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# ASSESSING THE IMPACT OF DIFFERENT POPLAR CLONES ON SOIL PROPERTIES, NUTRIENT CYCLING, AND LITTER DECOMPOSITION IN A SIX-YEAR-OLD AGROFORESTRY PLANTATION

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**ABSTRACT**

Poplar trees are increasingly significant due to rising wood demand and declining land productivity. A study at Dr. Rajendra Prasad Central Agricultural University, Pusa (Samastipur), evaluated the impact of seven six-year-old poplar (*Populus deltoides Bartr.*) clones (PAU-1, PAU-2, PAU-3, PAU-4, S-1, S-2, and G-48) on soil physicochemical properties, litterfall, nutrient cycling, litter decomposition, and nutrient release. Clones were planted in a randomized block pattern with three replications at a spacing of 4×2 meters. Soil samples were collected from seven poplar clones and open field sites at depths of 0 to 15 cm and 15 to 30 cm respectively. The G-48 clone showed the most notable pH reduction (0.197 units), followed by PAU-1 (0.180 units), while S-2 showed the least change (0.045 units). Electrical conductivity (EC) was lower under all plantations compared to open areas. Available macronutrients (N, $P_2O_5$, $K_2O$) improved for all plantations, with G-48 and PAU-1 showing the most significant enhancement. Clones G-48, PAU-1, and PAU-2 notably decreased bulk density and increased wet aggregate stability, with G-48 showing the highest stability. G-48 also had the highest litterfall (3.79 Mg $ha^{-1}$), followed by PAU-1 (2.98 Mg $ha^{-1}$) and S-2 (1.42 Mg $ha^{-1}$). The nutrient return order was N > K > P for all clones, with G-48 showing the greatest return. Leaf litter decomposition was fastest in G-48, PAU-1, and S-1, with half-lives of 47-58 days. G-48 exhibited unique nutrient release patterns, including initial immobilization of N and P for 150 days, followed by mineralization, while K showed continuous mineralization. The study highlights the diverse effects of Poplar plantations, particularly G-48, on soil properties and ecosystem dynamics, emphasizing their potential for enhancing soil quality and sustainable land management.

***Keywords*: ** Poplar Clones, Soil Properties, Nutrient return, Litterfall, Decomposition

## Introduction

Nutrient cycling is a crucial component of both naturally occurring forests and artificial plantations, since substantial amounts of nutrients are returned to the soil through litter fall and made accessible for cycling. Certain nutrients are kept in various plant organs, while others are utilized in physiological reactions. Some nutrients are also returned to the soil through litter, where they are partially absorbed by the roots of forests (Breeman 1995). The principal fluxes through the system trees are represented by the uptake and release of nutrients, making them significant factors at the stand level (Miller and Alpert 1984). Plant biomass's nutrient concentration is the outcome of a balance between nutrient intake, plant development, and nutrient retranslocation. The loss of these processes is likely to be impacted by a variety of environmental factors, including soil fertility and plant genetic makeup. (Hagen Thorn *et al.*, 2004).

The primary flow that transfers nutrients to soil is the fall of forest litter (Parzych *et al.,* 2008) and the volume, kind, and pace at which litter falls decompose are the primary factors influencing the development and productivity of forest ecosystems (Victor *et al.,* 2001). Tree species can influence the cycling of nutrients through a variety of factors, including the quantity of litter generated, the release of nutrients, and the chemical makeup of the litter (Rahajoe 2003). The nutrient release patterns of many tree species vary, and these patterns are influenced by several environmental conditions and the quality of the litter. (Khiewtam and Ramakrishnan 1993). It's critical to monitor nutrient returns via litter fall beneath various tree species in order to comprehend the dynamics of soil fertility.

