VARIABLE-RATE FERTILIZER APPLICATOR FOR OIL PALM

by: WAHID, B O; RAHIM, A S; TARMIZI, A M and BASRI, M W

Current commodities market competition and agriculture regulations are forcing the oil palm industry to seek more competitive management methods to produce palm oil. With the development of geographic information system (GIS), global positioning system (GPS), variable-rate technology (VRT) and remote sensing technology (RS), many oil palm plantations in this country have started adopting precision agriculture (PA) or technologies related to it to improve their productivity and profitability (Wahid *et al.*, 2000). Robert (1997) defined PA as an information and technology-based agricultural management system used to identify, analyse and manage soil spatial and temporal variability within fields for optimum profitability, sustainability and protection of the environment. In other words, the soil has to be treated according to natural rather than artificial boundaries such as blocks or fields.

VRT is one of the important components of precision agriculture. There are two categories of VRT; map-based and sensor-based. The map-based VRT is more applicable for the oil palm. It involves creating of variable-rate prescription maps that describe the varying amounts of agriculture inputs needed within the field. During the application, the controller and the applicator vary the application rate of agriculture inputs according to the variable-rate prescription map information installed in the controller. This technology requires accurate, reliable and high resolution variable-rate applicator to apply the variable-rate inputs successfully.

Fertilizer application is the most costly aspect of oil palm production, and PA practices was employed to ensure that the fertilizer is efficiently and judiciously utilized on a site-specific basis for optimum return. The hardware required to implement variable-rate fertilizer application varies according to situation and type of fertilizer used. Generally, a variable-rate fertilizer applicator is made up of three important components; the calibrator or controller, GPS and variable-rate applicator.

OBJECTIVES

A study was carried out to evaluate the fertilizer applicator's variable-rate system. The objectives were to:

- establish procedures of map-based variable-rate fertilizer application for oil palm;
- evaluate the performance of a variable-rate fertilizer applicator applying different types of compound fertilizer; and
- determine the accuracy of the basic GPS receiver in positioning the fertilizer placements.

METHODOLOGY

An evaluation study on the fertilizer applicator's variable-rate system was carried out at Block 10, MPOB Research Station, Bangi, Selangor. It was conducted on 1.3 ha of a slightly sloping site. The palms were planted in 1997 with a spacing of 9 m x 9 m x 9 m. The harvesting path and the frond pile were created between alternate palm rows. The variable-rate applicator was pulled along the harvesting path to apply the fertilizer.

The study site was mapped using a basic GPS receiver and variable-rate fertilizer map was created using Loris software (*Figure 1*). The Farm Site Mate Ver. 7.0 software was installed into the portable PC. The portable PC was used to download the variable-rate fertilizer map and link the information to the variable-rate applicator calibrator during the fertilizer application.

The variable-rate applicator system was configured for map-based VRT. A pull-type Kemira bogballe M1 variable-rate fertilizer
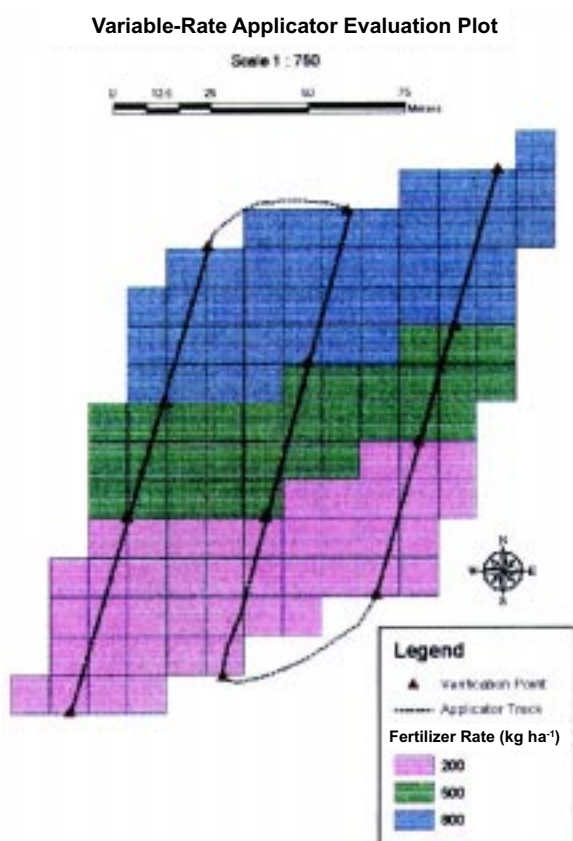
applicator with a twin-disc spreader was evaluated in this study. A 75 hp tractor was used to pull the applicator during the variable-rate fertilizer application. A Calibrator 2003 (bogballe), basic GPS receiver (HAiCOM) and portable PC (Compaq) were the main components used with the applicator. The overall hardware and software of the variable-rate fertilizer application system and their cost are shown in *Table. 1*. The Calibrator 2003 was the main component and used the variable-rate fertilizer map information from the portable PC to vary the applicator fertilizer application rate as a function of field position. The GPS was attached to the portable PC to determine the instantaneous position of the applicator as it operated in the field.

