AS> Vol.2 No.3, August 2011

OPEN ACCESS

Cropping frequency and N fertilizer effects on soil water distribution from spring to fall in the semiarid Canadian prairies

PDF (Size:755KB) PP. 220-237 DOI: 10.4236/as.2011.23031

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ABSTRACT

In the semiarid Canadian prairies, water is the most limiting and nitrogen (N) the second most limiting factor influencing spring wheat (Triticum aestivum L.) production. The efficiency of water-and nitrogen use needs to be assessed in order to maintain this production system. The effects of cropping frequency and N fertilization on trends in soil water distribution and water use were quantified for an 18-yr (1967-1984) field experiment conducted on a medium textured Orthic Brown Chernozem (Aridic Haploboroll) in southwestern Saskatchewan, Canada. Soil water contents were measured eight times each year and plant samples were taken at five phenological growth stages. The treatments studied were continuous wheat (Cont W), summer fallow - wheat, F-(W) and summer fallow - wheat - wheat, F-W-(W) each receiving recommended rates of N and phosphorus (P) fertilizer, and (F)-W-W and (Cont W) each receiving only P fertilizer, with the examined rotation phase shown in parentheses. Soil water conserved under fallow during the summer months averaged 25 mm in the root zone, and was related to the initial water content of the soil, the amount of precipitation received, its distribution over time, and potential evapotranspiration. Under a wheat crop grown on fallow, soil water contents between spring and the five-leaf stage remained relatively constant at about 250 mm, but those under a stubble crop, with 40 mm lower spring soil water reserves, increased slightly until about the three-leaf stage. During the period of expansive crop growth (from the five-leaf to the soft dough stage) soil water was rapidly lost from all cropped phases at rates of 1.87 $mm.day^{-1}$ for F-(W) (N+P), 1.23 $mm.day^{-1}$ for Cont W (N+P) and 1.17 $mm.day^{-1}$ for Cont W (+P). The initial loss was from the 0 - 0.3 m depth, but during the latter half of the growing season from deeper depths, although rarely from the 0.9 - 1.2 m depth. In very dry years (e.g., 1973, with 87 mm precipitation between spring and fall) summer fallow treatments lost water. In wet years with poor precipitation distribution (e.g., 1970, with 287 mm precipitation between spring and fall but 142 mm of this in one week between the three- and five-leaf stage) even cropped treatments showed evidence of leaching. The above-ground biomass water use efficiency for Cont W was 19.2 and 16.7 $kg.ha^{-1}.mm^{-1}$, respectively, for crops receiving (N+P) and P fertilizer only. Grain yield water use efficiency (8.91 $kg.ha^{-1}.mm^{-1}$) was not significantly influenced by cropping frequency nor N fertilizer. The 18 years of detailed measurements of plant and soil parameters under various crop management systems provide an invaluable source of information for developing and testing simulation models.

KEYWORDS

Fallow Frequency; Water Use; Plant Biomass; Spring Wheat; Soil Water

Cite this paper

Jong, R. , Campbell, C. , Zentner, R. , Basnyat, P. , Grant, B. and Desjardins, R. (2011) Cropping frequency and N fertilizer effects on soil water distribution from spring to fall in the semiarid Canadian prairies. *Agricultural Sciences*, 2, 220-237. doi: 10.4236/as.2011.23031.

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