Poplar is a deciduous tree that loses the majority of its leaves between November and December. Litter production and nutrient return from poplar litterfall varies according to tree age, intercropping, spacing, and other management strategies (Singh *et al*., 1989; Mohsin *et al*., 1996; Singh *et al*., 2007), which improves soil organic matter and nutrient status (Singh and Sharma 2007). Farmers have accepted poplar because of its quick growth, good market values for its multiutility wood, and lower rivalry with other crops. Litterfall decomposition and mineralization are principally determined by the physical and chemical quality of the litter, soil qualities, prevailing weather conditions, and decomposer communities (Upadhyay and Singh 1989). Understanding litterfall breakdown and nutrient release patterns aids in regulating litter inputs and soil nutrient status. As a result, I evaluated the quantity and return of nutrients by litterfall, as well as the release of nutrients (N, P, and K) during litter decomposition in six-year-old Poplar clone plantations. Because these fast-growing tree species bring social, economic, and environmental advantages during short cycles, it is critical to have a better knowledge of their effects on nutrient cycling processes and other components of soil fertility. The objectives of this study were: (i) To quantify the changes in soil properties under different six-year-old poplar clones (ii) To study the litter decomposition and nutrient release pattern under poplar clones

## Materials and Methods

### Study area

The current study was conducted at the agroforestry experimental field (Chhaunia), situated in Dr. Rajendra Prasad Central Agricultural University in Pusa, Samastipur, Bihar. In February 2016, a RBD was used to plant one-year-old Entire Trans Plants (ETP) of various poplar clones with exposed roots. The planting was carried out in pits measuring 50 cm × 50 cm × 100 cm. The investigation took place after a period of six years since the establishment of *Populus deltoides* plantations. This location is positioned at a latitude of 25° 59´ N and a longitude of 85° 48´ E, with an elevation of 53.12 m above mean sea level in the northwest alluvial plain of Bihar. The field is situated in a region with a sub-humid, sub-tropical monsoon climate. The pH level is slightly alkaline, ranging from 8.5 to 8.6, and the electrical conductivity (EC) varies from 0.38 to 0.46 $dSm^{-1}$. With depth, organic carbon content drops from 0.36% to 0.28%. Additionally, nutrient availability follows this trend: available nitrogen decreases from 127.6 to 115.2 kg $ha^{-1}$, available $P_2O_5$ from 23.5 to 11.8 kg $ha^{-1}$, and available $K_2O$ from 113.8 to 92.6 kg $ha^{-1}$. Finally, free $CaCO_3$ content ranges from 34.80% to 36.00%.

### Soil Analysis

Representative soil samples were taken at depths of 0-15 and 15-30 cm. Soil samples were collected, air-dried in the shade, pulverized using a pestle and mortar, passed through a 2 mm filter, and kept in polyethene bags for later analysis. Bulk density was determined using the core method (Black, 1965), wet aggregate stability was determined using Cornell's method (Moebius *et al*., 2007), pH was determined using a pH meter (Jackson, 1967), EC was determined using a conductivity meter (Jackson, 1967), mineralizable N was determined using alkaline $KMnO_4$ (Subbiah and Asija, 1956), available $P_2O_5$ was determined using ascorbic acid (Olsen *et al*., 1954), available $K_2O$ by ammonium acetate method (Jackson, 1967)

### Litterfall and Nutrient Return

Litterfall has been collected in litter traps (75 cm x 75 cm x 8 cm) randomly set under the trees before the litterfall began in October at monthly intervals until the trees shedded all of their leaves. The obtained samples were oven dried to a consistent weight at 60±2°C. Representative samples were collected, crushed, and kept in paper bags for further assessment of nutrient content in litter and total return of nutrients (N, P, and K) through litterfall each year.

### Weight loss in decomposing litter

Litterbag technique (Wieder and Lang, 1982). 25 cm × 25 cm nylon bags with a mesh size of 2 mm, each bag contains 25 g of dried leaves. Bags should be placed at a depth of 5 cm in the soil. 7×3 = 21 bags will be recovered at monthly intervals until full disintegration. The loss of dry matter in the decaying litter will be estimated on a monthly basis. The weight loss of decaying biomass will be estimated using the single exponential decay ($W_t/W_0 = e^{-kt}$). The decomposition constant (k) will be approximated as the slope of the linear regression between $\log_e (W_t/W_o)$ and t, where $W_o$ and $W_t$ are the litter dry weights at the start and end of time t (in days), respectively. Half-Life($T_{1/2}$) = 0.693/k.

