

Soybean Irrigation Management: Agronomic Impacts of Deferred, Deficit, and Full-Season Strategies

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ABSTRACT

The efficiency of irrigation water use is improved if irrigations are scheduled only when soil water depletion exceeds a chosen crop-specific threshold percentage of field capacity (FC). Further improvement may be possible by accounting for seasonal variance in yield sensitivity to water stress. In soybean [*Glycine max* (L.) Merr.], the vegetative and bloom stages are notably less sensitive to water stress than are the pod-set and seed-fill stages. A 2-yr experiment was conducted to determine the yield impact of deferring irrigation until the beginning-pod stage (R3). Eight soybean cultivars were evaluated in subplots within four main plot irrigation treatments: (i) full-season control, with a 35% FC soil-water depletion trigger to schedule irrigation that replenished 100% of the crop evapotranspiration (ET) loss since the prior irrigation; (ii) a defer-irrigation-to-R3 strategy with the 35% FC depletion trigger ignored until the onset of stage R3; (iii) a deficit irrigation strategy with irrigation events on the same dates as those in the full-season control, but limited to two-thirds of the control amount; and (iv) rainfed control. Below-normal spring rainfall in each year resulted in soil water depletion greater than 35% FC before irrigation commenced in the R3-deferred strategy but did not impact yield versus the full-season control yield. A season-long deficit irrigation strategy significantly reduced yield below the full-season control, though it still produced significantly more yield than the rainfed control. These findings suggest that differentials in sensitivity of the crop developmental stage should be incorporated into irrigation scheduling models.

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Abbreviations: C, cultivar; DAE, days after emergence; DF, deficit; ET, evapotranspiration; FC, field capacity; FS, full season; I, irrigation; IN, indeterminate cultivar; IWUE, irrigation water-use efficiency; MG, maturity group; NI, nonirrigated; PAW, plant available water; PWP, permanent wilting point; SD, semideterminate cultivar.

IRRIGATION OF SOYBEAN [*Glycine max* (L.) Merr.] in the Northern Great Plains of the USA occurs primarily in Nebraska, Kansas, South Dakota, North Dakota, and portions of the neighboring states. In Nebraska, about 50% of the state's total soybean area (2.02 million ha) was irrigated during the past decade. In the three other states, less than 15% of the total harvested soybean hectareage was irrigated (<http://quickstats.nass.usda.gov/>).

The seasonal cumulative evapotranspiration (ET) pattern for a soybean crop in a given field will depend on (i) the number of days between the date of crop emergence and date of physiological maturity (stage R7), and the latter date will depend on the cultivar maturity group (MG) chosen; (ii) the degree to which early spring snowmelt and preemergence rainfall have restored the soil water content to 100% FC in the 90- to 120-cm soil depth that will be accessed by soybean root hairs during the growing season; and (iii) the total amount of rainfall received at the given

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