

# Variation in Some Physicochemical Characteristics of Pineapple Orchard Soils of North-Eastern India

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Very few studies are available on physico-chemical characteristics of orchard soils, in general, and pineapple soils in particular. The aim of the present study was to work out seasonal and depth wise variations in physicochemical characteristics of pineapple orchard soil with a view to examine whether these characteristics vary with time, depth and age of the plantation. Attempt has also been made to investigate the interrelationships among these characteristics.

This study was conducted at Pineapple Research Station, Nayabaunglow situated at an altitude of 800m, latitude 25° 44' N and longitude 91° 53' E about 30 km north of Shillong, India. Data on climatic parameters are given in fig. 1. The pineapple growers in this region chiefly practise slash and burn agriculture. This practice consists of cutting down the forest of various stages of development allowing the slash to dry for a few months and burning the slash before cultivation. Farmers in this region do not generally use fertilizers.

The present study was conducted in 1-year, 5-year and 10-year old plantations for a period of 24 months (July 1985-June 1987). The plantation of three ages were selected to ascertain their effect on physicochemical characteristics

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of the soil. Samples from 0-10cm, 10-20cm and 20-30cm soil depths were collected from 5 random sites in each plantation at monthly intervals. These were mixed thoroughly to make a composite sample. Three replicates from each composite sample were analysed for the determination of soil water content, pH, organic C, total N, available P and exchangeable K using methods described by Allen (1974). Soil temperature was recorded at the time of sampling with the help of soil thermometer.

Data on various parameters were subjected to regression analysis. Following model was used:  $x = a_0 + a_1 \sin \theta m + a_2 \cos \theta m + a_3 \frac{1}{d} + a_4 \log(a)$ ; where  $x$  = the relevant parameter (soil temperature, soil water, pH, organic C, total N, available P and exchangeable K),  $\theta m = \frac{2\pi(\text{month})}{13}$ ,  $d$  = soil depth,  $a$  = plantation age,  $a_0$  = constant of regression and  $a_1, a_2, a_3, a_4$  = coefficient of regression.

It was held proper that the parameters vary inversely with soil depth and logarithmically with plantation age. The reason of using sinusoidal function (of time) is to capture harmonic nature of variation in the value of parameters changing with season. The model was estimated for different parameters using a

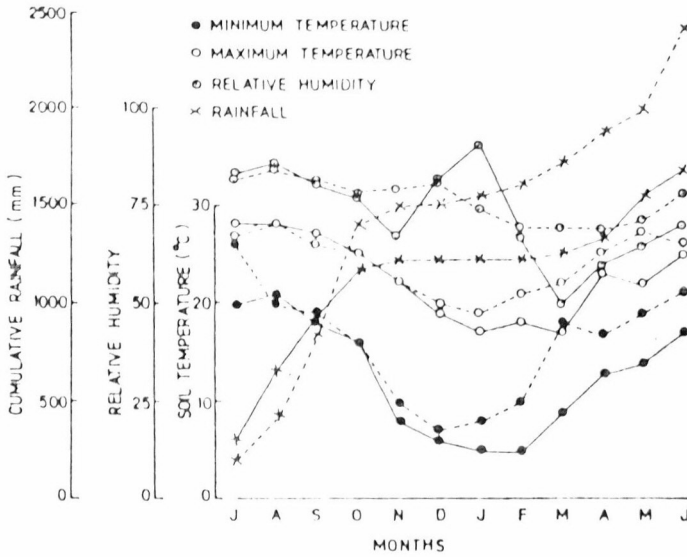


Fig. 1. Cumulative rainfall, relative humidity and ambient temperature of the study site (solid and broken lines respectively pertain to years 1985-86 and 1987-88)

computer programme meant for regression analysis.

Data for each parameter were pooled along replicates on 24 months for all the three levels of depth and plantation ages. Thus, the total number of observations for each parameter was  $24 \times 3 \times 3 = 216$ . For studying the interrelationships among parameters, coefficient of correlation was computed.

