia because of its high nutritious content and high demand. The USDA National Nutrient Database claims that the edible part of an okra pod (100g) contains 375 IU of vitamin A, 21.1 mg of vitamin C, 81 mg of calcium, 63 mg of phosphorus, and 303 mg of potassium. With an average productivity of 11.07 metric tonnes per hectare, 103,353 metric tonnes of okra were produced on 9,337 hectares of cultivation (MoALD, 2023). According to MoALD (2023), it makes up 3.32% of Nepal's total land used for vegetable agriculture. Bara, Rauthaut, Jhapa, Dhanusha, Kailali, Saptari, Chitwan, Morang, and Mohattari are the principal producing districts. According to Cooperation & Division (2022), Okra occupies one of the major areas of Nepal (Area: - 9,584 ha, Production: - 110,565 mt, Yield: - 11.54 mt/ha). Since, okra is a heavy feeder of both macro and micronutrients, for optimum growth and production proper nutrition and fertilizers should be applied. During land preparation, 20–25 tonnes of FYM are added per ha. For optimal yield, it is generally advised to utilise 50 kg K20, 60 kg P205, and 100 kg N. During the cultivation period, half of the N and the entire dosage of P205 and K20 are administered. Half should be supplied 30 days after seeding, and then the earthing up procedure should be carried out. (*Fertilizer Management for Okra: Dose, NPK, and Schedule*, 2022). Due to abundance, easy access and subsidy provided by government, farmers supply these nutrients in the form of chemical fertilizers. These chemical fertilizers degrade the quality of soil, as well as have negative impact to plants, humansas well as helpful organisms and micro-organism present in the environment. In the context of Nepal also, due to the unmanaged application of these fertilizers, the quality of soil has been degraded (Singh *et al.*, no date). Due, to this, there is a deficiency of various nutrients in the soil among which nitrogen deficiency is the major one. According to a report on the new business age, just 14% of Nepal's arable land is suitable for agricultural cultivation, 30% has medium nitrogen levels, and 56% has low nitrogen levels. Hence to decrease the deficiency of nitrogen in the soil and to provide the proper the nutrient to plant cattle urine is believed to be the best alternative to chemical fertilizers (Gottimukkala *et al.*, 2019), like urea as Nitrogenous substances are abundant in cattle urine, with urea accounting for roughly 69% of the total nitrogen concentration, which ranges from 6.8 to 21.6 g N per liter. Additionally, it has notable levels of uric acid (1.3%), creatinine (3.7%), hippuric acid (5.8%), and allantoin (7.3%). These nitrogen-containing substances support urine's ability to fertilise and play a part in the cycling of nutrients in agricultural systems.(Miah, Miah and Alam, 2017). Farmers in Nepal have paid close attention to gathering and using cattle manure, but they have paid little to no attention to gathering and using cattle urine. Cattle urine has a significantly higher nutrient content than other locally accessible manures, particularly nitrogen. Large amounts of nitrogen-rich cattle urine that could be utilised as an organic alternative to chemical fertilizers to increase crop yields are being wasted in rural Nepal(Sharma, 2001) .

Comment [RO1]: tones

Comment [RO2]: a negative

Comment [RO3]: on

Comment [RO4]: humans,

Comment [RO5]: replace with and

Comment [RO6]: Remove

Comment [RO7]: Remove ,

Comment [RO8]: Hence,

Thus, to study Okra productivity and soil chemical properties we conducted an experiment at the horticulture farm of the Institute of Agriculture and Animal Science, Lamjung, Nepa,l focusing on the application rates of cattle urine. Our objective was to assess the efficiency of cattle urine at varying ratios on vegetative growth, productivity, yield, and soil impact. This study proposes cattle urine as a promising, cost-effective source of nitrogen fertilizer, potentially reducing reliance on urea and other chemical fertilizers while ensuring optimal Okra productivity desired by farmers**.**

Comment [RO9]: ,

Comment [RO10]: okro

2. MATERIAL AND METHODS

2.1 Experimental Site and Climatic Situation

The experiment was carried out in the agricultural farm of Institute of Agriculture and Animal Science (IAAS), Lamjung Campus, which lies in Sundarbazar, Lamjung. Sundarbazar has a subtropical humid climate and is located at a latitude of 28°3'-28°30'N and a longitude of 84°11'- 84°38'E at an altitude of

Comment [RO11]: on

Comment [RO12]: of the institute

625 meters above sea level. This experiment was carried out during the period of Early May to Late August, 2024. According to the report of nearest meteorological station, the annual rainfall of our experimental area is about 2600 mm, and the average temperature is 22.50 °C with a maximum of 28.640 °C and minimum of 16.390 °C.

