SOIL SCIENCE CONFERENCE OF MALAYSIA 2013

Good Agriculture Practice (GAP) For Soil Health Sustainability

PROCEEDINGS OF SOILS 2013

BUKIT GAMBANG RESORT CITY, GAMBANG, PAHANG

16th -18th APRIL 2013

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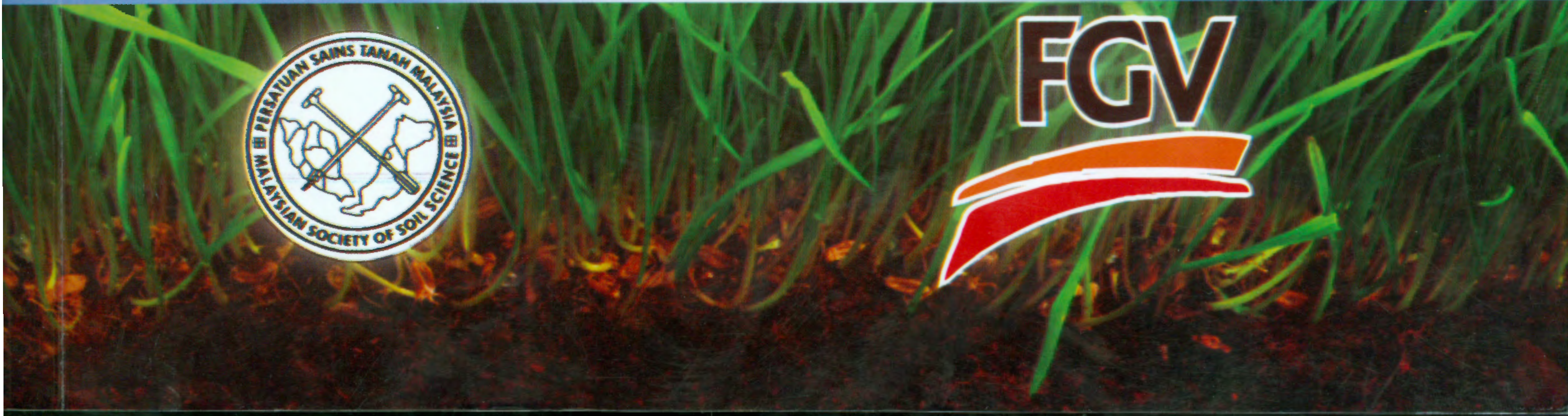

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NUTRIENTS LOSSES IN RUNOFF FROM CONVENTIONAL AND CONTROLLED-RELEASE FERTILIZERS UNDER IMMATURE OIL PALM CROPPING

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INTRODUCTION

Fertilizer is a crucial input material for sustainable crop production and plays an important role in food security (Xiang *et al.* 2008). According to FAO (2004), mineral fertilizers account for more than 90% of fertilizers used by all types of farming systems in Malaysia, and the main types are conventional forms which may be easily lost through runoff or leaching. In order to support growth and yield for high value crops such as oil palm, large amounts of nutrients such as nitrogen, phosphorus, potassium and magnesium are needed (Tarmizi and Mohd Tayeb 2006). Oil palm is the most productive oil crop in the world. Malaysia is ranked as one of the world's largest producers of Certified Sustainable Palm Oil (CSPO) with over 50% of total CSPO production globally (News Release on RSPO 2011) and an estimated export value of RM80.4 billion in the year 2011. Balanced fertilization plays a pivotal role in the sustainability and productivity of the oil palm sector. Malaysia's oil palm industry relies heavily on the application of chemical fertilizers, accounting for about 40-50% of the production costs. Due to periodic high rainfall intensity, there is high risk of occurrence of surface runoff. As a result of this, coupled with problems of inherent low soil fertility, loss of substantial amounts of applied nutrients can lead to serious economic ramifications. Another major challenge to the oil palm industry in Malaysia is the acute shortage of labor. Presently, the standard fertilizer practices involve the application of straight fertilizers in 4-6 splits per annum, which is both costly and labor intensive. In order to curb the growing challenge of labor shortage in an estimated over 5 million hectares of oil palm cultivation, there is need to adopt the 4R (right source, right rate, right time and right placement) fertilizer use stewardship (Roberts 2010) for efficient fertilizer utilization by crops. The use of controlled release fertilizers (CRFs) can reduce fertilizer application from 6 to 2 or 3 splits per annum, but there are limited reports about their performance on tropical crops such as oil palm. So far, studies on the extent of nutrient efficiency and losses through runoff in the Malaysia's oil palm plantations have only been limited to straight fertilizers (Kee and Chew 1996). This study was conducted to address the above knowledge gap in an effort to provide improved and efficient fertilizer recommendation program for sustainable oil palm production.