Soils of the study site are Oxisols, sandy loam in texture and reddish to reddish brown in colour. The mean soil water content ranged from 15.3 to 30.0 per cent, pH of the soils ranged between 4.0 and 5.7. The mean organic C, total N, available P and exchangeable K, respectively, in the three plantation soils ranged from 0.57 to 2.0 per cent, 0.2 to 0.68 per cent, 0.04 to 0.1g  $P\ kg^{-1}$  and 0.075 to 0.2g  $K\ kg^{-1}$ .

Seven regression equations were found after the computation of data. These equations are as follows:

$$\begin{aligned} \text{Soil temperature } (^{\circ}C) &= 22.032 - 1.763^{***} \sin\theta m + 6.958^{***} \cos\theta m + \\ & 23.394^{**} \frac{1}{d} - 0.172a; R^2 = 0.65 \end{aligned}$$

$$\begin{aligned} \text{Soil water } (\%) &= 24.502 + 0.818^{**} \sin\theta m + 4.100^{***} \cos\theta m - \\ & 14.086 \frac{1}{d} + 0.608a^{**}; R^2 = 0.47 \end{aligned}$$

$$\begin{aligned} \text{Soil pH} &= 4.951 + 0.058 \sin\theta m + 0.021 \cos\theta m + \\ & 1.407 \frac{1}{d} - 0.020a; R^2 = 0.04 \end{aligned}$$

$$\begin{aligned} \text{Organic C } (\%) &= 0.33 - 0.186^{***} \sin\theta m + 0.211^{***} \cos\theta m + \\ & 5.799^{***} \frac{1}{d} + 0.110a^{***}; R^2 = 0.43 \end{aligned}$$

$$\begin{aligned} \text{Total N } (\%) &= 0.433 - 0.029^{***} \sin\theta m + 0.071^{***} \cos\theta m + \\ & 1.472 \frac{1}{d} - 0.022a^{***}; R^2 = 0.49 \end{aligned}$$

$$\begin{aligned} \text{Available P } (mg\ 100\ g^{-1}) &= 5.986 + 0.067 \sin\theta m - 0.098 \cos\theta m + 5.816 \frac{1}{d} + \\ & 0.079a; R^2 = 0.02 \end{aligned}$$

$$\begin{aligned} \text{Exchangeable K } (mg\ 100\ g^{-1}) &= 10.329 - 1.009^{***} \sin\theta m + 2.204^{***} \cos\theta m \end{aligned}$$

+ 32.243\*\*\*  $\frac{1}{d}$  + 0.169a;  $R^2 = 0.40$  where m, d, a, respectively, indicate months, soil depth and plantation age.

The mean soil temperature was found 22°C. Temporal variations in soil temperature were found to be significant at  $P < 0.001$ . Depthwise also soil temperature varied significantly ( $P < 0.01$ ) while it did not vary significantly with the age of plantations. Temporal variation in soil water content was found to be significant ( $P < 0.01$ ). It also varied significantly ( $P < 0.01$ ) at different ages of plantation. This shows that the water retaining capacity of the soil increased with the increase in age of plantation. The mean soil water content was 0.25 kg kg<sup>-1</sup>. Temporal and depthwise variations in soil pH were also significant ( $P < 0.05$ ). pH decreased with increase in depth. In general, surface soil was found to be more acidic as compared to the soil at lower depth. Advancement of age did not show any significant impact on the soil pH.

Temporal and depthwise variations in organic C were found to be significant ( $P < 0.001$ ). It also varied significantly in different ages of plantations ( $P < 0.001$ ). Organic C showed inverse relationship with soil depth. The mean organic C content was 1.3 per cent. Surface soil had higher organic C content as compared to the deeper soils. With an increase in plantation age, organic C content also increased.

The mean total N content was 0.43 per cent. It varied significantly along depth ( $P < 0.001$ ) as well as with time ( $P < 0.001$ ). Age of the planta-

tion also showed the significant ( $P < 0.001$ ) effect on the total N content. Nitrogen content decreased with the advancement of plantation age. This may be attributed to the uptake of nitrogen by pineapple crop over the period of 10 years.

Available P in the soil did not vary significantly with depth, time and plantation age. The mean available P was 0.6 g kg<sup>-1</sup> dry soil. Exchangeable K varied significantly with time ( $P < 0.001$ ) as well as depth ( $P < 0.001$ ). Increase in age of the plantation did not show any marked effect on the potassium content of the soil.