Comment [RO13]: early

Comment [RO14]: late

Comment [RO15]: a minimum

2.2 Experimental design and treatments

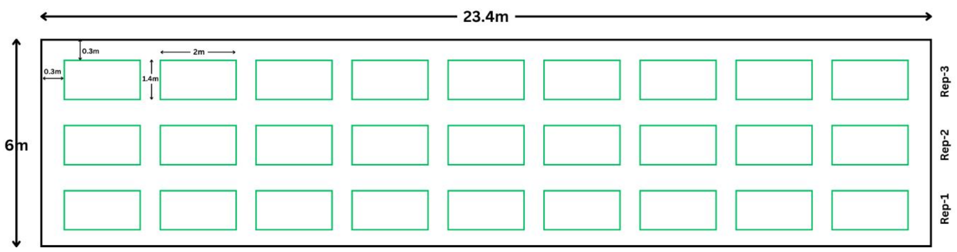

Figure 1Experimental layout in field condition

The experiment was conducted in a two-factorial randomized complete block design (RCBD) with three replications to evaluate the effects of two factors: Factor A (urine and water mixture) and Factor B (number of sprays) as shown in Table 1. Factor A consisted of three levels of doses: 1:5 (T1), 1:10 (T2), and 1:15 (T3), while Factor B involved three levels of the number of sprays: one spraying (S1), two sprayings (S2), and three sprayings (S3). The combination of these two factors resulted in nine treatments (T1S1, T1S2, T1S3, T2S1, T2S2, T2S3, T3S1, T3S2, and T3S3), which were randomly assigned to the plots within each replication. In total, twenty-seven plots were present in the entire field of area 140.4 m² (23.4×6 m), with a 0.6 m gap between the replications and a 0.3 m gap within the plots. Each plot, measuring 2.8 m² (1.4 m × 2 m), was designed to ensure uniform growth conditions, with all plants in each experimental plot evenly spaced as shown in Figure 1. Five sample plants were taken for each experimental plot.

Comment [RO16]: (number of sprays),

Table 1Treatments used in the experiment

S.N.	Factors	Symbols
Factor A: Dose		
1	1:05	T1
2	1:10	T2
3	1:15	T3
Factor B: Number of sprays		
1	One spraying	S1
2	Two spraying	S2
3	Three spraying	S3

2.3 Initial Soil Testing

A total of five samples were collected from an excavated soil to assess the fertility status of the soil. The collected samples were homogenized to prepare a representative 1 kg composite sample for chemical analysis. The analysis was carried out at the Soil and Organic Testing Laboratory, Pokhara. In the present study, the following key soil fertility parameters were measured to assess the nutrient status of the soil: organic matter content and available macronutrients-nitrogen, phosphorus, and potassium. The pH value of the soil was found to be 4.5, which is acidic in nature. Nitrogen content was measured at 0.13%, which falls into the medium category as per standard agronomic guidelines. Available phosphorus content was found to be 16.65 kg/ha, which falls into the low category and indicates a potential limitation for optimal crop growth. Potassium availability was determined to be 268.55 kg/ha, which falls in the medium range and is generally sufficient for most agricultural purposes. The results indicate that the fertility status of the soil is constrained primarily by its acidic pH and low phosphorus availability.

S.N	Soil component	Value obtained	Remarks
1.	PH	4.5	Acidic
2.	Nitrogen	0.13	Medium
3.	Phosphorus(kg)	16.65	low
4.	Potassium(kg)	268.55	Medium

Table 2 Results of Initial soil testing

2.4 Agronomic Practices

2.4.1 Field Preparation

By mid-March 2024, the experimental field had been thoroughly ploughed and then levelled. Individual plot sizes of 2.8 m² were designated in accordance with the experimental design.

