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Effects of supplemental irrigation on yield, water use efficiency and nitrogen use efficiency of potato grown in mollic Andosols

Felix Satognon , Seth F. O. Owido and Joyce J. Lelei Abstract

Background: Low soil fertility and reduced seasonal rainfall contribute to low potato (*Solanum tuberosum* L.) yield in Kenya. Nitrogen (N) deficiency is the major problem facing by the smallholder farmers of Kenya due to lack of fallow. Hence an introduction of supplemental irrigation with an adequate application of this nutrient could increase potato yield. The objective of this study was to determine the effects of supplemental irrigation and N-fertilisation on potato tuber yield, water use efficiency (WUE) and nitrogen use efficiency (NUE). The experiment was conducted in Nakuru County, Kenya for two seasons. The experimental soils are classified as mollic Andosols. The treatments comprised two irrigation treatments of full supplemental irrigation (FI) and rainfed production (RF) and four N levels of four N levels of 0 (N0), 60 (N1), 90 (N2) and 130 kg N/ha (N3).

Results: The results showed that total tuber yield, marketable tuber yield and NUE were significantly ($P < 0.001$) affected by irrigation \times N-fertilisation while WUE was only affected ($P < 0.001$) by N-fertilisation. The highest total tuber yield, 58.28 tonnes/hectare (t/ha), was recorded under FI combined with N3. Treatment FI significantly increased marketable tuber yield by approximately 125.58% in all N treatments compared to RF. The highest NUE of potato (236.44 kg/kg of N) was obtained under FI combined with N3 but not significantly different from the NUE of potato obtained under FI with N2. N-fertilisation N3 produced the highest WUE of 14.24 kg/m³. Significant correlation was obtained between tuber yield and number of tubers/plant ($r = 0.75$, $P < 0.001$), NUE ($r = 0.95$, $P < 0.001$) and WUE ($r = 0.72$, $P < 0.001$).

Conclusion: High potato yield and marketable tuber yield can be achieved in mollic Andosols when water deficits of the growing season are eliminated with supplemental irrigation and an application of 130 kg N/ha.

Keywords: N-fertilisation, NUE, Potato, Supplemental irrigation, WUE, Yield

Background

Potato (*Solanum tuberosum* L.) is the second most important staple food and cash crop in Kenya, after maize (*Zea mays*) (Muthoni et al. 2017; Waaswa and Satognon 2020). Its production is predominantly rainfed (Muthoni et al. 2021). Population pressure and the need to produce more to satisfy the demand for potato have consequently led to encroachment of farming into marginal lands, forest reserves and non-traditional

potato-producing areas (Muthoni et al. 2021). In Kenya, the area under production increased from 135,000 ha in 2008 to 217, 315 ha in 2018. Despite the increased area under production, a low yield of 8.6 t/ha was obtained in 2018, registering a decline of 60% from 2008 (FAOSTAT 2020; Mburu et al. 2020; Mcewan et al. 2021). Previous research attributed the low potato yield to the reduction of seasonal rainfall in the potato-growing areas of Kenya from 737 to 126 mm (Waaswa et al. 2021). Drought or dry periods between rainfall seasons and increased temperatures, which lead to high crop evapotranspiration, are experienced in 70–80% of the smallholder farms in Kenya (Bryan et al. 2013; Kimathi et al. 2021; Muthoni

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