SOIL PHYSICOCHEMICAL PROPERTIES UNDER PEPPER FARMING IN KAMPUNG BANTANG, SERIAN

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Soil Physicochemical Properties under Pepper Farming in Kampung Bantang, Serian

Wong King Hong

ABSTRACT

Pepper (*Piper nigrum* L.) is one of the main crops grown in Malaysia. This study compared the soil physicochemical properties under pepper cultivation at Kampung Bantang. Soil samples were collected from surface soils (0-10 cm) of four study sites, namely, pepper gardens of three different ages (less than one year, two years, five years) and fallow land. The soil analysis revealed that the surface soil of the study sites were clayey and strongly acidic. The total N values were found to be ranged from 1.80 g kg\(^{-1}\) to 4.34 g kg\(^{-1}\). It was also indicated that the available P content at the study sites ranged from 0.00 mg kg\(^{-1}\) to 490.28 mg kg\(^{-1}\). On the other hand, the exchangeable potassium (K) gave the value ranging from 0.09 cmol\(_e\) kg\(^{-1}\) to 0.99 cmol\(_e\) kg\(^{-1}\). The available P and exchangeable K were generally higher at fertilizing points than those at non-fertilizing points. From the soil analysis result, it could be deduced that the soil in Kampung Bantang is suitable for pepper cultivation. No significant difference was found for in most of the soil physicochemical properties between pepper farms and fallow land. However, there was nutrient accumulation in soil due to fertilizer application in pepper farms.

Key words: *Piper nigrum* L.; soil physicochemical properties; Sarawak
Sifat Fizikokimia Tanah di bawah Penanaman Lada di Kampung Bantang, Serian

Wong King Hong

ABSTRAK

Lada (Piper nigrum L.) adalah salah satu tanaman utama di Malaysia. Kajian ini membandingkan sifat fizikokimia tanah di bawah penanaman lada di Kampung Bantang. Sampel tanah diperoleh dari permukaan tanah (0-10 cm) di empat jenis guna tanah, iaitu kebun lada dengan tiga umur yang berlainan (kurang dari satu tahun, dua tahun, dan lima tahun) dan kawasan kosong. Analisis tanah mendapati bahawa permukaan tanah bagi tapak kajian adalah berliat dan berasid. Jumlah nitrogen adalah dari 1.80 g kg⁻¹ ke 4.34 g kg⁻¹. Kajian ini juga mendapati bahawa kandungan fosforus dalam tanah di tempat kajian adalah dalam liniungan 0.00 mg kg⁻¹ kepada 490.28 mg. Selain itu, kandungan kalium adalah dalam liniungan 0.09 cmolₑ kg⁻¹ to 0.99 cmolₑ kg⁻¹. Kandungan fosforus dan kalium adalah tinggi di kawasan membaja berbanding dengan kawasan tidak membaja. Dari analisis tanah, dapat simpulkan bahawa tanah di Kampung Bantang adalah sesuai untuk penanaman lada. Namun, terdapat pengumpulan nutrien di dalam tanah disebabkan oleh pembajaan di kebun lada.

Key words: Piper nigrum L.; sifat fizikokimia tanah; Sarawak
CHAPTER 1

INTRODUCTION

1.1 Background of the study

Pepper (*Piper nigrum* L.), well known as the “King of Spices” is dominant in the global spice trade (Wong *et al.*, 2010). The pepper industry in Malaysia is export-oriented as approximately 90% of the pepper produced is meant for export which contributes to national income (Rosli *et al.*, 2013). According to statistics by Malaysian Pepper Board (MPB), pepper export generated over RM 400 million in year 2014 (MPB, 2015). Therefore, it is an important cash crop in Malaysia. Besides, Malaysia was the largest pepper producer in the world in 1980s (Zainal Abidin & Abdul Rahim, 2012). Though it is now dominated by Vietnam, Malaysia is still listed as the top five largest pepper producers in the world now, together with India, Indonesia and Brazil (IPC, 2014).

