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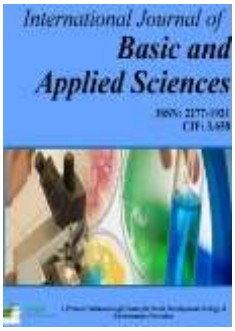

Full Length Research Paper

Effect of Different Aged Eucalyptus Plantations on Soil Nutrient of Agricultural Fields of Rae Bareli District of Uttar Pradesh, India

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ABSTRACT

When it was first introduced to India, eucalyptus was a very well-liked species. However, after a few years, it was discovered that due to its rapid growth, plantations were absorbing a lot of soil nutrients, which decreased the soil fertility status of agricultural fields. For this reason, the current study was created to evaluate its effects on soil nutrient status in the Raebareli district of Uttar Pradesh. It has been noted that soil pH and nutrient quality drastically change after eucalyptus plants. In addition to the analysis of the soil pH, the paper also examined the soil's Ca, Mg, Carbon, Total Nirogen, and C/N ration. A few findings, such as the rise in soil nitrogen after eucalyptus planting, require further research because the majority of studies found a decrease.

Introduction

Agriculture and its affiliated industries make up the majority of India's sources of employment and are the foundation of the country's economy. With 82 percent of farmers being small and marginal, agriculture still provides the primary source of income for 70% of rural households in India (https://www.fao.org India). Agriculture and related industry jobs account for about 54.6% of all employment (Census,2011). Land Use Statistics 2016–17 show that the country has a total area of 328.7 million hectares, of which 139.4 million hectares are listed as net seeded and 200.2 million hectares are grossly cultivated with a cropping intensity of 143.6%. 42.4% of the overall geographical area is represented by the net area sown. 68.6 million hectares are netly irrigated. Any alteration to change in their land use pattern from agriculture to agroforestry or plantations may cause change in soil nutrient status of the fields (Binkley and Menyailo,2005, Carnol and Bazgir,2013, Diego et.al.,2020,). By changing or adjusting land use methods, farmers have embraced a variety of agroforestry tactics to improve both their economic situation and the productivity of the land. But occasionally things don't work out well; eucalyptus is one such instance (Srivastava, 1996). Wen et al. (2009) and Zhu et al. (2009) reported that afforestation of exotic Eucalyptus spp. plantations is reported to negatively affect the soil physical and chemical qualities and plant community biodiversity in China.

Indian eucalyptus plantations have been the subject of intense debate since they first began because of their ecological impacts on the crop or their impact on the quality of the soil (Chandrashekhar et. al.,1987; Srivastava and Lal,1989). Even these plantations receive a lot of criticism because they introduce exotic species that are displacing native species on the lands (Palana, FAO). Being a species that grows quickly, it draws more water and nutrients from the soil to support its growth. Crop output and growth, particularly in wheat and rice, are suffering, as is the condition of the soil. According to reports, eucalyptus plantations lower crop yields, render soil infertile for future agriculture, and have an adverse impact on food production, farmer suffering, and other social effects. Wrong selection of species for plantations often lead to social, ecological and economic unrest (Kumar and Ramakrishnan,1989). Therefore, the present study was intended to measure the soil nutrient status under the eucalyptus plantation fields whether it is on bund plantation or on the full field of eucalyptus plantations.

Study area and climate

The agro-climate of Raebareli district is characterized by hot summers and cool winters. The region receives mean annual rainfall of 1000- 1200mm 70% of which is received during the summer monsoon period i.e. July to September. The rainfall covers about 70%of annual PET demand of 1400 to 1800mm and leaves an annual water deficit of 500 to 700mm. The region has an LPG of 150 to 180 days in a year. According to the water balance diagram the region experiences dry period from February to June with an annual mean temperature of more than 22°C and thus qualifies for ustic soil moisture and

hypothermic soil temperature regimes (Planning Atlas of Uttar Pradesh,1987).

