Pollarding *Faidherbia albida* tree reduces the complementarities benefit of underneath wheat productivity in Mojo, Ethiopia

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Introduction

Faidherbia albida is known for its adaptability in semi-arid and sub-humid regions. A peculiar characteristic (reverse phenology) of the tree makes it the most compatible agroforestry tree for most crops such as maize, millet, groundnut and sorghum with the range of 30-200% higher yield beneath the *F. albida* canopy due to a great amount of organic fertilizer incorporated from litterfall. Decomposition and subsequent mineralization of litter provides additional nutrients to the soil. For instance, levels of TN, OC and K were higher under the tree canopy. The tree does not compete with crops for water, light and nutrients as it enters into physiological dormancy during the cropping season. *F. albida* canopy is used to reduce heat stress and evapo-transpiration towards the onset of the dry period. The impact of environmental factors controlling crop yield has been studied extensively. Conducting research on physiological processes of intercropped trees such as long-term water budget and leaf phenophase are vital to understanding the type of interactions among different components. Despite numerous advantages of this tree, farmers around the study area heavily pollard the branches. As a result, this has a negative impact on tree growth and water relations, as well as underneath wheat productivity in the area.

Objective of the study

The main objective of this study was to investigate the impact of pollarding of *F. albida* on water relation and growth of the tree, as well as underneath wheat productivity under non-pollarded and pollarded *F. albida* compared with the open area.

Materials and methods

This experiment was conducted from 2015-2016 in Mojo, a semi-arid region of Ethiopia. The area usually experiences erratic rainfall and frequent droughts. Mean maximum and minimum temperatures were 35°C and 20°C in January and December, respectively. Mean annual rainfall is 800 mm. Cambium dynamics were measured using micro sensor dendrometer; soil moisture was determined using profile probe and delta – T soil moisture metre (Fig. 3); and sap flow was measured using heat ratio sensors (Fig. 4).