In pepper cultivation, site selection is very crucial to ensure high productivity. This is because it is a medium to long term crop with economic life span from 14 to 25 years, provided that the site is maintained properly (George, 2005). In Sarawak, pepper is normally planted by smallholder farmers primarily in fertile hill slopes. The smallholder farms are concentrated mostly in Kuching, Samarahan, Sri Aman, Betong and Sarikei. This cash crop is cultivated in small farms averaging 0.2 ha and provides important source of income for 67,000 rural families in the interior areas of Sarawak (Kamarulzaman *et al.*, 2013). Nevertheless, market factors such as pepper price and inputs price are affecting
Pepper farming in Sarawak (Rosli et al., 2013). Adding to that, Sarawak is also the largest pepper producer state in Malaysia, accounting for 98% of the country production. As a result, Sarawak Pepper had gained its commercial name internationally as Malaysian-grown pepper (Wong et al., 2010).

Pepper cultivation is often associated with shifting cultivation. For decades, shifting cultivation has been accused to cause soil erosion. That is the reason why numerous studies reported the problem of soil erosion and fertility loss in shifting cultivation (Borggaard et al., 2003; Rasul et al., 2004). In a recent study by de Neergaard et al. (2008), the researchers studied soil erosion from three different land uses in shifting cultivation system, namely upland rice, pepper garden and native forest. Nonetheless, they concluded that no significant soil erosion and quality loss under shifting cultivation system.

1.2 Problem statement

Many factors such as fertilizer application, plant spacing, irrigation method and so on had resulted in the low pepper production. Agro-based development was therefore introduced by Malaysian government. This was aimed to increase the utilization of agricultural produce, including pepper which would further contribute to the increase of downstream processing into industrial commodities (Khor, 2008).

Apart from that, nutrient management is regarded as the most important limiting factor in pepper farming as pepper is a nutrient demanding crop (Sivaraman et al., 1999). As a consequence, sound nutrient management plan is important for the sustainable production
of pepper. This is because the utilization pattern of nutrient over several years can be
different (Yap, 2012a).

There is a lack of information regarding the soil characteristics under pepper farming at
different ages of pepper in Sarawak. The recent studies related to pepper cultivation were
conducted by Tanaka et al. (2009) who worked on soil characteristics under cash crop
farming in upland areas of Sarawak and Yap (2012b) who compared the different
fertilization methods on the soil as well as yield and growth performance of black pepper.
Soil characteristics will provide indispensable information for the improvement of pepper
farming. This study was therefore conducted to enhance our understanding on the soil
fertility in pepper farming.

1.3 Objectives

The aim of this study was to investigate the soil properties under pepper cultivation in
Kampung Bantang, where pepper is one of the main sources of income for the villagers.
The study also compared the soil physicochemical properties under pepper farming at
different ages, in comparison with fallow land in the same area. This will give us an insight
on the suitability of the soil in Kampung Bantang for the purpose of pepper farming.
The objectives of this study were:

i. To determine soil physicochemical properties under pepper farming

ii. To compare soil physicochemical properties of peppers with different ages and fallow land
CHAPTER 2

LITERATURE REVIEW

2.1 General information on pepper (Piper nigrum)

Being a member under the family Piperaceae, the genus piper has more than 1,000 species but Piper nigrum is the most economically important species (Sulok et al., 2014). Pepper is a climbing vine remarkable for its pungent fruit used mainly as a spicy condiment in food worldwide (Seshachala & Tallapragada, 2012). In the Middle Ages, it was used to conceal the flavour of salted and cured meat (Singletary, 2010). Additionally, it is also used to impart the pungency to cooked vegetables and meals (Ahmad et al., 2013). Hence, pepper will continue to be a prominent spice worldwide in enhancing the food favour.

The great usages of pepper in various fields have secured itself a pivotal position in food, pharmaceutical, cosmetic and perfumery industries as a result of its recognition as an important source of natural antioxidant having anti-carcinogenic activity (Wong et al., 2010; Meghwal & Goswami, 2012). In brief, pepper constituents contain fiber, piperine, eugenol, enzyme lipase, minerals and essential oils such as α- and β-pinene, limonene, and β-caryophyllene (Singletary, 2010).

