Mechanical weed control in cassava: effects on weed biomass, labour requirements and root yields

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Introduction

Weed control is a major labor input in cassava production and commonly burdens women and children with drudgery of bending down and weeding by hand with short handled hoes. Chemical weed control has not been investigated as in other crops and mechanical weeding is uncommon. In multi-location trials covering all major Nigerian cassava growing areas we investigated if manually operated or engine driven mechanical weeders can attain the same weeding quality and root yields as manual weeding with the common short handled hoe within the same time and effort.

Materials and methods

Trials were conducted in Oyo, Ogun, Abia and Benue states in two consecutive years. The first trials tested 7 implements: short handled hoe (SHH), long handled hoe (LHH), rotary weeder (RW), spike weeder (SW), small motorized tiller (SMT), large motorized tiller (LMT) and motorized brush cutter (BC) (see images right hand bottom). Weeding was conducted at 4, 8, 12 and 24 weeks after planting, cassava density was 12500 ha^{-1}. Net-plots measured 4×8 m. Each implement was tested on ridged and flat soil and by female and male operators. In a third year the best two options, short handled hoe and small motorized tiller, were compared on large plots (~1250 m^2) to eliminate distortion in labour data on small plots and to investigate the users' perception on ease and challenges using the hand hoe versus the small motorized tiller called "Mantis".

The short handled hoe. About 70-80 cm long with a triangular blade of 12-18 cm side length.

Figure 6: Female Mantis tiller operator in a severely weed infested 5 weeks old cassava crop (left) and in an advanced (12 weeks) crop at the same site (right).

Results

The first trials across four sites showed differences between the root yields attained when weeding with the different implements (Figure 1&2). Although there were site x implement interactions, all partners agreed that the rotary weeder and the brush cutter are not suitable. The spike weeder was eliminated due to poor yield and the large labor time requirement.

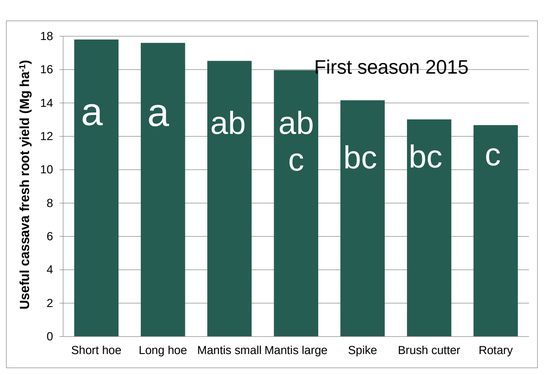

Figure 1: Cassava root yields attained when weeding with different implements. Means of four sites.

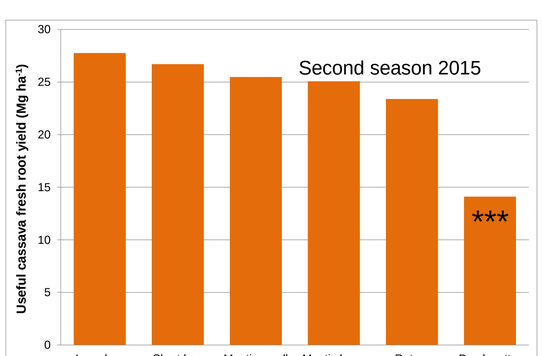

Figure 2: Cassava fresh root yields attained when weeding with different implements. * significantly different from all others.**

Results continued

In the second year data from 2 sites showed the motorized Mantis tillers to be faster than the hoes (Figure 3). Female operators required generally more time to weed yet the difference was only significant when using the long hoe. Fuel consumption of the brush cutter was up to 2 times higher than that of either Mantis tiller. Weed mass (Figure 4) and numbers were highest when motorized weeders were used. Unlike in the second season 2015 the yield differences between implements were not significant, yet there was a clear yield loss of close to 5 Mg ha^{-1}, when the brush cutter was used (Figure 5).

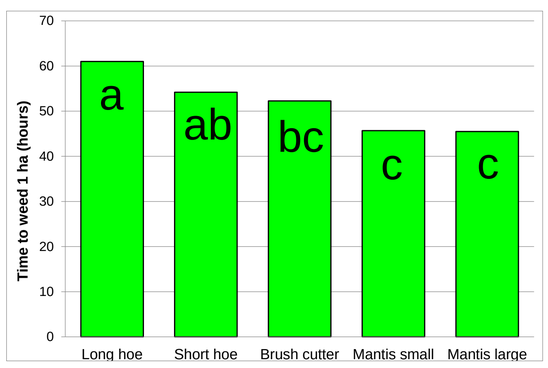

Figure 3: Time required to weed 1 ha with different implements. Means of two sites.

