Changes in the Chemical Properties of Peat Soil during Establishment of Pineapple

Salwa Adam
Noor Azimah Darus

ABSTRACT

Burning practice in replanting of pineapple in this country is common. The crop residues of pineapple are recycled through burning before planting. Burning had an impact on physical and properties of peat soil. This study was aimed to determine the effect of burning on the chemical properties of peat soils and to determine the volume (m^3) of peat lost due to burning during site preparation. Peat soils were sampled before, and after burning, and after one crop cycle and were analysed for pH, K, Ca, S, Mg, Fe and Zn. The nutrient elements were determined using inductively coupled plasma- optical emission spectroscopy (ICP-OES). The result indicated that pH pH, K, Ca, S, Mg, Fe and Zn were increased after burning. The nutrient flush from burning however could have contributed towards improving the low pH of peat soil which eventually increased the plant available nutrient. The increasing of soil pH is probably due to the increased of Ca and Mg after burning. However nutrient flush from burning was short lived. The flush lasted for about one year or less in the soil. The reduced nutrient was attributed to leaching and plant uptake. Residues burning also caused partial burning of the peat material itself, thereby will reduce peat volume and thickness due to combustion of peat material to produce carbon dioxides (CO_2). Burning practices resulted in a positive immediate impact in the terms of nutrient flush and improved pH, but could be resulted in substantial loss of peat in the long run. Other possible alternative to burning of plant residues included chipping and subsequently allowed them to decompose naturally.

***Key words**: Peat soil, burning, chemical properties, pineapple crop*

Introduction

In Malaysia, there are 2.365 million hectares (Melling *et al.*, 2008) of peatland which is mostly found along the poorly drained coastal areas. Malaysian peat consists of a mass of semi-decomposed organic material (hemist). It consists of woody materials in varying stages of decomposition with fibre content in the range 20-60 percent (Shamshuddin *et al.*, 1985). The high wood content causes various problems in mechanization on peat land. Recently, there are increasing areas of peat soil in Malaysia being converted into agricultural land. In Peninsular Malaysia, about 313,000 ha (32%) of the peat is used to cultivate paddy, oil palm, rubber, coconut, pineapple and mixed horticultural crops (Halimi *et al.*, 1998). Oil palm and pineapple are the two main plantation crops grown in tropical peat areas (Mutalib *et al.*, 1992) cited by Halimi *et al.* (1998).

Developing agricultural land on peat land requires several activities such as land clearing and irrigation systems developing that give an impact to the physical and chemical properties of the soil. Slash-and burn is the most common practice of land clearing for agriculture activities. Fire causes changes in soil physical and chemical properties and the nature of these changes can be variable depending on soil property, fire severity and fire fuel (Neary *et al.*, 1999). Land clearing through burning practices on peat soil could help eliminate the inherent characteristics of this type of soil by increasing soil pH and nutrient availability for plant uptake .The increased of pH is due to displacement of H^+ ions by base cations on the exchange site (Dikici & Yilmaz, 2006).

Pineapple (*Ananas comosus*) is an important food crop which is planted extensively in the tropical and sub-tropical regions. It is one of the major commercial fruits in Malaysia, and is mainly used as fresh dessert fruits or for the preparation of canned pineapple in the form of slices or rings, juices and jams. Pineapple has distinct parts as roots, stem, leaves, peduncle, fruit and crown. Except for the fruit, the rest are returned to the soil ecosystem to become one of the sources of the plant's nutrients. Normally, pineapple residue in Malaysia is usually burnt. The plant residue is recycled through burning before replanting (Ahmed *et al.*, 1998). Burning is a simple method for land preparation of pineapple because this practice could reduce production cost through minimization of tillage problems, disease and pest control (Jordon, 1985) as cited by Ahmed *et al.* (1999).

Burning, however, lead to environmental pollution and global warming. Open burning on peat soil gives greater impact compared to other soil. This is due to the inherent characteristics of peat soil which comes

from plant residues. Peat is developed in large water-logged basins from dead vegetation under anaerobic condition where the rate of organic matter (OM) buildup is faster than breakdown. The soil contains at least 65% OM (less than 35% mineral material (Melling *et al.*, 2008). Burning on peat soil will lead to the loss of peat material and shrinkage of peat land.

