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Short Review Paper

Impact of potassium on forest vegetation in south-west Bengal, India

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Abstract

Forest patches of Bankura, Paschim Bardhaman and Birbhum districts of the south-west part of West Bengal are dominated by four timber tree species like Shorea robusta, Holarrhena antidysenterica, Buchanania lanzan and Acacia catechu where Shorea robusta is recorded the highest among them. Substrate soils of these forest floors are covered with Alfisol comprising aluminum and iron as main ingredients. Collected soil samples from the selected pedons in the study area revealed higher content of potassium ranging from 55.20 to 671.89kg/ha in comparison to nitrogen and phosphorus, the other two chief soil nutrients of the plants. Even a forest soil sample of the study area shows an exceedingly high value of 671.89kg/ha obtained in the result of the soil chemical parameters analysis using the standard method for potassium extract. Further, the dominant four timber tree species of the vegetation type of the forest floors in the study area revealed different values for the potassium content and those values of potassium splendidly not only classify the habitat for each individual species but restrict the range of potassium content for the individual plant species. Forest soils covered with Holarrhena antidysenterica (Kurchi) trees show higher values of potassium content ranging from 93.38 to 671.89kg/ha, in contrast, the substrate soils of the Sal forest show relatively lower values for potassium ranging from 55.2 to 397.04kg/ha though the Sal trees (Shorea robusta) are abundantly occurred in these forest patches dominating over the other vegetation.

Keywords: Potassium, forest vegetation, soil nutrients.

Introduction

Forest patches are scattered all along the districts of Bankura, Paschim Bardhaman and Birbhum in the south-west part of West Bengal[1]. Among them, remarkably important forests like Joypur and Beliatore forests of Bankura district, 11-miles forest of Birbhum district and Garh Jangal and Aduria forests of Paschim Bardhaman districts are considered as model forest stands for pilot survey to get a picture of overall scenario of the forest patches of three districts of West Bengal[2]. Forest cover of these three districts including the study areas of Aduria, Garh Jangal, 11-Miles, Joypur and Beliatore forests offer a picturesque landscape with vast stretches of Sal, Piyal, Kurchi, Khoir trees, flowering trees like Palas, Mahua and Kusum, and lofty plants like Sonajhuri or Akashmoni and Eucalyptus encompassing the forest stands surrounding the border. These forest patches are covered with the typical Alfisol soil layers. Alfisol with slight admixture of red soil is characteristically poor substrate soils for the forest vegetation. Generally, forest vegetation is often grown up frequently on poorly fertile soils along with incredibly low available pools of nutrient cations for the plants. The loss of potassium in the forest floors will occur when the amount of rainfall exceeds the plant evaporation transpiration rates[3,4]. Over the long haul this will deplete the soils in potassium which is often found in older soils. Annual average rainfall around 1500 mm in these districts favours the high content of potassium. A closed climax forest minimizes the potassium losses under the natural biological web interactions, but the forest patches covered with mixed vegetation enhances the potassium concentration. Other factors like the presence of a near neutral pH and ample calcium are particularly important[5,6]. Potassium is a spectacular source of the soil nutrients for the plants and can stimulate a significant increase in the soil organic matter and soil nutrients. And the potassium has an amazing ability to accumulate the element and maximize the soil organic matter which is critical to optimize water and aeration in the soil condition[7]. In a forest area potassium would foster an improved productivity and greater long term sustainability and utility where the limitation of nitrogen can be provided by legumes the need for phosphorus by rock phosphate and ensuring mycorrhizal activity[8].

In the forest patches, potassium leaching process has been accelerated with the decrease soil pH. Soil samples revealed pH ranges from 4.65 to 5.76 might enhance potassium content of the sampled soils in the present study area in the three districts of south-west West Bengal. Variations of available potassium are observed more than nitrogen and phosphorus in the ecotypes of the terrestrial forest floors. Availability of potassium is strongly correlated with the water availability as observed in the recent stoichiometric studies that plays an important role in elemental composition of the individual timber tree species.

