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Research Application Summary

Effects of tillage practices and cropping systems on maize grain yield in Gurue, Mozambique

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Abstract

Conservation agriculture (CA) practices are being promoted in southern Africa to increase crop production in light of the highly depleted soils. The Mozambican population is highly depended in maize making the country extremely vulnerable as any decrease in maize production brings food insecurity. Inclusion of legumes in rotation or association with maize under CA system has potential to maintain soil fertility but also improve on maize yields. However, the advantage of CA practices in a maize–legume cropping system over conventional tillage needs to be demonstrated to farmers for it to be adopted. A study was done at Gúrue Research Station in Zambézia Province, Central Mozambique. The trial was designed as a randomized complete block in a split plot arrangement replicated four times. The main plot factor was tillage practice (conventional and conservation tillage) while the sub-plot factor was intercrop combination (sole maize, maize/cowpea, maize/beans and maize/soybean). The study demonstrated benefit in CA to increase productivity of maize-legume cropping system.

Key words: Conservation agriculture, maize, Mozambique

Résumé

Les pratiques de l'agriculture de conservation sont en train d'être encouragées en Afrique australe afin d'augmenter la production agricole en considération des sols appauvris. Les populations mozambicaines dépendent fortement du maïs, ce qui rend le pays extrêmement vulnérable car toute diminution de la production en maïs entraîne une insécurité alimentaire. L'intégration des légumineuses en rotation ou en association avec le maïs dans un système d'agriculture de conservation, a le potentiel de maintenir la fertilité du sol mais aussi d'améliorer les rendements en maïs. Cependant, l'avantage des pratiques d'agriculture de conservation dans un système de culture maïs-légumineuses par rapport au travail conventionnel du sol doit être démontré aux agriculteurs pour qu'elles soient adoptées. La présente étude a été conduite à la station de recherche de Gúrue dans la province de Zambézia, au centre du Mozambique. L'expérimentation a été conçue dans un dispositif de bloc aléatoire complet dans un arrangement de split plot avec quatre répétitions. Le principal facteur pour la parcelle était la pratique du travail du sol (labour conventionnel et de conservation) tandis que le

facteur considéré pour la sous-parcelle était la combinaison de culture intercalaire (maïs, maïs/niébé, maïs/haricot et maïs/soja). L'étude a démontré l'avantage de l'agriculture de conservation dans l'amélioration de la productivité du système de culture maïs-légumineuses.

Mots clés: Agriculture de conservation, maïs, Mozambique

Background

Degradation of cropland soils represents a major challenge for sustainable productivity in smallholder systems of Sub-Saharan Africa (SSA). Smallholder farmers in SSA are characterized by low yields, food insecurity, malnutrition and depletion of soil fertility (Giller *et al.,* 2006; Mathijs, 2012). In SSA, the management of soil fertility is primordial for increased productivity and efficient use of the available resources (Corbeels, 2013). The challenges faced by smallholder farmers in Southern Africa include lack of agricultural knowledge and skills, limited mechanization and insufficient access to inputs.

Conservation agriculture practices are being promoted in southern Africa as options for coping with needs to sustainably increase crop production (Ndah, 2014). Lower crop yields are a concern for the Mozambican government due to the high percentage of smallholder farmers that depend on agriculture for subsistence (Mcnair, 2013). Maize is a major food and cash crop for smallholder farmers in Mozambique and is grown on about 85% of the cropped area every year. The high dependence on maize makes Mozambique vulnerable, as any decrease in maize production is synonymous with food insecurity.

Decline in soil fertility due to continuous monocropping is becoming a restrictive factor for crop production in Mozambique (Bationo *et al.,* 2011). Inclusion of legumes in rotation or association with maize under conservation agriculture system is envisaged to play important roles in mitigating effects of continuous monocropping of maize (Yadav *et al.,* 1998; Thierfelder *et al.,* 2012). Studies have demonstrated that conservation agriculture with legumes increases income and enhances food security (Sebetha, 2015). Other attributes of a maize-legume intercropping include maximising land use and reducing the economic risks (MMbaga and Friesen, 2003). However, the effect of conservation agriculture and conventional tillage practices on maize–legume cropping systems on crop yield has not been investigated in Mozambique. Determining these effects is the subject if this study.