**Nutrient release from decomposing litter:**

The proportion of nutrients produced from decomposing litter at each plot of poplar trees will be calculated at $t_0$ and t time by using the equation $Y_0=X_0$ Initial nutrient concentration, where $X_0$ is the amount of litter at time $t_0$ and $Y_0$ is the concentration of nutrients in the litter at that time. (Triadiati *et al.*, 2011)

## Results and Discussion

### Soil Physical Properties

Bulk density variations were observed among the seven poplar clones and in an open space without trees in two soil depths (0-15 cm, 15-30 cm). S-2 and S-1 displayed higher values, indicating potential soil compaction, while G-48 exhibited the lowest bulk density, suggesting better soil structure (Table 1). This decrease might be due to the increased buildup of organic matter caused by the deposition of fallen leaves, recycling of fine roots, twigs, and other organic sources in soils beneath poplar clone development over the previous years. (Laik *et al.,* 2009a)

wet aggregate stability was observed in six-year-old poplar clones at surface and subsurface soil layers. G-48 displayed the highest stability (20.407%), while S-2 had the lowest (11.237%) in table 1. All clones showed higher stability than the open condition (8.316%). Six-year-old poplar clones impact soil aggregate stability, a key indicator of soil health. Perennial vegetation enhances stability through microbial activity and permanent root biomass, retaining carbon and nitrogen. (Dhaliwal *et al.*, 2017)

### Soil Chemical Properties

In contrast to open areas, all poplar clones exhibited a decline in both surface and sub-surface soil pH (Table 2), with S-2 displaying the highest mean pH (8.580 at 0-15 cm, 8.690 at 15-30 cm) and G-48 showing the lowest (8.415 at 0-15 cm, 8.550 at 15-30 cm). The open condition had a mean pH of 8.680. Significant variations in pH levels were observed among poplar clones, and a notable interaction effect between clones and depths was noted. Soil depth significantly influenced pH, with lower values at 0-15 cm compared to 15-30 cm. In terms of electrical conductivity (EC), all poplar plantations demonstrated lower values than open areas (Table 2). EC ranged from 0.240 to 0.360 dS $m^{-1}$, with S-2 having the highest (0.375 dS $m^{-1}$) and G-48 the lowest (0.255 dS $m^{-1}$) in surface soil. Subsurface soil EC ranged from 0.225 to 0.345 dS $m^{-1}$.

Afforestation often leads to a decline in soil pH in salt-affected soils due to the decomposition of leaf litter, deceased root matter, and compounds released by plant roots (Das *et al.*, 2007). Various poplar clones contribute to enhanced soil quality by reducing electrical conductivity (EC) through increased root and leaf litter volume, facilitating salt mobilization (Das and Chaturvedi, 2008).

### Available Macronutrients

Before the trial began, the available N status in surface soil was 127.6 kg $ha^{-1}$ and 115.2 kg $ha^{-1}$ in subsurface soil. After six years, the available nitrogen in surface and subsurface soils varied from 131.4 kg $ha^{-1}$ under S-2 to 169.5 kg $ha^{-1}$ under G-48, and from 114.3 kg $ha^{-1}$ under S-2 to 143.7 kg $ha^{-1}$ under G-48 (Table 3). At 15-30 cm soil depth, the available N content of the soil was decreased.

Litterfall from several forest tree species has been shown to boost available soil nitrogen considerably (Sartori *et al.*, 2007). Higher available N was found in the G-48 and PAU-1 clones in the current analysis. The increased accessible N in these poplar clones can be linked to increased litter generation and the breakdown of finer roots. Higher accessible N in lower soil depths than in open (without trees) may be attributed to leaching of available N and N release from root breakdown.

Before the trial began, the soil accessible $P_2O_5$ was 23.5 and 11.8 kg $ha^{-1}$ in surface and subsurface soils, respectively (Table 1). After 6 years of cultivation, accessible $P_2O_5$ varied from 21.47 kg $ha^{-1}$ in S-2 to 34.67 kg $ha^{-1}$ in G-48 in surface soil and from 11.96 kg $ha^{-1}$ in S-2 to 21.83 kg $ha^{-1}$ in G-48 in sub-surface soil (Table 5). Surface soils have greater accessible soil $P_2O_5$ than subsurface soils, regardless of poplar clone. The available soil $P_2O_5$ varied depending on the clone. When compared to open plots, all of the poplar clones exhibited a large amount of accessible $P_2O_5$.The higher accessible P under these poplar clones planting might be attributed to increased litter formation and breakdown of finer roots. According to Laik *et al.*, (2009a and 2009b), organic acids generated during residue decomposition increase phosphorous release by lowering metal ions binding phosphate by chelation and competing for exchange sites.