Comment [RO17]: leveled

2.4.2 Manure and Fertilizer Application

The recommended dosage of inorganic fertilizer was 60:30:30 kg NPK ha^{-1} and 10 tons/ha of Farm yard Manure (FYM). Before seeding, a 25 g half dose of urea and full doses of potassium and phosphorus were applied. The leftover urea was used as a top dressing at 25 DAS and 40 DAS. Cattle urine was sprayed at the base of plants at 25 DAS, 40 DAS, and 55 DAS in the following ratios: 1:5, 1:10, and 1:15 (Urine: Water), respectively.

Comment [RO18]: urine

2.4.3 Seed Sowing

Okra seeds of the variety Arka Anamika were soaked in water for 6–8 hours prior to planting in order to soften the seed coat and initiate growth-related metabolic processes, thereby increasing germination rates. Following this, 20 seeds per plot were line-planted at a depth of 3 cm to ensure consistent seed spacing and placement

Comment [RO19]: placement.

2.4.4 Irrigation

Irrigation was done to each plot immediately after sowing to ensure the best germination. Subsequent surface irrigation was done at every 3-day interval due to dry season conditions.

2.4.5 Crop Protection

During the study period, the two main pests impacting the okra (*Abelmoschus esculentus*) crop were aphids (*Aphis gossypii*) and jassids (*Amrascabiguttulabiguttula*). Neembin insecticide was applied at a concentration of 2 millilitres per litre of water to reduce Jassid infestations. G-care was used at a concentration of 1.5 ml per litre of water in cases of severe aphid outbreaks, and it proved to be more effective than earlier treatments.

2.4.6 Thinning

Thinning is the process of removing extra plants or seedlings from a crop row or plot. This was done after 21 days of sowing. Thinning guarantees sufficient distance between plants, which lessens competition for sunshine, water, and nutrients and helps in the proper development of plants.

2.4.7 Intercultural Operations

Regular weeding and hoeing were carried out to ensure plant health and productivity during the cultivation period. These operations aimed for proper growth and development of healthy okra plant by reducing weed competition.

Comment [RO20]: plants

2.4.8 Harvesting

Okra is harvested after 50 to 60 days of planting, ensuring that the harvesting coincides with the peak maturity of the crop, which is when the pods are between 3 and 5 inches long, firm, and have a bright green colour, which are signs of peak maturity(Franklin, n.d.).

2.5 Data collection and analysis

Data on various plants' parameters were recorded during the experimentation. Plant height (cm) was measured with the help of a meter scale from the ground level to the growing tip of the plant at 30, 45, and 60 DAS. The number of leaves per plant was counted at the 4th, 6th, and 8th week. The pods per plant were recorded by counting the total pods of the selected plants. Stem diameter was measured using a digital vernier calliper and expressed in millimetres. Pod length was determined by measuring the selected pods using a scale, while pod diameter was measured at the base, mid, and tip of the pod using a vernier calliper. Yield was recorded by weighing the total harvested produce from each plot and was expressed in kilograms per square meter.

The bucket augers were used to collect soil samples for analysis. From each plot, three samples were taken from 15 cm below the ground, mixed uniformly, and made into one representative sample per plot. The collected soil samples were shade-dried for two days and then broken into smaller pieces using a mortar and pestle. The final soil sample for testing was prepared by passing coarse fragments through a 2 mm mesh soil sieve. Soil data was taken as per the soil test report submitted by the Soil and Fertilizer Testing Laboratory, Gandaki Province, Nepal.

After data collection, the data were organized and tabulated according to replications and treatments. Data entry and tabulation were performed using MS-Excel Version 16.74, and MS-Word 2019 was used for word processing. Statistical analysis of the collected data was carried out using R version 1.4.1106 to determine treatment effects and variability among replications.

3. RESULTS AND DISCUSSIONS

3.1 Plant Height

The results revealed a significant effect of the urine-to-water ratio and spraying frequency on plant height at 30, 45, and 60 DAS, as shown in Table 3. The plant height increased with time across all treatments. At 30 DAS, the highest plant height (10.06 cm) was recorded in the 1:5 urine-to-water ratio, followed by the 1:10 ratio (9.14 cm), while the lowest plant height (8.37 cm) was observed in the 1:15 ratio. A similar trend was observed at 45 DAS, where the 1:5 ratio exhibited a significantly greater height (40.62 cm), followed by 1:10 (28.91 cm) and 1:15 (27.31 cm).

