

EFFECT OF FERTILIZER ON GROWTH AND YIELD OF CASSAVA (*MANIHOT ESCULENTA CRANTZ*)

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INTRODUCTION

Cassava (*Manihot esculenta* Crantz) has the inherent capacity to produce reasonable yields under poor soil and climatic conditions. As a result, increasingly marginal lands, where no other can grow, are being used for cassava production. In addition, continuous cassava cultivation without any crop management (i.e. fertilizer application) degrade lands further and consequently decrease yield. It has been demonstrated that fertilizer application can increase cassava production and can sustain productivity for longer period in poor soils. To maintain sustainable cassava production, crop management are necessary. Applications of moderate levels of nitrogen (N) , phosphorus (P) and potassium (K) were shown to significantly increase cassava yields and sustain productivity for longer periods in poor soils.

The objective of current study were to determine effective management practice (1) fertilizer combination that could give the highest root yield, (2) most monetary benefit taking into account input cost.

MATERIALS AND METHODS

Effect of fertilizer application was studied in four on-farm experiments in Tboung Khmum province, a major Cassava growing area of Cambodia (11°54'20.39" N 105°38'29.39" E) during 2014-15 season. A popular variety, KU50, was used in all experiments. The experiments evaluated the effect of 2 rates of 15:15:15 and 2 rates of combination of 15:15:15 with KCl or cow manure. A randomized complete block design (RCBD) was used with three replications. The five treatments were: T1= Control (no fertilizer) T2= 15:15:15 (200kg/ha), T3= 15:15:15 (100kg/ha), T4=15:15:15 + KCl (100/ha + 50kg/ha), T5= Cow manure +15:15:15 (5t/ha + 100kg/ha). The experiments were conducted on *Labansiek* (Eutric Nitisol) (White et al., 1997) soil. Land preparation was done by tractor ploughing.

The stakes of 20-25 cm length collected from Seed farm of Kampong Cham province, were vertically planted on 13 June 2014. One stakes per hole with plant to plant distance of 1.0 x 1.0 m and plot size were 6 x 5 m. and in each plot there were 30 plants. Cow manure was incorporated into soil a few days before planting. Chemical fertilizers were applied on 25 July 2014, side dressed ~10 cm depth and ~15 cm away from the plants and covered with soil. Weeding was carried out manually with a native hoe 4 times during the life of the crop starting at 30 days after crop establishment and thereafter at 60, 90 and 150 d to keep the plots weed-free. Cassava root were harvested 15 March 2015, 9 months after planting. From each plot 12 plants were harvested leaving out the 18 plants as border plants for yield measurement.

Statistical analyses

Data were analyzed by calculation of the means, standard errors and analysis of variance (ANOVA), where appropriate using GenStat for Windows statistical software (VSN International Ltd) and differences were considered significant at $P < 0.05$.

RESULTS AND DISCUSSIONS

Cassava root yield was significantly increased by fertilizer application compared to non-fertilized controls (the most common farmer practice) in all four on-farm experiments (Fig 1). Root yield of cassava ranged from 15.1 to 23.6 t/ha in control treatments. In two of the experimental sites, 100 kg/ha of mixed NPK fertilizer (15-15-15) plus 50 kg/ha of KCl resulted in the highest root yield, 47% and 84% higher and in the other 2 sites, 200 kg/ha of mixed NPK fertilizer resulted in the highest root yields, 39% and 60% higher root yields compared to unfertilized controls. Application of properly balanced fertilizers, with adequate levels of potassium (K) in particular, is needed for high root high yields. Potassium is often depleted in soils where cassava roots have been harvested over many years without fertilization to compensate for nutrient removal. Both of the highest-yielding treatments contained adequate levels of potassium.