At the start of the trial, the available $K_2O$ in surface and subsurface soil was 113.8 and 92.6 kg $ha^{-1}$, respectively (Table 1). After 6 years of poplar planting, the available $K_2O$ in surface and subsurface soils varied from 123.8 kg ha$^{-1}$ under S-2 to 144.8 kg ha$^{-1}$ under G-48, and from 97.7 kg ha$^{-1}$ under S-2 to 123.7 kg ha$^{-1}$ under G-48 (Table 6). The available $K_2O$ in the soil reduced as soil depth increased. The interaction between clone and soil depth has been found to have a considerable impact on soil $K_2O$ levels.

Soil organic matter is crucial for rehabilitating degraded wastelands, governing soil aspects. Consequently, soil organic matter acts as an essential but temporary element that governs various physical, chemical, and biological aspects of the soil (Jha *et al.*, 2010). The study reveals that increased organic matter in diverse poplar clone plantations enhances soil fertility through nutrient recycling. Decomposing leaves and roots contribute nutrients, enriching the soil with minerals and fostering a sustainable environment.

Nitrogen, phosphorus, and organic carbon exhibit a positive correlation in soil, linked to their association with soil humus. Organic matter significantly influences these nutrients (Gupta and Sharma, 2009). In this study, soil nitrogen and phosphorus levels align with soil organic carbon trends, peaking in the 0-15 cm layer and decreasing with soil depth, indicating nutrient recycling and biomass influence.

Soil organic matter has limited influence on potassium availability as it doesn't directly provide potassium. The increase in accessible potassium is linked to improved soil conditions from tree presence (Gupta and Sharma, 2009). Agroforestry elevates soil nutrient levels, capturing precipitation and reducing nutrient leaching, leading to enhanced nitrogen, phosphorus, and potassium availability compared to sole cropping (Kumar *et al.*, 2005).

## Litterfall, Nutrient Concentration and Nutrient Return

Litterfall from poplar plantations varied significantly among the seven poplar clones. The G-48 Poplar clone plantation exhibited the highest litterfall (3.79 Mg ha$^{-1}$), next by PAU-1 (2.98 Mg ha$^{-1}$), while the S-2 Poplar clone plantation had the lowest litterfall (1.42 Mg ha$^{-1}$). Furthermore, N, P, and K concentrations varied significantly across the seven six-year-old Poplar clones (Table 4). The greatest nutrient contents were found in the G-48 Poplar clone, whereas the lowest were found in the S-2 Poplar clone.

The G-48 Poplar clone showed the highest litterfall, benefiting soil fertility and ecosystem functions. Its superior nutrient concentrations (N, P, K) indicate efficient nutrient uptake. Conversely, the S-2 clone exhibited lower litterfall and nutrient levels. The increased litter production with tree age, emphasizing complex results. (Mohsin *et al.*, 1996).

Nutrient return through litterfall varied significantly among the seven poplar clones, focusing on N, P, and K contents. In Table 4, G-48 exhibits the highest nutrient return (N: 45.59 kg ha$^{-1}$, P: 6.03 kg ha$^{-1}$, K: 20.66 kg ha$^{-1}$), while S-2 shows the lowest (N: 10.75 kg ha$^{-1}$, P: 1.8 kg ha$^{-1}$, K: 4.83 kg ha$^{-1}$). High nitrogen levels in the G-48 Poplar clone contribute to increased litterfall, as nitrogen-rich litter decomposes faster, releasing nutrients into the soil. Conversely, low phosphorus concentrations may limit nutrient recycling. The observed nutrient return order (N > K > P) highlights nitrogen's crucial role in soil enrichment, followed by potassium and phosphorus.

