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Litter fall and Potential Nutrient Returns from Pecan nut (*Carya illinoinensis*) in Agroforestry System in Indian Himalaya

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ABSTRACT
Litterfall from trees is the main processes accounting for soil improvement in agroforestry systems. The extent of nutrient return into soil depends on the tree species, management practices and the quantity and quality of litter. A field investigation was carried out to study litterfall production and nutrient contents in the litterfall under crown of pecan nut tree in rainfed condition. Total annual accretion of litterfall found 2143.3 kg $ha^{-1}yr^{-1}$ and relative abundance of nutrients in litter fall of pecan nut tree were in the order of C>N>K>P. The total nutrient buildups from above mentioned litter fall of pecan nut could be carbon 901.91 kg ha^{-1} yr^{-1}, nitrogen 57.44 kg ha^{-1} yr^{-1}, phosphorus 3.21 kg ha^{-1} yr^{-1} and potassium 43.29 kg ha^{-1} yr^{-1} found in agri-horti system. There was significant build up of soil organic carbon and available NPK in the agri-horticultural systems.

Keywords: Litterfall, Pecan nut, Nutrient content, Soil fertility, Agroforestry

1. Introduction
Depletion of natural resources and decreasing soil fertility are worldwide phenomenon. Presently, agroforestry system is an alternative for conservation of natural resources and optimization of productivity. Researchers are recommending agroforestry systems as a sustainable form of land use to increase biomass production in agricultural systems [1-2]. A major part of the annual gain of energy and matter by plants is shed as litter which enters into decomposition subsystem as dead organic matter or detritus. This organic matter subjected to microbial decay in soils comes from several sources. Agroforestry systems are helpful to maintain soil organic matter and to promote nutrient recycling depending on tree species [2-4]. It is a reservoir of mineral nutrients and influences the hydrology. The amount and pattern of litter fall varies with the type of species, growth and age, tree density, canopy characteristics, intercrops, season, etc. Trees grow naturally in agricultural fields and have formed important traditional agroforestry systems in the hills of Himalaya, India. This study envisages providing information on litter fall and potential returns of nutrients from pecan nut in agroforestry system in mid hills of Himalaya of Kumaon region.

2. Materials and Methods
The study site is located at Hawalbagh, experimental site of Vivekananda Parvatiya Krishi Anusandhan Sansthan, Almora, at 1250 m elevation in Kumaun Himalaya. The litter input was measured from 12 litter traps of 1.0 m X 1.0 m size which were put beneath the canopy of the trees. Litter from the traps was collected after every 15 (fifteen days). The samples were oven dried at 70±1 ^{0}C to constant weight. Litter samples collected from litter traps were pooled together in proportion to their volume to get annual samples. These composite samples were grounded in Wiley mill and analyzed for different nutrients. Carbon and nitrogen content was determined with the CHN analyzer. Phosphorus was estimated spectrophotometer and potassium by flame photometry. The nutrient concentration was multiplied by the weight of annual litter fall to compute the amounts of potential nutrients returns to the soil.

3. Results and Discussion
The total annual litter fall in pecan nut was 2143.3 kg $ha^{-1}yr^{-1}$ in agroforestry system and out of total litter fall leaf litter contributed most. The amount and pattern of litter production varies with tree species, their growth pattern, age, density and canopy characteristics [5] and also the environment including temperature, water and mineral nutrient availability which limit litter

production [6]. The litter fall in pecan nut was relatively more concentrated in the winter months with the peak litter fall occurred in November. The major litterfall coincided with the months between October and December, the low rainy season and low temperature months. Variations in litter fall between different tree species were also observed by [7-8]. The average concentration of nutrients in litter fall of pecan nut tree carbon (42.08%), nitrogen (2.68%), phosphorus (0.15%) and potassium (2.02%) were found (Table 1).

Table 1: The average concentration of nutrients in litter fall of pecan nut tree

Nutrients	Concentration (%)
C	42.1
N	2.68
P	0.15
K	2.02

The order of relative abundance of nutrients in litter fall was N>K>P which agrees with findings of others. On the basis of total litter fall, the potential amount of nutrients that could be released annually was worked out in pecan nut (238 trees ha^{-1}). The total nutrient buildups from above mentioned litter fall of pecan nut were carbon 901.91 kg ha^{-1} yr^{-1}, nitrogen 57.44 kg ha^{-1} yr^{-1}, phosphorus 3.21 kg ha^{-1} yr^{-1} and potassium 43.29 kg ha^{-1} yr^{-1} found in agri horticulture system (Table 2). These results are in agreement with findings of [9-10]. Pecan nut based agri horticulture system is important technology particularly in hilly region where large proportion of land is degraded and agriculture is highly risky and is beneficial for long term and maintained crop productivity on sustainable basis.

Table 2: The potential amount of nutrients that could be released from pecan nut litter fall

Nutrients	Potential Nutrient Return (kg ha^{-1} yr^{-1})
Carbon	901.9
Nitrogen	57.4
Phosphorus	3.2
Potassium	43.2

4. Conclusion

We conclude that pecan nut in agri horticulture systems produce a substantial amount of litter, which varies both in quantity and quality depending upon growth pattern, age, density and canopy characteristics and also the environment including temperature. The results of the study have contributed to understanding of litterfall, nutrient content and potential nutrient returns which may be helpful in soil enrichment. Pecan nut may add a substantial amount of N, P and K through litter addition to the soil. This potential is of immense importance and useful for synchrony between nutrient release from litter and crop demand as the tree remains in the field for a long period.

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