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EFFECTS OF SUPPLEMENTAL WATER ON SUNFLOWER PRODUCTIVITY IN NORTHWEST KANSAS

R. M. Aiken and R. D. Stockton

Summary

Available soil water can limit sunflower productivity by direct effects on canopy function, as well as indirect effects on canopy and seed development. The objective of this study was to determine effects of water deficits on oilseed sunflower development, seed yield and quality, and water use in semi-arid cropping systems. Supplemental water treatments were applied to sunflower during vegetative, reproductive, or both growth stages. Seed yields ranged from 2100 to 2700 lbs/a in 2000, and were reduced by 38% in 2001. Reduced yields in 2001 are attributed to severe sunflower moth infestation (24% reduction) and inadequate irrigation amounts (14% reduction). Crop water use appears to be limited by available soil water when relative soil water (in the wettest soil layer) is less than 60% of water holding capacity. Available water affects crop canopy development as well. Results from related studies suggest control of insect pests is required to achieve yield potential of supplemental water for improved water use.

Introduction

Available soil water frequently limits grain productivity in rain-fed, semi-arid cropping systems of the central Great Plains. Water use for sunflower can exceed that of other summer crops, due to higher transpiration rates, greater rooting depth, and extraction of soil water. Available soil water can limit sunflower productivity by direct effects on canopy function, as well as indirect effects on canopy and seed development. Knowledge of these effects can guide management decisions to sustain or improve water management for sunflower productivity. Improving the productive use of water by sunflower cultivars would enhance the array of management alternatives for farmers seeking profitable crops for rain-fed and limited irrigation crop systems in this region. The objective of this study was to determine effects of water deficits on oilseed sunflower development, seed yield and quality, and water use in semi-arid cropping systems.

Procedures

Sunflower seed (SF 187, oilseed) was planted (30-inch rows) in early June, into disked and harrowed soil (Keith silt loam), in 20 ft x 90 ft experimental plots, using a fluted coulter and double-disk opener. Soil fertility was amended with 100 lb N/a and 30 lb P_2O_5/a. Weeds were controlled by herbicide (sulfentrazone, or Spartan, 3 oz/a and pendimethalin, or Prowl 3.3EC, 3.5 pt/a). Water deficits (defined as difference between available water and field capacity of rooted soil, exceeding 4 inches) developed according to available soil water, crop growth, weather conditions, and experimental treatment (flood irrigation, using dikes to control runoff).

Supplemental water treatments were:

SIT1 no supplemental water
SIT2 water during reproductive development and grain fill (R1 – R9)
SIT3 water during grain fill (R6 – R9)
SIT4 water during reproductive development (R1 – R5)
SIT5 water throughout growing season (V12 – R9).

Sunflower crop development (leaf appearance and reproductive growth stage) was noted at weekly intervals. Canopy leaf area was measured weekly, using a Li-Cor 2000 canopy analyzer. Soil water was measured at weekly intervals by neutron thermalization. Crop stand (V8 and R9), yield components, and above-ground biomass were measured at physiological maturity from two

17 ft by 5 inch rows from each of four replicated plots. Plots were also machine-harvested when seed moisture was less than 12%. Seed was analyzed for moisture content, test weight, seed weight, and oil content.

Results

Irrigated yields in 2001 were 38% lower than yields in 2000 (Table 7). Yield reductions are attributed to a severe sunflower moth infestation, which reduced irrigated sunflower yields by 24% in Crop Performance Trials,[1] as well as insufficient irrigation amounts in 2001, due to faulty readings of soil water. Supplemental irrigation increased seed yields by 480 lbs/a each year, a lower response than expected. It is likely that insect pests limited yield potential of crop with adequate water supply.[2]

Crop water use appears to be limited by available soil water when relative soil water (in the wettest soil layer) is less than 60% of water holding capacity (Figure 4). This result is consistent with other field observations, though the threshold relative water content may vary with soil conditions. Leaf area at flowering (R5) is correlated with relative soil water, observed during the mid-bud (R3) growth stage (Figure 5). Thus, available soil water also appears to alter canopy development, though the effect may be delayed by two weeks.