The quantity of input of litterfall, the age and development of the trees, and the concentration of nutrients in the litterfall all had an impact on how much nutrients were returned to the ecosystem through litterfall (Mohsin *et al.*, 1996).

## Weight loss in decomposing litter

The litterbags were placed beneath poplar plantations in the plow layer of the soil in November. The breakdown was identified faster in the G-48, PAU-1, and S-1 clones than in the PAU-2, PAU-3, PAU-4, and S-2 clones. Leaf litter took 9 months to totally decompose in G-48, PAU-1, and S-1, but there was still some litter remaining after 9 months in PAU-2, PAU-3, PAU-4, and S-2 (Figure 1). This faster decomposition rate can be attributed to the increased microbial activity in plantations, likely due to the larger amount of litter-fall ha$^{-1}$ and favourable soil temperature and moisture conditions in the soil. Similarly, Rani *et al.* (2016) found that P. *pyrifolia*, poplar, teak, and Eucalyptus had breakdown rates of 100%, 98%, 99%, and 88%, respectively, during a 10-month period.

## Linear regression between time(t) and ln ($W_t$ / $W_0$)

Linear regression analyzed the relationship between time (t) and ln ($W_t/W_0$) for different poplar clones. Decomposition constants (k) ranged from 1.192 to 1.468 mg g$^{-1}$ day$^{-1}$, indicating varying decomposition rates. Intercepts (A) ranged from 6.798 to 7.472, and correlation coefficients (r) from -0.773 to -0.690, revealing moderately strong negative correlations. Estimated half-lives ($T_{1/2}$) ranged from 47 to 58 days, reflecting the time for half of the initial weight to decompose. Similar linear decomposition models were also found by Issac and Nair (2002).

## Nutrient release pattern in the decomposing litter biomass

Among all the studied clones, G-48 and PAU-1 exhibited superiority, and so the nutrient release pattern was derived for these clones. N and P displayed an immobilization phase up to 150 days following litter implantation and then a mineralization phase because of the high C:N ratio of litter, more nitrogen and phosphorous are required for the growth and survival of microbial biomass to decompose litter (Figure 2). K, on the other hand, displayed mineralization phase throughout the decomposition period because potassium is not an important component of microbial biomass structure.

## Conclusion

The study revealed significant variations in soil properties and ecosystem dynamics among different poplar clones and soil depths. The G-48 poplar clone stood out, causing the most notable decrease in pH, lowest electrical conductivity, and highest wet aggregate stability. This clone also contributed to the highest litterfall and rapid leaflitter breakdown, emphasizing its role in nutrient replenishment. Additionally, all poplar clones positively influenced soil nutrient availability, with G-48 leading in nutrient release patterns. Overall, poplar plantations, especially those with G-48, demonstrated positive impacts on soil quality, highlighting their potential for sustainable land management and ecosystem enhancement.

**Table 1:** The impact of six-year-old poplar plantations with varying clones on bulk density and wet aggregate stability

| Poplar clones | BD (Mg cm$^{-3}$) | | | Wet aggregate stability (%) | | |
|---|---|---|---|---|---|---|
| | 0-15 cm | 15-30 cm | Mean | 0-15 cm | 15-30 cm | Mean |
| **PAU-1** | 1.379 | 1.400 | 1.389 | 22.725 | 14.970 | 18.847 |
| **PAU-2** | 1.384 | 1.408 | 1.396 | 20.630 | 13.918 | 17.274 |
| **PAU-3** | 1.407 | 1.419 | 1.413 | 19.828 | 13.095 | 16.461 |
| **PAU-4** | 1.423 | 1.427 | 1.425 | 18.657 | 11.050 | 14.853 |
| **S-1** | 1.440 | 1.455 | 1.448 | 15.660 | 9.585 | 12.622 |
| **S-2** | 1.446 | 1.469 | 1.458 | 14.425 | 8.050 | 11.237 |
| **G-48** | 1.367 | 1.384 | 1.376 | 24.168 | 16.647 | 20.407 |
| **Open condition** | 1.453 | 1.482 | 1.468 | 10.205 | 6.428 | 8.316 |
| **Mean** | 1.412 | 1.430 | | 18.287 | 11.819 | |
| **Factors** | **C.D.(P≤0.05)** | | **S.Em ±** | **C.D.(P≤0.05)** | | **S.Em ±** |
| **Clone (T)** | 0.008 | | 0.003 | 0.707 | | 0.243 |
| **Depth (D)** | 0.004 | | 0.001 | 0.353 | | 0.122 |
| **Interaction (T×D)** | NS | | 0.004 | 0.999 | | 0.344 |

