# PROCEEDINGS OF THE SOIL SCIENCE CONFERENCE OF MALAYSIA 2014

## SOIL MANAGEMENT AND ENVIRONMENT

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


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Organized by:

PERSATUAN SAINS TANAH MALAYSIA
MALAYSIAN SOCIETY OF SOIL SCIENCE

UniMAP

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Malaysian Society of Soil Science (MSSS)
Universiti Malaysia Perlis (UniMAP)

2014 Malaysian Society of Soil Science



ISBN 978-967-9945-36-2

9 789679 945362

Published by:
Malaysian Society of Soil Science
Department of Land Management
Faculty of Agriculture
43400 UPM Serdang
Selangor Darul Ehsan, Malaysia
http://www.msss.com.my

# EFFECT OF FERTILIZER FORMS ON NUTRIENT RUNOFF LOSSES IN OIL PALM

**Vijiandran J.R[1,2], Husni M.H.A. [1], Xaviar A.[2] and Teh C.B.S[1]**
[1] *Department of Land Management, Faculty of Agriculture, Universiti Putra Malaysia*
[2] *United Plantations Berhad, Teluk Intan, Perak*

## INTRODUCTION

Oil palm is the largest agricultural commodity in Malaysia with its total planted area reaching 5.23 million hectares in 2013. The industry contributed an average of RM 64.52billion per year in export earnings over the last 5 years making it one of the most profitable agricultural crop in the country (MPOB, 2014).

Oil palm requires large quantities of fertilisers to sustain high yields and it is the largest cost element taking up about 60 % of field upkeep cost (Comte et al., 2012; Goh and Härdter, 2003). Mineral or straight fertilisers had been the major source of fertilisers in the industry, owing to its relatively cheaper prices and the possibility to vary nutrient inputs for each individual field. However, use of straights requires higher application frequency which could be labour intensive. Compound and controlled released fertilisers is a possible alternative for straights as it could be applied in lesser frequency which is beneficial in current times where the industry is facing a shortage in labour force.

Soil and nutrient losses studies through surface runoff and erosion under the oil palm environment was carried out by a number of scientists namely Maeneet. al (1979), the Malaysian Palm Oil Board (PORIM, 1994) and Chew et. al. (1999). However, most of these studies have only addressed nutrient losses influenced by various soil type, palm age, terrains and erosion control measures. Studies on the effect of fertiliser forms comparing controlled released fertiliser, compounds and straights on nutrient losses are lacking. Hence, this paper discusses the effect of fertiliser forms on primary nutrient losses in mature oil palm.

## MATERIALS AND METHODS

The study was carried out at of United Plantation Berhad's Lima Blas (3° 45' 25"N, 101° 20' 25"E) estate located at the Hulu Selangor district. A field with a nine-year-old oil palm planting was selected for the study. Nutrient loss studies were conducted for one calendar year from 1 January 2013 to 31 December 2013. The soil type in the area was the Serdang Series (TypicKandiudults) with a $6^0$ slope. Three erosion plots measuring 20 by 6 m encompassingtwo palms was set up. Soil and runoff losses were collected and measured using a manifold-tipping bucket collection system (Ghulam, 2003).

Each plot was fertilised either with straights or compoundsor controlled release fertilisers. Nutrient input given to all treatment plots was calculated to be similar. Fertilisers were applied around the palm circle manually with a free band of 0.9m from the palm trunk at a frequency of three applications a year. Details of nutrient input per palm per year is given in Table 1.

Table 1 :Details Of Nutrient Inputs For Erosion Plot Palms

| Nutrient | Rate (kg palm$^{-1}$ year$^{-1}$) | Frequency per year |
|---|---|---|
| Nitrogen (N) | 1.10 | 3 |
| Phosphorus (P) | 0.41 | 3 |
| Potassium ($K_2O$) | 0.59 | 3 |

Nutrient loss was measured through two major ways:1) losses through the eroded soil (bed load and suspended load) and 2) losses through the runoff water. Soil and nutrient losses was measured for a period of one year at every rainfall episode exceeding 7 mm as soil erosion is generally considered tooccur when rainfall exceeds 7mm (Morgan, 2006).

In addition to soil and nutrient loss measurement, three rounds of foliar sampling of frond 17 were carried out during the course of experiment to study the foliar nutrient content in the palms and nutrient uptake. Sampling was done prior to application of fertilisers.

Prior to the implementation of treatments, palms in all three plots were not fertilised for a period of approximately 8 months to allow the plots to stabilise. Nutrient loss measurements were carried out one month prior to the start of the trial to quantify the nutrient losses for an unfertilised plot.

## RESULTS AND DISCUSSION

### Rainfall Recorded

Total rainfall recorded throughout the study period was at 2939 mm over 144 days. Highest rainfall recorded in the month of November at 546mm spread over 17 days. Figure 1 show the monthly rainfall trend.