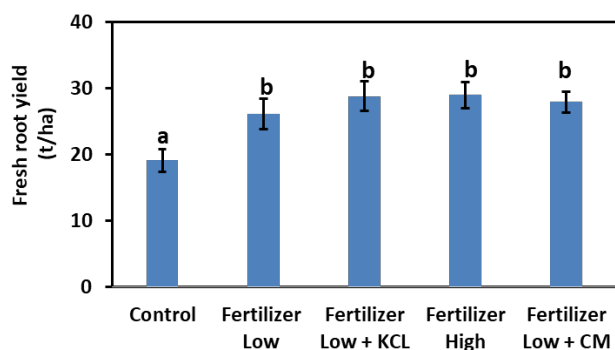


Fig 1: Fresh root yield of cassava at maturity (9 months of growth) with different level of fertilizer in all for experimental sites. Control, without any fertilizer; Fertilizer high= 15:15:15 (200 kg/ha), Fertilizer Low= 15:15:15 and (100kg/ha), CM= 5 t/ha cow manure KCL= 50 kg/ha. Standard error bars refer to fresh root yield (n = 3). Bars with different letters are significantly different (P < 0.05).

The economic benefits of improved fertilizer management are determined by the additional value generated (yield x the field price of cassava roots) minus the additional cost of purchasing the fertilizer. The field price represents the standing value of the crop before harvesting and loading. In 2015, the price of cassava was \$87 USD/t at nearby collection points and farmers would pay 30,000 Riel/t (\$7.22) for harvesting and loading. The cassava price declined significantly in 2016-17 due to changing global markets (see Newby et al, 2017). As such, sensitivity analysis was conducted using the lowest price in 2016 (\$55 USD/t) minus increased costs for harvesting and loading, resulting in a field price of \$46 USD/t. The cost of fertilizer has also been reduced to reflect the current prices. Table 1 indicates the total cost that vary (fertilizer), the marginal cost (MC), the marginal net benefit (MNB) averaged across the five treatments, and the marginal rate of return (MRR). The MRR is the additional income divided by the additional cost of the treatment.

Table1 – Economic analysis of fertilizer treatments across four locations.

Treatments	2015 (actual year)				2016 (low price)			
	Costs that vary	MC	MNB	MRR	Costs that vary	MC	MNB	MRR
Control 0:0:0	0				0			
15:15:15(100kg/ha)	60	60	496.80	828%	55	55	266.04	484%
15:15:15+KCl(100/ha+50kg/ha)	91	31	185.07	597%	80	25	99.58	398%
15:15:15(200kg/ha)	120	29	-15.15	-52%	110	30	-22.01	-73%
CM+15:15:15(5t/ha+100kg/ha)	235	115	-198.10	-172%	180	70	-117.92	-168%

The results show a very attractive average MRR generated by applying the low level of compound fertilizer (828% in Fig 2a). Put another way, for every dollar invested in fertilizer, a farmer could expect to get to

receive invested dollar back, plus an additional \$8.28. Importantly, even under the low price scenario the application of low levels of fertilizer produce an attractive return (597%). This is also true if all sites are considered separately (Fig 2b). The MRR would remain above 200% unless the price at the collection point fell below \$32.70 or a field price of \$23.60.

The application of additional KCI also appears to produce attractive returns under both price scenarios. However, a broad recommendation cannot be made given that there was no statistically difference between this treatment and the low rate due to the variability in response across the sites in which case the cheapest treatment should be recommended. In two of the sites, there was a strong response to applying KCI, which would results in a very high MRR. This highlights the potential benefits of developing site-specific recommendations. Increasing the level of compound fertilizer (200kg of 15-15-15) did not produce a significant difference in agronomic terms over the low rate, and was a dominated treatment in economic terms. The high costs of manure and low response relative to the low treatment also meant that it was not an economic option for farmers.



Fig 2a – Marginal rate of return analysis across all sites under two price scenarios; **Fig 2b** – Marginal rate of return analysis for each site under the low price scenario.

CONCLUSIONS

Cassava roots yields can be increased and soil fertility depletion can be prevented by application of adequate amount of fertilizer. The results show that farmers could expect a significant response to applying low levels of fertilizer that would result improved cash incomes. Applying additional fertilizer beyond a low rate should be considered on a site-by-site basis. Tailoring a more balanced low fertilizer blend based on the site-specific soil fertility could also enhance the returns farmers get from small investments in fertilizer.