Method of study

Soil sampling was done twice in bund plantations of eucalyptus of 3-year and 7-year-old plantations; before monsoon in the month of May,2018 and after monsoon in the month of September,2018 at a distance of 0-5m, 5-10m and 10-15m. Soil samples were collected at 0-10cm depth for analysis of soil nutrients and pH. Air dried soil samples were passed through 2mm sieve and kept in glass jar for subsequent analysis. Samples were analysed by standard procedures (Allen, et.al., 1974). Thus, total nitrogen was estimated by phenol di- sulphonic acid method, organic carbon was estimated by Walky-Black method. Calcium and magnesium were analysed by EDTA titration method. Soil extraction for cations were carried out with 1N ammonium acetate at pH07. Soil pH were measured using pH meter in 01: 05 soil: water v/v.

Result and Discussion

Soil pH:

In agroecosystems where there was no eucalyptus plantation (NEP) pH value decline from alkaline (7.9) towards more neutral with increase in the distance from bund beyond 10m. In 3- year- old eucalyptus plantations on bund (BEP3) the pH was mildly alkaline till 5m distance, but it increased significantly between distance of 5 to 10m distance with the subsequent decline in pH value after 10m. The seven-year-old eucalyptus plantations (BEP7) on the bund show a reverse trend in pH values when compared to the NEP. The pH was 7.9 till 5m distance from the band but it increased with the increase in the distance from 5 to 15 m towards increased alkalinity with pH value of 8.2. 7-year-old full field eucalyptus plantations (FEP7) did not show any significant differences in the pH values between 0-15m distances. Similar trends followed during the month of September also.

The pH of the soil is significantly impacted by eucalyptus plantations. The pH of the soil is influenced by a number of variables, including soil microbial activity, CEC, and BD. The majority of researches have reported that soil pH has decreased after plantations, however the current study also finds that soil pH tends to decline when land use changes from agriculture to eucalyptus plantations. Many employees also observed a decrease in soil pH following the installation of eucalyptus (Rhoades and Binkley 1996; Cao et al. 2010). However, there was no discernible change between the 3 and 7-year-old Eucalyptus plantations. The pH of the soil in eucalyptus plantations was substantially lower than that of soils in untouched forests. The causes may result from Eucalyptus species immobilising soil exchangeable bases, which creates an increase in ions such Al3+ and H+ in the soil. (Aweto and Moleele 2005).

