THE EFFECTS OF IMPROVED FALLOWS AND TILLAGE MANAGEMENT ON SOIL AND WATER CONSERVATION IN A SANDY SOIL

BY

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ABSTRACT

Research on improved fallows has concentrated on soil fertility benefits neglecting possible benefits to soil and water conservation. The objective of this study was to determine changes in infiltration rates, water and nutrient losses, hydraulic conductivity, soil porosity, water retention, aggregate stability and maize yields during the cropping phase in a maize-fallow rotation, under conventional tillage (CT) and no tillage (NT). The study was carried out on plots where a 2-year planted fallow-maize rotation was practiced since 1992/93 cropping season. Soil and water conservation were investigated using simulated rainfall at an intensity of 35 mm h^{-1}, infiltration rates were measured using double rings and hydraulic conductivity and porosity were measured using a tension infiltrometer. Soil samples for the measurement of soil water retention and aggregate stability were collected and measurements were done in the laboratory. Treatments evaluated were planted fallows of *Acacia angustissima (A. angustissima)* and *Sesbania sesban (S. sesban),,* natural fallow (NF) and continuous maize (*Zea Maize*).

Improved fallows resulted in significantly higher ($P<0.05$) infiltration rates. Steady state infiltration rates were not achieved in *A. angustissima* and NF but reached 24 mm h^{-1} and 5 mm h^{-1} in *S. sesban* and continuous maize at fallow termination (October 2000). At the beginning of the second season (October 2001), steady state infiltration rates were could not obtained again for both *A. angustissima* and NF under CT and NTas infiltration rates were >35 mm h^{-1}. Two years after fallow termination (October 2002) steady state infiltration rates averaged 21, 14 and 5 mm h^{-1}, for NF, *S. sesban* and continuous maize. Runoff losses from the same simulation measurements were significantly lower ($P<0.05$) in fallows than in continuous maize. These losses were 44% in continuous maize compared to 22% in *S. sesban* and none in *A. angustissima* and NF plots after 30 minutes at fallow termination (October 2000). After one year, the average runoff loss across conventionally and NT plots increased to 57% for continuous maize, 30% for *S. sesban* and no losses for *A. angustissima* and NF. In October 2002, runoff losses were 63%, 61% and 45% for continuous maize, *S. sesban* and NF. In *A angustissima* there were no runoff losses throughout the of study.

Aggregate stability using the water stable aggregation method, the macroaggregation index (Ima) was 550, 480, 450 and 300 for NF, *A. anguistissima, S. sesban* and continuous maize respectively. In October 2002 Ima in CT plots had decreased to 270, 390 and 260 in for NF, *A. angustissima* and *S. sesban* respectively. Ima in NT plots also decreased to 290, 450 and 270 for NF, *A. angustissima* and *S. sesban* respectively. There were no changes in Ima in continuous maize for either tillage systems. Cumulative kinetic energy required to rapture aggregates also declined from 859, 568 and 395 joules g^{-1} of aggregate at fallow termination (October 2000) to 231, 395 and 236 for NF, *A. angustissima* and *S. sesban* respectively for CT plots and 372, 491 and 268 joules g^{-1} of aggregate for NT plots two years after fallow termination. There were no changes in the amount of energy required to break aggregates in continuous maize, ranging from 80-100 joules g^{-1} of aggregate over the two-year period. Using the different assessment methods, aggregate stability was significantly higher ($P<0.05$) in fallows relative to continuous maize. No till resulted in significantly ($P<0.05$) more stable aggregates than CT.

Improved fallowing also resulted in significantly higher ($P<0.05$) soil water retention, hydraulic conductivity and an increase in the proportion of larger pore sizes one year after fallow termination. Hydraulic conductivity at 5 cm tension was between 0.7 and 0.9 cm h^{-1}, in improved fallows relative to 0.5 cm h^{-1} in continuous maize. Pores were significantly higher ($P <0.05$) in fallows. At 5cm tension the number of pores m^{-2} varied from 285-443, whilst in continuous maize they were less than 256 pores m^{-2}. At 10cm tension the number of pores m^{-2} varied from 4500-8900 in fallows relative to 3900 pores m^{-2} in continuous maize. There were no significant tillage effects ($P<0.05$) on water retention, hydraulic conductivity and porosity.

Maize yields were significantly higher ($P<0.05$) in improved fallows than in continuous maize and NF for both 2001 and 2002. In 2001 maize yields were 1.8, 1.2, 0.7 and 0.5 t ha^{-1} for *A. angustissima,* continuous maize, *S. sesban* and NF respectively under CT. Under NT yields were 1.3, 0.8, 0.7 and 0.2 t ha^{-1} for *A. angustissima,* continuous maize, *S. sesban* and NF respectively. In 2002 yields under CT were 1.7, 1.3, 1.2 and 0.5 t ha^{-1} for *S. sesban,* continuous maize, and NF and *A. angustissima* respectively. Corresponding yields under NT were 1.5, 0.6, 0.3 and 0.25 for *S. sesban,* continuous maize, NF and *A. angustissima* respectively. Generally CT out yielded NT ($P<0.05$) during both cropping seasons irrespective of fallow treatment.

These results showed that fallowing resulted in reduced water and soil losses during the cropping phase compared to continuous maize cropping. Reduced water and soil losses were a result of increased infiltration rates and aggregate stability during fallowing. However these benefits decreased with the introduction of tillage as shown by the decline in infiltration rates and aggregation from fallow termination (October 2000) to October 2002. Therefore fallowing can improve soil and water conservation relative to continuous maize cropping. Among the fallows, *A.angustissima* and NF had the least soil and water losses, compared to *S. se*sban. However improved fallows proved superior to NF in maize yields because they fixed nitrogen, which is used during crop growth. The benefits of improved soil physical properties accrued during fallowing did not translate to improved yields in NF because the chemical fertility was more limiting than soil physical properties. This study demonstrated that fallowing improved soil and water conservation thereby emphasising the need for inclusion of improved fallows by farmers in their crop rotations.

LIST OF ACRONYMS

ACRONYM	MEANING
S. sesban	*Sesbania sesban*
A. angustissima	*Acacia anguistissima*
NF	natural fallow
CT	conventional tillage
NT	no tillage
C	carbon
OC	organic carbon
SOC	soil organic carbon
SOM	soil organic matter
OM	organic matter
N	Nitrogen
P	Phosphorous
t	Tonnes
ha	hactares

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