MATERIALS AND METHODS

An investigation at the experimental field of Taman Pertanian Universiti in Puchong, UPM (02°N 59.035', 101°E 38.913') was conducted to study nutrient losses via surface runoff of briquette and granular type of controlled-release fertilizer (Kamila™

CRF) and mixture fertilizer under oil palm cropping. Experimental plots with 4 m x 4 m were delineated along 10% slope gradient and transplanted with 12 months old oil palm seedlings. The fertilizers were surface placed under the canopy of each plant. Captured runoff was measured and sampled after each rainfall event that produced measurable runoff with a minimum of 10mm by means of collection tanks. Rainfall was measured using an onsite rain gauge. Four fertilizer treatments including a control were laid out in a randomized complete block design (RCBD) with three replications (Table 1).

Table 1: fertilizer treatments and nutrients rates

Fertilizer	Nutrient rate					Total
	........kg/palm/application.....				g/palm/application	kg/palm/application
	N	P_2O_5	K_2O	MgO	B_2O_3	Fertilizer
Control	0.00	0.00	0.00	0.00	0.00	0.00
Mixture	0.36	0.22	0.72	0.072	13.5	1.95
CRF Briquette	0.36	0.22	0.72	0.072	13.5	1.80
CRF Granule	0.36	0.22	0.72	0.072	13.5	1.80

The total amount of eroded soil was collected from the tanks after thoroughly mixing the runoff and sediment by means of a sampling cup attached to a long rod. For runoff water analysis, an aliquot of each sample was filtered (Whatman No. 5) to analyze for NH_4^+-N, P, K, Mg and B concentration, while the sediment retained after filtration was dried at 105 °C for 24 h, weighed and subsequently analyzed for total nutrient losses. Analysis of variance and treatment means comparisons were performed using the procedures from Statistical Analysis System (SAS) computer software (Version 9.2).

RESULTS AND DISCUSSION

The soil is of Serdang series type (Typic Kandiudult) and sufficient in major nutrients such as total N (0.26%), available P (22.3ppm) and exchangeable K (0.12 cmol/kg). The pH of the soil was slightly acidic (4.76). The textural evaluation of the soil shows that it is relatively high in sand (60%) as opposed to the displaced sediments which were dominated by silt particles. The cumulative amount of rainfall for the 28 recorded events over four months was 1111mm, representing over 40% of mean annual rainfall in Malaysia. This implies that large numbers of storms with possibly larger intensities have occurred. Runoff measurements vary significantly among rain events due to intensity effects of rainstorms. The occurrence of heavy rain during the period under study has caused significant sediment loss due to surface runoff. Previous reports in Malaysia showed that, soil erosion under oil palms on slopes of 4-7% consisted of about 6-13 t ha^{-1} yr^{-1} (Maene *et al.* 1979; Lim 1990) compared to jungle area. Factors which affect the rate of soil loss are rainfall, rate of run-off, soil types, slope, plant cover and presence or absence of conservation measures. Soils can be vulnerable to runoff and erosion when high rainfall intensities occur.

Table 2: Nutrients lost through runoff in 28 rainfall events (4 months)

Treatment	Nutrients in runoff				
	..................kg/ha..................				...g/ha...
	NH_4^+-N	P	K	Mg	B
Control	0.56c	0.23b	2.39d	0.23b	7.09d
Mixture	1.09ab	0.27b	5.87a	0.79a	16.32a
CRF Briquette	0.92b	0.32b	3.44c	0.36b	11.34c
CRF Granule	1.21a	0.62a	4.87b	0.49b	14.12b

Analysis of NH_4^+-N, P, K, Mg and B load in the runoff revealed that the nutrient amounts ranged from 0.56-1.21 kg ha^{-1}, 0.23-0.62 kg ha^{-1}, 2.39-5.87 kg ha$^{-1,}$ 0.23-0.79 kg ha^{-1} and 7.09-16.32g ha^{-1}, respectively (Table 2). Nutrients load in from the control plots are indicative of supply from the soil system. Generally, lower concentrations of NH_4-N were measured in runoff in response to all treatments. Similarly, phosphates concentration showed lower values; this effect can possibly be attributed to low solubility of P from the phosphate rock fertilizer, which was the source of P from the mixture fertilizer. The loss of the nutrients in all treatment plots appeared to be low per hectare basis with a declining trend, after an initial slight ascent. Estimated chlorophyll readings (SPAD values) for the CRF treatments appeared to be higher than that of mixture and control plants. SPAD values increased tremendously after fertilization (Figure 1). Leaf chlorophyll content may be used as an indirect indicator of crop nitrogen status.

