

Research Application Summary

Mobile Night Kraals in Crop Fields: Sustainably Improving Soil Productivity

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Abstract

Soil productivity is positively related to soil pH. Animal manure is good alternative for improving soil pH over time. “Impacting” is a term used to refer to the establishing of mobile kraals in crop fields, to create nutrient hot spots. This study sought to assess the effect of impacting on soil pH. The study was carried out at Lupane State University, Zimbabwe. A randomized complete block design with two treatments was used: Kraal and no Kraal treatments. Soil samples were collected before planting. Data were analysed using the unpaired t-test. The pH in kraal treated plots averaged 6.0, while for the no-kraal plots, it averaged 4.8. Impacting can therefore be used to improve soil pH in one season. More research is needed on the effects of impacting duration on soil compaction and its effect on crop growth and development.

Key words: Animal manure, crop growth, impacting, pH, Zimbabwe

Résumé

La productivité du sol est positivement liée au pH du sol. Le fumier animal est une bonne alternative pour améliorer le pH du sol au fil du temps. “L’impacting” est un terme utilisé pour désigner l’établissement de kraals mobiles dans les champs de culture, afin de créer des points chauds de nutriments. Cette étude a évalué l’effet de l’impacting sur le pH du sol. L’étude a été réalisée à l’Université d’État de Lupane, au Zimbabwe. Une conception en blocs complets randomisés avec deux traitements a été utilisée : avec Kraal et sans Kraal. Des échantillons de sol ont été prélevés avant la plantation. Les données ont été analysées à l’aide du t-test non apparié. Le pH dans les parcelles traitées au kraal était en moyenne de 6,0, tandis que dans les parcelles sans kraal, il était en moyenne de 4,8. L’impacting peut donc être utilisé pour améliorer le pH du sol en une saison. Des recherches supplémentaires sont nécessaires sur les effets de la durée de l’impacting sur la compaction du sol et son effet sur la croissance et le développement des cultures.

Mots clés : Fumier animal, croissance des cultures, impacting, pH, Zimbabwe.

Introduction

Soil productivity in most of African communal and smallholder crop fields continues to decline. Soil productivity is positively related to soil pH (Mukungurutse *et al.* 2018). Soil pH is mostly influenced by soil parent material, percentage of sand and fertilizer application. In Lupane and most of Zimbabwe communal and smallholder farms, soils are predominantly sandy and are acidic (Shoko and Moyo, 2011; Mukungurutse *et al.*, 2018). In addition, over the years, the use of acidifying fertilizers has been mismatched with liming requirements (Nyamangara and Mpofo, 1996). Acidic soils are less productive: Nutrients are not readily available and microbial activity

in the soil is reduced (Mukungurutse *et al.*, 2018). The combined effect of poor soils and changing climate patterns increases crop stress resulting in reduced productivity and sustainability of farming. Liming is required at above 500 kg/ha to improve soil productivity (Shoko and Moyo, 2011). Liming products are not readily available to communal and smallholder farmers and where available are often unaffordable. Animal manure is a good alternative for improving soil pH over time (Whalen *et al.*, 2000; Naramabuye *et al.*, 2008). In communal areas of Zimbabwe, application of animal manure follows a gradient with the fields close to the homestead getting more manure than those further away from the homestead. The use of mobile night cattle kraals in crop fields (impacting), is a possible method of improving soil pH with accessible resources (Chinyere *et al.*, 2015).

“Impacting” is a term used (by those implementing the technology) to a crop-livestock integration technology where mobile kraals are placed in crop fields and cattle spend several nights before the kraal is moved to a new location within the field. Both solid and liquid excreta from the cattle are left where the kraal was placed creating a nutrient hot spot.

Communal grazing of livestock in rural areas presents an opportunity to improve crop-livestock farming systems through impacting. Impacting has the potential to improve soil health in crop fields (Chinyere *et al.*, 2015). The technology reduces labour needed to carry manure from permanent kraals into the crop field. Some farmers in Hwange in Zimbabwe and in other parts of the country have started using the technology and have reported improved yield in one season implementation. There is need to understand the changes that take place when impacting crop fields. This study seeks to assess the effect of impacting on soil pH in crop fields.

Materials and Methods

The study was carried out at Lupane State University research plot in Lupane, Zimbabwe. The soils are predominantly Kalahari sands. A randomized complete block design with two treatments was used: Kraal and no Kraal treatments. In 2016/17 season, three kraal treatments were established and in 2017/2018 season, 13 kraal treatments were set-up. For the kraal treatments, 18 cattle spent the night in one kraal for 7-10 days, then moved to the next plot. Each plot was 8 m by 8 m. Soil samples were collected before planting and sent for analysis. Data were analysed using the unpaired t-test in Numbers Version 3.1 (1769).

Results

Soil pH was significantly different between the kraal and no-kraal treated plots in both 2016/17 and 2017/18 seasons (Table 1). The pH in kraal treated plots averaged 6.0 for the two seasons while for the no-kraal plots, it averaged 4.8 (Table 1).

Table I. Soil pH results for the kraal and no kraal treated plots

	Kraal	No-Kraal	P-value
2016/17 season	6.4	4.8	0.026
2017/18 season	5.6	4.8	0.016
Average	6.0	4.8	0.001

Discussion

Soil pH is a good indicator of how suitable a soil is able to sustain crop growth. Soil pH of 6.0 to 7.5 is considered best for most crops including maize. Without kraal treatment, pH was acidic at

4.8. Nitrogen, phosphorus, potassium, sulphur, calcium magnesium and molybdenum are largely unavailable when pH is below 5.5 (United States Department of Agriculture Natural Resources Conservation Service [USDA-NCRS], 2014). Most communal and smallholder farmers do not lime their crop fields. Generally, input schemes avail seed and fertilizer to communal farmers without consideration for soil pH. Therefore, the fertilizer, although applied, is still not available to the growing crop. Thus, a poor crop yield is obtained. Manganese, copper, zinc and boron are moderately available. Only iron is available in acidic soil (United States Department of Agriculture Natural Resources Conservation Service [USDA-NCRS], 2014). At pH 6.0, nutrients are available or moderately available (United States Department of Agriculture Natural Resources Conservation Service [USDA-NCRS], 2014). One week of kraal treatment increased nutrient availability by correcting soil pH to 6.0 from 4.8 within the same season. Applying cattle manure improves soil pH (Whalen *et al.*, 2000; Chinyere *et al.*, 2015; Mtangadura *et al.*, 2017) but there is increased labour and nutrient gradients in applying the manure in crop fields.

Conclusion

The use of impacting technology can improve soil pH in one season and make nutrient available for plant uptake. More research is however needed on the impact of kraal duration on soil compaction and its effect on crop growth and development.

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