AGRONOMIC EFFECTIVENESS OF PHOSPHATE FERTILIZERS FOR MATURE OIL PALM

by: ZIN Z ZAKARIA; TARMIZI, A M; HAMDAN, A B and KHALID, H

427

MPOB INFORMATION SERIES • ISSN 1511-7871 • JUNE 2008 MPOB TT No. 402

Phosphate rock (PR) is used almost exclusively as P fertilizer for perennial crops in Malaysia. This is attributed to its rapid P dissolution and high P sorption capacity under the high rainfall and acidic soil conditions in the country. It is, of course, also cheap. For decades, Christmas Island Rock Phosphate (CIRP) was the main PR used, until a hiatus in its production in 1987 allowed the entry of other P.

The P responses by mature oil palm to CIRP have been well studied. The effectiveness of the fertilizer on crop performance depends not only on its inherent characteristics, but also on the chemical reactions between the P fertilizers and the soils to which they are applied and their physical factors. However, studies on the other PRs, particularly the reactive ones, are rather limited. In view of their different effectiveness on oil palm, a field evaluation was conducted on commercially available PRs, and the results reported here.

FIELD EVALUATION

Field trials were conducted over a six-year period on 10-year old palms at two locations in Peninsular Malaysia. One of the trials was on Rengam series (Typic Paleudult, an inland sedentary soil from granitic parent materials), and the other on Jawa series (Sulfic Tropaquept, a coastal soil derived from marine alluvium).

A randomized complete block design (RCBD) was used to compare six PRs. The P fertilizers were CIRP, Tunisia or Gafsa PR (TPR), Jordan PR (JPR), North Carolina PR (NCPR), China PR (CPR), and Triple Super-phosphate (TSP). The evaluation was based on the FFB yield obtained and leaf nutrient contents.

P CONTENTS AND SOLUBILITY OF FERTILIZERS

The P contents and solubility of the fertilizers are shown in *Table 1*. As expected, TSP (not being a PR) was the most soluble and had the highest P content (20.4%). For the PRs, the total P_2O_5 content ranged from 30% to 34%. The P solubilities (in 2% CA) of the reactive PRs such as NCPR, JPR and TPR are higher (above 40%) than those for the non-reactive PRs (CIRP and CPR).

PERFORMANCE OF THE FERTILIZERS

The mean FFB yields produced by the P fertilizers are shown in *Table 2*. All the fertilizers increased FFB yield at both locations. However, only on the inland soil were the differences significant between the fertilizers.

The reactive PRs did not produce higher FFB yield than TSP and the non-reactive PRs. Earlier, Zin *et al.* (2005) had reported superior performance by reactive PR on young immature oil palm. This suggests that higher P solubility is more important for immature than the mature palms.

In terms of leaf nutrient content, all the P fertilizer treatments was observed to be adequate in their leaf P levels. However, TSP produced higher leaf P than the other treatments, particularly on sedentary soil.

RELATIVE AGRONOMIC EFFECTIVENESS OF P FERTILIZERS

The relative agronomic effectiveness (RAE) of the P fertilizers was computed, *i.e.* % RAE = FFB yield (PR) / FFB yield (TSP) x 100. Based on the mean FFB

ISSN 1511-7871
9 771511 787001

Malaysian Palm Oil Board, Ministry of Plantation Industries and Commodities, Malaysia
P. O. Box 10620, 50720 Kuala Lumpur, Malaysia. *Tel*: 03-87694400 *Website*: mpob.gov.my *Telefax*: 03-89259446

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TABLE 1. P CONTENTS AND SOLUBILITY OF P FERTILIZERS

P Fertilizer	P content (%)		Solubility total P_2O_5 (%)			CA (%)
	P_2O_5	P	2% CA	2% FA	AAC	
CIRP	32.5	14.2	28.5	34.3	11.4	24.2
TPR	29.9	13.0	45.2	75.4	17.5	32.0
JPR	32.5	13.0	40.9	66.2	15.9	32.6
NCPR	30.3	13.3	53.1	86.3	22.3	31.0
CPR	34.3	15.5	21.3	22.4	8.0	29.2
TSP	46.7	20.4	100.0	-	-	11.6

Note: CA: citric acid; FA: formic acid.
AAC: ammonium acetate.

