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The Impact of Oil Palm and Rubber Plantations to the Microenvironment

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ABSTRACT

Oil palm is a perennial plant belonging to family Palmae and sub family Cocoideae. It is scientifically named as *Elaeis guineensis* and is cultivated as a source of vegetable oil in West and Central Africa, where it originated. Oil Palm was cultivated in Sri Lanka in 1968 at Nakiyadeniya estate by Mr. M. Jerry Wales an European planter. Currently oil palm is more profitable compared to other plantation crops in Sri Lanka. This study was conducted to study the impact of oil palm and rubber plantations on the corresponding microenvironment. Study was done in Hulandawa estate in Namunukula Plantation PLC. One acre of 15 year and five year old oil palm and rubber plantations were selected. Using random sampling soil samples were collected in each plantation in the both inter row and fertilizer circle. Also using quadrant plant species count was taken in the undergrowth of rubber and oil palm cultivations. The soil samples were analysed to check soil pH, moisture, organic carbon, and available nitrogen. Oil palm plantation undergrowth vegetation was dense as in rubber but had more shade and moisture loving plants. Soils were more acidic with oil palm and possible reasons for this are discussed. Oil palm plantation soil had higher organic carbon, available nitrogen and moisture content than in rubber plantations and reasons and impacts are discussed.

KEYWORDS: Micro environment, Oil palm, Rubber, Soil characters

INTRODUCTION

Oil palm (*Elaeis guineensis)* is a plantation crop belonging to family Palmae and sub family Cocoideae having a high economic value. This crop is cultivated as a source of vegetable oil in West and Central Africa, where it originated and in South Asian countries like countries like Malaysia, Indonesia, Thailand and Sri Lanka. It is also planted as an ornamental tree in many subtropical countries (Anon, 2015b). Oil palm covers 2% of total cultivated lands in the world and is contributing to 30% of the world's total vegetable oil requirement. Apart from being a vegetable it is also used in making soaps, candles and lubricating greases. Palm-kernel oil is used in manufacturing edible products such as margarine, chocolate confections and pharmaceuticals.

Palm oil industry helps in the economic development of many countries. The wild oil palm that grows in Central and West Africa consists mainly of a thick-shelled variety with a thin mesocarp, called Dura. Breeding work, particularly crosses between Dura and a shell-less variety (Pisifera), have led to the development of a hybrid with a much thicker mesocarp and a thinner shell, termed Tenera. All breeding and planting programs now use this latter type, the fruits of which have a much higher content of palm oil than the native Dura.

Oil palm is cross pollinated and usually the pollinating agent is the wind. Inflorescences on adult oil palms appear as males, followed by females or *vice versa* (Anon, 2016a). M. Jerry Wales, an European planter, commenced the cultivation of oil palm in Sri Lanka in 1968 at Nakiyadeniya Estate by planting 68 oil palm plants covering an extent of 0.50 ha. Since 1968, oil palm cultivation has rapidly increased throughout the low country wet zone of Sri Lanka as it was seen as an economical and a profitable crop.

Currently oil palm is relatively more profitable compared to other plantation crops in Sri Lanka. Palm oil plantations generate an income of Rs.150,000 to Rs.200,000 per hectare per annum whilst tea and rubber plantations are struggling to make profits.

Commercial palm oil cultivation started in Sri Lanka on a 20 ha land in Nakiadeniya. Further, Galle, Matara, Kalutara, Colombo, Kegalla, Gampaha, Kurunegala, Kandy, Matale and Ratnapura districts (Anon, 2016c) of the country have suitable climatic conditions for growing oil palm. It also provides the workers, e.g. the harvesters, to earn a higher income than those working in other plantation crops. An oil palm harvester earns from Rs.65,000 to Rs. 105,000 a month compared to a good tea plucker who earns around Rs.25,000 per month (Anon, 2015b). Oil palm has a tremendous advantage over other vegetable oil producing crops. It has a potential oil yield of 3,000 to 4,000 litres per hectare per annum (Anon, 2015 a).

Rubber cultivations will start yielding in five to seven years, whereas oil palm starts yielding in three years although its peak yield will be between seven and 18 years. After 18

years the yield will gradually decrease. At this point the grower will need to consider removing old palms and planting new palms to replace the old palms. At present 7,945 ha of land is under oil palm cultivation in Sri Lanka. In 2013, Sri Lanka produced 66,967 mt of palm oil, compared to 61,635 mt in the previous year. The country has only two palm oil mills, one owned by Watawala Plantations Ltd. and located at Nakiyadeniya Estate in Galle District, and the other owned by Namunukula/Elpitiya/ Kegalle plantations and located in Baduraliya in Kalutaara district.