A review article by Meghwal & Goswami (2012) on the “chemical composition, nutritional, medicinal and functional properties of black pepper” stated the importance of
pepper as having bioavailability enhancement nature, carminative property, anti-inflammatory action, cholesterol lowering capacity, immune enhancer ability, anti-pyretic, anti-periodic, antimicrobial and rubefacient activity. In India, it was often used as herbs in Ayurvedic medicine and has potential value to treat the gastrointestinal disorders and chronic malaria. Pepper was also used for the epilepsy treatment in traditional Chinese medicine (Singletary, 2010).

With the advance of research and development (R&D), as well as the increasing demand on natural products, pepper will definitely find its ultimate values in various industries and scientific research (Wong et al., 2010).

2.2 General overview of pepper cultivation in Malaysia

Under the Malaysian Pepper Board Act 2006, a statutory body named Malaysian Pepper Board (MPB) was established to oversee all the activities regarding pepper in the country, for example, the grading of pepper for export (Iskandar et al., 2013).

According to the Pepper Statistical Yearbook (IPC, 2014), a total area of 468,158 hectares were planted with pepper worldwide in year 2013. Out of these total land areas, Malaysia has a total pepper planting area of 15,000 hectares. In the year 2013, total production of pepper in Malaysia was 25,000 tonnes which included production of 17,500 tonnes of black pepper and 7,500 tonnes of white pepper (Figure 2.1).
The pepper industry in Malaysia is export-oriented as approximately 90% of the pepper produced is meant for export which contributes to national income (Rosli et al., 2013). Until 1980, Malaysia was the largest pepper producing country in the world (Zainal Abidin & Abdul Rahim, 2012). However, the production is now dominated by Vietnam and a few other countries (Figure 2.2).
Pepper vine is usually being planted on fertile hill sloppy ground with good drainage in tropical warm climate like Malaysia. Some of the examples of pepper varieties planted in the country are Sariki, Kuching, Indonesia, Indian, Semongok Aman, Semongok Emas and Semongok Perak (Rosli et al., 2013).

In brief, Malaysia produces two types of pepper, known as black pepper and white pepper. Sarawak Pepper is the commercial name for both white and black peppers exported from Malaysia. The processing method of these peppers is used to differentiate them from one another. Black pepper is produced by drying the mature berries of *Piper nigrum* under the sun for about 3 to 10 days. On the other hand, white pepper is processed by retting the ripe or almost ripe berries in running water to remove the pericarp and pulp prior to drying. Often, 80% of them will be processed into black pepper (Zainal Abidin & Abdul Rahim,
Nonetheless, the quality of white pepper is higher than that of black pepper and therefore white pepper is often more expensive than black pepper (Liew et al., 2000).

2.3 Pepper cultivation practices in Sarawak

It dated as far back as 1856 when pepper was cultivated in Sarawak. The commercial production of pepper only started about 20 years later (Ravindran, 2003). During Brooke administration, the Land Incentive and Import of Foreign Labour policies were introduced to facilitate the pepper industry development in Sarawak. The quick recovery of the world economy after World War II contributed to the increasing demand of pepper. Consequently, pepper industry transformed from subsistence production based on shifting cultivation into a more commercialized farming, partly income-orientated from cash crops (Rosli et al., 2013).

In Sarawak, pepper is usually harvested from April to September every year with May and June as the peak season (Iskandar et al., 2013). This crop is grown predominantly in Sarawak by the rural farmers which provide them with an important source of income. The profitability of pepper depends on various factors, such as price fluctuations and government pepper subsidy schemes (Wadley & Mertz 2005).

Apart from that, pepper cultivation is usually labour intensive. The capital needed per hectare is also a burden to farmers who are mostly smallholder farmers. In addition, unexpected diseases such as Phytophthora foot rot, blackberry, velvet blight and wrinkled leaf diseases as well as damaging pests, such as tinged bugs, pepper weevils and
nematodes will also create problem to farmers and cause a serious money loss to them (Zainal Abidin & Abdul Rahim, 2012).