Two types of compound fertilizer, MPOB F1 (compact) (*Figure 2a*) and MPOB F2 (granular) (*Figure 2b*) were evaluated for their suitability for variable-rate application. The fertilizers were applied at three different rates, 200, 500 and 800 kg ha^{-1}.

APPLICATION OF RESULTS

Application Pattern

Earlier evaluation using granular fertilizer indicated that the total spread width of the applicator was 27 m; *i.e.* 13.5 m on each side of the applicator. The distribution patterns of the fertilizer showed that about 80% of the fertilizer was distributed at the frond pile; that is 7.5 – 10.5 m from the spreader on either side (Juhani Uoti and Kenneth Jacob, 2001). Based on these

Figure 1. The variable-rate fertilizer map.

TABLE 1. ESTIMATED COST OF HARDWARE AND SOFTWARE OF THE VARIABLE-RATE FERTILIZER APPLICATION SYSTEM

No.	Items	Cost (RM)
1.	Tractor (60 hp)	60 000
2.	Variable-rate applicator (inclusive of controller/calibrator)	25 000
3.	Basic Global Positioning System	1 140
4.	Portable PC	2 850
5.	GIS software for desktop/laptop personal computer	8 800
6.	GIS software for portable personal computer	4 700
	Total cost	**102 490**

Figure 2a. Compact compound fertilizer.

Figure 2b. Granular compound fertilizer.

results, it is recommended that the application of fertilizer in the oil palm field using the applicator be carried out in alternate harvesting paths (*Figure 3*).

Application Rate

Application rate results indicated that the granular compound fertilizer was more suitable for variable-rate application than the compact compound fertilizer. For the three application rates tested; 200, 500, and 800 kg ha^{-1}, only the application of 800 kg ha^{-1} compact fertilizer was significantly lower than the targeted rate (*Figure 4*).

GPS Receiver Accuracy

The palm canopy, multipath and many other factors could cause errors in the GPS receiver readings and fertilizer placements. These errors had caused the applicator to wrongly place the fertilizer either outside or short of the variable-rate area boundary. The descriptive statistics of the GPS receiver errors are shown in *Table 2*. Using a differential GPS receiver and real-time GPS reading error correction, is expected to
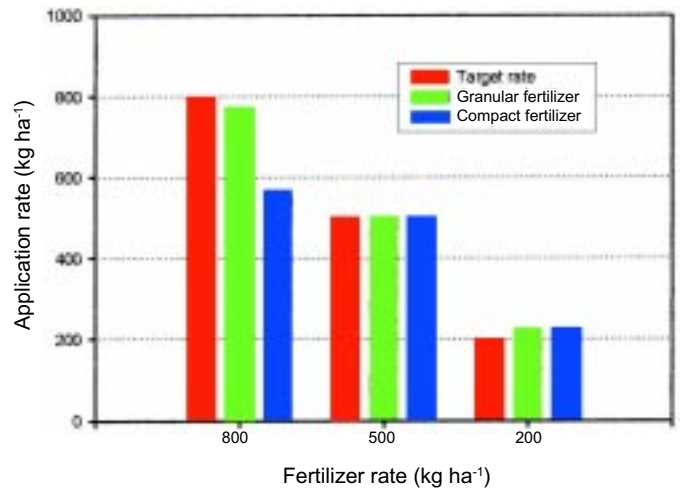