Rubber small holders complain that oil palm cultivations deplete the ground water thereby depriving rubber plants of adequate supply of water. Rubber Research Institute denies that oil palm depletes the ground water resources. However many are of the view that the Rubber Research Institute has not undertaken adequate research before expressing its opinion. Another concern is that the oil palm removes about ten times more soil nutrients than rubber, while fertilizer costs keep escalating. But the oil palm growers argue that cost of production of a kilogram of fresh fruit bunches (FFB) is Rs.12.00 against a selling price of Rs.25.00. In other words, the massive productivity and price of goods can easily absorb the high fertilizer costs (Anon, 2015b).

In this background the objective of this study was to compare the micro-environmental conditions of rubber and oil palm plantations grown in the wet zone of the country. The outcome of the study would benefit the policy makers in the country to take appropriate decisions with regard to the palm oil industry.

MATERIALS AND METHODS

Location

This study was carried out in the Hulandawa Estate managed by the Namunukula Plantations Ltd. and at the soil laboratory in the Department of Plantation Management, Wayamba University of Sri Lanka. One hectare of five and fifteen years old cultivations of both oil palm and rubber were identified from the Hulandawa estate for the study.

Sampling of Plant Species

The quadrant method was used to study the plant species associated with both rubber and oil palm cultivations of different ages. A quadrant having the dimensions of 1 × 1 m and made out of PVC tubes was used to gather data. In each of the four study plots, the quadrant was placed at ten random points to gather information with regard to the vegetation associated with the micro-environment of the main crop.

Soil Sample Collection

Random sampling was used to obtain soil samples for the analysis of soil physical and chemical properties. Ten (10) random points was selected using the quadrant method in all four (04) sites selected for the study. Five (05) random points will be from the fertilizer circle whilst the other five (05) were from the centre of four (04) plants. Further, from each point the soil samples were drawn from two depths, 0-15 and 15-30 cms. Soil augurs were used to obtain the soil samples from different soil depths. The soil samples from each of the treatments were mixed separately to prepare composite samples (Dharmakeerthi *et al.*, 2007). Composite samples were adequately sealed and transported to the soil laboratory in Wayamba University for analysis. Soil samples were analysed to gather the following data.

Soil pH

This was measured by using a pH meter and as described by Dharmakeerthi *et al.* (2007).

Soil Moisture Content

The soil moisture content was determined as previously done by Dharmakeerthi *et al.* (2007).

Soil Available Nitrogen

Spectrophotometer at 410 wave length was used to determine the available nitrogen in soil (Dharmakeerthi *et al.*, 2007).

Soil Available Organic Carbon

Was estimated according to Walkey and Black method (Dharmakeerthi *et al.*, 2007).

Experimental Design and Statistical Analysis

The experiment was laid out in a Completely Randomized Design (CRD) consisting of five replicates for each composite sample. Data were analyzed using Analysis of Variance procedure with Statistical Analysis System (SAS; 9.2).

RESULTS AND DISCUSSION

In the five year old plantations, rubber and oil palm recorded 350 and 320 number of total plants per square meter respectively. Hence the number of plants in the ground vegetation is marginally high in the rubber crop (Table 1). The number of plant species present is also marginally high in rubber (16 species) than in oil palm (13 species). The dominant species in Oil palm cultivations is *Nephrolepis* which is moisture and a shade loving plant species. The number of total plants in a square meter of

Table 1. Species associated with ground vegetation in rubber and oil palm plantations of different ages

Scientific Name	Common Name	Average Plant Density (per m^2)			
		15 years after planting		5 years after planting	
		Rubber	Oil palm	Rubber	Oil palm
Clidemiahirta	*Boo bovitiya*	2.51	12.56	6.28	10.93
Nephrolepisexcelsa	*Mevana*	1.47	10.83	1.14	3.44
Nephrolepis spp.	*Mevana*	-	36.36	-	24.68
Hedyotisverticilata	*Shrubby false button weed*	32.79	7.74	9.42	3.75
Axonopuscompressus	*Pothuthanakola*	19.79	2.13	10	15.93
Lophatherum gracile	*Bata thanakola*	11.23	17.41	16.86	6.25
Urenalobota	*Apala*	12.7	-	14.57	6.25
Mimosa pudica	*Nidikumba*	1.47	-	1.71	0.62
Desmodiumtriflorum	*Udupiyaliya*	9.89	-	10.28	-
Syngoniumangustatum	*Welkohila*	3.84	-	2	-
Vernoniacinerea	*Monarakudumbiya*	0.44	-	-	-
Mikaniascandens	*Wathupalu*	0.74	-	-	-
Caryotaurens	*Kithul*	0.74	-	2.86	-
Tridax spp.	*Arunadevi*	1.47	-	4.57	23.44
Cinnamon zelanicum	*Cinnamon*	0.44	-	-	-
Passiflorafoetida	*Bush passion fruit*	-	0.39	-	-
Alstoniamacrophylla	*Havarinuga*	-	0.77	-	-
Puerariajavanica	*Pueraria*	-	0.58	2.28	-
Elaeisguineensis	*Oil palm*	-	0.77	-	-
Cyperusrotundus	*Kaladuru*	-	0.77	-	0.94
Stachytophetasurunai	*Balunakuta*	-	0.96	1.43	0.62
-	*Suru nai*	-	9.48	-	-
Sauropusandrogynus	*Japan batu*	-	-	13.14	-
Ecliptaprostrata	*Kekiridiya*	-	-	1.43	0.94
Alysicarpus vaginalis	*Aswenna*	-	-	2	1.56
Total number of individuals		677	517	350	320

