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Development of site-specific nitrogen fertilization strategies for sites with high and low plant available soil water capacity

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Rationales for site-specific nitrogen fertilization on sites differing in water availability are not well defined. Field studies were conducted to determine the interacting effects of N fertilization (N treatment), irrigation and drought stress (water supply treatment) on wheat yields, and yield components on two sites within a heterogeneous field. N rates were 120 kg ha-1 and 180 kg ha-1. Irrigations were applied or water stress was induced by withholding rain-water by sheltering plots during rain events between two-node stage and flag leaf stage in 2000, and between three-node stage and appearance of awns in 2001. Soil water content was monitored during the spring- summer growing season. Two-years data suggest soil water depletion down to 50 cm of soil depth on the loam-sandy sites (low plant available soil water capacity) and down to more than 90 cm on the loamy and silt-loamy sites (high plant available soil water capacity). The total amount of soil water consumed down to 50 cm was similar on both sites of each field. Soon after the water supply treatment was terminated, the level of soil water depletion was similar for all water supply treatments of each site. The effect of the site on grain yield interacted with water supply treatment but not with N treatment. Within the sites, nitrogen was the yield- limiting factor on the sites of high plant available soil water capacity, but on the sites of low plant available soil water capacity, water prevailed over nitrogen as limiting factor. The factor site was, however, the dominant cause of variation in grain and straw yield, seed weight, N, P and K uptake (higher at the sites of high plant available soil water than at the sites of low plant available soil water) and grain P concentration (lower at the sites of high plant available soil water than at the sites of low plant available soil water) in a field. Irrigation reduced substantially the differences between the sites. Water use efficiency was higher at the site of high plant availability of soil water than at the site of low plant available soil water and much higher in the second experimental year than in the first. Based on the consumption of soil water only, water use efficiency was considerably higher on the site of low plant available soil water than on the site of high plant available soil water site in the second experimental year. Soil mineral N, monitored only in 2001, was higher on the site of low plant available soil water than on the site of high plant available soil water before, during and after the trial. The findings of the present study show the importance of the site and the distribution of precipitation during the growing season and suggest that distinct fertilizer recommendations for each site of a field are necessary when soil texture is variable. Yield is strongly influenced by precipitation during heading until grain-filling, but stress during jointing limits yield potential that is hardly regained when stress is relieved. On sites of high plant available soil water, plants are less susceptible to stress during jointing and thus, an increase in applied N if required for higher yield is in most cases appropriate for these sites. On sites of low plant available soil water, only if rainfall during jointing is above average, an increase in the amount of applied N to obtain higher yield on sandy sites may be indicated, but also augments the risk of N leaching