AFRICA PLANT NUTRITION RESEARCH HIGHLIGHTS

Enhancing Maize Productivity through Improved Irrigation Scheduling and Integrated Nutrient Management in Southern Malawi

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Maize (Zea mays) is the staple food crop in Malawi with an annual average per capita consumption of 179 kg and occupies 70% (1.6 million ha) of the total arable land (Josser and Lewis, 2003). Maize production has remained low, with yields of 1.86, 1.85, and 1.21 t/ha for smallholder irrigated winter maize, estate, and smallholder rainfed maize production, respectively. These yields are far below the potential yields of about 10 t/ha in high rainfall areas and irrigated production systems (Zambezi et al., 1993). The main factors constraining rain-fed maize productivity in the Shire Valley region in southern Malawi include low (<600 mm/yr) and unreliable rainfall, and poor soil fertility conditions associated with cultivation of crops with little fertilizer and organic nutrient inputs. Maize yields in smallholder irrigation schemes during the dry winter season are mainly constrained by a combination of inadequate and inefficient water and fertilizer use. Current farmer management practice is characterized by poor irrigation management with oversupply of water early in the season leading to scarcity of water at critical stages of maize growth. The recommendations for use of mineral and organic fertilizer resources are also not defined, with farmer practices varying considerably. Improved irrigation scheduling and use of appropriate amounts and sources of N can increase the efficiency with which limited water and nutrient resources are used in smallholder irrigation schemes (Sivakumar and Wallace, 1991).

In order to define appropriate irrigation scheduling for optional water management in maize production in southern Malawi, research was conducted to evaluate irrigation scheduling options and organic and inorganic fertilizer management for maize at Kasinthula Research Station. A split-plot experiment with four irrigation frequency treatments as main plots and four sources of nitrogen as sub-plots was conducted for three winter seasons (2005-2007). The irrigation of 40 mm every 3-4 days was chosen to represent current farmers practice. The main-plot was composed of four irrigation frequencies as follows:

- i. Irrigating to field capacity at 40% of crop available water depletion.
- ii. 40 mm of water every 3-4 days
- iii. 40 mm of water every 7 days
- iv. 40 mm of water every 14 days

Sub-plot fertilizer treatments consisted of 110-120 kg N/ha supplied as N fertilizer, cattle manure and their combinations as follows:

- i. 120 kg/ha N (urea)
- ii. 10 t/ha manure
- iii. 80 kg/ha N Urea + 3.3 t/ha manure (2U:M)
- iv. 40 kg/ha N Urea + 6.6 t/ha manure (U:2M)

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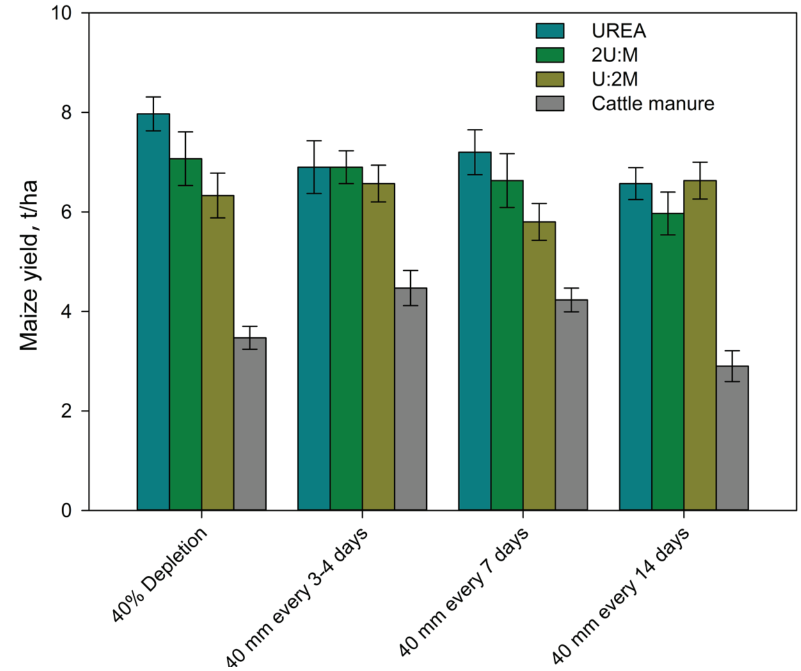

Figure 1. Effects of irrigation water management and mineral and organic sources on N on maize productivity in southern Malawi.

