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The role of irrigation in the soil-crop system

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Agricultural production is performed in 85.5% of the total area of Hungary. Yearly average precipitation is 550-600 mm. Due to global warming, flooding, inland inundation and drought are frequent within a year. Extreme weather circumstances pose new challenges for crop producers. The results of long-term field experiments provide guidance to how each production technological intervention affects crop production, average yield and yield security.
Examinations were performed on mid-heavy calcareous chenozem soil in a multifactorial small plot long-term field experiment under natural precipitation supply and irrigated circumstances to analyse the effect of irrigation and N fertilisation on soil moisture and maize grain yield.
Drought and optimal years were involved in the examination. Six fertiliser treatments were used (0, 30, 60, 90, 120, 150 kg N ha-1) each year. Irrigation was performed with a Valmont linear equipment. Changes in soil moisture balance were examined with TDR-based soil moisture probes in the 0-120 cm profile. Evaluation was performed with SPSS.
The moisture profiles of the 1.2 m soil profile show contrasting tendencies in different crop years in both irrigation treatments. In drought years, the 0-0.15 m layer showed the lowest moisture values (8.3–9.6 v/v%), increasing towards deeper layers. The significant ($p<0.05$) moisture content difference of 11–12 v/v% measured at the 12-leaf-stage constantly decreased by the end of the growing season as soil moisture stock decreased. In wet years, the highest moisture content was observed in the 0.15–0.30 m layer (37–39v/v%), decreasing towards deeper layers (13–16 v/v%).
At natural precipitation supply, yield linearly increased until 60 kg ha-1 N in both years, but no yield surplus was obtained above this dose. Our results show that increasing N doses do not always cause yield increase if the water needed for nutrient uptake is limited.
In irrigated treatments, the highest statistically significant yield was observed at 120 kg ha-1 N in dry years. Irrigation had a significant yield-increasing effect (4.2 t ha-1) ($P<0.001$). However, in wet years, irrigation caused yield decrease (-1.8 t ha-1), significance level: 0.1%. Yield decrease caused by irrigation was the highest on plots with natural nutrient supply and the lowest N dose (30 kg ha-1) (2.6–2.7 t ha-1) and constantly decreased with decreasing fertiliser doses.
Severe water deficit was observed in the environment of the seedling without irrigation and under dry circumstances, but there was favourable water supply in deeper layers. From the silking stage and especially during grain filling, the water deficit of the examined profile greatly reduced yield. Optimum water supply was observed in wet crop years.
In irrigated treatments, the impact of irrigation water could be shown until early grain filling, but the resulting yield surplus seemingly contradicts this fact. Moisture content is lower from the last third of grain filling in the upper soil layers as opposed to non-irrigated treatments, showing the increased water uptake of irrigated maize. In wet years, the irrigated soil profile had lower moisture from sowing to harvesting, similarly to the end of the previous year.