Table 7. Water supplement effects on sunflower yield components

Watering Regime	Stand	Harvested Seeds/Plant	Seed Weight	Seed Yield	Oil	Biomass
	plants/a		g/1000 seed	lbs/a[1]	%	lbs/a
			2000			
1	14,875	1,897	46	2,119	37.7	6,193
2	15,750	1,799	54	2,602	40.0	7,572
3	15,250	1,814	53	2,703	40.6	7,247
4	14,875	1,784	51	2,541	38.3	6,943
5	14,500	1,945	50	2,348	40.2	6,590
			2001			
1	23,375	873	43	1,237	36.8	4,911
2	23,125	1,001	48	1,705	38.3	5,905
3	23,125	964	45	1,544	39.0	5,451
4	23,250	984	41	1,419	36.6	5,543
5	21,750	1,062	47	1,722	37.2	5,837

[1]Yield is adjusted to 10% moisture content

[1]Kansas Performance Tests with Sunflower Hybrids, Report of Progress 888, 2001.
[2]Effects of Insecticide Timing and Planting Period on Sunflower Productivity in Northwest Kansas, Report of Progress, 2003.

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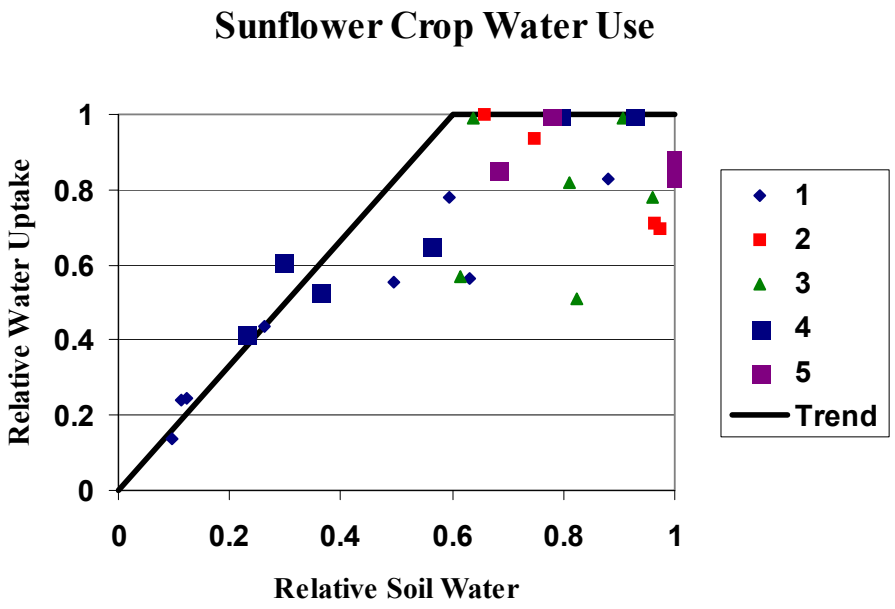

Figure 4. Water uptake by sunflower (relative to maximum observed uptake) in relation to the available soil water in the wettest soil layer (relative to available water capacity).

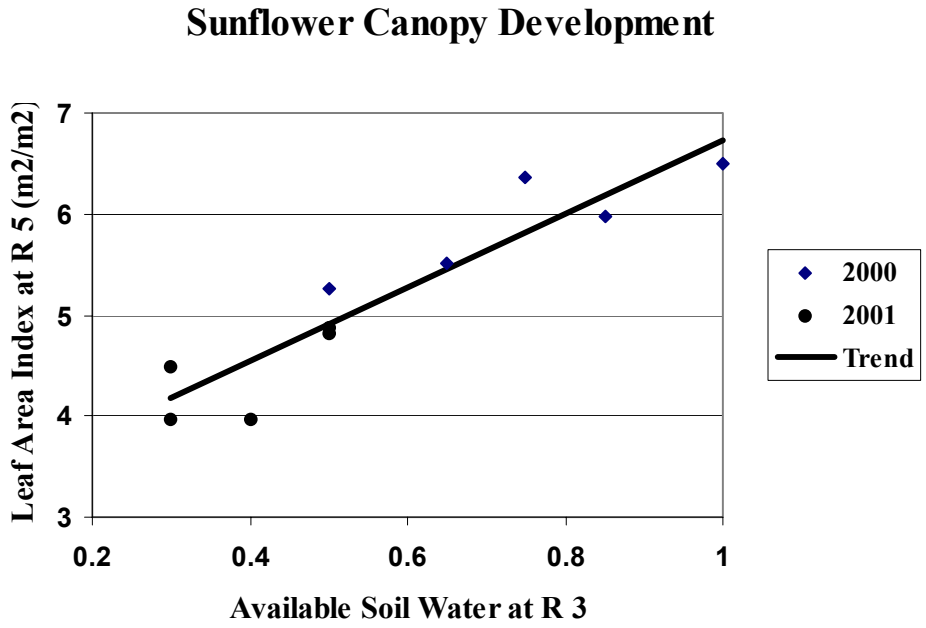

Figure 5. Sunflower leaf area at flowering (R5) in relation to available soil water at mid- bud (R3) growth stage.