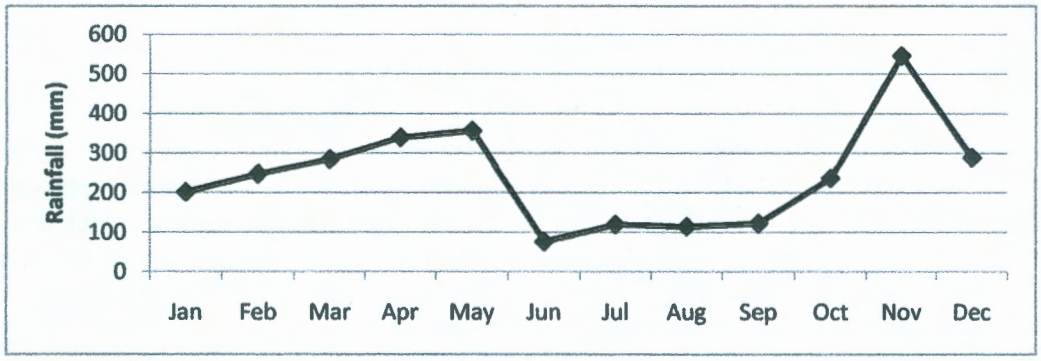



*Figure 1 : Monthly rainfall at Lima Blas Estate for 2013*

**Soil Loss Recorded**

Soil and runoff losses recorded during the study period are given in Table 2

Table 2 : Soil and runoff losses recorded from 1 January 2013 to 31 December 2013

| Loss Pathways | Loss Recorded |
|---|---|
| Runoff Water | 813 mm |
| Bed Load | 7.80 Mg $ha^{-1}$ $yr^{-1}$ |
| Suspended Load | 2.32 Mg $ha^{-1}yr^{-1}$ |
| *Total Soil Loss Recorded* | *10.12 Mg $ha^{-1}$ $yr^{-1}$* |

**Nutrient Losses**

Nutrient losses are measured through two major pathways, loss from the eroded soil (soil) and as dissolved nutrients in the runoff water (water). Table 3 provides details of nitrogen, phosphorusand potassium loss from the three plots.

Table 3 : Effect of Fertiliser types on nutrient losses (kg nutrient $ha^{-1}$ $yr^{-1}$)

| Nutrient | Straights | | | Compounds | | | Control Release | | |
|---|---|---|---|---|---|---|---|---|---|
| | Soil | Water | Total | Soil | Water | Total | Soil | Water | Total |
| Nitrogen | 24 | 140.42 | 165.22 | 22.64 | 140.1 | 162.74 | 22.78 | 134.24 | 157.02 |
| Empty Plot | 9.22 | 72.12 | 81.35 | 12.39 | 79.71 | 92.6 | 10.12 | 68.33 | 78.45 |
| Net Loss | 14.78 | 68.3 | 83.87 | 10.25 | 60.39 | 70.14 | 12.66 | 65.91 | 78.57 |
| Phosphorus | 5.35 | 4.03 | 9.38 | 5.32 | 5.09 | 10.41 | 5.39 | 3.05 | 8.44 |
| Empty Plot | 8.29 | 1.3 | 9.59 | 8.48 | 2.6 | 11.08 | 8.76 | 2.85 | 11.6 |
| Net Loss | 0 | 2.73 | 0 | 0 | 2.49 | 0 | 0 | 0.20 | 0 |
| Potassium | 3.83 | 84.33 | 88.66 | 3.75 | 75.5 | 79.25 | 7.54 | 73.78 | 75.9 |
| Empty Plot | 0.67 | 52.33 | 53.00 | 0.84 | 69.95 | 70.80 | 0.74 | 57.75 | 58.49 |
| Net Loss | 3.16 | 32 | 35.66 | 2.91 | 5.55 | 8.45 | 6.8 | 16.03 | 17.41 |

Compound fertilisers recorded lowest losses of primary nutrients compared to the straights in the first year of study. Compounds recorded 34.2 % and 18.1% lower losses compared to straight and controlled release fertilisers, respectively.

Nitrogen recorded the largest loss for all plots compared to phosphorus and potassium. Similar results had been reported by Goh et. al, (1999) and Meane et. al (1979) from mature oil palms. Nitrogen losses were low in both the eroded sediments and as dissolved nutrients in the water for compound fertilisers. For the first year of study, compounds recorded 16.4% lower nitrogen losses compared to straights. Source of nitrogen in all three fertiliser types was similar, i.e. ammonium nitrate, thus the differences in losses is most likely attributed to the physical form of fertilisers.