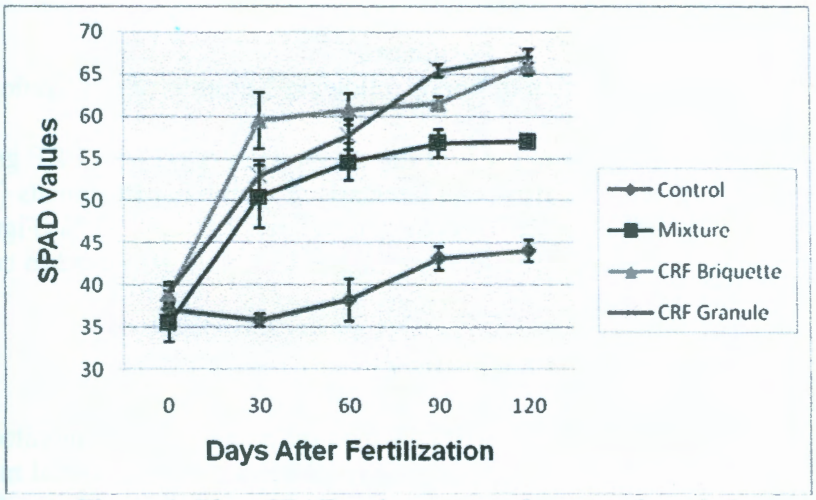

Figure 1: Plant SPAD values over a four month period

Table 3: Effect of fertilizer treatments on palm bole growth

Fertilizers	Bole Diameter (cm) ....Months....................		
	0	2	4
Control	5.70a	8.07c	13.15c
Mixture	5.95a	11.50b	17.89b
CRF Briquette	5.43a	11.97b	22.00a
CRF Granule	5.85a	12.45a	20.03a

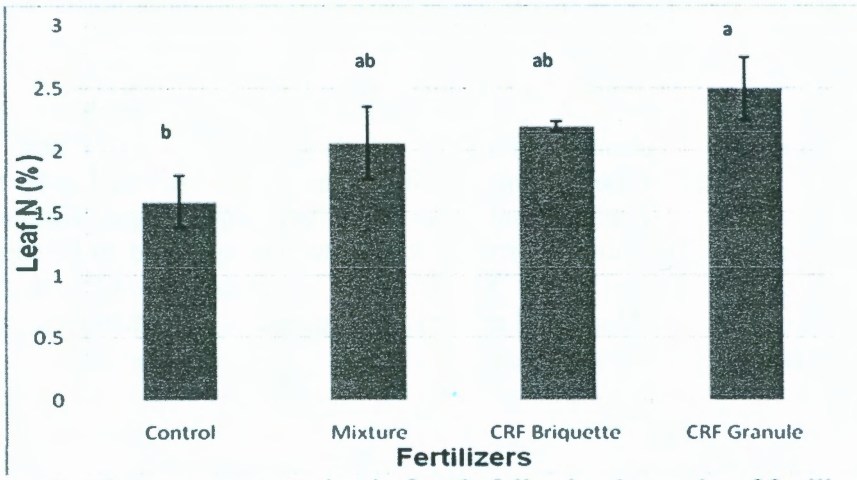

Figure 2: Nitrogen concentration in fronds following 3 months of fertilization

Plant bole diameter increased during the four month growth period with CRF granule showing significantly higher bole growth in comparison with other treatments (Table 3). Leaf nitrogen at 3 months after fertilization ranged from 1.59 to 2.83 % (Figure 2) Application of granular CRF appeared to show higher leaf N as compared to control treatment.

CONCLUSION

Nutrients in surface runoff from a newly established oil palm field was monitored to determine the impacts of granular and briquette type CRF with conventional mixture fertilizer. Generally, after the initial rain events, nutrients concentration in the filtrate declined and remained low. Nitrogen and P losses in runoff during the four month study period were substantially low, accounting for less than 2% of applied fertilizers. However, significant amount of K and Mg were lost via runoff from mixture fertilizers accounting for 4% and 10% respectively of the added fertilizer. The study is not yet conclusive; more nutrient loss pathway measurements and time are required to better quantify the nutrient loss.

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