THE EFFECT OF INTERCROPPING SYSTEM OF IMMATURE RUBBER-BANANA-PINEAPPLE ON SOIL PROPERTIES AND SOIL EROSION: A PRELIMINARY OBSERVATION

(Pengaruh sistem intercropping karet muda-pisang-nenas terhadap sifat-sifat dan erosi tanah: Suatu penelitian pendahuluan)

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ABSTRAK

Penelitian pendahuluan untuk mengevaluasi beberapa sifat tanah di bawah sistem *intercropping* antara tanaman karet muda-pisang-nenas telah dilakukan satu tahun setelah penanaman. Penelitian difokuskan terhadap perubahan sifat-sifat tanah terutama kerapatan isi, kestabilan aggregat, kandungan bahan organik, dan biomass akar. Disamping itu, besarnya aliran permukaan dan kehilangan tanah juga diukur dengan menggunakan simulator hujan mini. Hasil penelitian menunjukkan bahwa sifat-sifat tanah di bawah tanaman nenas lebih baik dibandingkan dengan pisang dan karet, aliran permukaan dan kehilangan yang paling rendah juga ditemukan di bawah barisan nenas.

Key word: intercropping, soil properties, runoff, soil loss.

INTRODUCTION

Intercropping can be defined as the simultaneous cultivation of two or more crops on the same area of ground. The crops are not necessarily sown at the same time, and their harvest time may be quite different, but they are usually present together for a substantial part of their growing period (Ramert, 1996).

The types of intercrop currently used are selected for their efficiency in controlling soil erosion and for beneficial influence on the growth and yield of major crop. Although creeping legumes have been found to be efficient cover plants, both from the stand point of erosion control and crop improvement, their effect is not permanent because four or five years after establishmented these plants die off, as a result of shading effect from the canopy of tree crops (Soong *et al.*, 1980). In some tropical countries, most farmers, especially the small holders are planting banana and pineapple as intercrops because these crops are short term and more income generating. Pineapple when planted as intercrop with other crops also act as an erosion control measure due to its thick and dense canopy which provides a protection cover to soil against heavy rainstorms and resist run off on the soil surface.

Surface cover and crop/plant canopy directly affect the soil detachment process by intercepting raindrops and dissipating their kinetic energies before impact on the soil surface. The effective energy of raindrops after the canopy interception depends on the height of plant and type of life structure. A shorter, bushy canopy such as annual and shrubs generally dissipates the falling drop completely (Sharma, 1996).

The greatest negative effect of erosion on soil productivity is decrease in water holding capacity, water stable aggregate and pour pore size distribution while clay fraction and bulk density is increased.

Zainol and Mokhtaruddin (1993) found that intercropping activities affect the nature of the soil aggregates and stability of the soil and at three years after establishing rubber and its intercropping component, the finer aggregates were greatly reduced. Therefore, it is reflected that larger aggregates would improve resistance of soil to erosive effects of raindrops and runoff whereas finer aggregates would enhance the removal of sediments from the soil surface. Sanmugam (1996) found that soil aggregates (during establishment period) of banana-pineapple plot were more stable than monocrop plots of these crops.

Ghulam (1995) found that when cocoa was intercropped with banana, soil loss was less than 10 t ha^{-1}.$year^{-1}$ as compared to other cleaned weeded areas (77.2 t ha^{-1} $year^{-1}$). Almas (1998) found that soil loss under bare plot (105.5 t ha^{-1}) was four times higher than under intercropping of banana and pineapple (26.4 t ha^{-1}) during the experimental period of nine months.

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Based on above aspect, the aim of the study is to evaluate the effect of intercropping system of immature rubber, banana and pineapple on certain soil properties, runoff and soil loss after one year planting.

MATERIALS AND METHODS

Study Site

The study was conducted in a small holder farm at Bukit Naring, Jelai, situated at a distance of 22 kilometers from Taiping, Perak on a hilly area under Munchong soil series (Tropeptic Haplorthox). The soil texture was sandy clay and the slope of area ranges from 15 –22%.

Data Collection

For data collection, study site was divided into 3 sub sites along the slope namely: top, center, and bottom of the slope for evaluation of bulk density, aggregate stability, water retention characteristic, organic matter content, root biomass, runoff and soil loss.

Soil Properties

Soil samples were taken from beneath each crop for evaluation of bulk density and water retention. Composite bulk samples consisting of soils taken from five points were obtained for aggregate stability and organic matter content analysis.