**Table 2:** The impact of six-year-old poplar plantations with varying clones on soil pH and electrical conductivity (EC)

| Poplar Clones | pH | | | EC (dS m$^{-1}$) | | |
|---|---|---|---|---|---|---|
| | 0-15 cm | 15-30 cm | Mean | 0-15 cm | 15-30 cm | Mean |
| **PAU-1** | 8.435 | 8.565 | 8.500 | 0.265 | 0.235 | 0.250 |
| **PAU-2** | 8.475 | 8.585 | 8.530 | 0.280 | 0.250 | 0.265 |
| **PAU-3** | 8.495 | 8.620 | 8.558 | 0.305 | 0.265 | 0.285 |
| **PAU-4** | 8.525 | 8.655 | 8.590 | 0.320 | 0.280 | 0.300 |
| **S-1** | 8.560 | 8.675 | 8.617 | 0.355 | 0.315 | 0.335 |
| **S-2** | 8.580 | 8.690 | 8.635 | 0.375 | 0.345 | 0.360 |
| **G-48** | 8.415 | 8.550 | 8.483 | 0.255 | 0.225 | 0.240 |
| **Open** | 8.720 | 8.640 | 8.680 | 0.425 | 0.385 | 0.405 |
| **Mean** | 8.526 | 8.622 | | 0.3 | 0.288 | |
| **Factors** | **C.D.(P≤0.05)** | | **S.Em ±** | **C.D.(P≤0.05)** | | **S.Em ±** |
| **Clone (T)** | 0.020 | | 0.007 | 0.012 | | 0.004 |
| **Depth (D)** | 0.010 | | 0.003 | 0.006 | | 0.002 |
| **Interaction (T×D)** | 0.029 | | 0.009 | NS | | 0.006 |

**Table 3:** The impact of six-year-old poplar plantations with varying clones on Available N, Phosphorous ($P_2O_5$), Potassium ($K_2O$) in soil.

| Poplar clones | Available N (kg ha$^{-1}$) | | | Available $P_2O_5$ (kg ha$^{-1}$) | | | Available $K_2O$ (kg ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 0-15 | 15-30 | Mean | 0-15 | 15-30 | Mean | 0-15 | 15-30 | Mean |
| **PAU-1** | 159.2 | 137.6 | 148.4 | 30.53 | 19.50 | 25.02 | 142.7 | 116.4 | 129.5 |
| **PAU-2** | 151.1 | 130.6 | 140.9 | 28.75 | 17.21 | 22.98 | 136.1 | 115.4 | 125.7 |
| **PAU-3** | 148.8 | 126.2 | 137.5 | 27.81 | 14.91 | 21.36 | 135.2 | 110.7 | 122.9 |
| **PAU-4** | 146.5 | 122.7 | 134.6 | 26.46 | 14.25 | 20.35 | 129.9 | 109.7 | 119.8 |
| **S-1** | 135.3 | 116.9 | 126.2 | 23.76 | 12.14 | 17.95 | 125.9 | 104.4 | 115.1 |
| **S-2** | 131.4 | 114.3 | 122.8 | 21.47 | 11.96 | 16.71 | 123.8 | 97.7 | 110.7 |
| **G-48** | 169.5 | 143.7 | 156.6 | 34.67 | 21.83 | 28.25 | 144.8 | 123.7 | 134.2 |
| **Open** | 124.9 | 112.2 | 118.5 | 20.22 | 12.89 | 16.56 | 122.3 | 101.9 | 112.1 |
| **Mean** | 145.8 | 125.5 | | 26.712 | 15.89 | | 132.5 | 109.9 | |
| **Factors** | **C.D.($P \leq 0.05$)** | | **S.Em ±** | **C.D.($P \leq 0.05$)** | | **S.Em ±** | **C.D.($P \leq 0.05$)** | | **S.Em ±** |
| **Clone (T)** | 4.06 | | 2.12 | 0.59 | | 0.20 | 1.79 | | 0.62 |
| **Depth (D)** | 2.53 | | 1.56 | 0.29 | | 0.10 | 0.89 | | 0.31 |
| **Interaction (T×D)** | 6.81 | | 3.41 | 0.83 | | 0.29 | 2.53 | | 0.87 |