At 60 DAS, the 1:5 ratio continued to show the highest plant height (69.92 cm), followed by 1:15 (62.85 cm), while the lowest value (59.60 cm) was recorded in the 1:10 ratio. Regarding the spraying frequency, plant height consistently increased with the number of sprays. At 30 DAS, the maximum height (10.68 cm) was observed in the 3-spray treatment, which was significantly higher than the 2-

spray (9.06 cm) and 1-spray (7.82 cm) treatments. Similarly, at 45 DAS and 60 DAS, the 3-spray treatment exhibited significantly greater plant heights of 39.68 cm and 73.17 cm, respectively, compared to other treatments.

The statistical analysis (LSD values) indicated significant differences ($p < 0.05$) in plant height across all treatments. The variation in plant height can be attributed to the optimal availability of nutrients, especially nitrogen, in the higher concentration of cattle urine (1:5 ratio) and frequent applications (3 sprays). These findings align with previous studies that reports frequent nutrient application improves vegetative growth in okra (Patience Abidemi Omololu *et al.*, 2023).

Comment [RO21]: report

Table 3 Effect of cattle urine in plant height at 30,45 and 60 DAS of okra

Trt	D30	D45	D60
Ratio			
1:5	10.06^{a}	40.62^{a}	69.92 ^{a}
1:10	9.14^{b}	28.91^{b}	59.60^{c}
1:15	8.37^{c}	27.31^{b}	62.85 ^{b}
Spray			
1 spray	7.82 ^{c}	26.004 ^{c}	53.33^{c}
2 sprays	9.06 ^{b}	31.16 ^{b}	65.86^{b}
3 sprays	10.683 ^{a}	39.68 ^{a}	73.17^{a}
LSD	0.77	2.58	2.18
CV%	8.33	7.96	3.41
GM	9.19	32.28	64.12
p-value	***	**	**

Means in column followed by similar letter/s are not significantly different, CV=coefficient of variation, NS= non-significant; *= p<0.05; **p<0.01; ***= p<0.001 in LSD

3.2 Number of leaves per plant

The number of leaves per plant exhibited significant differences at all growth stages (30, 45, and 60 DAS) due to variations in the urine-to-water ratio and spraying frequency (Table 4). At 30 DAS, the highest number of leaves (9 leaves) was recorded in the 1:5 urine-to-water ratio treatment, followed by the 1:15 ratio (8 leaves), while the lowest number (7 leaves) was observed in the 1:10 ratio. Similarly, at 45 DAS, the maximum number of leaves (20 leaves) was noted in the 1:5 ratio treatment, followed by the 1:10 ratio (18 leaves), with the minimum (17 leaves) in the 1:15 ratio. At 60 DAS, the highest number of leaves (20 leaves) continued to be recorded in the 1:5 ratio treatment, followed by 18 leaves in the 1:10 ratio, whereas the lowest number (15 leaves) was observed in the 1:15 ratio.

In terms of spraying frequency, the number of leaves increased with an increase in the number of sprays. At 30 DAS, the maximum number of leaves (10 leaves) was observed in the 3-spray treatment, which was significantly higher than the 2-spray (9 leaves) and 1-spray (6 leaves) treatments. A similar trend was observed at 45 DAS and 60 DAS, where the 3-spray treatment consistently resulted in the highest number of leaves (20 leaves and 19 leaves, respectively), while the 1-spray treatment produced the fewest leaves (15 leaves and 14 leaves, respectively). These variations can be attributed to improved nutrient availability and better plant metabolism facilitated by the higher nutrient concentration in the 1:5 ratio and frequent sprays.