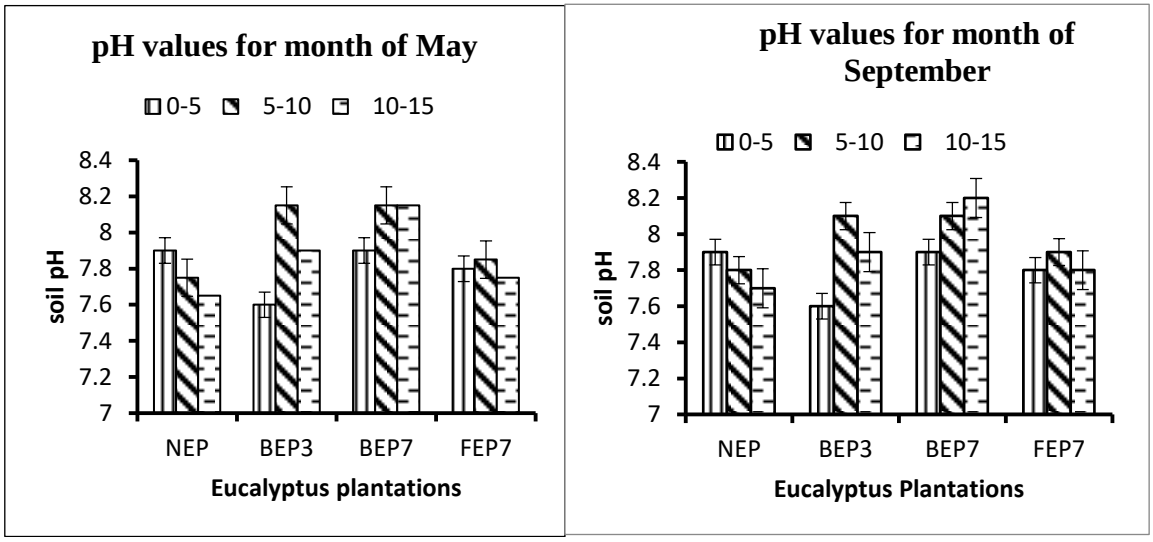

Fig.1. Soil pH at different distance (0-5m,5-10m,10-15m) of Bund and Full field plantations of Eucalyptus.

Soil Calcium

Soil calcium percentage was significantly higher between 0 to 5m distance in NEP during both the month of May and September compared to other three sites of eucalyptus plantations. Calcium concentration was lowest in BEP7 at all the three distances measured during the months of May to September. This trend was constant at all the sites (figure 2). Ca has been highly demanding in Eucalyptus plantations for its growth and productivity.

According to Aweto and Moleele (2005), a decrease in pH in plantation soil would result in a reduced level of soil base saturation because these exchangeable bases (Ca2+, Mg2+, and K+) get immobilised over time, depleting the soil's exchangeable bases. In their study in South Africa, Tererai et al. (2014) discovered that soil exchangeable cations like Ca and Mg were generally greater in 19 uninvaded sites and decreased throughout the Eucalyptus camaldulensis invasion gradient (lightly, moderately, and strongly invaded) in all seasons. This study indicated that Ca concentration rose after eucalyptus plantations; further research is needed on this.

Soil Magnesium

Magnesium concentration showed a reverse trend to calcium in all the sites. In BEP7 where the concentration increased significantly ($P<0.05$) with the increase in the distance from 0 to 15 m. The concentration was lowest in the field with no eucalyptus plantation (NEP). Similar trend was followed during the month of September at all the sites. (Figure 3).

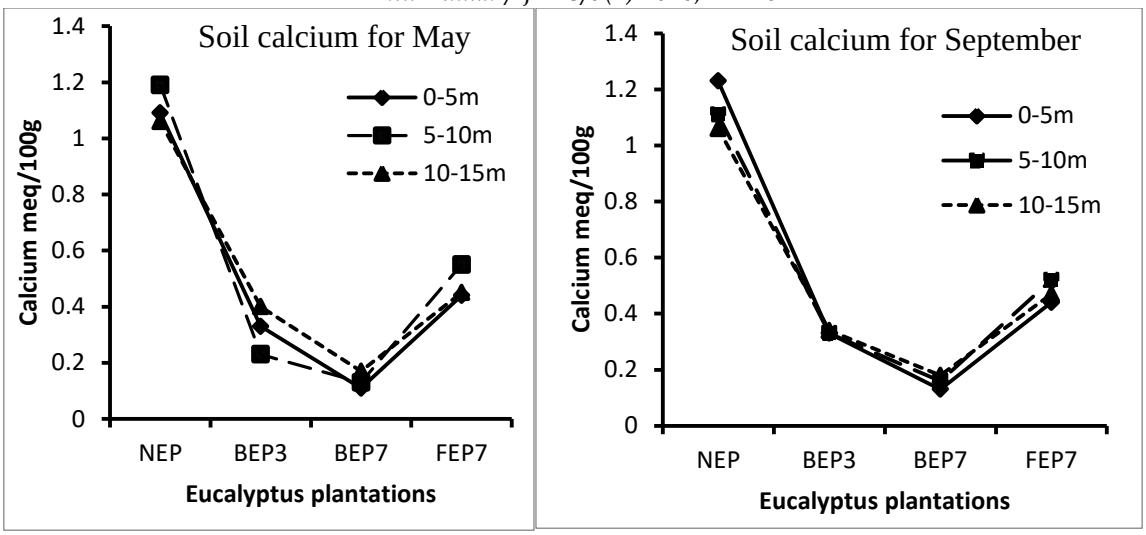

Fig.2. Soil Calcium(meq/100g) at different distance (0-5m,5-10m,10-15m) of Bund and Full field plantations of Eucalyptus