The seasonal variation in phosphorus content showed that the concentration reached maximum during spring which may be related to the rapid releases of this nutrient from the litter. Greater microbial activity releases the phosphorus at a faster rate (Ahlgren & Ahlgren 1965) and this may be the possible reason for increased phosphorus content during the spring as the higher microbial activity was observed during the same period (Tiwari *et al.* 1987). The drop in winter in the phosphorus content is probably due to the lower microbial activity during the same period. The concentration of available phosphorus remained more or less constant in the deeper soils in all the plantations studied. Phosphate is relatively immobile (Bieliesski 1973) and this may be the reason for minimal variations noted along depths.

The concentration of exchangeable K was maximum in surface soil and it decreased with

Table 1. Correlation coefficient (*r*) values among various parameters under pineapple orchard soil

	Soil temperature	Soil water	Soil pH	Organic carbon	Total nitrogen	Avail. P	Exch. K
Soil temperature	—	0.456	NS	0.508	0.557	NS	0.534
Soil moisture	0.456	—	NS	0.274	NS	NS	0.257
Soil pH	NS	NS	—	NS	NS	NS	NS
Organic carbon	0.508	0.274	NS	—	0.446	NS	0.515
Total nitrogen	0.557	NS	NS	0.446	—	NS	0.395
Available phosphorus	NS	NS	NS	NS	NS	—	NS
Exchangeable K	0.534	0.257	NS	0.515	0.395	NS	—

Note: Values > 0.217 are significant at  $P < 0.001$ ; NS indicates not significant

increase in soil depth. Exchangeable K concentration was lower during winter. Similar results were also recorded by Singh (1980) in broad leaved forest soils. Higher concentration of exchangeable K during spring may be due to the rapid release of this nutrient from the decomposing organic matter (Tukey *et al.* 1958). The rate of release of non-exchangeable potassium to exchangeable form has been found to be a temperature-dependent phenomenon (Haagsma & Miller 1963). In the present investigation a positive correlation ( $r=0.534$ ,  $P<0.001$ ) between exchangeable K and soil temperature was observed. This relationship clearly defines the occurrence of higher levels of potassium during higher temperature conditions. Water content of the soil was also found to be positively correlated ( $r=0.257$ ,  $P<0.01$ ) with the available potassium content. Kuchenbuch *et al.* (1986) also reported similar results.

The higher concentration of organic C, total N, available P and exchangeable K in surface soils might be due to higher organic matter content in the surface layer (Bielieski 1973; Gupta & Rorison 1975) which is continuously enriched by the nutrients released from the decomposing litters. The temporal variations in nutrients are attributable to the variations in biological activity occurring in this zone. The nutrient levels of deeper soils mainly depend on the mineralization process at the surface layer because the nutrients released in the surface layer percolate down the profile along with the gravitational water. Increased organic C was noted in spring and lower values were recorded in winter.

Correlation coefficient ( $r$ ) values were calculated for various parameters and are presented in table 1. Soil temperature showed positive correlation with the organic C, total N and exchangeable K contents of the soils. Soil water content showed positive correlation with the organic C and exchangeable K of the soil. Soil pH did not correlate with any of the studied parameters.

Physicochemical characteristics, *viz.* soil temperature, moisture, organic C, total N and exchangeable K were significantly influenced by the soil depth and time factor. The same was not found true in case of available P. Age of the plantation also affects the soil moisture, organic C, total N and exchangeable K contents of the soils significantly. But on the other hand soil temperature, pH and available P content of soil were not influenced by the age of plantation.

Statistical analysis of the data has revealed that there was a general trend of depletion of nitrogen from the soils of pineapple plantations with the age of the plantations and there was an accumulation of organic C in soils of plantations of higher ages. This indicates that possibly an application of nitrogenous fertilizers may improve the crop yield in the plantations of higher ages. Though a trend of accumulation was observed in case of potassium and phosphorus also, the same was not statistically significant. This study reveals that continued maintenance of pineapple plantation over a period of 10 years has little or no adverse effect on the physicochemical characteristics of soils. This reflects that, in general, this management practice is ecologically sustainable.

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