Trt	D30	D45	D60
Ratio			
1:5	9^{a}	20^{a}	20^{a}
1:10	7^{b}	18^{b}	18^{b}
1:15	8^{b}	17^{b}	15^{c}
F test	**	*	***
LSD	1.01	1.72	1.39
CV%	12.18	9.266	7.875
GM	8.37	18.62	17.77
Spray			
1 spray	6^{b}	15^{b}	14^{b}
2 sprays	9^{a}	19^{a}	18^{a}
3 sprays	10^{a}	20^{a}	19^{a}

Table 4 Effect of cattle urine in number of leaves per plant at 30,45 and 60 DAS of okra

F test	*	**	***
LSD	1.01	1.72	1.39
CV%	12.18	9.266	7.875
GM	8.37	18.62	17.77

*Means in column followed by similar letter/s are not significantly different, CV=coefficient of variation, NS= non-significant; *= p<0.05; **p<0.01; ***= p<0.001 in LSD*

3.3 Stem diameter

The application of cattle urine significantly influenced stem diameter across all stages of observation (30, 45, and 60 DAS). At 30 DAS, the 1:5 urine-to-water ratio resulted in the largest stem diameter (1.40 mm), whereas the smallest (0.91 mm) was observed in the 1:15 ratio, as shown in table 5. A similar pattern was seen at 45 DAS, with the 1:5 ratio producing the thickest stems (1.67 mm) and the 1:15 ratio yielding the thinnest (1.20 mm). At 60 DAS, the maximum stem diameter (2.64 mm) continued to be recorded in the 1:5 ratio, while the minimum (2.05 mm) was in the 1:10 ratio.

Spraying frequency also had a notable impact on stem diameter. The 3-spray treatment consistently recorded the highest stem thickness across all stages, with values of 1.40 mm, 1.75 mm, and 2.59 mm at 30, 45, and 60 DAS, respectively. In contrast, the 1-spray treatment exhibited the lowest stem diameter, measuring 0.79 mm, 1.12 mm, and 1.98 mm at the same stages.

The statistical analysis confirmed significant differences ($p < 0.05$) among treatments, reflecting the role of frequent applications and nutrient concentrations in enhancing stem growth. Comparable results have been reported by earlier studies emphasizing the importance of nutrient management in promoting stem development (Magar *et al.*, 2023).

Table 5 Effect of cattle urine in stem diameter at 30,45 and 60 DAS of okra

Trt	**D30**	**D45**	**D60**
Ratio			
1:5	1.40[a]	1.67[a]	2.64[a]
1:10	0.95[b]	1.42[b]	2.05[b]
1:15	0.91[b]	1.2[c]	2.12[b]
Spray			
1 spray	0.79[c]	1.12[c]	1.98[c]
2 sprays	1.07[b]	1.42[b]	2.25[b]
3 sprays	1.4[a]	1.75[a]	2.59[a]
F value	**	***	**
LSD	0.078	0.09	0.104
CV%	7.22	6.34	4.58
GM	1.09	1.43	2.27

Means in column followed by similar letter/s are not significantly different, CV=coefficient of variation, NS= non-significant; $*= p<0.05$; $^{**}p<0.01$; $^{***}= p<0.001$ in LSD

3.4 Length of pods

The pod length of okra varied significantly among the treatments, as shown in Figure 2. The maximum pod length was observed in treatment T1S3 (16.69 cm), followed by T2S3 (15.97 cm) and T3S3 (15.83 cm). Conversely, the shortest pod length was recorded in treatment T2S1 (12.86 cm). This variation in pod length could be attributed to the different ratios of cattle urine and water, along with varying spray frequencies. The current findings align with thoseAminu *et al.*,who reported pod lengths ranging from 9.13 cm to 13.80 cm. Differences in nutrient availability and spray frequency may have contributed to the observed variation in pod length.

Comment [RO22]: those of

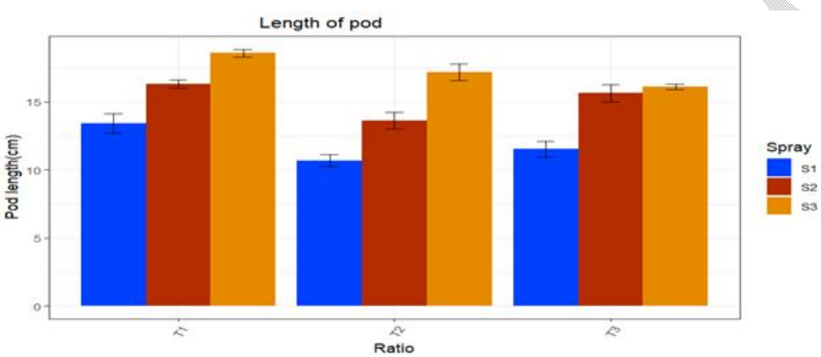

Figure 2 Effect of cattle urine in length of pods

3.5 Diameter of pods

The diameter of okra pods exhibited significant variation across different treatments of cattle urine and spraying frequencies, as presented in Figure 3. The maximum pod diameter was recorded in treatment T1S3 (12.77 mm), followed by T2S3 (12.25 mm) and T3S3 (12.15 mm). Conversely, the minimum pod diameter was observed in treatment T3S1 (10.35 mm). The increase in pod diameter in treatments with higher cattle urine concentrations and more frequent spray applications may be attributed to the enhanced availability of essential nutrients such as nitrogen, potassium, and other micronutrients present in cattle urine.

