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Cassava Response to Fertilizer Application

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Continuous cassava cultivation without fertilizer application will lead to soil nutrient depletion and cause yield losses over time. Fertilizer recommendations based on the principles of 4R Nutrient Stewardship will help cassava farmers reap the benefits of their investment in fertilizer.

KEYWORDS:
yield gaps; tuber yield; food crop production; sustainable intensification.

ABBREVIATIONS AND NOTES:
N = nitrogen; P = phosphorus; K = potassium.

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Cassava is the third most important source of calories next to rice and maize in tropical countries. However, many years of inadequate attention has tagged cassava as the "poor man's crop." Ironically, cassava's on-going contribution to food security and its many industrial uses amounts to a large and positive impact on rural industrial development and on-farm income. Cassava's rising demand for food, feed, and industrial purposes is driving a need to increase its production.

In Southeast Asia, more than 8 million farmers grow cassava (CGIAR, 2015). Cassava production in the region accounts for 22% of world production (FAOSTAT, 2017). Traditionally, farmers produced cassava for food. However, over the past 50 years, particularly in Cambodia and Indonesia, cassava grown for industrial purposes has steadily increased. Thailand is now the world's second largest cassava producer next to Nigeria and is the world's top cassava exporter (Treesilvattanakul, 2015). Increased cassava production is serving a rising demand for cassava-based livestock feed, starch, and bio-fuels.

A large yield gap between average and potential yields of cassava in Southeast Asia indicates an opportunity to increase cassava production through intensification. The average yield of cassava in Southeast Asia ranges from 4 to 27 t/ha (**Figure 1**,

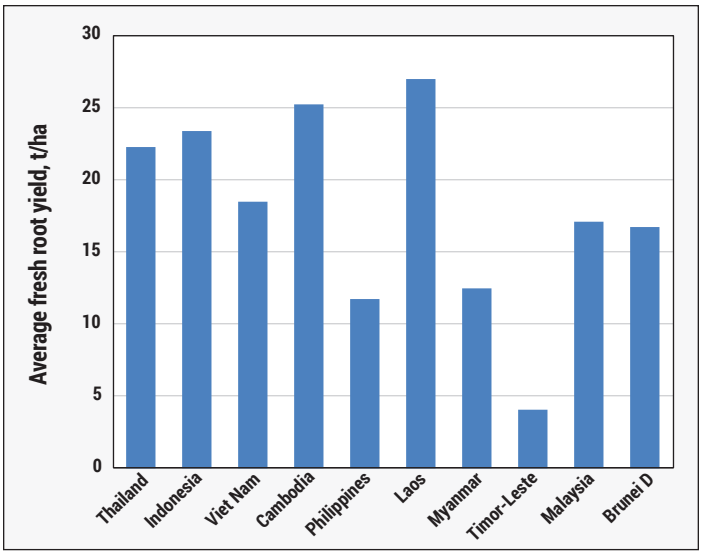

Figure 1. Average fresh root yield of cassava in Southeast Asian countries in 2014 (FAOSTAT, 2017).

FAOSTAT, 2017). In an optimal growing environment the yield of cassava could reach 90 t/ha (El-Sharkawy, 2004).

Improved crop management practices including high-yielding varieties, good quality planting materials, sufficient moisture, proper plant spacing, and pest and disease control are needed to close the cassava yield gap. Optimal nutrient management is also required to ensure that the crop is provided with the nutrients needed for full growth and development. However, farmers often grow cassava with minimal or even no fertilizer inputs. A study in Cambodia revealed that only 10 out of 45 sampled households applied fertilizers to their cassava crop. Application rates were low at 0 to 7 kg N/ha, 0 to 11 kg P_2O_5/ha, and no fertilizer K (Sopheap et al., 2012). A similar study of 450 farmers in the Philippines also found minimal fertilizer application at 0 to 109 kg N/ha, 0 to 26 kg P_2O_5/ha, and 0 to 29 kg K_2O/ha (PSA, 2014).

