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SOIL MANAGEMENT AND ENVIRONMENT

PUTRA PALACE, KANGAR, PERLIS
8th – 10th APRIL 2014

Editors:

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PERSATUAN SAINS TANAH MALAYSIA
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RUNOFF LOSS OF NUTRIENTS AS IMPACTED BY CONVENTIONAL AND CONTROLLED RELEASE FERTILIZERS APPLICATION

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INTRODUCTION

Oil palm (*Elaeis guineesis Jacq.*) has emerged as the most important source of vegetable oil due to its very high productivity, versatility and profitability. The crop is predominantly cultivated on tropical soils that are dominated by Ultisols and Oxisols. Chemically, these soils are acidic and low in fertility. Malaysia is ranked as one of the world's largest producers of palm oil with an estimated total export value of about RM61 billion ($20 billion) in 2013. Fertilizers are crucial in oil palm production, accounting for 50-70% of field operational costs and about 25% of total production cost (Caliman *et al.,* 2007; Goh and Härdter, 2003). Mineral fertilizers, mainly conventional forms account for more than 90% of fertilizers used by all types of farming systems in Malaysia (FAO (2004).The oil palm requires quite large quantities of fertilizers to achieve good yields (Comte *et al.,* 2012). Frequent application of large amounts of conventional fertilizers under high rainfall conditions easily subjects the nutrients to be lost through runoff or leaching. Such losses are detrimental to both profits and the environment. As such there is a need to develop alternative innovations to make mineral fertilization for high value crops such as oil palm more economically viable and ecologically compatible.

Another major challenge faced by the oil palm industry in Malaysia currently is the shortage of labor. Presently, the standard fertilizer practices involve the application of straight fertilizers in 4-6 rounds per annum, which can be costly and labor intensive. In order to curb the growing challenge of labor shortage under an estimated 5 million hectares of oil palm cultivation in Malaysia, there is need to adopt improved fertilizer use stewardship for efficient nutrient utilization by crops. Among such strategies would be the use of controlled release fertilizers (CRFs) which can reduce fertilizer application to 2 splits per annum. However, there are limited reports about their performance on tropical crops such as oil palm. 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). As such, this study was conducted to address this knowledge gap in an effort to provide improved and efficient fertilizer recommendation program for sustainable oil palm production. The objectives of the study were to quantify nutrients loss via surface runoff from applied conventional (Mixture fertilizer) and CRFs (KAMILA CRF^{TM}). The study further seeks to assess agronomic performance of immature oil palm with respect to application of Mixture and CRFs.

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 surface runoff loss of briquette and granular type controlled release (KAMILA CRF^{TM}) and mixture fertilizers under oil palm

cropping (Table 1). Plots measuring 4 m x 4 m were delineated along 10% slope gradient and transplanted with 12 months old oil palm seedlings. Captured runoff and sediments were measured and sampled after each rainfall event that produced measurable runoff using collection tanks.

Table 1: Fertilizer and nutrients rates

Fertilizer	Nutrient rate (kg/ha/yr)				
	N	P	K	Mg	B_2O_3
Control	0.00	0.00	0.00	0.00	0.00
Mixture	48.96	13.07	81.60	5.86	1.24
CRF Briquette	48.96	13.07	81.60	5.86	1.24
CRF Granule	48.96	13.07	81.60	5.86	1.24

Precipitation was measured using an onsite rain gauge. Fertilizer treatments were surface applied in two splits per annum under the palm canopy. A field scale is being implemented to predict loss of nutrients via runoff and sediment from the experimental site.

RESULTS AND DISCUSSION

Total observed precipitation during the period of study was at 2635 mm with a monthly mean reading of 220 mm. Collected runoff volume as percentage of rainfall ranged from 3-26% with a mean value of 13%. Annual sediments loss ranged from 6-7 t/ha. Highest sediment loss was generated in the month of November (2012) with a maximum value of 1.2 t/ha (Figure 1). Soil erosion losses in fields chiefly depend on rainfall, slope of the land and management practices.