The findings of the present study are consistent with the results of similar studies, which reported significant improvements in pod diameter with organic amendments, including cattle urine, due to better nutrient uptake and soil fertility enhancement (S. S. Lakhawat *et al*., 2021). Furthermore, variations among treatments could also be associated with differences in the efficiency of nutrient absorption influenced by spray frequency.

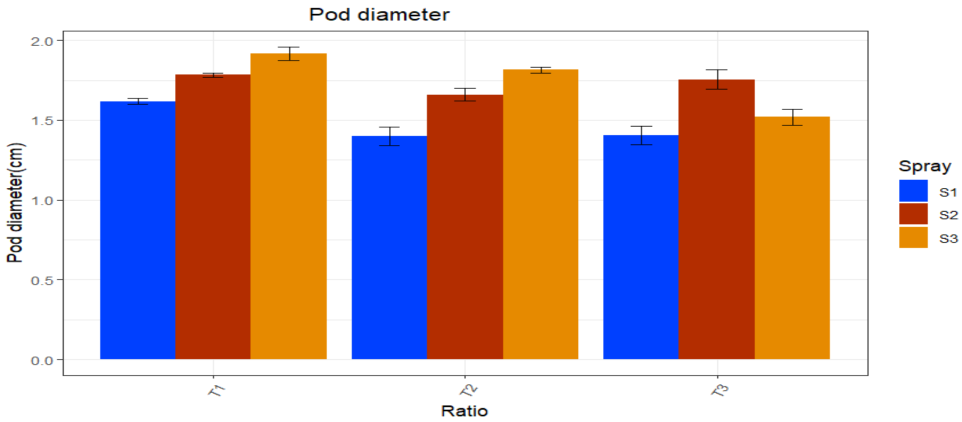

Figure 3 Effect of cattle urine in pod diameter

3.6 Yield (kg per meter square)

The yield of okra per square meter showed significant differences among the treatments with varying cattle urine concentrations and spraying frequencies, as depicted in Figure 4. The highest yield was recorded in treatment T1S3 (3.45 kg/m²), followed by T2S3 (3.15 kg/m²) and T3S3 (2.85 kg/m²). In contrast, the lowest yield was observed in treatment T3S1 (1.95 kg/m²).

The improved yield in treatments with higher cattle urine concentrations and frequent spraying can be attributed to better nutrient availability and uptake by the plants, which enhanced vegetative growth, flowering, and fruiting. These results align with previous studies that have demonstrated significant increases in crop yield with the application of organic fertilizers such as cattle urine (Muqtadir *et al.*, 2019). The increase in yield could also be due to improved soil microbial activity and nutrient cycling induced by cattle urine, enhancing soil fertility and plant health.