Although cassava can grow better than other crops in poor soils, the crop does respond well to fertilizer application. A study comparing the yield of fertilized and unfertilized cassava in four locations in the Philippines (with three varieties per location) showed that cassava yield can be increased greatly through fertilizer application (**Figure 2**).

The 4R Nutrient Stewardship concept of applying the right source of plant nutrients at the right rate, at the right time, and in the right place (IPNI, 2012) provides guidelines on fertilizer management that will help farmers reap the full benefits of their investment in fertilizer.
The following are practical tips for applying 4Rs in cassava:

Right Source

- Determine the availability of fertilizers or nutrient sources and check their nutrient content.
- Mixture of single and compound fertilizers can be used as long as it satisfies the nutrient requirement of the crop to achieve a certain target yield. Check fertilizer mixture compatibility at http://seap.ipni.net/article/SEAP-3024
- Check the price of the fertilizer source. The increase in benefit coming from the increase in yield of cassava through fertilizer application can mask the additional cost that comes from it.
- Use farm-available nutrient sources such as plant residues and animal manure. These organic nutrient sources can also improve soil properties.

Right Rate

- Use site-specific fertilizer application rates, if available.
- Determine the nutrient requirements of the crop. High-yielding varieties need higher fertilization rates than low-yielding varieties.
- Determine the fertility status of your soil. Soils with high fertility supply more nutrients than their low fertility counterparts.
- Consider other bio-physical constraints. Low yield is expected in sites that are prone to water logging or drought.
- Fertilizer rates can be adjusted based on farmer's budget for economic yield. Farmers with budget constraints can opt to target relatively lower yields thereby reducing fertilizer rates and investment.
- Over application of any particular fertilizer is not economical. Do not apply excessive amounts of N, as it will increase crop foliage and sacrifice tuber yield (Ukaoma and Ogbonnaya, 2013; Sangakkara and Wijesinghe, 2014).

Right Time

- Apply N, P, and K fertilizer 2 to 4 weeks after planting to ensure that the crop has enough nutrients to support its early growth.
- Moderate rates of N fertilizer can be applied in two or three splits to increase N recovery efficiency and induce good yields (Sangakkara and Wijesighe, 2014).
- A full dose of P should be applied in the first application to support root development.
- K fertilizer may be applied in two to three splits to minimize losses (i.e., if the required rate is high or if the soil is light textured).
- Ensure that soil moisture is sufficient and weeds surrounding the plants are removed before fertilizer application.
- Application of fertilizer during heavy rains is not advisable. It can cause nutrient losses due to erosion and leaching.

Right Place

- Make sure that the fertilizer is easily accessible to plant roots.
- Apply the fertilizer 15 to 20 cm from the base of the plant and cover with soil by hilling-up or by drilling holes. This can also minimize nutrient losses due to volatilization and run-off.

Similar results were obtained in studies conducted in Thailand, Indonesia, and Vietnam (Ngoan and Howeler, 2002; Yuniwati et al., 2012; Pongpet et al., 2016).

A study on the effect of fertilizer application on continuous cropping of cassava from 2004 to 2007 in Indonesia revealed that without fertilizer application, cassava yield decreased from more than 20 t/ha in the first year to less than 10 t/ha in the third year, after which the yield remained constant at about 9 t/ha (Yuniwati et al., 2012). Continuous cultivation of cassava without fertilizer application can lead to yield decline and soil degradation due to soil nutrient mining.

