Drought influence on maize dry matter production and grain yield in Canterbury

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Abstract

Maize production is increasing in Canterbury to meet the silage requirements of the expanding dairy and beef feedlot industries. The crop requires warm, frost-free conditions and good water availability, but the cool, drought prone Canterbury climate is marginal for maize. Therefore good irrigation management is likely to be a key requirement for successful maize production. This paper describes briefly an experiment whose aim was to determine the response of an intensively-managed maize crop to a range of timings and intensities of drought caused by the withdrawal of irrigation for varying durations at various times.

Seed of the hybrid maize cultivar P3902 was sown in a deep Templeton silt loam in the DSIR/MAF rainshelter at Lincoln on 6 November 1990. The crop was managed intensively, with recommended chemical weed control and fertiliser. Irrigation treatments were designed to subject plants to varying degrees of drought from emergence, from about silking, or during grain fill.

Oven dry grain yields ranged from 11.5 t/ha to 9.5 t/ha, and biomass yield from 20.6 t/ha to 15.2 t/ha. These were associated with potential soil moisture deficits ranging from 64 mm to 409 mm. The range of grain yields was quite small, and reflected the extensive root system developed by the crop in the deep soil at this site - water was extracted from as deep as 1.4 m.

The sensitivity of grain yield to drought did not vary with drought timing, but the deficit at which the response became apparent (critical deficit D_c) increased with time as the roots explored a greater soil volume. D_c increased from 97 mm for early drought to 157 mm for middle drought and was not reached (i.e., $D_c < 338$ mm) for the late drought treatments. This was probably a reflection of the relatively slow development of a very deep root system through the growing season. The response of grain yield to drought once D_c was exceeded was 11 kg/(ha.mm), or 0.077% of the potential yield.

In contrast, biomass production was about twice as sensitive to early drought as to midseason drought, where it was similar in percentage terms to the response of grain yield. For biomass production, as for grain production, the degree of late drought was insufficient to cause a response. Values for D_c were similar to those for grain production, and varied in the same way. Increases in harvest index indicated that grain production partly compensated for reduced biomass production during early drought.

There was no significant variation in the number of grains per unit area, but mean grain mass varied significantly. Most of the variation in grain yield was associated with variation in the latter component ($r^2 = 0.74$, $P < 0.05$). There was no correlation of yield with grain number per unit area, and grain number per unit area and mean grain mass were uncorrelated.

Despite the small range of yields in this experiment, maize will benefit from irrigation in the marginal Canterbury climate, especially on the lighter soils. It is particularly important to avoid water stress early in growth when the root system is shallow and the sensitivity of biomass production to drought is high.

A full report of the experiment will be submitted to the New Zealand Journal of Crop and Horticultural Science.