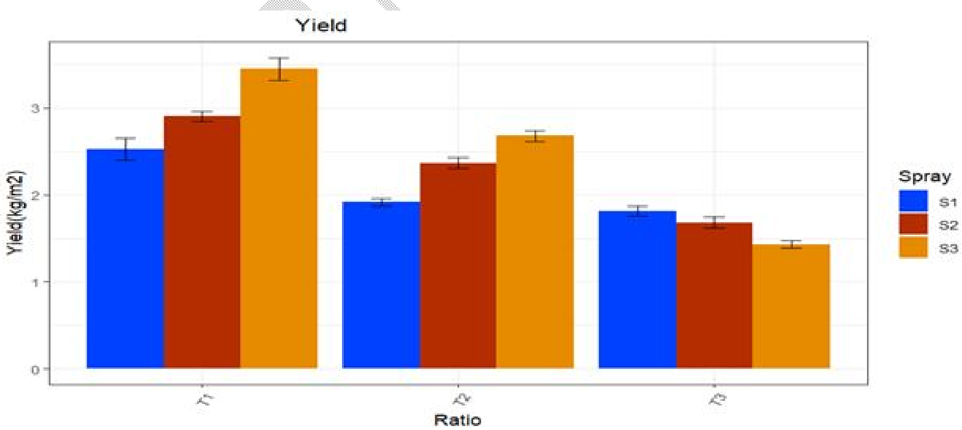

Figure 4 Effect of cattle urine on Yield

3.7 Soil Analysis

The soil properties showed significant variations across the different treatments of cattle urine ratios and spraying frequencies, as outlined in Table 6. The nitrogen (N), phosphorus (P), and potassium (K) contents in the soil varied significantly depending on the cattle urine application rate and spraying frequency. Among the treatments, the highest nitrogen content (0.224%) was recorded in the 1:5 cattle urine to water ratio (T1), followed by 1:15 (0.165%) and 1:10 (0.162%). Similarly, the maximum phosphorus content (45.78 mg/kg) was observed in the 1:5 ratio (T1), which was significantly higher than the other treatments. Potassium content was also highest in the 1:5 ratio (326.00 mg/kg) compared to the 1:10 (186.67 mg/kg) and 1:15 ratios (201.38 mg/kg). For spraying frequencies, three sprays recorded the highest nitrogen content (0.23%), followed by one spray (0.162%) and two sprays (0.16%). Phosphorus content was significantly higher in three sprays (44.69 mg/kg) compared to one spray (32.19 mg/kg) and two sprays (25.33 mg/kg). In contrast, the potassium content was highest in one spray (258.37 mg/kg) and decreased slightly with increased spraying frequencies (231.38 mg/kg for two sprays and 224.3 mg/kg for three sprays).

The observed increase in soil nitrogen, phosphorus, and potassium with higher concentrations of cattle urine and more frequent sprays can be attributed to the rich nutrient composition of cattle urine, which enhances soil fertility and nutrient availability. These findings align with existing studies that report significant improvements in soil nutrient content with the application of organic fertilizers, including cattle urine(Sadhukhan, Bohra and Choudhury, 2018; Pandit *et al.*, 2024). The slight decline in potassium content with more frequent spraying may be due to nutrient leaching or other soil dynamics. These results underscore the potential of cattle urine as a sustainable and nutrient-rich amendment for improving soil chemical properties, contributing to the overall productivity of crops like okra.

Table 6 Effect of cattle urine in final soil analysis

Trt	**N**	**P**	**K**
Ratio			
1:5	0.224[a]	45.78[a]	326.00[a]
1:10	0.162[a]	12.48[c]	186.67[c]
1:15	0.165[a]	43.93[b]	201.38[b]
F test		***	***
LSD	0.128	0.23	0.99
CV%	69.75	32.25	0.420

Spray			
1 spray	0.162^{a}	32.19^{b}	258.37^{a}
2 sprays	0.16^{a}	25.33^{c}	231.38^{b}
3 sprays	0.23^{a}	44.69^{a}	224.3^{c}
F test		***	***
LSD	0.128	0.23	0.99
CV%	69.75	32.25	0.420
GM	0.184	35.21	238.022

*Means in column followed by similar letter/s are not significantly different, CV=coefficient of variation, NS= non-significant; *= p<0.05; **p<0.01; ***= p<0.001 in LSD*

4. CONCLUSION

This study highlights the significant role of cattle urine application to okra growth, yield, and improvement in soil fertility with a view to establishing it as a viable sustainable agricultural practice and at low cost. Among the treatments evaluated, the 1:5 cattle urine-to-water ratio with three sprays was the most effective treatment regarding plant height, stem diameter, number of leaves, pod diameter, pod length, and overall yield. This treatment also positively favoured the chemical properties of the soil, improving nitrogen, phosphorus, potassium, and organic matter contents, hence contributing to the better health of the soil. The results demonstrated that cattle urine was an organic fertilizer substitute for synthetic fertilizers and one of the feasible ways in which resource-constrained farmers can attain higher productivity and sustainability in okra production. Further research may also be done on the long-term effects of the application of cattle urine in crop rotation systems and scalability across agroecological zones. It is such eco-friendly practices that, once integrated, will help farmers not only improve crop performance but also contribute toward soil conservation and environmental sustainability.