Runoff and soil loss

Amount of run off and soil loss under each crop was measured by using a small rainfall simulator. It produces an 18 mm rain shower in three minutes, thus giving intensity equivalent to 36 $cm.hour^{-1}$. The rain drops falls from an average height of 0.4 m onto a 0.0625 m^2 surface area of the test plot. Detail of the design, operational procedures and field plot preparation are fully described by Kamphorst (1987).

Measurement of Root Biomass

Soil samples for the determination of root biomass of the crops were collected by root auger method (Chan, 1976; Goh and Samsudin, 1993) at the depths of 0-15 and 15-30 cm. Samples were collected randomly 30 cm from the banana, pineapple and rubber rows. In the laboratory, each soil core was weighed immediately and then soaked in water before pouring the content into 1 mm sieve. To assist dispersion of clay and separate roots from the soil, they were immersed in a solution of sodium phyroposphate (10 g l^{-1}) for 1-2 days (Drew and Saker, 1980).

RESULT AND DISCUSSION

The mean values of soil properties studied under those intercopping are shown in Table 1. It was found that there was no statistically difference among crop treatment one year after planting for two depth (0-15 cm and 15-30 depth). The bulk densities were 1.14, 1.14 and 1.11 $g.cm^{-3}$ at the depth of 0-15 cm and 1.20, 1.26, and 1.20 $g.cm^{-3}$ at the depth of 15-30 cm for pineapple, rubber and banana respectively.

The highest soil aggregate stability (stability index and water stable aggregate>0.5) was found under pineapple hedgerow for both depths followed by banana and rubber.

Table 1. Mean values of soil properties under intercropping of immature rubber-banana-pineapple one year after planting

Depth (cm)	Treatment	Bulk Density ($g\ cm^{-3}$)	Aggregate Stability SI	WSA>0.5	OM (%)
0-15	Pineapple	1.14 a	0.65 a	73.70 a	3.53 a
	Banana	1.11 a	0.57 a	71.20 a	3.22 a
	Rubber	1.14 a	0.50 a	73.37 a	3.44 a
	CV	9.37	16.45	6.11	17.80
15-30	Pineapple	1.20 a	0.51 a	71.98 a	3.39 a
	Banana	1.20 a	0.48 a	70.40 a	3.68 a
	Rubber	1.26 a	0.47 a	72.67 a	2.76 a
	CV	6.30	23.50	11.43	19.21

Means followed by the same letter are not significantly different (P<0.05) by Duncans's Multiple Range Test.
Note : SI = Stability Index WSA = Water Stable Aggregate OM = Organic Matter

In the case of organic matter, soil under pineapple showed the higher soil organic matter content compared to banana and rubber at 0 - 15 cm depth and under banana at 15-30 cm depth. This is because the dense of pineapple hedgerow enables the organic matter, which is carried by runoff to accumulate around it. In the case of soil under banana and rubber which are more exposed than pineapple, organic matter is easily lost due to erosion as reflected by the lower values.

The direct effect of organic matter content expressed in stability index of the soil where the soil stability under pineapple is the highest for both depths (Table 1). The effect of organic matter to soil stability has been reported by many researchers for examples Zainol and Mokhtaruddin (1993), Sanmugam (1996) and Gerzabek *et al.* 1997).

Root biomass of the crops under these intercropping is expressed by dry root weight. Root weigh of each crop for 0-15 cm and 15-30 cm shown in Figure 1. It shows that the highest dry root weigh occur in banana for both depth followed by pineapple and rubber. Even though dry root of banana was higher than the two other crops, they were not significantly different among the crops. The size and amount of banana root grows and distributes faster due to presence of mother plant and its suckers which enable them produces more root in short periods. Performance of tall plant causing negative impact to amount of soil loss and runoff in the surface area (see Figure 2).

Amount of run off and soil loss was measured *in situ* using a small rainfall simulator (Kamphorst 1987) showed in Figure 2. The highest runoff and soil loss was found under rubber namely: 13092.8 $cm^3 m^{-2}$ and 269.4 $g m^{-2}$ and significantly different with two other crops whereas between banana and pineapple insignificant each other. The order of runoff from intercropping system at 0-15 cm depth was rubber> banana> pineapple. The lowest runoff and soil loss occurs in pineapple due to the difference in plant performance and their leaves coverage. Rainfall collected by pineapple leaves is released by leaf drop and stem flow on to the soil surface much slower and weaker than drips produces by rubber and banana plot.