The establishment of pineapple crops on peat requires cleaning of thick natural vegetation which needs to be burned under control. Control burning is limited in its area coverage and size of fire as compared to open burning. Burning may lead to sudden flush of nutrients in the form of ash and the loss of peat material itself which is converted to CO_2. It would be important to know how much nutrients are flushed out after burning and how much (volume) of peat materials are being lost during plantation establishment. The objective of this study is to determine the status of nutrients in burnt and unburnt spot and to determine the volume (m^3) of peat lost due to burning during site preparation.

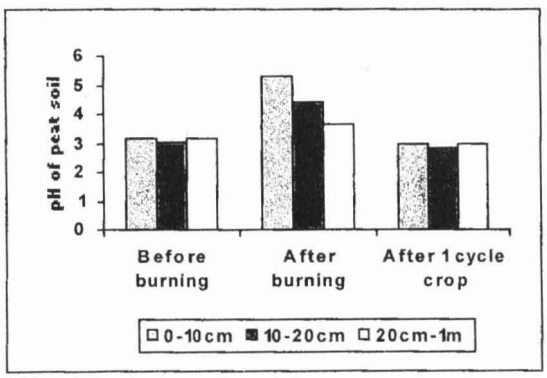
Materials and Methods

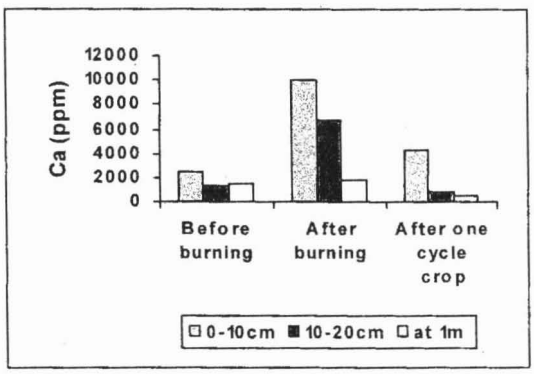
Soil sampling and field assessment were carried out at pineapple field located in Kampung Johan Setia, Klang Selangor. The soil type of the area is peat soil. The peat soil was categorized as deep peat because the thickness is more than 1.5m (Melling *et al.*, 2008). Farmers in this area mostly practiced burning for land clearing. Natural vegetation was destroyed and the area has been planted with pineapple crops. The soil samples were collected from three locations which consist of area before burning, immediately after burning and after one crop cycle. Soil samples were collected from an area of 6 acre which covers burnt spots. The samples were collected at three different depths which are 0-10cm, 10-20cm and at 100cm. Soil samples were randomly taken from 5 sampling points for each location and replicated three times to give a total 45 soil samples. The samples were analyzed for pH, phosphorus (P), potassium (K), calcium (Ca), sulfur (S), magnesium (Mg), ferum (Fe) and zinc (Zn). The soil samples were extracted through wet digestion while the pH of soil samples was determined in 1: 2.5, soil: water suspension (Kalra & Maynard, 1991). Total peat loss was measured using grid wire mesh (0.5m x 0.5m).