ground vegetation was 677 and 517 for 15 year old rubber and oil palm respectively. The number of plant species present per square meter was similar and 14 and 13 for rubber and oil palm respectively. As in the five year old cultivations the dominant species under oil palm was *Nephrolepis* which is a more water and shade loving plant (Anon, 2016d). Hence when considering the ground vegetation in both crops and at both ages the underground vegetation is rich. Further, the ground vegetation becomes denser with the age of the plantations of both crops. Presence of *Nephrolepis* as the dominant species and similar density of plants as in the rubber crop indicates a relatively more moist and shady microenvironment in oil palm cultivations.

The soil pH value differed significantly with the crop, age of plantation and the location in which soil samples were drawn (Table 2). Among the two crops soil was more acidic in the soil where oil palm was grown (Table 3). Further, soil was more acidic in the fertilizer circle than in the inter row for both crops. Among the two crops oil palm is given relatively high quantities of fertilizer including urea (Anon, 2015b). Further, with the age of the crop the quantity of fertilizer given is high. Hence, it appears that the soil becomes more acidic when more quantities of urea fertilizer are used (Anon, 2016e). The reason for the soil in the fertilizer circle to be more acidic (Table 3) could also be due to the application of chemical fertilizer to this area. Relative to the rubber plantations the economical yield is relatively more in oil palm plantations (Anon 2016b). Thus with the crop there will be relatively higher levels of captions such potassium, magnesium and calcium removed. If the replacement is not undertaken that could lead to acidic soils (Ziblim *et al., 2012.*) The moisture content, organic carbon and available nitrogen show significant differences between rubber and oil palm and 15 years and 5 years. There were no significant differences between inter row and fertilizer circle, and 15 cm depth and 30 cm depth (Table 1).

In both 15 year and five year old oil palm plantations the soil had higher moisture content than in the corresponding age rubber plantation soils (Table 4). Similarly, in both 15 and five years old oil palm plantations the organic carbon content was higher than in the corresponding age rubber plantations (Tables 4). Also, in both 15 year and five year oil palm plantations the available nitrogen content in the soil was higher than in corresponding age rubber plantations (Tables 4). The relatively higher canopy cover and the dry matter production capacity of oil palm when comparing with the rubber crop could be the reason for such differences in the soil characteristics. Also, in Hulandawa estate, empty fruit bunches are added to the oil palm fields. This may also be a reason for more favorable soil moisture, soil organic matter and

Table 2. The statistical differences in some soil physical and chemical properties of rubber and oil palm cultivations of different ages

Parameters	pH	Moisture (%)	Organic carbon (%)	N (%)
Crop	0.0001	0.0005	0.0001	0.0001
Age of plantation	0.0001	0.0002	0.0001	0.0001
Location	0.0011	0.2572	0.1458	0.6174
Depth	0.8433	0.1894	0.1394	0.4330
P value	0.0001	0.0001	0.0001	0.0001
R- Square	77.7%	29.3%	18.6%	68.3%

Crop- Rubber and oil palm, Age of plantation- 15 and 5 years, location- inter row and fertilizer circle, depth- 15 cm and 30 cm, if p value < 0.05 there is a significant difference

Table 3. Mean value of pH

CROP	15 years after planting		5 years after planting	
	Inter row	Fertilizer circle	Inter row	Fertilizer circle
Rubber	3.98^a	3.93^a	3.48^a	3.42^a
Oil palm	3.68^b	3.54^b	3.31^a	3.09^b

Means followed by same letter in each column are not significantly different at 0.05 level

Table 4. Mean value of moisture, organic carbon and available nitrogen in 15 years and 5 years after planting

Crop	15 year			5 year		
	Moisture %	Organic carbon %	N %	Moisture%	Organic carbon %	N %
Rubber	8.56^b	5.18^b	0.01^b	23.83^b	7.57^b	0.0232^b
Oil palm	23.09^a	5.83^a	0.02^a	28.91^a	9.39^a	0.0234^a

Means followed by same letter in each column are not significantly different at 0.05 level

available nitrogen content in lands cultivated with oil palm.

CONCLUSIONS

Due to higher soil moisture content in both 15 and five year old oil palm plantations than in the corresponding age rubber plantations, it could be concluded that oil palm crop is able to conserve more moisture than the rubber crop. It is also apparent that the oil palm plantation soils are more acidic than the rubber soils. Soil organic carbon and available nitrogen levels are more favorable in palm oil soils. More number of moisture and shade loving plant species are also found in the undergrowth of oil palm plantations than in the rubber crop. Findings of the study indicate oil palm as an environmentally friendly crop under good agricultural practices.

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