The first phase of erosion process is the breakdown of the soil by raindrop impact. This provides a reservoir of loose particles on the soil surface ready for transport down slope by surface runoff. However, this process can be enhanced by the presence of a vegetation cover. This occurs because the canopy of vegetation intercepts the rainfall and changes both its spatial and drop size distribution (Morgan, 1987).

The amount of soil detachment or soil aggregate beneath a vegetation cover depend upon the percentage of cover, the height of that cover above the soil surface and whether or not the plants generate leaf drip. Taller canopies produce large-size recoalesced drops which are generally prolate in shape. Such drops may be more erosive due to their higher detachment efficiency than similar size raindrops falling at terminal velocities (Moss and Green, 1986; Sarma and Gupta, 1989).

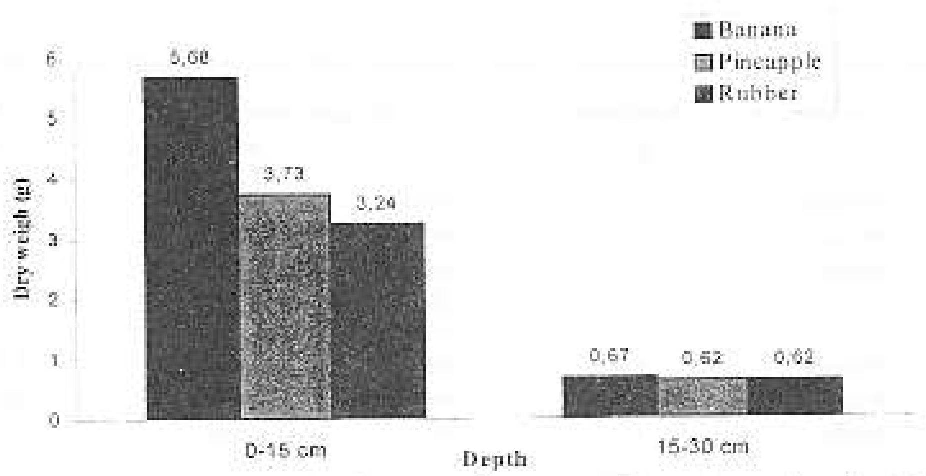
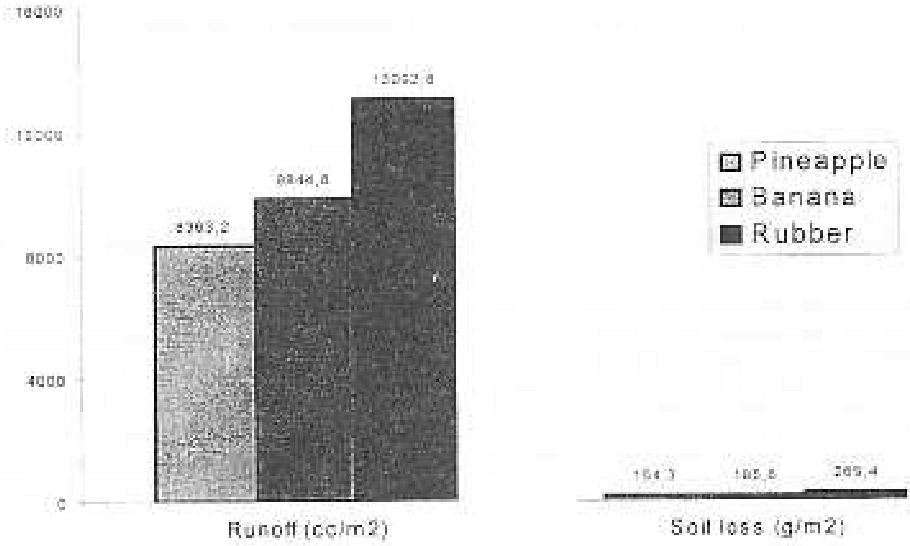


Figure 1. Dry root of crops under intercropping system of immature rubber-banana-pineapple



Furthermore, the increase in soil cohesion due to root reinforcement is often with higher infiltration rates promoted by the root network and higher rates of evapo-transpiration. Together these effects imply an important engineering role for the plant cover in contributing to a drier and stronger soil environment.

CONCLUSSION

Preliminary observation indicated that there was no difference in soil properties detected in the first year of intercropping of rubber, banana and pineapple. In case of organic matter content, it gave good contribution resulting in good aggregate stability of soil. Due to performance of plant, the highest runoff and soil loss occurs in rubber followed by banana and pineapple. In terms of soil properties and soil erosion as a whole it was found that pineapple enhances soil properties during the first year of planting.

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