Water use by sunflower and sorghum

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The material presented here is part of the CSIRO Project Cropfuel Programme. Specifically, it is an evaluation of the prospects for dryland sunflower cropping in southern Australia, sorghum being included in the experiments as an alternative summer crop and to provide a field comparison between the C_3 and C_4 photosynthetic pathways.

Methods

The crops were grown in a drying cycle from the point of accumulation of about 10% of final total dry weight until maturity. The cycle started with a full profile and was maintained by automatic rainshelters. Short-season hybrids (sunflower - 'Suncross 150'; sorghum - 'Nugget') were used in two experiments done in 1982 and 1983, respectively years of below-average and average evaporation. There were 12 replicates in the first year and five in the second. Crop water use was measured by neutron probe.

Results and Discussion

Uptakes by the species during the drying cycle are shown in Table 1.

Table 1. Water uptake mm.

	1982		1983	
Depth	Sunflower	Sorghum	Sunflower	Sorghum
0-1 m	159	155 ± 5.0	123	113 ± 6.1
0-2 m	111	57 ± 5.0	100	37 ± 6.1
0-2 m	270	212 ± 3.5	223	150 ± 4.3

There was, then, little difference between the species in uptake from 0-1 m, but sunflower drew 2-3 times more than 1-2 m; total uptake by sunflower was 28% (1982) and 49% (1983) greater than that by sorghum. At all levels, uptake was much faster by sunflower, which removed all available water to 1.5 m or more, and overall extracted 90% of the available water from 0-2 m; by contrast, sorghum removed 65%, leaving some available water at all levels below 0.5 m, the amount increasing with depth.

Heavy use of deep-stored water by sunflower may therefore limit the frequency with which it can he grown where effective rainfall during its growth period is low and the likelihood of early recharge of the profile to depth is small. Grain yields, harvest indexes and water use efficiencies in grain production are given, on dry weight and energy bases, in Table 2; the energy basis is the better one for comparison because of the large qualitative difference between the seeds of the two species.

Table 2. Grain dry weight yield, energy yield, harvest indexes (HT) and water use efficiencies (WDE).

	SUNFLOWER		SORGHUM		SUNFLOWER		SORGHUM	
	Grain	HI	Grain	HI	Grain	HI	Grain	HI
	g/m^2				MJ/m^2			
1982	149	.33	190	.39	4.26	.44	3.57	.40
1983	108	.35	103	.29	3.02	.45	1.94	.30
	WUE							
	$g/m^2/mm$				$KJ/m^2/mm$			
1982	.55		.85		15.8		16.8	
1983	.48		.69		13.5		12.9	

The transformation of the data to energy terms - which better reflect the commercial value of the grain - brings about a dramatic shift in the relative yields and WUEs of the species, which are substantially improved in sunflower. The lack of difference of WUEs in seed energy production is particularly surprising in view of the substantial superiority in WUE of the C_1 over the C_3 photosynthetic pathway.