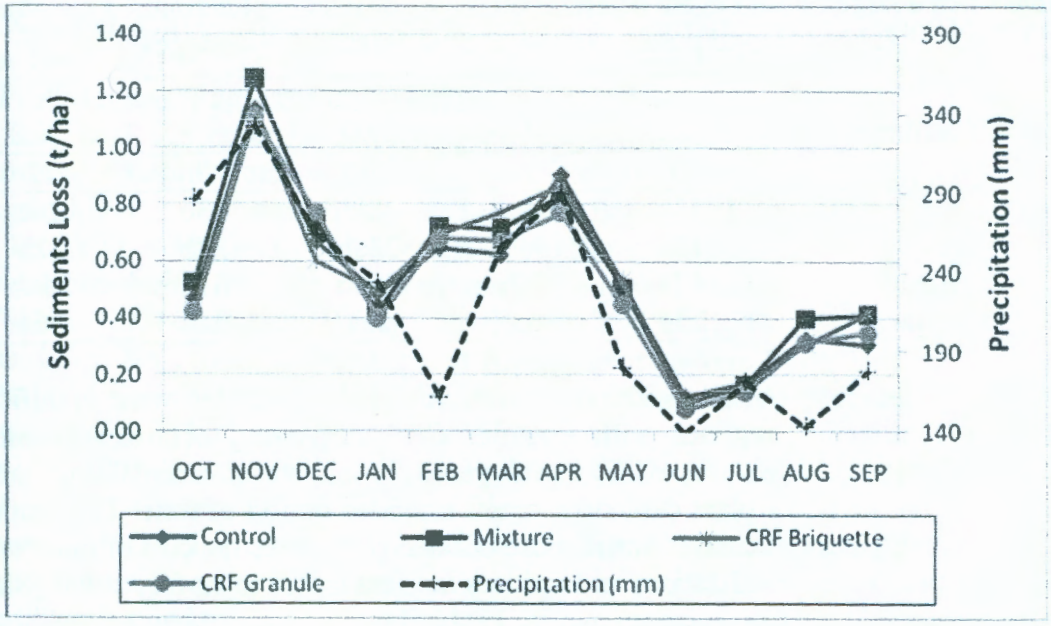

Figure 1: Monthly soil loss and precipitation

Total losses of N, K, Mg and B via runoff were greatest for mixture fertilizer treatments, accounting for 5%, 11%, 12% and 6% of the added nutrients, respectively, while loss of N, K, and Mg from granular CRF represented 2%, 4% and 3%, respectively of the added nutrients (Table 2). Loss of P in all fertilized plot was considerably low. Generally, losses of nutrients in eroded sediments are substantially lower than those from runoff.

Table 2: Nutrients loss in runoff from applied fertilizers

Fertilizer	Nutrients loss in runoff				
	.....kg/ha.....				...g/ha...
	N	P	K	Mg	B
Control	1.20c	0.40c	3. 70c	0.51c	20.44cd
Mixture	3.85a	0.70b	12.48a	1.20a	92.79a
CRF Briquette	1.81b	0.64b	5.96b	0.76b	27.55c
CRF Granule	1.98b	0.92a	6.83b	0.68bc	32.53b

Data from the current study seem to concur with other studies previously conducted in Malaysia. For example, studies conducted by Maene *et al.* (1979) showed that on average, 11% N, 3% P, 5% K and 6% Mg of applied fertilizers were lost in surface runoff alone during a low rainfall year on a 9% slope. The findings further indicated that the harvesting paths are the most susceptible areas to surface runoff due to compaction of the soil by machinery operations. Nutrient runoff potential during storm events is influenced by numerous factors such as amount and intensity of rainfall, antecedent rainfall conditions, timing and rate of fertilization, ponding, and irrigation management practices (Kim *et al.*, 2006). According to Wallace *et al.* (2013), despite the advantages we would normally anticipate from vegetative land cover, large losses of nutrients in surface runoff are still possible when a large rainfall event occurs soon after fertilizer application.

Table 3: Frond number of palms at different growth stages

Fertilizer	Frond Number/plant				
	.....Months after fertilization.....				
	0	3	6	9	12
Control	13a	17c	20c	23c	26c
Mixture	13a	19ab	24ab	28b	32b
CRF Briquette	12a	19ab	25ab	31a	34ab
CRF Granule	13a	20a	26a	32a	36a

Plant growth parameters such as frond number and bole diameter were significantly affected by fertilization regimes with granular CRF surpassing control and mixture treatments (Table 3). The use of CRFs is generally aimed at maintaining nutrient availability at the levels of plant demand over an extended period of time. This improves plant growth and quality, increases nutrient use efficiency, reduces the cost of maintenance associated with repeated fertilizations and reduces nutrient losses to surface water (Shaviv, 2001).

CONCLUSION

Overall runoff loss of K and Mg from Mixture fertilizer was significantly higher compared with CRF treatments, representing 11-12% of applied nutrients. Runoff loss of Mg from CRF briquette and granule treatments (KAMILA CRF™) was in the range of 3-4%. The findings suggest that CRF application played an important role in reducing runoff-related nutrients loss. More research is needed to better elucidate mechanism of nutrients loss from oil palm ecosystems during specific rainfall intensity events.

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