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Research Application Summary

Improving soil hydrological properties of denuded semi-arid rangeland in south-eastern Kenya using reseeding technology

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Abstract

A study was conducted to establish the contribution of *Eragrostis superba*, *Enteropogon macrostachyus* and *Cenchrus ciliaris* in improving soil hydrological properties in semi-arid Kenya. Kamphorst rainfall simulator was used on bare ground and at different grass stubble heights. The experiment was set up under sprinkler irrigation system. Sediment production as a function of runoff and infiltration capacity was significantly different ($p<0.05$) at different stubble heights. *Cenchrus ciliaris* had the greatest influence on improving soil hydrological properties followed by *Enteropogon macrostachyus* and *Eragrostis superba* respectively. An increase in grass height increased infiltration capacity, reduced runoff and sediment production.

Key words: Reseeding, sediment production, semi-arid, soil hydrological properties

Résumé

Une étude a été menée pour déterminer la contribution des *Eragrostis superba*, *Enteropogon macrostachyus* et *Cenchrus ciliaris* dans l'amélioration des propriétés hydrologiques des sols dans les zones semi-arides du Kenya. Le simulateur de pluie Kamphorst a été utilisé sur le sol nu et à différentes hauteurs d'herbe chaume. L'expérience a été réalisée sous le système d'irrigation par aspersion. La production des sédiments comme une fonction de ruissellement et de capacité d'infiltration a été significativement différente ($p <0,05$) à différentes hauteurs de chaume. *Cenchrus ciliaris* avait la plus grande influence sur l'amélioration des propriétés hydrologiques du sol, suivi par *Enteropogon macrostachyus* et *Eragrostis superba*, respectivement. Une augmentation de la hauteur de l'herbe a augmenté la capacité d'infiltration mais a réduit le ruissellement et la production de sédiments.

Mots clés: Réensemencement, la production de sédiments, semi-aride, les propriétés hydrologiques des sols

Background

The arid and semi-arid lands (ASALs) of Kenya have undergone increasingly land use pressure within the last 15 years, largely due to human population increase causing a decline in forage resources which is threatening the sustainability of land based production systems (Mganga *et al.,* 2010). Demands placed on land and water resources in these fragile dryland ecosystems by rapidly expanding populations, agricultural intensification, urbanization and industrialization have combined to intensively exploit the natural resources in these semi-arid environments. This has resulted into land degradation. Although land degradation occurs under a wide variety of conditions and environments, semi-arid to weakly aridic areas of Africa are particularly vulnerable as they have very fragile soils. Degradation in these areas is evident in a decline in productivity, a loss of biodiversity and an increasing rate of soil erosion (Visser *et al.,* 2007). Soil erosion is the single most visible form of environmental degradation in the semi-arid environment in south-eastern Kenya. Ironically, it is also the most reversible, that is, the most responsive to restoration and rehabilitation efforts.

Literature Summary

The primary purpose of range reseeding is to improve existing ground cover and biomass to an extent not possible by grazing management alone (Makokha *et al.,* 1999). Range reseeding involves reseeding denuded land by seeds of superior plants or the establishment of completely new pastures, with or without irrigation (Mganga *et al.,* 2010). According to Musimba *et al.* (2004), the grasses that have given best results in East Africa are all native. Perennial range grasses have evolved adaptive mechanisms for survival and are thus preferable to all other plants. Six grass species with high potential for reseeding various ASALs include: *Cynodon dactylon, Cenchrus ciliaris, Enteropogon macrostachyus, Eragrostis superba, Chloris roxburghiana* and *Chloris gayana*.

The aim of this study was to determine the impact of grass reseeding technology in improving soil hydrological properties of a degraded semi-arid environment using *Cenchrus ciliaris, Enteropogon macrostachyus* and *Eragrostis superba.*

Study Description

This study was conducted in the semi-arid district of Kibwezi in south-eastern Kenya. The Kamba agro-pastoralist is the main ethnic inhabitants in the study area (Nyangito *et al.,* 2009). The climate is typical semi-arid with an average annual rainfall,

evaporation and temperature of 600mm, 2000mm and 23°C respectively. The natural vegetation is woodland and savanna.

Seed viability test as described by Tarawali *et al.* (1995) was used in this study. A sample of 100 seeds was used for each grass species. Three main plots measuring 15 x 5 m (75m^2) sub-divided into 3 sub-plots of 5 x 5 m (25m^2) was laid out in a Complete Block Design (CBD). Simulated rainfall (Young and Burwell, 1972) was used to study soil hydrological responses and sediment production in all the sub-plots. Infiltration capacity in all the sub-plots at different grass stubble heights was measured using the Kamphorst rainfall simulator (Kamphorst, 1987). Sediment produced was washed into storage bottles and later filtered off and dried at 105°C for 24 hours. Sediment production and infiltration rates were estimated at different heights of 0 cm (bare ground), 20 and 40 cm.

Research Application

The results showed that there was a difference in seed germination between the three grass species tested (Fig. 1). *Enteropogon macrostachyus* had the highest germination percentage of 53%. Percentage germination for *Cenchrus ciliaris* and *Eragrostis superba* was 12 and 10%, respectively.

Results for the soil hydrological responses showed significant difference across the three grass species used at the three different stubble heights. *Cenchrus ciliaris* reported the best hydrological responses. *Enteropogon macrostachyus* and *Eragrostis superba* were ranked second and third respectively. There was a general increase in infiltration capacity and decrease in sediment production and run-off with an increase in grass stubble heights.

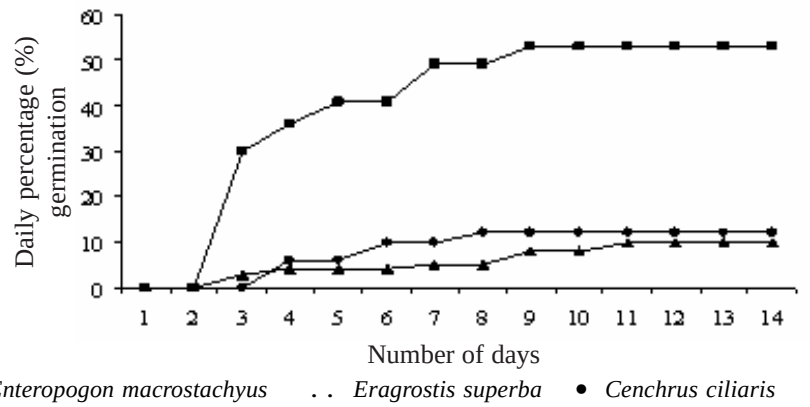

Figure 1. Daily percentage seed germination of *Enteropogon macrostachyus, Eragrostis superba* and *Cenchrus ciliaris,* under room conditions, 30º C in the study area.

Recommendation

Range rehabilitation using grass reseeding technology improves the soil hydrological properties of the soil in semi-arid environments particularly by reducing runoff that is common in bare degraded grazing area. Locally adapted grass species notably *Cenchrus ciliaris*, *Eragrostis superba* and *Enteropogon macrostachyus* need to be incorporated in rehabilitation programmes in semi-arid environments as a means of combating land degradation.

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