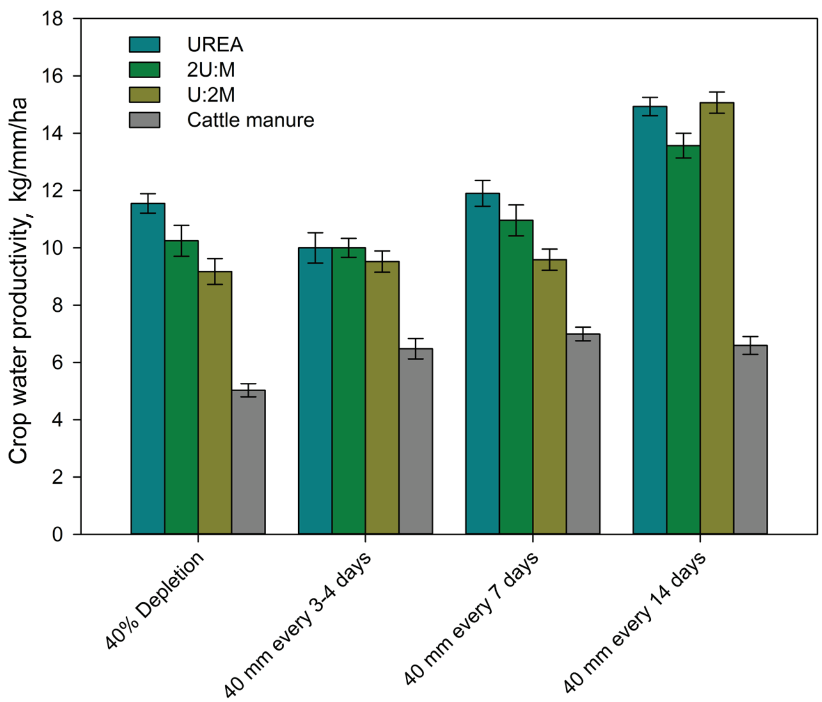

Figure 2. Influence of irrigation water management and mineral and organic sources on N on crop water productivity in southern Malawi.

Urea was applied in two equal splits at planting and at three weeks after crop emergence. All plots received a blanket application of 30 kg P/ha. Manure was applied and incorporated into the soil three weeks before planting. Maize variety DK 8031 was planted on ridges with 0.75 m between ridges and 0.25 m between plants. The plot sizes were 10 ridges (7.5m x 20 m) with a net plot of 6 ridges (4.5 m x 16 m). Crop Water (CWP) was then calculated by dividing the maize grain yield (kg/ha) by the amount of irrigation water (mm) for that particular treatment. Grain yield data was subjected to ANOVA using the Genstat and LSD0.05 test separating statistical significant means.

Results from the experiment showed significant interactions ($P < 0.01$) between the effect of irrigation scheduling and nitrogen sources on maize grain yields **(Figure 1)** across all seasons. The water balance scheduling at 40% soil moisture depletion with full urea-N had the highest yields among the four irrigation frequencies **(Figure 1)** but this was not significantly different from either 40 mm every 3–4 days or 40 mm every 7 days. The highest maize grain yields were obtained with full urea N, although this was not significantly different from the mean grain yields from the 2U:M and U:2M treatments for the four seasons. There were no significant differences in yields for the 2U:M and U:2M treatments for all irrigation schedules. The lowest maize yields were produced with sole manure under the four irrigation treatments.

CWP was highest for irrigation scheduling at 40 mm after 14 days **(Figure 2)** with at least 30% of the N applied as urea, but there were no significant differences for the other irrigation schedules. Targeting irrigation scheduling to 40 mm every 14 days with application of sole urea or in combination with manure provided the best option to optimize maize yields, while achieving high CWP.

Efforts to increase maize productivity in smallholder irrigation schemes in southern Malawi should focus on supporting farmers to manage irrigation schedules efficiently, by reducing irrigation frequency, as well as prioritizing use of mineral N sources over animal manure. Results from this study show that crop water productivity can be increased by more than 50% with a small effect on maize productivity by reducing the current scheduling to 40 mm every 14 days. When combined with N application, this can result in tripling the current maize yields over the current irrigation and fertilizer application practice. Where available, manure may replace part of the mineral N, although it is imperative to combine the manure with mineral N.

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