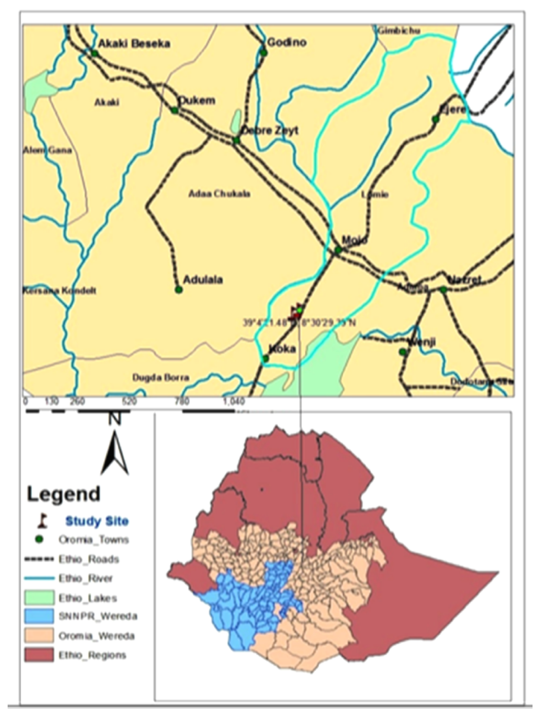

Fig. 1 Map of study area

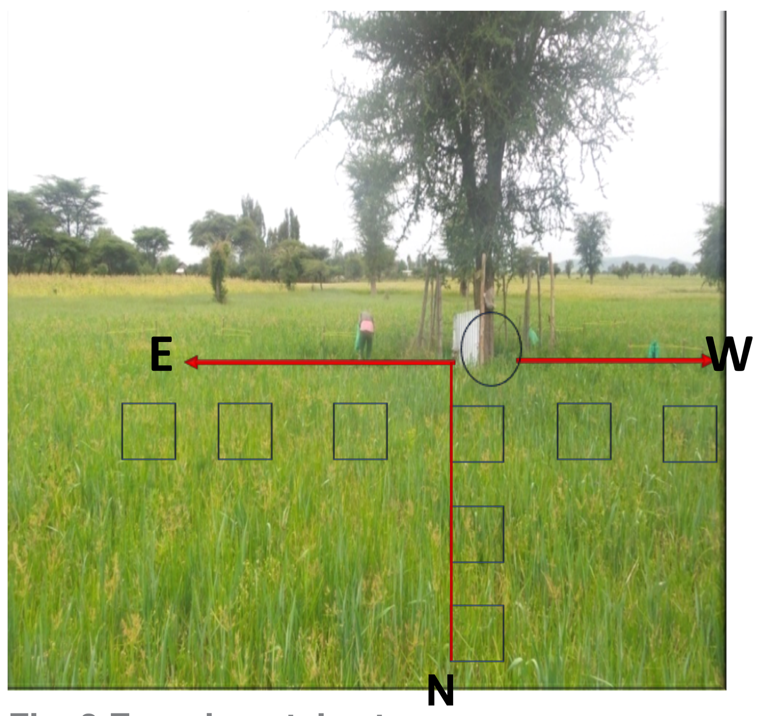

Fig. 2 Experimental set-up

Fig. 3 Soil moisture % measurement using Profile probe and Delta T meter

Fig. 4 Heat ratio method sap flow sensors

Results

Most of the measured parameters showed significantly ($P<0.05$) different between the tree management. Cambial dynamics was reduced by up to 96% due to pollarding effects compared to the non-pollarded, as pollarding trees reduces annual circumference change by up to 78%. (Fig. 5). Maximum soil moisture percentage was recorded in September ca 68%, otherwise it was below 50% on average across all the depth classes under pollarded *F. albida*. The average soil moisture percentage under non-pollarded *F. albida* tree was significant compared to under pollarded once across similar depths (Fig. 6). Sap volume was reduced when the tree was pollarded and during defoliation from non-pollarded *F. albida*, respectively, around the onset of the main rainy season (June-July). The highest monthly sap volume being 4590L for non-pollarded *F. albida* (153L Day^{-1}) compared to 403L (13.4L day^{-1}) in pollarded trees during the dry season (January-March) each year (Fig. 7). The highest aboveground biomass were 4.1t ha^{-1} and 3.5 t ha^{-1} obtained from 1m distances under non-pollarded and pollarded *F. albida* trees, respectively (Fig. 8). On the other hand, the highest grain yields were 4.0 t ha^{-1} and 2.3 t ha^{-1} obtained under non-pollarded and pollarded *F. albida*, respectively (Fig. 9).

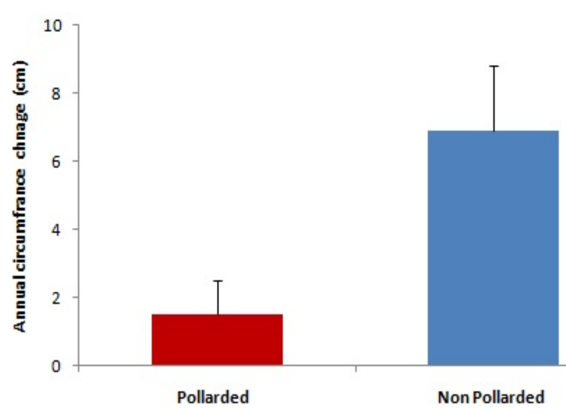

Fig. 5 Annual circumference change (cm)