TABLE 2. EFFECTS OF P FERTILIZERS ON FRESH FRUIT BUNCH (FFB) YIELDS AND LEAF NUTRIENT CONTENTS OF OIL PALM PLANTED ON INLAND AND ALLUVIAL SOILS

P fertilizer	FFB yield (t ha^{-1} yr^{-1})		Nutrient contents (%)							
	Soil types		Inland sedentary soil				Coastal alluvial soil			
	Sedentary	Coastal	N	P	K	Ca	N	P	K	Ca
CIRP	24.05Ab	24.96a	2.85a	0.15a	1.04a	0.61b	2.55a	0.15a	0.84ab	0.40a
TPR	24.07Ab	25.12a	2.80a	0.15a	1.01a	0.64ab	2.51a	0.15a	0.84ab	0.37a
JPR	24.28a	25.31a	2.89a	0.15a	0.95a	0.67ab	2.58a	0.15a	0.86a	0.37a
NCPR	24.08ab	25.00a	2.83a	0.15a	1.00a	0.68a	2.51a	0.15a	0.81b	0.40a
CPR	23.25ab	24.56a	2.81a	0.15a	0.99a	0.61b	2.52a	0.15a	0.82ab	0.41a
TSP	23.94ab	25.35a	2.85a	0.16a	1.03a	0.62b	2.49a	0.15a	0.86a	0.37a
Control (Zero P)	19.69b	23.84a	2.76a	0.14a	1.13a	0.64Ab	2.49a	0.14a	0.85ab	0.35a

Note: Means in the same column with the same letters are not significantly different at $P<0.05$ level with DMRT.

production over six-years, the RAEs of all the PR fertilizers (including the reactive PRs) were similar, and slightly higher than that of TSP (*Figure 1*). On both soils, CPR was the least effective among the PRs, and this may be due to its inferior solubility. The reactive PRs were not superior to the non-reactive PRs on both soils.

ECONOMIC ANALYSIS

Based on the FFB yields produced by the fertilizers over six-year, the return to investment (ROI) or profitability was computed, *i.e.* ROI = gross return (GR) / total variable cost (TVC). On the inland soil, the highest ROI (2.59) was obtained using CIRP, followed by JPR with ROI 2.57. However, on the coastal soil, TPR and JPR gave the highest ROI of 2.74, followed by TSP with 2.72.

CONCLUSION

It can be concluded that reactive PRs such as TPR (Gafsa) JPR, and NCPR were not superior to the more soluble TSP and the non-reactive PRs. Thus, any of them (possibly with the exception of CPR) may be used for mature oil palm on sedentary and alluvial soils. The choice will depend on which is the cheapest.

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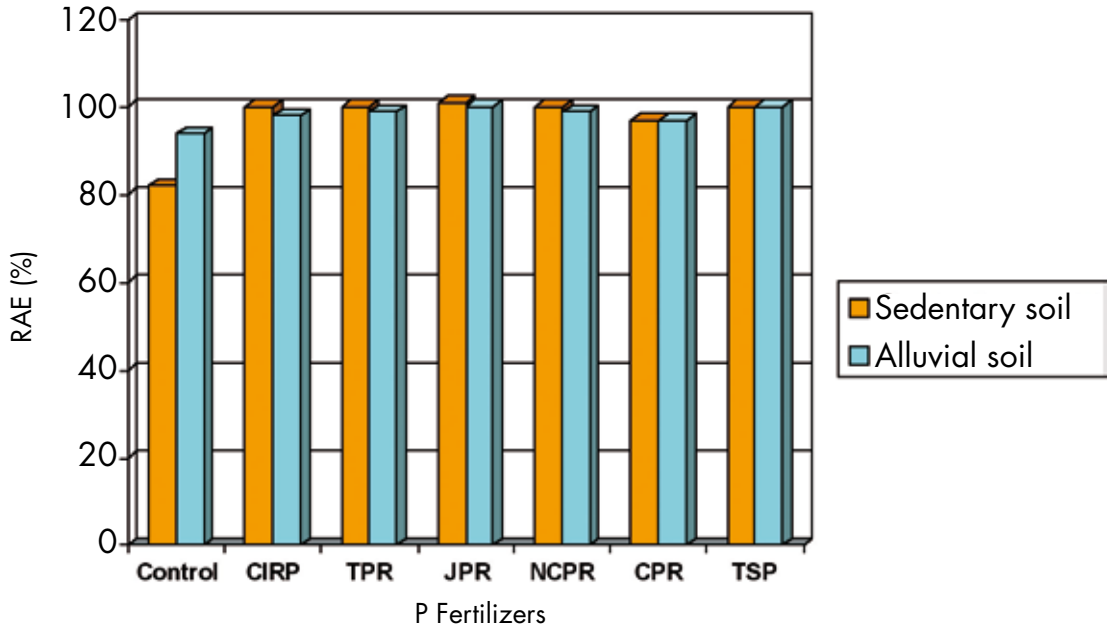

Figure 1. Relative agronomic effectiveness (RAE) of P *fertilizers on inland and coastal soils.*

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For more information kindly contact:

Director-General
MPOB
P. O. Box 10620
50720 Kuala Lumpur, Malaysia.
Tel: 03-87694400
Website: www.mpob.gov.my
Telefax: 03-89259446