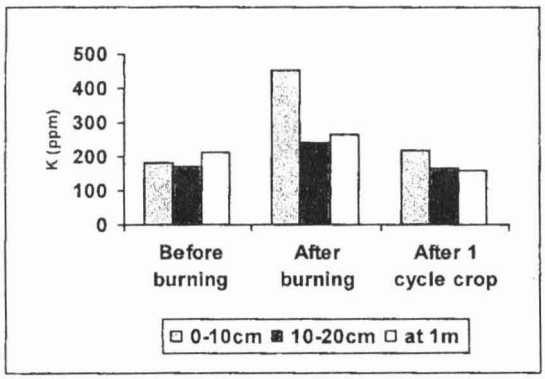
Results and Discussions

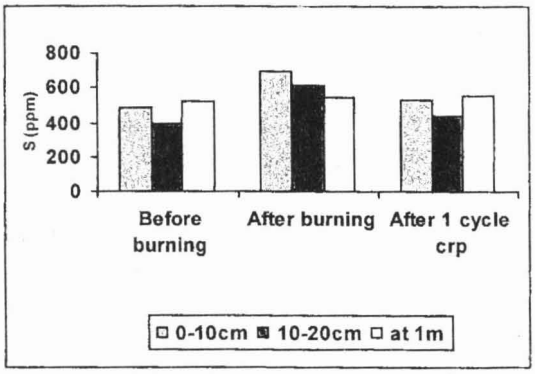
Chemical properties

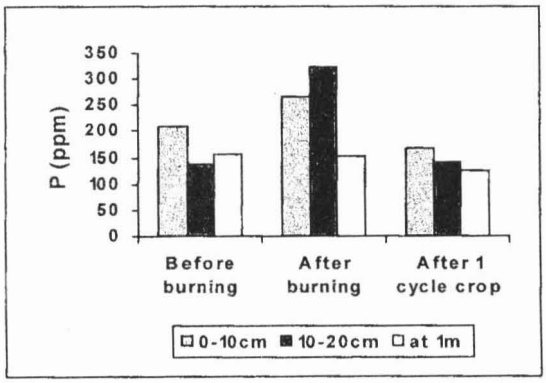
Figure 1: Comparison of pH, available of potassium (K), phosphorus (P), zinc (Zn), calcium (Ca), sulphur (S), magnesium (Mg), ferum (Fe) and in the 0-10, 10-20, at 100 cm layers of peat soil.

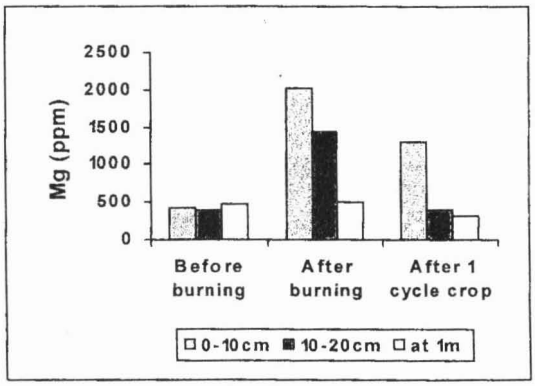


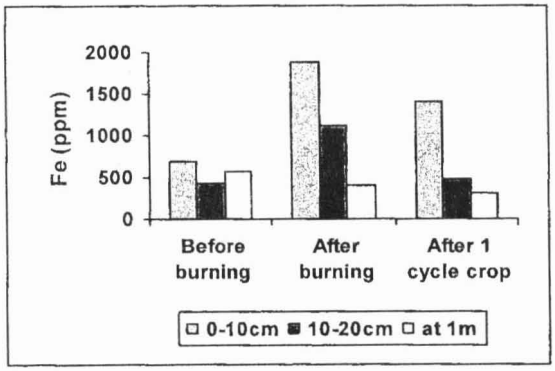


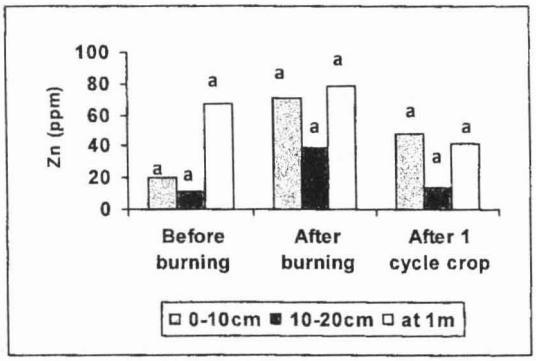












Result from the study showed that there was an increase in the soil pH for the plot immediately after burning at 0-10cm depth. The soil pH increased from 3.91 to 5.31. Unfortunately the pH of after burning plot decreased later after the one cycle crop. It means the pH of peat soil after burning did not last. The increase in soil pH is probably due to the increase of Ca and Mg after the process burning of plant residue during land clearing activity. The increase in soil pH can directly affect the availability of plant nutrients (Dikici & Yilmaz, 2006). Figure 1 shows the concentration of available P, K, Ca, Mg, S, Fe and Zn from three different plots. The result shows there was an increase in concentration of all elements after burning. The increases of the elements are due to the high amount of nutrients in pineapple residues and organic matter in the peat soil itself. This is because the amount of nutrient elements released through burning depends upon the total nutrient content in the biomass and intensity of burning (Juo & Manu, 1996). The increasing concentration of Ca and Mg on the topsoil of burned location has directly affected and increased the soil pH.

