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Research Application Summary

Evaluation of the performance of Centre Pivot Sprinkler irrigation system and its effects on crop yield at Kagera, Tanzania

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Abstract

The study evaluated the performance of the centre pivot sprinkler irrigation system and its effects on sugar cane yield at Kagera Sugar Estate. The study also examined soil parameters that influence cane yield and the quality of irrigation water. Centre pivot GP7 had average coefficient of uniformity of 96.9% as opposed to 86.2% for BPS. On the other hand lower water holding capacity and low acidity reduced cane yields significantly. The results show that poor pivot performance and soil properties greatly reduce sugarcane productivity.

Key words: Coefficient of uniformity, sprinkler irrigation, sugar cane, Tanzania

Résumé

L'étude a évalué la performance du système d'irrigation dans le centre d'arrosage à pivot et de ses effets sur le rendement de la canne à sucre à « Kagera Sugar Estate ». L'étude a également examiné les paramètres du sol qui influent le rendement de la canne et la qualité de l'eau d'irrigation. Le Centre pivot GP7 avait un coefficient moyen de l'uniformité de 96,9% contre 86,2% pour le secteur parapublic. D'autre part, la capacité inférieure de rétention d'eau et une faible acidité, réduisent les rendements de la canne de manière significative. Les résultats montrent que la performance pauvre d'un pivot et les propriétés du sol réduisent considérablement la productivité de la canne à sucre.

Mots clés: Coefficient d'uniformité, l'irrigation par aspersion, la canne à sucre, de la Tanzanie

Background

The performance of centre pivot sprinkler irrigation is the major factor contributing to the sugarcane yield at Kagera Sugar Estate, Tanzania. The fields irrigated by properly designed irrigation system and that operate under optimal condition give high yields. The design of the system should consider factors that influence the performance, such as the condition of sprinkler packages, strength and direction of the wind and the pressure variation

within the system. These factors need to be correctly managed to ensure that the distribution uniformity and efficiencies are in acceptable level.

Climate change resulting in droughts, has caused water resources to become scarce. Thus, water resources have to be utilised properly to protect and conserve the available water reserves. In irrigated agriculture this will have to be obtained through the effective management of water application and avoiding over irrigation. Therefore, irrigation systems have to apply water in the most efficient way possible to prevent unnecessary losses and water wastage.

Literature Summary

Centre pivot system is classified as a medium to low pressure sprinkler system capable of irrigating large circular areas. It consists of a single galvanised steel lateral which rotates about a fixed point in the centre of the irrigated field. It is equipped with impact or spray sprinklers mounted on top or below the lateral through tubes usually dropped near the crop canopy (Lalouette *et al.*, 1998).

The performance of centre pivot sprinkler irrigation system can be quantified by distribution uniformity and uniformity coefficient (Tarjuelo *et al.*, 1999), application efficiency, and potential application efficiency (Merriam and Keller, 1978).

Soil parameters that influence low cane yield include bulk density in relation to roots penetration (Arkansas, 2002), low fertility (Ontario, 2009), salinity and sodicity (Moberg, 2001), low pH (Harris, 2005), occurrence of soil toxicity, cation and anion exchange capacity (Camberato, 2001), and low water infiltrability (Magongo, 1995). The qualities of irrigation water also influence cane yield (Ross, 1997). The effects of both centre pivot system and soil parametrs on sugar cane yield were studied.

Study Description

Two centre pivots were selected by stratified random sampling. High yielding fields were represented by centre pivot GP7 while the low yielding fields were represented by BP5. The fields under test were divided into three portions covering the radii of 100 – 250 m, 250 – 400 m, and 400 – 550 m (Omary *et al.*, 1997) of the centre pivot and laid in three lines with (3 *3) m apart along the lateral to cover the distance of 9 m* 105 m by using the fixed grid system. The irrigation system brought up to proper operating pressure, and passed over the aligned catch

cans (Rogers *et al*., 2005) and test results were recorded in the data sheet. The procedures were repeated in the radii 250 – 400 m, and 400 – 550 m length of the pivot and each procedure repeated three times (Omary *et al.*, 1997).

Soil samples for determination of soil properties were collected from six blocks irrigated by centre pivots GP7 and BP5. Eighteen composite samples were taken from points with similar characteristics based on pedogeomorphic approaches, packed in the labelled plastic bags and brought to the Soil Science Laboratory at Sokoine University of Agriculture in Morogoro, Tanzania for analysis. Data for centre pivot performance were analysed using formulas and Microsoft office excel. Statistical approaches were also used to establish significance. Water samples were also collected for laboratory analysis.

Research Application

The results showed that low yields were contributed by both poor pivot performance and soil parameters. Centre pivot GP7 had average coefficient of uniformity (CU) of 96.91% while it was 86.28% for BP5; average distribution uniformity (DU) of 95.1% and 78.23%; average potential application efficiency **(**PELQ) of 86.83% and 79.14%; and average application efficiency (AELQ) of 64.97% and 59.36%. The minimum recommended values for CU, DU, PELQ, and AELQ were 85%, 75%, 90%, and 85%. The performance parameters for GP7 were within the recommended minimum values except AELQ which was lower than the minimum recommended value, whereas PELQ and AELQ for BP5 were lower than the minimum recommended values.

Soil parameters that contributed to low yield of sugarcane were low water holding capacity, low cation exchange capacity; high level of acidity due to water logging caused by poor levelling of land during preparation and poor design of drainage system resulting into limitation of nutrients availability for the plants; poor structure and high density as a result of compaction by farm machinery. Irrigation water quality was good and did not likely contribute to low yield.

Recommendation

To improve the uniformity of application and efficiencies, sprinkler package should be reviewed and the operating pressure adjusted to the required range. A system with automatic water pressure control valves at the water pump stations should be installed so as to avoid system damage during high system pressure above the threshold value. This would improve

uniformity, discharge and hence ensure high efficiencies of the system.

Land levelling during preparation and subsoil tilling should be done in order to increase permeability of the soil (reducing water logging), reduce bulk density of the soil, and soil acidic problem. In addition, drainage system should be designed and constructed to avoid salinity problems in future, reduce the rise of water table and water logging. Currently, the drainage system is not well designed and hence the company uses a lot of human resource particularly for drainage work during rainy season. Also application of sugarcane trash should be practiced as a tillage method so as to improve soil structure, improve soil organic carbon as well as reduce run off problems.

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