**Table 4:** Litterfall, Nutrient concentration and Nutrient return through litterfall in various poplar clones

| Poplar clones | Litterfall (Mg ha$^{-1}$) | Nutrient concentration (%) in litterfall | | | Nutrient return (kg ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|
| | | N | P | K | N | P | K |
| **PAU-1** | 2.980 | 1.188 | 0.160 | 0.523 | 35.24 | 4.76 | 15.63 |
| **PAU-2** | 2.604 | 0.965 | 0.154 | 0.467 | 25.13 | 3.99 | 12.14 |
| **PAU-3** | 2.252 | 0.909 | 0.143 | 0.430 | 20.27 | 3.22 | 9.69 |
| **PAU-4** | 1.919 | 0.841 | 0.138 | 0.392 | 16.04 | 2.63 | 7.49 |
| **S-1** | 1.587 | 0.794 | 0.130 | 0.358 | 12.53 | 2.05 | 5.64 |
| **S-2** | 1.423 | 0.754 | 0.126 | 0.337 | 10.75 | 1.80 | 4.83 |
| **G-48** | 3.794 | 1.273 | 0.168 | 0.576 | 45.59 | 6.03 | 20.66 |
| **C.D.($P \leq 0.05$)** | 0.114 | 0.026 | 0.003 | 0.005 | 0.67 | 0.10 | 0.16 |
| **S.Em ±** | 0.043 | 0.008 | 0.001 | 0.002 | 0.22 | 0.03 | 0.05 |
| **C.V. (%)** | 4.631 | 4.242 | 4.380 | 3.930 | 7.43 | 5.56 | 7.92 |