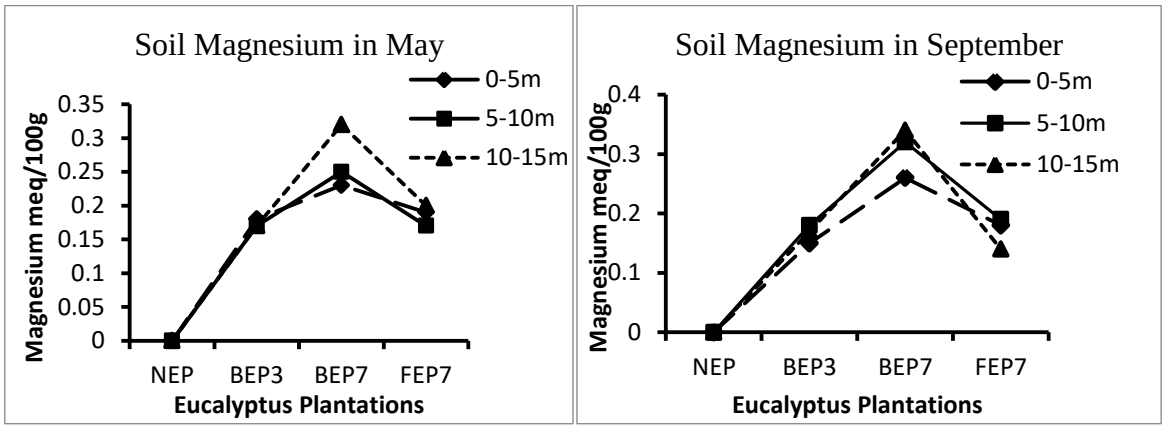

Fig.3. Soil Magnesium (meq/100g) at different distance (0-5m,5-10m,10-15m) of Bund and Full field plantations of Eucalyptus.

Organic carbon

Organic carbon percentage values were significantly higher at a distance of 0-5m in the NEP and BEP3 sites, however the concentration of organic carbon in BEP7 showed higher values at a distance of 5 to10 m, but in FEP7 the corresponding values showed higher concentration only at a distance of 10 to 15 m during the month of May. However, this trend reversed in the month of September where the percentage of organic carbon increased significantly ($P<0.05$) up to 5 m distance for BEP7, and for BEP3 and NEP 7 they did not show any significant difference in organic carbon percentage at 5 to 10 m and 10 to 15 m distance. (Figure 4).

Significant changes in soil organic matter (SOM) have been seen in Brazil after short-rotation Eucalyptus spp. plantings replaced the country's native vegetation (Lima et al., 2008). Additionally, Jan et al. (1996) found that Shorea robusta wild forest soil in Uttar Pradesh, Pakistan underwent considerable changes in organic matter when compared to Eucalyptus spp. plantation soils. Bernhard-Reversat (1998) has observed similar findings.

Total Nitrogen

Total nitrogen percentage was significantly higher at a distance of 0 to 5 m in all the plantation fields. The total nitrogen concentration was also significantly higher (P,0.05) at a distance of 10 to 15 m, but the nitrogen concentration declined significantly with the increase in the distance from 10 to 15m in FEP7. In all the sites except FEP7 the nitrogen concentration declined significantly with the increase in the distance up to 15 during the month of May. In September also the trend was similar with the total nitrogen concentration being significantly higher up till 5m distance at all the sites and subsequent decline in concentration of Nitrogen with increase in the distance up to 15 m. However, at a distance of 5m the nitrogen availability was significantly higher($P<0.05$) in BEP7 as compared to other sites. (Figure 5).