However there is a slightly decrease of the elements after one cycle crop planting of pineapple. The reduction of concentration in P, K, Mg, Ca, S Fe, and Zn is probably due to nutrient uptake by plant during crop development, especially K is important to increase sugar and acid content in the pineapple fruit. Besides that nutrients may be lost through volatilization and export of ash particles by updraft and being lost after burning through leaching (Dikici& Yilmaz, 2006 and Juo & Manu, 1996). Potassium is highly leachable because of high porosity of the peat soil. The porosity of peat soil in this area is high due to the presence of partially decomposed organic matter containing a lot of macropores that allows the movement of nutrient into deeper horizons especially during wet season. Therefore, it was noticed that the highest available P was observed at 10-20cm

depth of soil sample (322 ppm) compared to top soil (266 ppm). This situation occurred because during the burning of peat, some of the materials collapsed and the ash seeped further down the soil profile (Juo & Manu, 1996).

Furthermore, the reduction of nutrients because the nutrients were removed through harvested crop (Juo & Manu, 1996) and might be blown or washed off site and converted to unavailable form and antagonism of nutrients which excess of calcium may depress the concentration of potassium (Shamshuddin *et al.,* 1985). Since the soil pH had increased after burning, the concentration of Fe is supposed to be low. This is because the availability of iron should be limited in soils with high pH (Malvi, 2011). However from this study the results showed there was an increase in concentration of Fe while at the same time the soil pH also had shown some improvement due to burning. It was not sure how the trends had occurred. It could be due to increased in water table where increased the Fe concentration.

Physical Properties

Burning has caused destruction of the structure in the surface layer (topsoil) and loss of peat due to combustion. The amount of peat due to loss before establishment of pineapple is greater as compared to lost during replanting of pineapple. It was found that, burning before establishment of pineapple and during process of replanting pineapple stubble causes loss of peat about 74.2 ha^{-1} and 20.6 ha^{-1} respectively. This is probably due to the amount of natural vegetation is greater during site preparation than the amount of pineapple stubble which directly affects the amount of peat loss. The more the plant residues the larger the fire will be cause greater peat loss. The results of burning were the released of carbon to the atmosphere in the form of CO_2 and left the nutrients in the form of ash. Furthermore the depth of peat will decrease as burning is being practiced annually for replanting pineapple. Fire also will affect the stability of the ground. The removal of soil layers at the surface leads to enhanced erosion and the destruction of deeper layers which can lead to structural collapse and also the smouldering fires also can lead to local subsidence of the soil (Dikici & Yilmaz, 2006).

Conclusion

The increase of nutrients due to burning is possibly due to the large amount of nutrient stored in pineapple residues and organic matter on peat itself. However, farmers cannot depend entirely on the nutrient from the flush to support pineapples crop and have to apply fertilizer heavily. This is due to heavy leaching of nutrients in peat soils. Since burning was practiced annually for replanting of pineapple it is not impossible for the nutrients in peat soil to gradually decrease during burning. However, the burning of pineapple stubble had brought back those nutrients into the soil although only temporarily. Although burning increases the amount of nutrients in the soil, which short lived enhances growth performance of pineapple, it also has negative effects. In this study, it was observed there is loss of peat after burning. Burning of pineapple stubble had affected the surface of peat material which reduced the depth of peat. This may not have the immediate impact but could be substantial in the long run. Thus, burning should be avoided during crop establishment. The use of shredder to shred plant materials and old stubbles and not to restore to burning is an alternative to burning and is more sustainable.

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SALWA ADAM, NOOR AZIMAH DARUS, Universiti Teknologi MARA Pahang, salwa@pahang.uitm.edu.my, noorazimah@pahang.uitm.edu.my