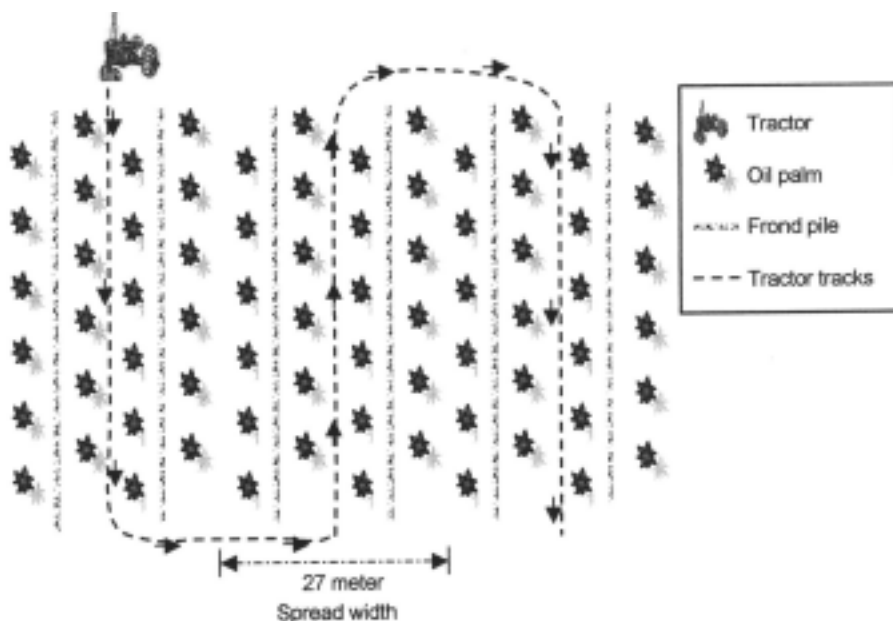*Figure 4. Variable-rate fertilizer accuracy.*

Figure 3. Recommended fertilizer application pattern in the oil palm field.

TABLE 2. DESCRIPTIVE STATISTICS OF GLOBAL POSITIONING SYSTEM (GPS) RECEIVER READING ERRORS

Parameter	Range	Minimum	Maximum	Mean	Std. deviation	Variance
GPS Receiver Errors (m)	8.75	0.33	9.08	4.22	2.64	6.98

improve the fertilizer placement accuracy by the variable-rate fertilizer applicator.

CONCLUSION

The variable-rate fertilizer applicator hardware and software used in this study had successfully executed the variable-rate technique. The present map-based variable-rate procedure that has been developed can be used to apply the variable-rate fertilizer in the oil palm field. Results of the study indicated that the granular compound fertilizer was more suitable for variable-rate application than the compact compound fertilizer. The fertilizer placement accuracy by the variable-rate fertilizer applicator can be improved by using a differential GPS receiver and real-time GPS reading error correction.

REFERENCES

JUHANI UOTT and KENNETH JACOB (2001). New technologies for improved nutrition management in oil palm plantations. *Proc. of the 2001 PIPOC International Palm Oil Congress.* MPOB, Bangi. p.159-164.

ROBERT, P C (1997). Remote Sensing: a potential powerful technique for precision agriculture. Workshop on Precision Technology for Plantation Management. Asgaard Information Services.

WAHID, B O; CHAN, K W and TARMIZI, A M (2000). Precision agriculture practices: development in oil palm plantation. Paper presented at the Precision Farming Seminar at Universiti Putra Malaysia, Selangor. 17 pp.