The impact of tree pruning on *Grevillea robusta*'s water use and maize productivity in semi-arid Rwanda

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1. Introduction

Farming systems in the semi-arid Bugesera region of Rwanda combine crops and trees in an agroforestry-based intercropping system, with *Grevillea robusta* being a common tree species. The integration of trees on smallholder farmers' fields has been reported to result in competition for resources. Pruning at 75% was used to manage the competition between *G. robusta* and maize. This study aimed to investigate the effect of pruning on water uptake in G. robusta and productivity of associated maize.

2. Materials and Method

Sap Flow Metres were installed on six mature *G. robusta* trees at Rweru in Bugesera District from July 2014 to November 2016. The Heat Ratio Method (HRM) was followed for water uptake analysis (Burgess et al., 2001). On-farm split plot design was used to assess maize grain yield response, diurnal sap flow rate and daily sap volume data. The observations involved 36 farmers.

3. Results

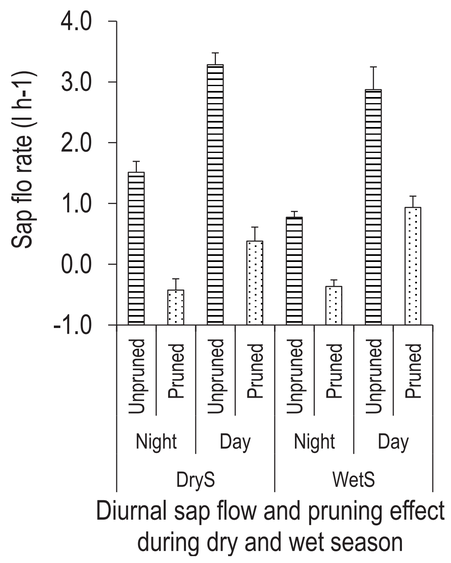

Figure 1: Hourly sap flow rate during the dry (15-18 Jul. 2014) and wet (6-9 Dec. 2014) season

3.1. Diurnal Sap flow rate–

3.1.1. The unpruned *G. robusta* sap flow rate (2.1 l h^{-1}) was significantly higher than the pruned *G. robusta* sap flow rate (0.13 l h^{-1}).

3.1.2. Day time (06:00-17:30) sap flow rate 1.87 l h^{-1} was significantly higher than night time (18:00-05:30) sap flow rate 0.38 l h^{-1}.

3.1.3. Night time (18:00-05:30) sap flow rate of 0.54 l h^{-1} during the dry season was significantly higher compared to night time sap flow rate during the wet season 0.205 l h^{-1}

3.2. Daily sap flow volume

The sap flow volume in unpruned *G. robusta* varied from 78.0 to 23.9 l d^{-1}, while the pruned *G. robusta* varied from 28.1 to 9.2 l d^{-1} from 1 July to 31 Dec. 2014. July to August period was the dry season while September to December was the rainy season. Pruning *G. robusta* significantly reduced daily sap water volume uptake by 54.9 l d^{-1} (69.7%) considering the max. value and 14.2 l d^{-1} (61.5%) the min. value.

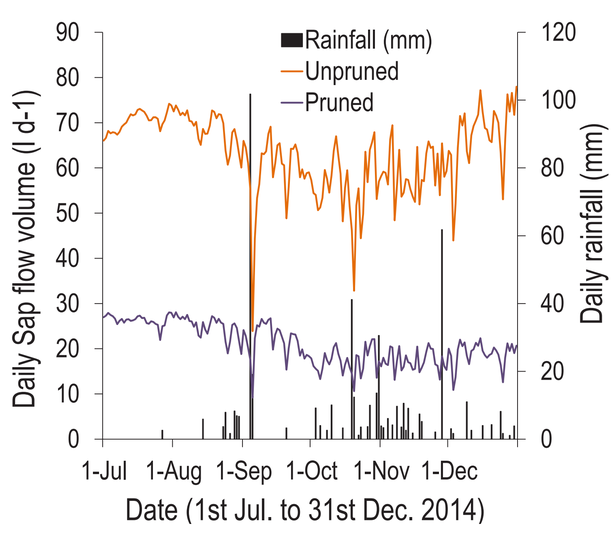

Figure 2: Daily sap flow volume trend in *G. robusta* in Bugesera

Sap Flow Meter installed in *G. robusta* tree

During frequent rainstorms, hydraulic lift (upward water uptake) decreased in response to increased *G. robusta* water storage.

On-farm sap flow experiment involving *G. robusta* and maize crop grown in Bugesera

Pruning *G. robusta* led to a significant increase in maize yield during both rainy seasons. This was 3.0 t ha^{-1} from 2.3 t ha^{-1} during 2015 B and 2.2 t ha^{-1} from 1.9 t ha^{-1} during 2016 A .

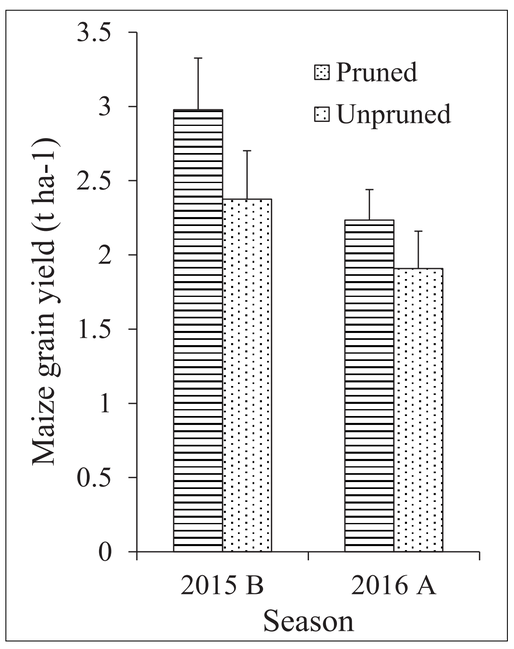

Figure 4: Maize grain yield during long rains (Mar. to Jul. 2015) and short rains (Oct.2015- Jan. 2016)

4. Conclusion and recommendations

Pruning significantly reduced daily sap water volume uptake of *G. robusta* by 68%. This resulted in an increase in maize grain yield. The additional advantage of *G. robusta* pruning is to provide households with firewood. To reduce tree-crop competition, pruning is recommended for *G. robusta* in semi-arid regions. We also recommend that tree water use of other important agroforestry species especially indigenous ones with differing leafing phenologies should be investigated. Buyinza et al 2019

5. References

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