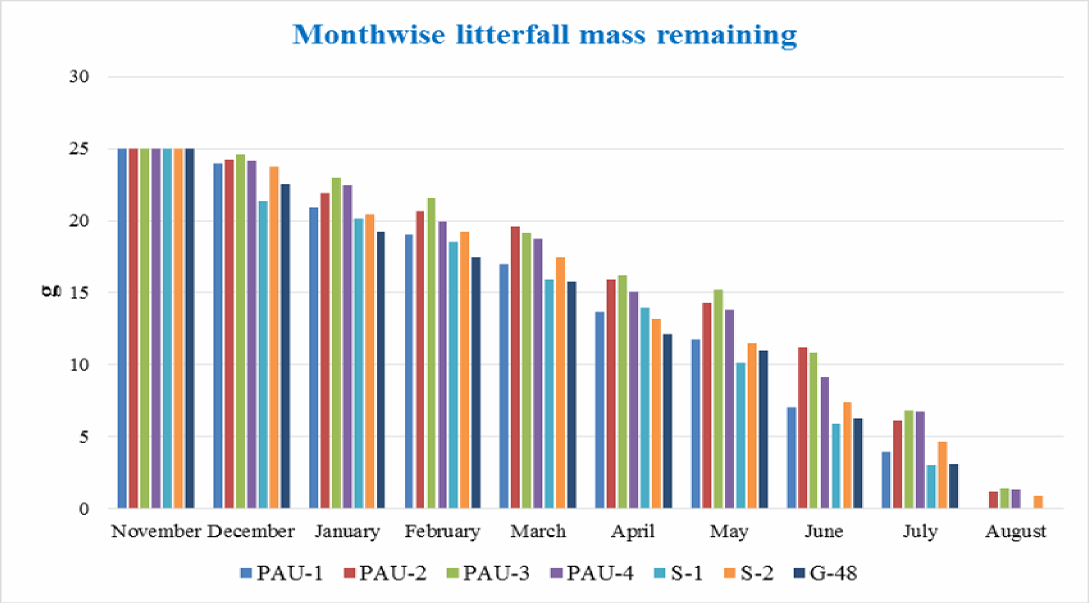

**Fig. 1 :** Month wise leaf litter mass remaining (%) as influenced by various poplar clones

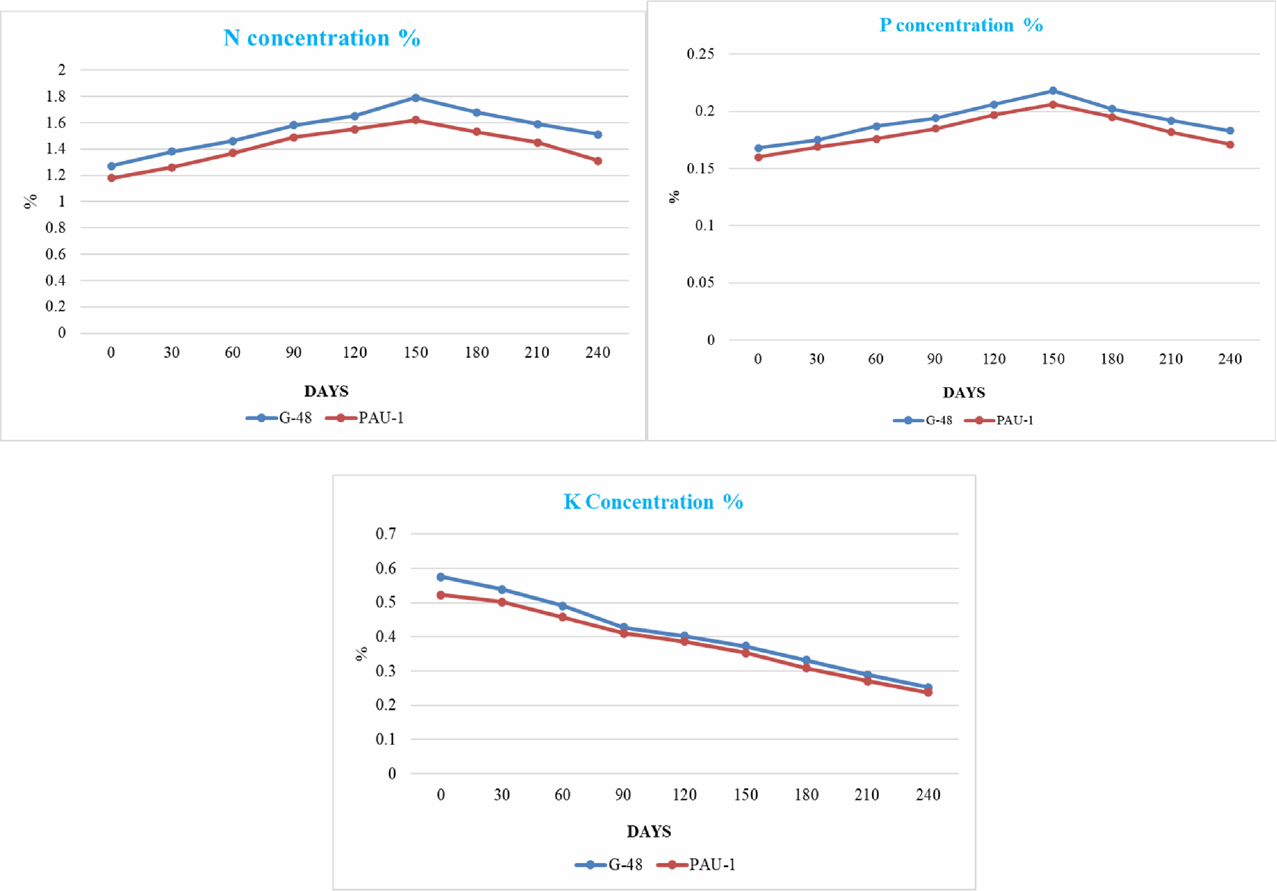

**Fig. 2:** Fluctuations in the Nitrogen, Phosphorous and Potassium content percentage during the decomposition of leaf biomass from the G-48 and PAU-1 Clones.

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