Despite all these obstacles, the Sarawak Pepper is still well known for its quality and hence it has earned high reputation in the world. As a result, Sarawak registered its geographical indication (GI) under the Geographical Indications Act 2000, Geographical Indications Regulations 2001 on 4 November 2003 (Iskandar et al., 2013).

2.4 Agronomic practices in pepper farming

Pepper is adaptable to a great variety of soils. However, sandy loam clay to clay loam is the preferable soil texture as it allows better root penetration. In Sarawak, soil series of the Merit family in the Red Yellow Podzolic group are the most common soil used for pepper cultivation. Both the Tarat series and the fine clayey soils of the Semengok series are preferred in Malaysia due to their high productivity (George, 2005).

Traditionally, farmers in Sarawak used Belian post as support for pepper vines (Sadanandan, 2000). Pepper is propagated mainly by vegetative cuttings. The recommended spacing is 1.8 m x 2.4 m, accommodating about 2,300 plants/ha. However, the average plant density is only 1970-2000/ha (George, 1981). Farmers having limited land area may choose closer spacing between pepper vines.
2.5 Fertilizer in pepper farming

Fertilizer is important in crop production. Applying optimum dose of fertilizer will increase the growth and development of pepper as well as maximize its yield (Khan et al., 2010). Pepper, like other crop, grows well when it is adequately supplied with the essential nutrients through fertilization (Olaniyi & Ojetayo, 2010).

Peter et al. (2000) reported that the macronutrients must be applied in sufficient quantities to compensate the nutrient losses through leaching. This is because an adult black pepper vine removes 233.4 g N, 16.8 g P, 171.9 g K, 18.3 g Mg, 75.0 g Ca, 365 mg Fe, 281 mg Mn, 104 mg Zn, 89 mg Cu and 60 mg B. Meanwhile, Hanafi et al. (1993) found that a major proportion of the total P (79%) in pepper plant was accumulated in stem and leaves as compared to the roots (21% of the total P in pepper plant). As a result, a higher amount of P is required for the growth and development of stem and leaves. In this scenario, the application of manure or fertilizer is of importance to replenish nutrients removed by pepper as to maintain the soil fertility (Hamza et al., 2004).

The acidic soil in tropical countries such as Malaysia favours phosphate fixation, which results in considerable immobilization of any fertilizer P applied to these soils. In these circumstances, the use of phosphate rock (PR) as a direct-application fertilizer is preferable over the use of water-soluble P fertilizer (Sabrina et al., 2013). Under the compound traditional farming system, poultry dropping contains large amount of nutrients required by pepper (Alabi, 2006).
On the other hand, Olaniyi & Ojetayo (2010) highlighted the great influence of organomineral fertilizer, inorganic fertilizer and their combination at different levels on the growth parameters and yield components of pepper. In Malaysia, there is an increasing trend of using inorganic fertilizers in pepper farming. Based on the current practice, pepper farmers are required to apply about 1, 2 and 3 tonnes of compound fertilizer (12%: 12%: 17%: 2% (Mg) + trace elements) per hectare per year, for the first, second and third year of pepper planting, respectively (Yap, 2012b).

Fertilizer application is essential for pepper cultivation. Nevertheless, the excessive usage of synthetic agrochemicals in replenishing soil fertility for agricultural activities should not be taken for granted as such practice could lead to residue toxicity and environmental pollution (Duarah et al., 2011). One of the better suggestions by Yap (2012b) is the integrated use of chemical and organic fertilizers for the sustainable management of pepper production in Malaysia. Thus, the challenge now is to maintain the sustainability of pepper production by minimizing harmful effects from fertilizer application (Duarah et al., 2011).
CHAPTER 3

MATERIALS AND METHODS

3.1 Study area

This study was conducted in Kampung Bantang, located in Serian District. In a direct distance, Kampung Bantang is located approximately 36 km southeast of Kuching with approximate latitudes of N 01°10’57.9” and longitudes E 110°27’49.6” (Figure 3.1).

Figure 3.1: Location of Kampung Bantang (Google Map, 2015)