BUNCH ASH: AN EFFICIENT AND COST-EFFECTIVE K FERTILIZER SOURCE FOR MATURE OIL PALM ON PEAT UNDER HIGH RAINFALL ENVIRONMENT

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Peat with an area totalling approximately 2.6 million hectares is considered a major problem soil in Malaysia (Mutalib *et al.*, 1991). In Sarawak alone, peat area covers approximately 1.6 million hectares or 13% of the total land area in the state (Teng, 2003). The poor inherent physical and chemical properties of peat make its development for oil palm cultivation difficult and costly. Low soil bulk density, high water table, subsidence, low pH, high carbon and nitrogen ratio (C/N) and low nutrient status are among the major properties of peat that need amelioration for successful cultivation of oil palm. Generally, peat is highly deficient in potassium (K) and therefore, oil palm requires high amount of external K application. Using bunch ash as a source of K is more advantageous and preferable since it helps to neutralize soil acidity (Gurmit *et al.*, 1986; Mohd Tayeb, 2002).

Fertilizer accounts for about 25% of the total crude palm oil (CPO) production cost and with increasing cost of fertilizers, precision in fertilizer application for sustained high yield and profits has become more essential. In peat, K fertilizer constitutes a higher proportion of the total amount of fertilizer application in which 5.0 kg palm^{-1} yr^{-1} of muriate of potash is recommended for mature oil palm besides urea and rock phosphate requirements of about 1.0 kg palm^{-1} yr^{-1} each (Gurmit *et al.*, 1986; Mohd Tayeb, 2002). Fertilizer application in peat area in Sarawak becomes more critical due to high leaching environment. High rainfall, fluctuating water-table and high total porosity of peat significantly increase fertilizer losses due to leaching. It is imperative that an efficient source of K fertilizer be identified for oil palm under such situation.

MATERIALS AND METHODS

The trial was initiated in 1998 at MPOB Research Station in Sessang, Sarawak. Initially, the peat depths ranged from 250 to 300 cm and the nature of mineral subsoil below the peat layer was non-sulphidic clay. Between 1994 and 2004, the station received high rainfall averaging 3600 mm annually with occasional dry months (rainfall below 100 mm mth^{-1}). Standard land clearing method, *i.e.* underbrushing and felling, burning, stacking, soil compaction and hole-in-hole planting technique was adopted. MPOB's DxP materials were planted at density of 160 palms ha^{-1} in May 1993. Field maintenance works and fertilizer application followed normal estate practices.

The trial was a randomized complete block design (RCBD) of a split plot with six replicates. The main plots tested three sources of K fertilizer *viz.* muriate of potash (MOP), sulphate of potash (SOP) and bunch ash (BA). The nutrient content of each fertilizer is summarized in *Table 1*. The sub-plots tested three different fertilizer rates *viz.* 1.2, 2.4 and 3.6 kg K_2O palm^{-1} yr^{-1} in two split applications. The treatments commenced in the fifth year after planting with all fertilizers

TABLE 1. NUTRIENT CONTENT OF DIFFERENT K FERTILIZER

Type of fertilizer	Nutrient content
Muriate of potash (MOP)	60% K_2O; 35% Cl
Sulphate of potash (SOP)	50% K_2O; 17% S
Bunch ash (BA)	30% K_2O; 4% P_2O_5; 6% MgO; 5% CaO; pH=12

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broadcasted in the weeded palm circle. FFB yields for six-year period were obtained by carrying out palm-to-palm recording of bunch number and weight, commencing at second year after treatment. The soil chemical properties and leaf tissues were analysed according to the standard procedure of the *MPOB Soil and Plant Analysis Manual* (Zulkifli and Masnon, 1993a,b).

The data were kept and managed by a relational database for agronomy data systems (READA). Analysis of variance (ANOVA) and Duncan's Multiple Range Test (Duncan's Test) of Statistical Analysis Systems (SAS^{TM}) were used to analyse the data. Six years of FFB yield were used to calculate the financial performance of the three sources of K fertilizer with three different rates by examining the variable costs and determining the cost of FFB production, gross return, gross margin and returns on investment (ROI). Analysis carried out was based on the current (2004) annual market FFB price and fertilizer cost.

RESULTS AND DISCUSSION

The effect of K fertilizer application on six-year mean FFB yield is summarized in *Figure 1*. The result shows that increase in bunch ash (BA) rate from 1.2 to 2.4 kg K_2O palm^{-1} yr^{-1} significantly increased the FFB yield from 21.2 to 26.0 t ha^{-1} yr^{-1} amounting to 23% increment but further increase up to 3.6 kg K_2O palm^{-1} yr^{-1} achieved no significant difference. MOP and SOP on the other hand, increased FFB yield by only 4% to 8% respectively and not significant. Higher FFB yield obtained from BA compared with the equivalent quantity of K applied as MOP and SOP suggests that BA is the best source of K fertilizer for mature oil palm on peat. The result also indicates that the agronomic optimum requirement of BA for mature oil palm on peat is 8.0 kg palm^{-1} yr^{-1}.