Methodology

Study area. Gúrue Research Station, in Centre Mozambique, is located in Gúrue District (Zambézia Province) within the R10 agro-ecological zone. The Mutequelesse experimental site where research trials were setup lies between 15°25'S 36 p 42'S at an altitude of 678 m. Temperature ranges from 15 to 23 p C and with annual rainfall ranging from 1800 to 2000 mm (Gyogluu, 2011; MAE, 2005). The most predominant soils are Ultisols and Oxisols (FAO, 2006).

Experimental design and treatments. Experiment land was prepared before the onset of rains. Main and sub-plots were laid out in the field. Main plots measured 41 m x 24 m while sub-plots measured 4.5 m x 5.0 m. A 2 m path was left between replications while a 1 m path was left between sub-plots. Two seeds of maize and legume were sown per hill and later thinned to one plant per hill 15 days after emergence (15 DAE). The trial design was a randomized complete block design in a split plot arrangement replicated four times. The main factor was farming system and included conventional and conservation tillage) while the sub-plot treatments were the four levels of maize-legume intercrop and four rotation levels. The response functions for maize intercropped or in rotation with beans, soybean and cowpea were determined.

In conservation agriculture plots, no tillage was carried out but crop residues from previous cropping season were added to the plots before planting the crop. In the conventional tillage treatment, land was tilled before seeding. Crop residues were removed from these plots before planting any crop.

In conventional agriculture plots, glyphosate was applied before planting at a rate of 2.5 l / ha. Further manual weed control was done as necessary. While on conventional tillage plots weeding was done entirely manually.

At harvesting time, grain yield and yield components were estimated from a net sub-plot consisting of the 4 middle rows. Sub-samples of 8 plants were collected and air dried to determine yield and yield components for maize and the legume. Data for 100-grain weight, biomass and grain yield were recorded. Maize grain yield and biomass were determined from the net harvest of 2 m^2 and converted into t/ha.

Data were summarised and subjected to analysis of variance (ANOVA) to determine the effects of treatments on maize and legume yield. Statistical analysis was done using GENSTAT statistical package version 17. Where F was significant, means were separated using the Least Significant Difference test at $P \leq 0.05$.

Table 1. Yield and 100 seed weight of maize and legumes grown as intercrops under conventional and conservation agriculture

Treatment description	Conservation agriculture		Conventional tillage	
	Yield (t/ha)	100 seed weight (g)	Yield (t/ha)	100 seed weight (g)
Sole Maize	4,51[a]	31,25[b]	4,69[a]	30,25[b]
Maize-cowpea intercrop	9,45[a]	31,25[b]	9,02[a]	26,00[b]
Maize-common beans intercrop	4,72[a]	29,25[b]	2,26[a]	28,50[b]
Maize soybean intercrop	5,89[a]	30,00[b]	4,95[a]	26,25[b]
P-Value*	>0.05	>0.05	>0.05	>0.05

*P>0.05 means no significant different difference was observed across cropping system

Research application

Results from the trial showed that the performance of conventional agriculture and conservation tillage were not significantly different for yield and 100 seed weight. It is remarkable that CA treatments outperformed conventional practices at different maize-legume intercrop. In CA plots, maize yielded better when was intercropped with common beans. However, yield differences comparing CA to conventional tillage when maize was intercropped with cowpea and soybean were smaller than in common beans intercrop.

Conclusion

This study showed that there are benefits of adopting CA practices among smallholder farmers in Gurue. High increase in maize yields was observed in CA treatment compared to Conventional tillage. However, there is need to do further research to adopt CA practices.

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