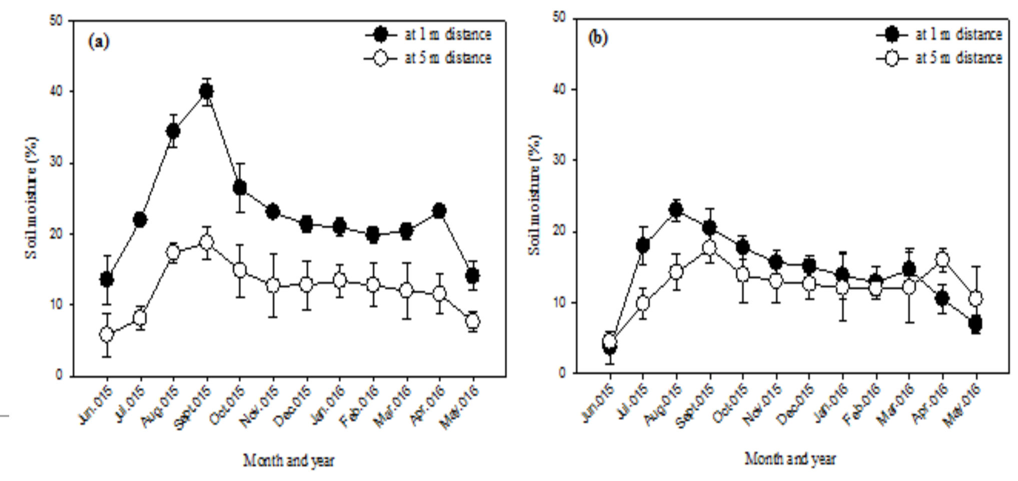

Fig. 6 Monthly soil moisture % non-pollarded (a) and pollarded (b)

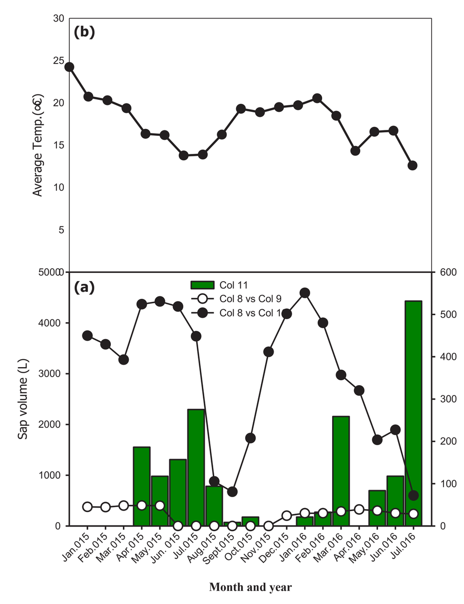

Fig. 7 Monthly sap volume of non pollarded, pollarded and rainfall (a) and mean temperature (b)

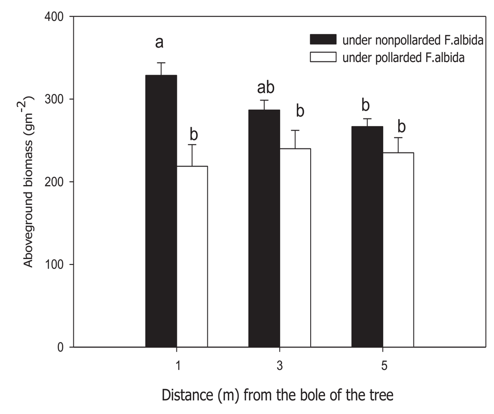

Fig. 8 Aboveground biomass wheat

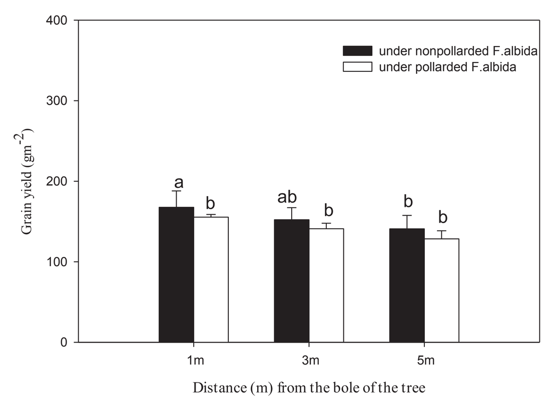

Fig. 9 Grain yield of wheat

Conclusions

- Pollarding the branches of *F. albida* significantly reduces cambium dynamics and will curtail tree growth
- Soil moisture percentage varies (both spatial and temporal) under non-pollarded and pollarded trees. However, the change under pollarded trees is significant compared to non-pollarded during the dry period
- Highest monthly sap volume was 4590L for non-pollarded *F. albida* (153L day^{-1}) compared to 403L (13.4L day^{-1}) in pollarded trees during the dry season (January-March) each year; lowest sap volume recorded during the wet season (September) from non-pollarded and pollarded were 403L and 1.3L, respectively
- Due to pollarding, aboveground biomass and grain yields under pollarded *F. albida* were reduced by 14% and 42%, respectively
- In general, pollarding *F. albida* tree reduces both tree growth and the underneath wheat productivity

Acknowledgements

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