The effects of K fertilizer application on leaf K level and soil pH are summarized in *Figures 2* and *3* respectively. Increase in K rate showed significant improvement in leaf K level for all types of K fertilizer with slightly higher response recorded from BA. Sufficiency level of leaf K was obtained at K rate more than 2.4 kg palm^{-1} yr^{-1} of K_2O ranging from 0.90% to 1.00%. Application of BA significantly improved the soil pH as compared to other K fertilizer sources (*Figure 3*). Due to the pH increasing effect, higher FFB yield and leaf K responses were obtained from BA application as compared to the equivalent K applied as MOP and SOP.

The financial analysis of the three K fertilizers used is summarized in *Table 2*. Due to high FFB yield obtained and the relatively lower cost of BA fertilizer, application of 8.0 kg palm^{-1} yr^{-1} of BA gave the lowest cost of FFB production of RM 88.39 t^{-1} subsequently achieving the highest gross returns, gross margin as well as ROI value.

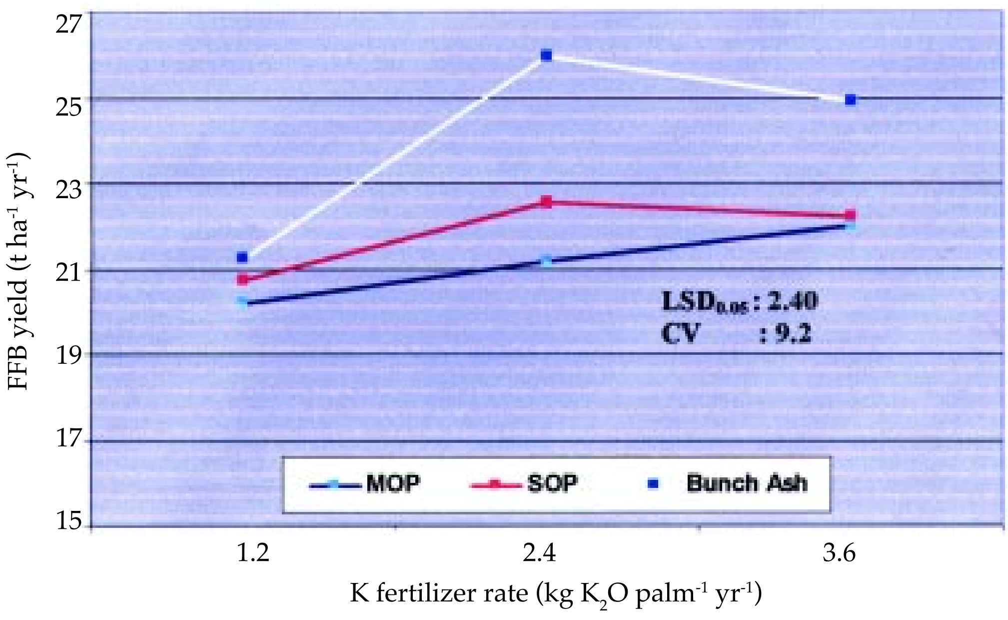

Figure 1. Effect of K fertilizer application on FFB yield (6-year mean) of oil palm planted on peat.

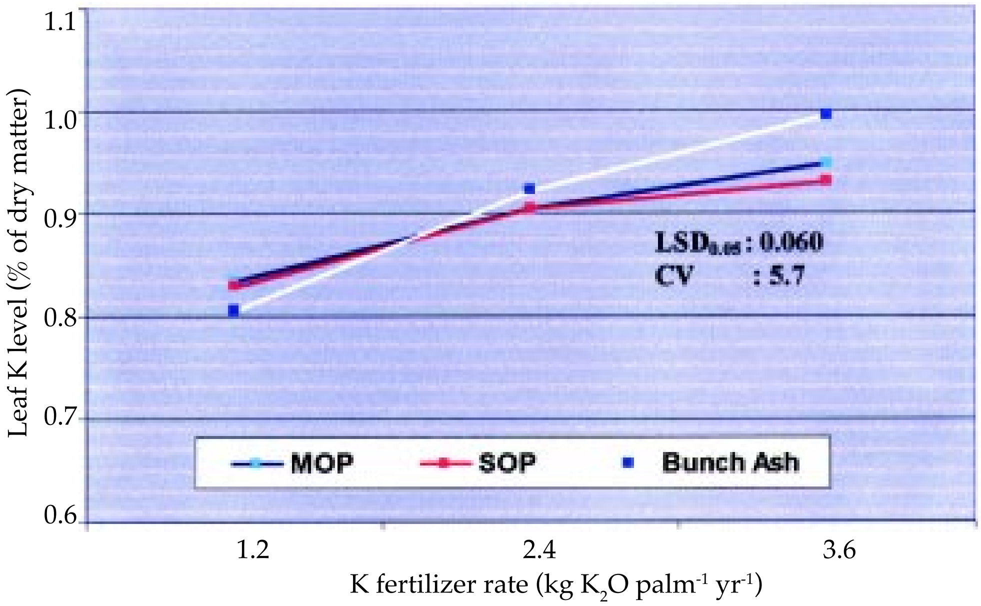

Figure 2. Effect of K fertilizer application on mean leaf K level (frond 17) of oil palm planted on peat.