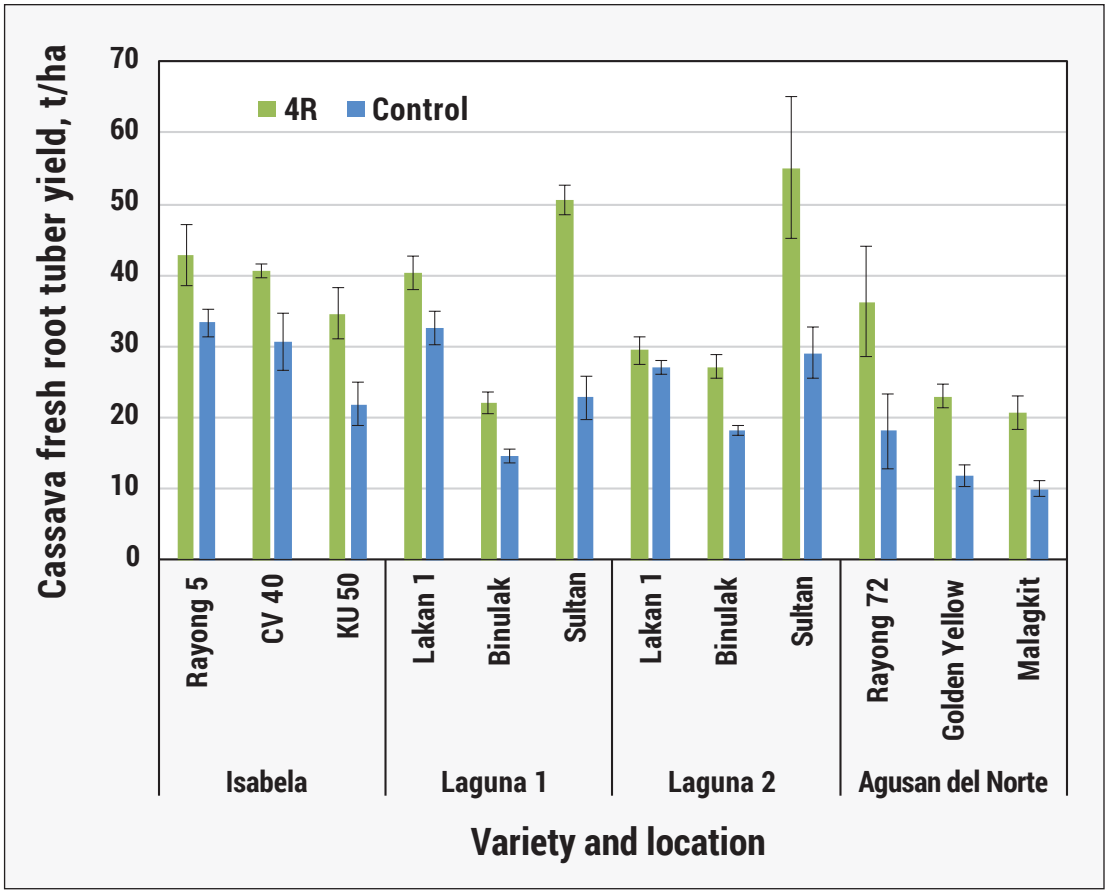

Figure 2. Effect of 4R-based fertilizer application on cassava fresh root yield at four locations in the Philippines using three varieties, 2015-2016. Error bars indicate the standard error of the mean.

Summary

Increasing demand for cassava drives the need for an increase in the crop's production. Optimal nutrient management is key in closing wide yield gaps and in attaining sustainable intensification in cassava. Farmers must be informed that, as with other crops, cassava needs fertilizer to achieve high yields. Continuous cropping of cassava without balanced fertilizer application can lead to soil nutrient depletion and yield decline over time. Fertilizer recommendations based on 4R principles are key to realizing the full benefits of fertilizer application in cassava. **BC**

TAKE IT TO THE FIELD

In cassava, optimal application of:

- N is needed to develop a large enough bulk of foliage as the assimilating area needed for the development of tubers
- P is essential for the synthesis of starch and normal root production
- K plays a special role in the translocation of photosynthates from the leaves to the tuberous roots
- N, P, and K together stimulates early growth, which provides a competitive advantages against weeds and reduces the impact of erosion

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