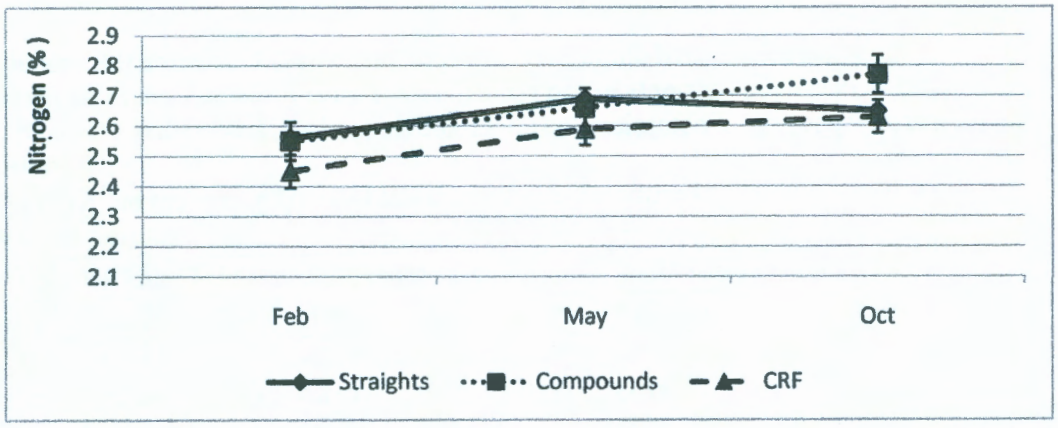
Phosphorus losses were only found in the runoff water with controlled released fertilisers recording the lowest loss at 0.20 kg per hectare per year. Rock phosphate was used as the source of phosphorus for all three fertilisers. In view of the slow dissolving

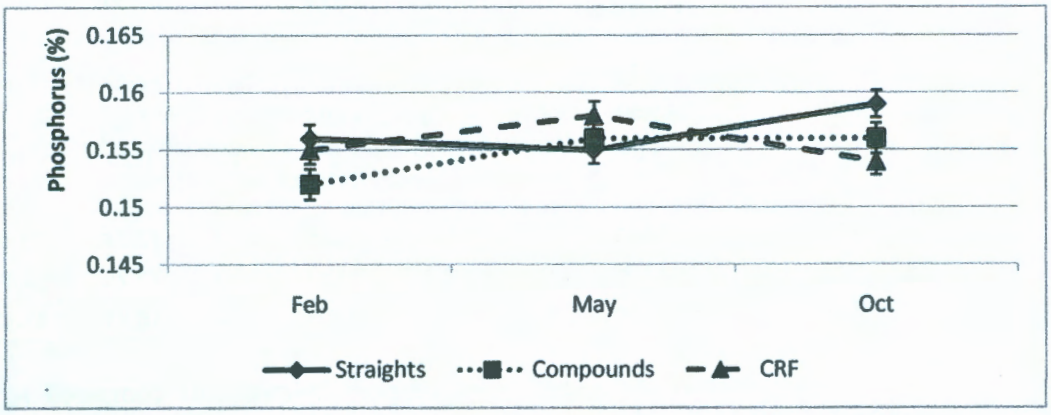
nature of rock phosphates(Havlin et. al, 2004), low phosphorus loss was expected in the study.

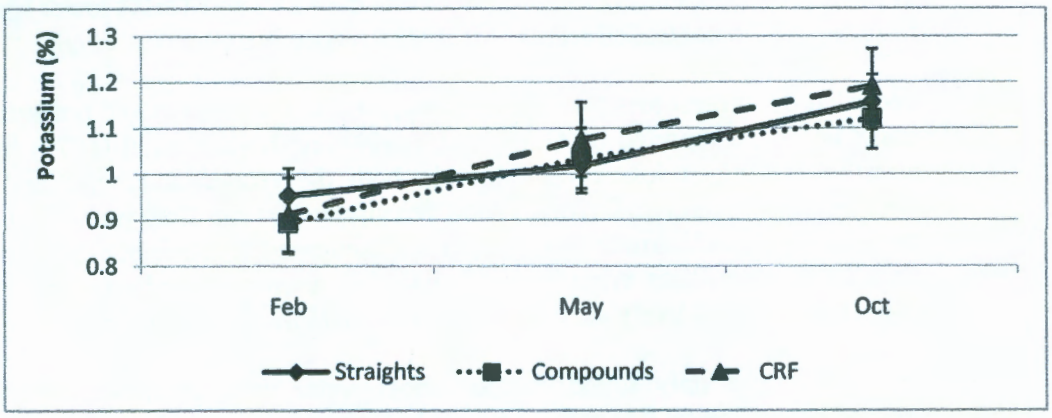
Similar to nitrogen losses, potassium losses was also the lowest in the compounds, recording 76.3% lower losses compared to straights and 51.5% lower than controlled released fertilisers inferring a possibilityof better uptake of potassium in the palms through compounds. However, the foliar levels do not show such trends.

**Foliar Nutrient Content**

Figures 2 to 4 shows the changes in foliar nitrogen, phosphorus and potassium.



Application of different type of fertilisers did not show any significant differences in foliar nutrient levels though significant differences were noted in nutrient losses. Foliar levels of N, P and K indicates palm growth is healthy with no nutrient deficiencies.

## CONCLUSION

Compound fertilisers show lower nutrient losses than straight and controlled release fertilisers in the first year of study.Thus a possibility of using compounds at a lower rate compared to straights may be possible owing to its lower nutrient losses. However, this possibility needs further verification through long term data collection in the erosion plotsand field experiments to compare the efficiency of compounds with straights in term of yield and vegetative parameters including cost benefit analysis.

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