Thus, the content of potassium is more important in the fundamental elemental composition of the individual tree species than the nitrogen and phosphorus revealed in the stoichiometric study. In plant cells, potassium is considered as the most abundant cation and in leaves, it is second most abundant after nitrogen[9-11]. About 2.6% potassium weighs the crust of the earth but still it is a neglected soil nutrient in the field of research for global change[12]. Impact of such potassium on the individual plant species in the forest patches of the study area is the objective of the present study.

Results and discussion

Forest soil samples are collected from the selected pedons from Joypur forest (J1-J3, J11-J15), Beliatore forest (B1, B11-B15), 11-Miles forest (E1-E2), Aduria forest (A1, A11) and Garh Jangal forest (G1) for the soil chemical analysis of different physico-chemical parameters following the standard methods. The obtained result shows the content of available potassium for a natural terrestrial forest soil sample an exceedingly high value of 671.89kg/ha using the standard method for the soil chemical analysis, and therefore, a question might be arisen whether it is natural for the soils sampled at a terrestrial forest patch. The result obtained for potassium is above the threshold, but it is possible to get such high results given the other factors like weathering of minerals, fertilizers, and other pollutants as well as run off wastewater from communities which may trigger that values[13-15]. But there is no chance of mixing of fertilizers with the soil samples in these forest patches from the agricultural run off as the vegetation is surrounded by badlands and no river or even a streamlet is flowing within the periphery of the forest stand. And the chance of mixing other pollutants like municipal wastes with the soils is also impossible as the nearest town is far away from about 50km.

It is certainly a remarkably interesting fact about NH_4OAc-K, the higher value of potassium in the forest soils is quite dynamic. Ammonium-acetate (NH_4OAc) is the most widely used soil test for potassium (K) based on air-dried or oven-dried samples applying soil potassium (K) extraction with neutral 1 M Ammonium-acetate. A huge variation in K (potassium) value is found for the soil samples collected during summer stress period versus rainy season samples[16-19]. So, it is equally important to compare the soil test value taken at similar timings of sampling, which is comparable with the type of extractant, mineralogy, texture, pH etc. to give more facts about such values[20,21]. For the collected soil samples in the forest patches of the south-west part of West Bengal, the texture of the soil samples in an average, coarse sand ranged from 2-20%, fine sand 14-22%, very fine sand 11-24%, silt 21-39%, and clay 14-34% that constitute the forest soils. pH ranges from 5.1 to 5.76, electrical conductivity (EC) varies from 0.02-0.07dSm^{-1}, available nitrogen (N) ranges from 140-595kg/ha, available phosphorus (P) ranges from 4.87-133.06kg/ha, available potassium (K) from 67.35-671.89 and organic carbon (OC) from 0.25 to 0.78% and the samples were collected during the commencement of the spring in between summer and rainy season, still the soil samples show such high value for potassium (Figure-1). The percentage of relative humidity varies between 49% and 85%, minimum in the month of April and maximum during the month of August. For the soil moisture variability at those sampling sites such values for the content of potassium are common, though the past-history of K-fertilization for the selected forest patches is not known.

