# Impact of center pivot irrigation system uniformity on growth of potato crop and residual soil nitrogen

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**Abstract:** Maintaining the homogeneity of soil nitrogen (N) and plant vigor across agricultural fields is a major concern for farmers and agricultural scheme planners, particularly fields that are irrigated through pressurized systems, such as center pivots. Therefore, this study was carried out on a 30 $hm^2$ potato field located 650 km south of Riyadh, the capital city of the Kingdom of Saudi Arabia, to investigate the impact of the center pivot irrigation distribution uniformity on the crop development and the spatial distribution of residual soil N. Irrigation performance test was designed to investigate water application rate and distribution uniformities. The overall water application uniformity coefficients (Cu), determined through Christiansen (CuC) and Heerman (CuH) methods, were determined at 81.29% and 80.64%, respectively. However, the overall water distribution uniformity (Du) was determined at 70%. A considerable variability in the distribution uniformity of irrigation water was observed across the experimental field (a Du value of 67% over the medium spans compared to a Du value of 88% over the inner spans). Results of this study showed a linear correlation between the irrigation water distribution uniformity and the soil N ($R^2$=0.88). On the other hand, the vegetation cover distribution, indicated by the Cumulative Normalized Difference Vegetation Index (CNDVI), was not found to be much responsive to the irrigation distribution uniformity ($R^2$=0.11). A time series of successive NDVI maps extracted throughout the potato crop growth stages showed a consistent trend in the distribution of NDVI across the field, with $R^2$ values that ranged between 0.25-0.73.

**Keywords:** irrigation performance, uniformity, center pivot, soil nitrogen, NDVI
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## 1 Introduction

An excellent irrigation system is that which uniformly and consistently discharges an appropriate amount of water. Compared with conventional surface irrigation methods, sprinkler irrigation systems contribute significantly to an effective and consistent application of irrigation water with less labor costs[1], and the result is more yields per unit volume of water[2]. The functionality of an irrigation system is affected by various activities, including layout, construction and setting up, operation, maintenance and optimal use of irrigation water. Therefore, the effective implementation of these activities requires appropriate monitoring of the functional methods of irrigation[3]. According to Raine et al.[4], the capability of the field irrigation system to uniformly and effectively provide irrigation water is a significant component affecting the agronomic and economic stabilities of the agricultural systems. In addition, Solomon[5] stated that due to the fact that irrigation uniformity guaranteed optimum crop yield and productive use of resources, engineers considered it as a key point in the design, selection and management of irrigation systems.

Enhancing irrigation functionality is an important aspect in irrigating agricultural fields, especially in the arid zones, and depends mainly on climatic and economic measures. Enhanced water distribution uniformity assists farmers optimize the use of limited water to obtain higher yields and benefit the ecosystem, thus enhance livelihood in the region[6]. The advantages of more efficient systems include less pressure on water resources, reduced leaches of agro-chemicals to groundwater and surface water and enhanced productivities and total profits[7], in addition to the possibility of irrigating more areas using the available amount of water. Because of the ever increasing water demand and the accelerated decline in the finite water resources, useful and uniform distribution of water are keys for the optimum functionality of any

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