When Eucalyptus spp. plantations are harvested, significant amounts of nutrients are exported, which results in a decrease in the amount of soil nutrients like total N and accessible P. Leite et al. (2010) made this point. In the middle Himalayas, plantings of Eucalyptus spp. that were 1 to 8 years old were compared to naturally occurring mixed broad leaf forest by FAO (2011). According to the study, reforestation with plantations of Eucalyptus spp. lowered soil total N and accessible P. Following eucalyptus plantations, overall nitrogen levels typically tend to decline (Alemie ,2009; Tererai et al. 2014).

But in our study, the overall nitrogen concentration increased after eucalyptus plantations. This might be because more chemical fertilisers were applied to agricultural crops, but more research is required.

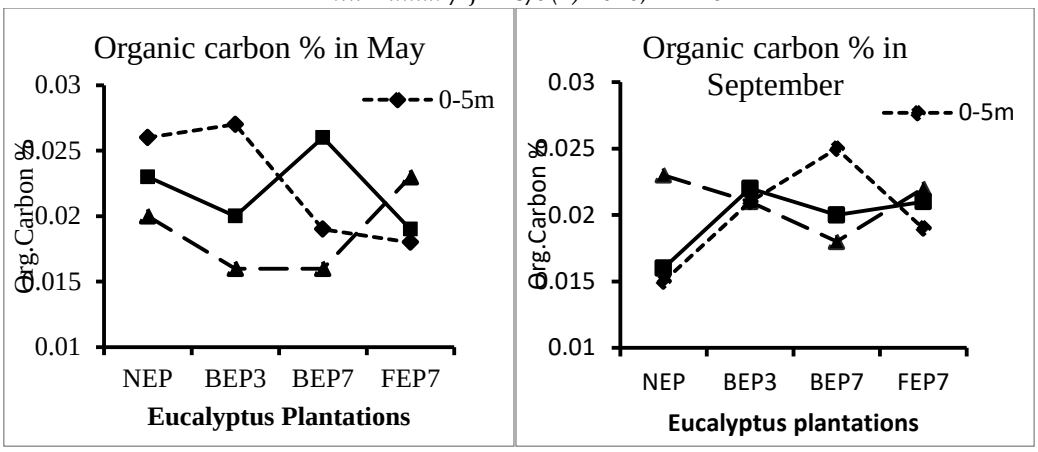

Fig.4. Soil Organic Carbon (%) at different distance (0-5m,5-10m,10-15m) of Bund and Full field plantations of Eucalyptus.