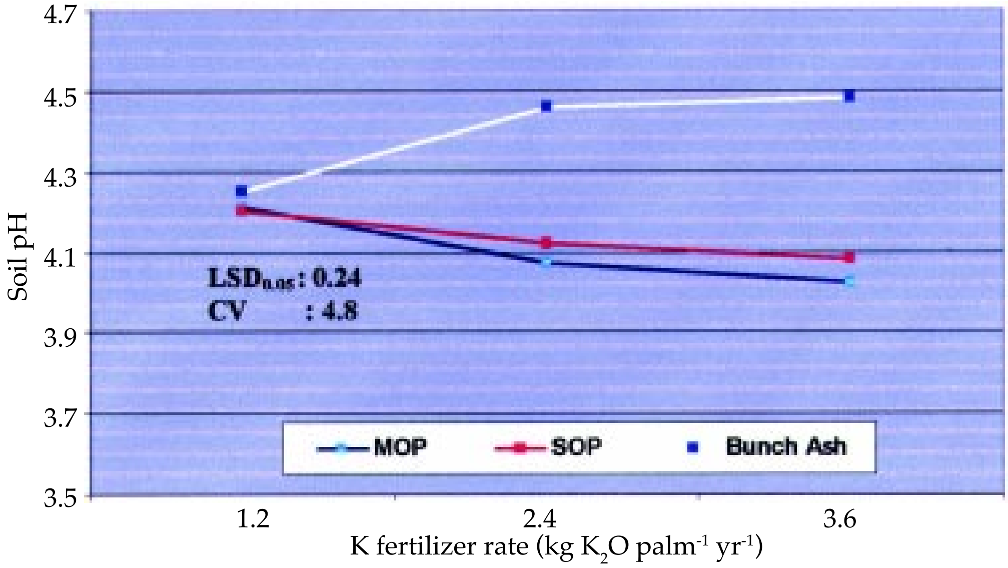

Figure 3. Effect of K fertilizer application on soil pH (0-40 cm).

TABLE 2. FINANCIAL ANALYSIS OF DIFFERENT K FERTILIZER APPLICATION

Fertilizer source	Rate (kg palm^{-1} yr^{-1})	FFB yield (t ha^{-1} yr^{-1})	Gross return (RM ha^{-1})	K fertilizer cost (RM ha^{-1})	Total variable cost (RM ha^{-1})	Cost of FFB production (RM t^{-1})	Gross margin (RM ha^{-1})	ROI
MOP	2.0	20.21	4 648.30	310.40	2 102.00	104.02	2 546.30	2.21
MOP	4.0	21.16	4 866.80	620.80	2 465.93	117.03	2 400.87	1.97
MOP	6.0	21.97	5 053.10	931.20	2 804.73	127.65	2 248.37	1.80
SOP	2.4	20.73	4 767.90	537.60	2 356.40	113.67	2 411.50	2.02
SOP	4.8	22.54	5 184.20	1 075.20	2 970.27	131.78	2 213.93	1.75
SOP	7.2	22.22	5 110.60	1 612.80	3 501.20	157.57	1 609.40	1.46
BA	4.0	21.24	4 885.20	128.00	1 967.40	92.61	2 917.80	2.48
BA	8.0	25.95	5 968.50	256.00	2 293.73	88.39	3 674.77	2.60
BA	12.0	24.90	5 727.00	384.00	2 389.47	95.98	3 337.53	2.40

Notes: Based on: FFB price of RM 230.00 t^{-1}; MOP price of RM 970.00 t^{-1}; SOP price of RM 1400.00 t^{-1}; BA price of RM 200.00 t^{-1}.
ROI: the ratio of gross return to total variable cost.

The results showed that BA is the most cost effective K fertilizer source and the economic optimum rate of BA for mature oil palm on peat is 8.0 kg $palm^{-1}$ yr^{-1}.

CONCLUSION AND RECOMENDATION

FFB yield, leaf K and soil pH responses were obtained from the various sources and rates of K fertilizer applied to the mature oil palm on peat. However, highest significant increase in FFB yield was recorded from the BA application. The improvement in the soil pH from application of BA is due to its strong alkaline property which contributed to the positive responses obtained. The results clearly indicate that bunch is the best source of K fertilizer for mature oil palm on peat under high rainfall environment.

Low FFB production cost was obtained from BA application compared to MOP and SOP. At the equivalent rate of 2.4 kg $palm^{-1}$ yr^{-1} K_2O application, the FFB production cost from BA application was 24% and 33% lower compared to MOP and SOP applications respectively. The financial analysis also showed that the application of 8.0 kg $palm^{-1}$ yr^{-1} of BA gave the highest gross return, gross margin and ROI value, and is the agronomically and economically optimum rate. It is recommended that this finding be adopted for mature oil palm planted on peat under high rainfall environment.

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