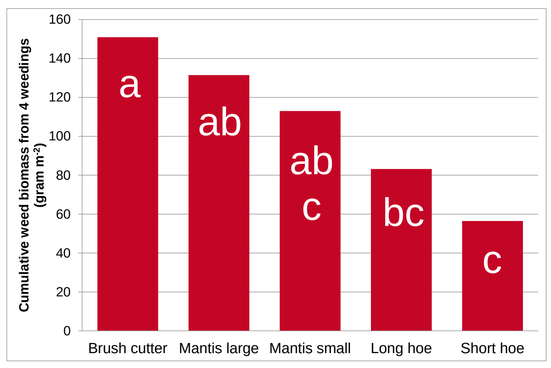

Figure 4: Weed mass cumulated from 4 weedings with different implements.

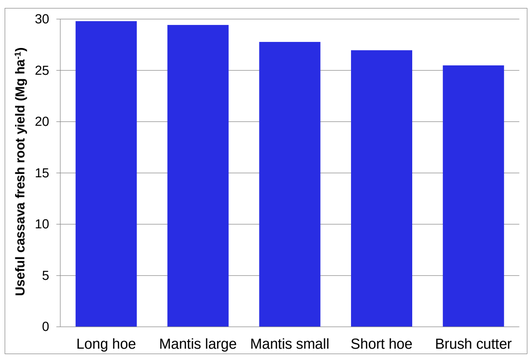

Figure 5: Useful cassava fresh root yield attained in 2016 using different weeding implements. Note: no significant differences

Results continued

Considering labor time, fuel consumption, weed mass and cassava root yields lead to the elimination of the brush cutter. The large Mantis tiller was found too heavy and difficult to control in advanced cassava crops (Figure 6) and was discontinued. The long hoe performed well yet operators were not used to target weeds with a long handle, causing increased weeding time. For this reason it was not considered for follow up research.

Results continued

The comparison of the short hoe and the small Mantis tiller in large plots revealed that labor data obtained in small plots are not realistic. In small plots weeding a ha required between 45 and 60 hours, while in the large plots the average time to weed one ha was 106 hours with a wide range (50-260 hours ha^{-1}). Apparently the operators are getting tired in large plots, slowing down the weeding to half the speed compared with small plots.
The mantis tiller required about half the time to weed compared with the short hoe (Figure 7).

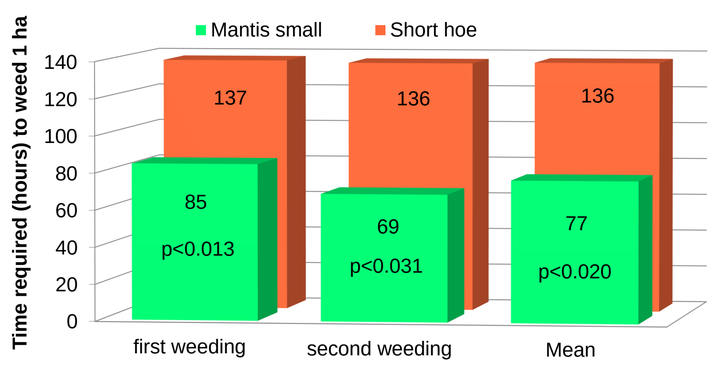

Figure 7: Time required in hours to weed 1 ha at the first and second weeding when using the short hoe and the motorized mantis tiller.
P values within the same weeding indicate the level of significance between implements

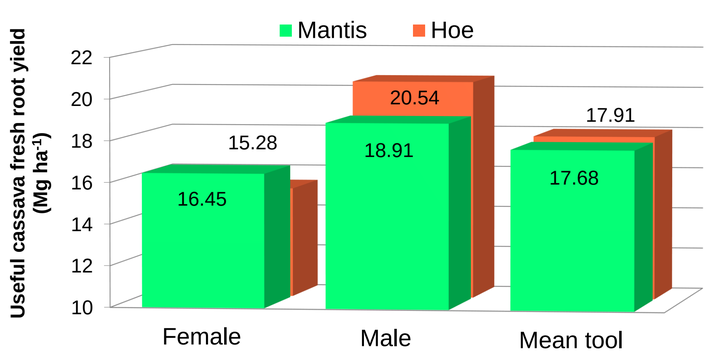

Figure 8: Useful cassava fresh root yield (Mg ha^{-1}) attained by female and male operators weeding with the short hoe and the motorized mantis tiller. Note: No significant differences between treatments.

Results continued

The root yield was unaffected by the weeding implement (Figure 8). Root yield differences were not found when females or males operated the implements. The difference between yields attained by male and female operators (3.86 Mg ha^{-1}) was not significant (p<0.085).

Conclusion

The initial investment of around 600 US $ for the Mantis tiller plus the required modification from tillage to weeding tines and the fuel consumption and eventual maintenance costs have to be balanced against the time saved.
Manual weeding currently costs around 100 $ ha^{-1} in Nigeria. A skilled Mantis operator can do the weeding in half the time thus would cost around 50 $ per ha plus fuel which was around 20 l ha^{-1} or 8.5 $ at current prices. This would lead to a saving of around 40 $ per weeding and would depreciate the machine cost at 12 to 14 weeding operations, not considering maintenance and spare parts.
The mantis tiller would thus be a viable alternative to short hoe weeding.

Large Mantis **Small Mantis** **Brush cutter**

Rotary weeder **Spike weeder** **Long hoe**