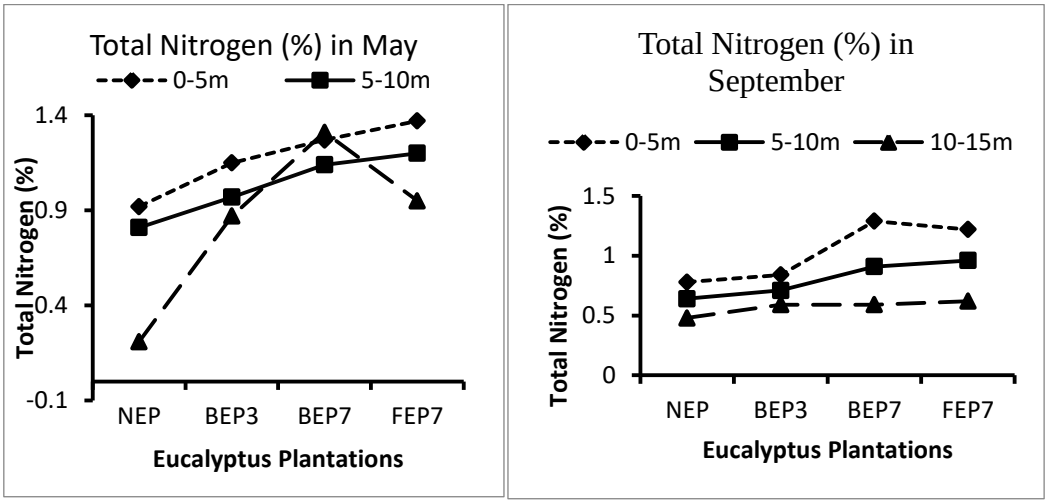

Fig.5. Soil Nitrogen (%) at different distance (0-5m,5-10m,10-15m) of Bund and Full field plantations of Eucalyptus.

C/N Ratio

Carbon to nitrogen ratio (C: N) is the weight of carbon divided by the weight of nitrogen in a composting material (Wortman et al., 2006). Carbon to nitrogen ratio is an important factor that influences the rate of decomposition of organic material to form humus. C/N ratio was significantly higher in BEP7 in at a distance between 10 to 15 m and minimum in FEP7. Between a distance of 5 to 10m and 0 to 5 m the C/N ratio was higher in FEP7 site during the month of May. However, the reverse trend was observed during the month of September where C/N ratio declined significantly in BEP7 between distance of 10 to 15 m and showed increased C/N ratio at 5 to10 m distance from the bund. These values did not show any significant variation for other sites. Leite et al. (2010) noted that a lot of nutrients are. Because soil accessible N is bound during microbial decomposition of the low nitrogen litter, a high C:N ratio causes soil nitrogen to become immobilised (Briones and Ineson, 1996). According to reports, Eucalyptus species create significant amounts of litter material with high C:N ratios, high lignin content, and high phenolic content (CastroDez et al., 2011).

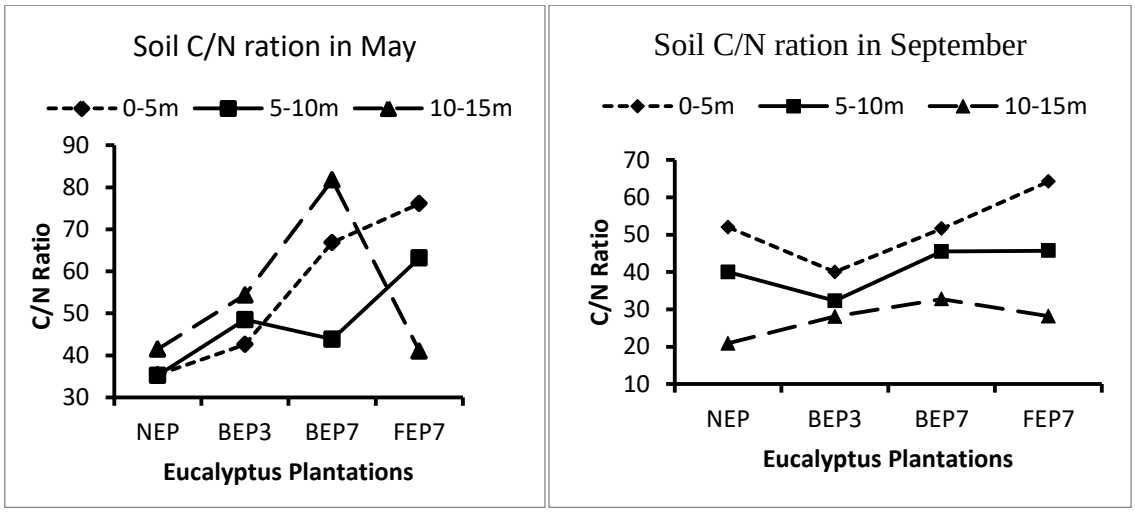

Fig.6. Soil C/N Ratio at different distance (0-5m,5-10m,10-15m) of Bund and Full field plantations of Eucalyptus.

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