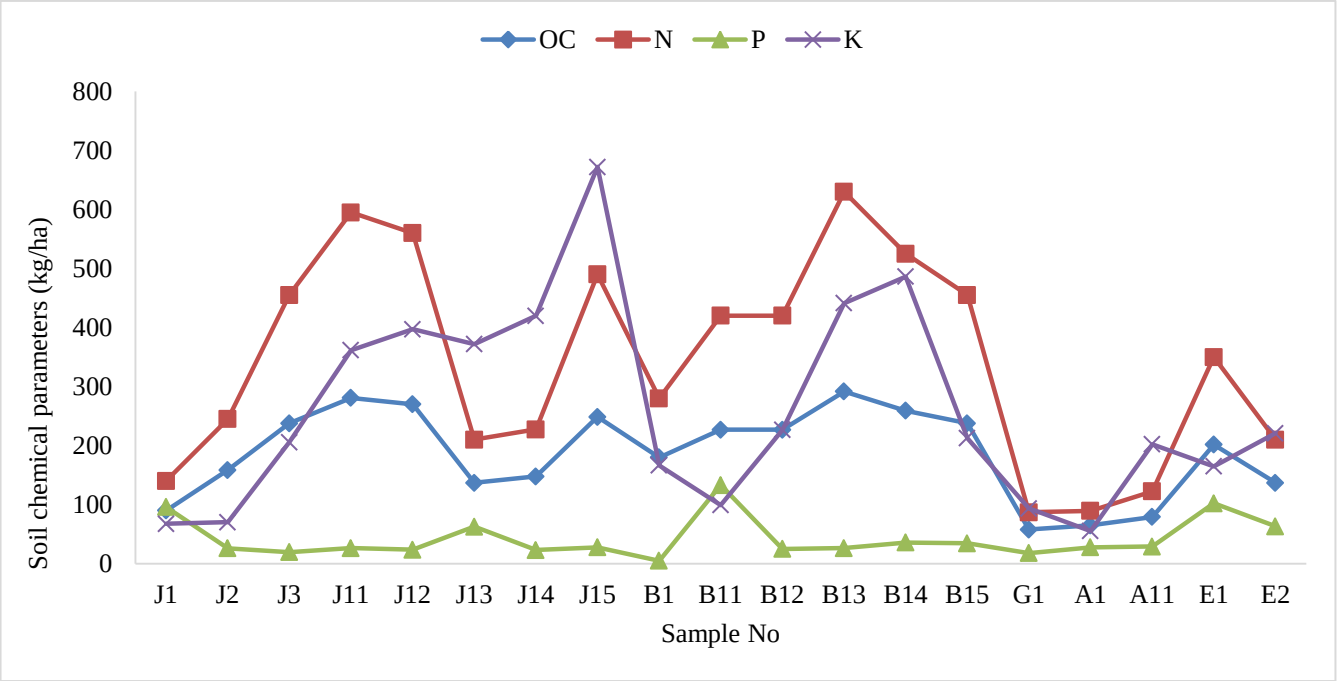

Figure-1: Soil chemical parameters of the forest soil samples of West Bengal.

There is no surprise with this level of NH_4OAc-K for so much variation in soil test values as the soils analyzed were under mixed vegetation[22,23]. The samples were collected from the selected pedons covered with the mixed vegetation dominated by the four species like Sal (*Shorea robusta*), Kurchi (*Holarrhena antidysenterica*), Piyal (*Buchanania lanzan*) and Khoir (*Acacia catechu*) where Sal trees (*Shorea robusta*) are occurred as the highest timber tree species in the selected forest patches of the present pilot survey. The dominant four timber tree species of the vegetation type of the forest floors show different values for the potassium and those values of potassium splendidly not only classify each individual species but restrict the content of potassium for the individual species. Forest soils covered with *Holarrhena antidysenterica* (Kurchi) trees show higher values of potassium content ranging from 93.38 to 671.89kg/ha, in contrast, the forest soils show relatively lower values for potassium ranging from 55.2 to 397.04kg/ha though the Sal trees (*Shorea robusta*) are abundantly occurred in these forest patches dominating over other vegetation. Other dominant species *Buchanania lanzan* (Piyal) revealed values for the potassium content in between *Holarrhena antidysenterica* and *Shorea robusta* of the forest patch. Potassium content ranges from 205.58 to 441.17kg/ha for *Buchanania lanzan* (Piyal) and the *Acacia catechu* (Khoir) tree species revealed the potassium values ranging from 67.35 to 166.5kg/ha (Figure-2).