REFERENCES

Aminu, D. *et al.* (2016) 'Varietal performance and correlation of okra pod yield and yield components', *Acta Universitatis Sapientiae, Agriculture and Environment*, 8(1), pp. 112–125. Available at: https://doi.org/10.1515/ausae-2016-0010.

Fertilizer Management for Okra: Dose, NPK, and Schedule (2022). Available at: https://www.agrifarming.in/fertilizer-management-for-okra-dose-npk-and-schedule (Accessed: 22 January 2025).

Comment [RO23]: in

Comment [RO24]: Remove

Franklin, S. and (no date) *Effect of Harvesting Stages on Seed Yield and Quality of Okra (Abelmoschus esculentus L. Moench)*. Available at: https://doi.org/10.17582/journal.sja/2022/38.3.871.884.

Gottimukkala, K.S.V. *et al.* (2019) 'Cow Urine: Plant Growth Enhancer and Antimicrobial Agent', *Journal of Horticulture and Plant Research*, 8, pp. 30–45. Available at: https://doi.org/10.18052/www.scipress.com/JHPR.8.30.

Khan, A. (2009) 'Generation mean analysis of water stress tolerance in okra (Abelmoschous esculentus L.)', *Pakistan Journal of Botany*, 41, pp. 195–205.

Magar, S.K. *et al.* (2023) 'Effect of integrated nutrient management on growth, yield, and soil nutrient status in okra (Abelmoschus esculentus cv. Arka Anamika)', *Archives of Agriculture and Environmental Science*, 8(1), pp. 49–54. Available at: https://doi.org/10.26832/24566632.2023.080108.

Miah, M.N.A., Miah, M.R.U. and Alam, M.Z. (2017) 'Determining Chemical Composition of Cattle Urine and Indigenous Plant Extracts', *International Annals of Science*, 3(1), pp. 23–26. Available at: https://doi.org/10.21467/ias.3.1.23-26.

Muqtadir, M. *et al.* (2019) 'Growth and yield of okra influenced by different types of fertilizers and netting', *Progressive Agriculture*, 30, pp. 1–9. Available at: https://doi.org/10.3329/pa.v30i0.41550.

Pandit, N.R. *et al.* (2024) 'Cattle-Urine-Enriched Biochar Enhances Soil Fertility, Nutrient Uptake, and Yield of Maize in a Low-Productive Soil', *Nitrogen*, 5(1), pp. 16–27. Available at: https://doi.org/10.3390/nitrogen5010002.

Patience Abidemi Omololu *et al.* (2023) 'The effect of organic manure on growth and yield of okra (Abelmoschus esculentus L.)', *International Journal of Science and Research Archive*, 10(1), pp. 605–610. Available at: https://doi.org/10.30574/ijsra.2023.10.1.0784.

Aminu, D. *et al.* (2016) 'Varietal performance and correlation of okra pod yield and yield components', *Acta Universitatis Sapientiae, Agriculture and Environment*, 8(1), pp. 112–125. Available at: https://doi.org/10.1515/ausae-2016-0010.

S. S. Lakhawat, P.D. *et al.* (2021) 'Effect of Organic Manures and Liquid Formulations on Growth, Yield and Quality of Okra [Abelmoschus esculentus (L.) Moench] cv. Arka Anamika', *International Journal of Current Microbiology and Applied Sciences*, 10(6), pp. 426–433. Available at: https://doi.org/10.20546/ijcmas.2021.1006.045.

Sadhukhan, R., Bohra, J.S. and Choudhury, S. (2018) 'Effect of Fertility Levels and Cow Urine Foliar Spray on Growth and Yield of Wheat', *International Journal of Current Microbiology and Applied Sciences*, 7(03), pp. 907–912. Available at: https://doi.org/10.20546/ijcmas.2018.703.106.

Sharma, A. (2001) *A handbook of Organic Farming*.

Singh, P. *et al.* (no date) 'AN OVERVIEW ON OKRA (ABELMOSCHUS ESCULENTUS) AND IT'S IMPORTANCE AS A NUTRITIVE VEGETABLE IN THE WORLD', *International Journal of Pharmacy and Biological Sciences*, 4(2).