Conclusion

The chemically analyzed value 671.89kg/ha obtained for potassium of a terrestrial forest soil sample is quite natural for the forest soil of the forest floor in the south-west Bengal including the ranges of potassium content for the individual timber tree species. Content of such potassium in the forest floors of south-west part of West Bengal can provide a clue that happens to soil test values when a soil type with uniform mineralogy and texture, is acted upon with different forest species[24-26]. An interesting feedback, we can get it with an additional data on different soil microbial communities plus microbial biomass carbon (Cmic), microbial biomass nitrogen (Nmic) and microbial biomass phosphorus (Pmic) including microbial biomass potassium (Kmic) with the variations in other nutrients as well in the subsequent studies[27]. In such case, rhizopshere effect will be particularly important consideration while dealing with such a huge variation in soil test values, since soils are collected at almost same point of time[28]. Textural variation is also one factor, and step down regression analysis would reveal the factors contributing towards such variation. The practical utility of such variations and these changes in soil test values offer possible changes on carbon footprint of these four dominated forest timber tree species, a big question to be answered which is to be considered in the future studies on these forest floors[29]. Further, if a distinct variation in soil test values as per stand of different forest species is found, the root density vis-a- vis root education dictating such variation in soil test values will be observed including potassium for the individual timber tree species of the selected forest patches in the districts of Bankura, Birbhum, and Paschim Bardhaman of the south-west part of West Bengal. The present pilot survey is preliminary that restricts the limitations of such different factors in the present study. Subsequent sampling and analysis of soil, and monitoring of environmental factors will provide adequate data and will be useful for managing the forest patches in West Bengal.

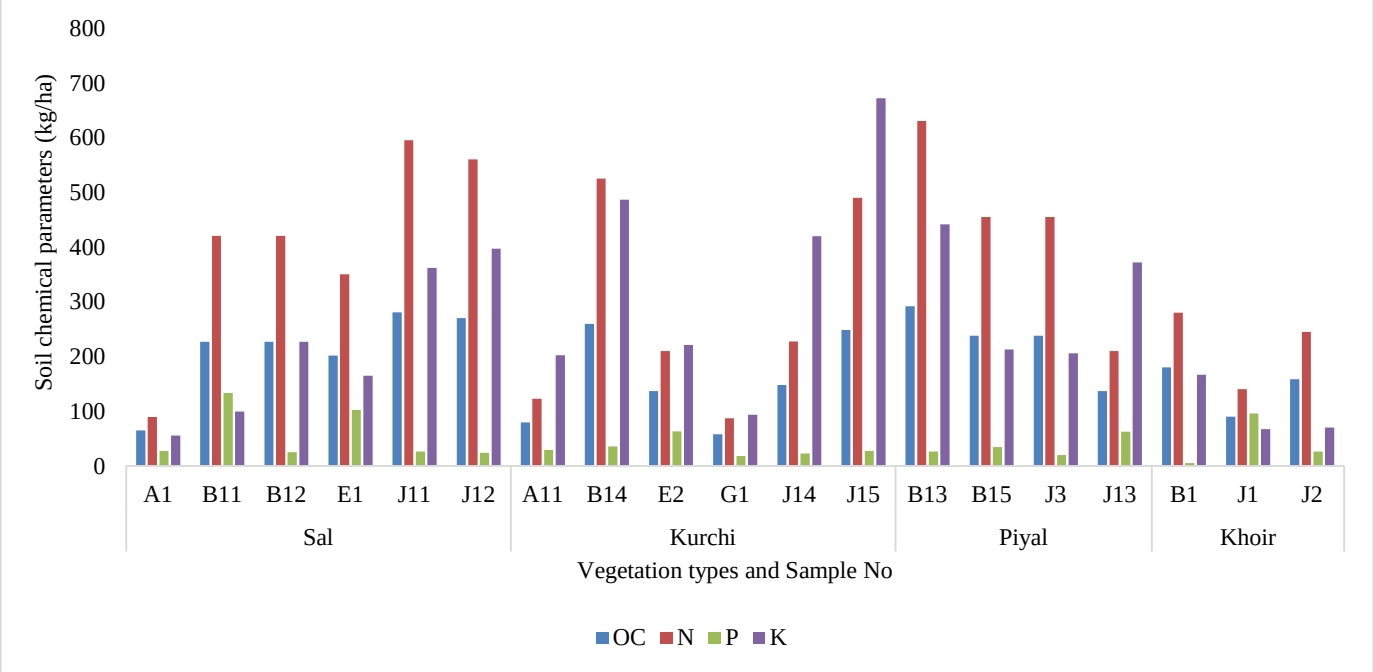

Figure-2: Soil substrate characteristics of different vegetation types in the forest floors of West Bengal.

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