

Wet soil culture of soybeans: plant growth and yield

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Most agricultural crops including soybeans are believed to prefer a free-drainin; to a waterlogged soil. However research with continuous irrigation, termed wet soil culture (WSC), has shown that soybeans acclimate readily to growth on saturated soils (1).

WSC is achieved experimentally in plastic-lined soil beds in which a water table is maintained some cm below the soil surface (1). In the field, plants are grown on raised beds separated by furrows containing a low volume water flow. In both systems, roots and nodules proliferate in the small depth of wet but aerated soil. WSC has resulted in doubling of root DM(2), increased nodule mass (35 to 50 times greater) (1), and equivalent N₂ fixation rates per unit of nodule mass (2), compared to well-watered controls. Rapid above-ground growth rates following acclimation have resulted in grain yields 16-68% greater than controls under a range of conditions (2,3).

A major aim of current research is to understand the physiological basis of these responses. Increases in grain yield suggest superior performance during grain development; this hypothesis was examined in a study at Lawes in 1981.

Methods

Light-enhancing treatments (reflective sheeting, or removal of alternate plants). or nitrogen-enhancing treatments (weekly spray with urea solution, or removal of the centre leaflet of the top 5 leaves, to increase assimilate supply to the nodules via illumination of lower leaves) were imposed on conventional furrow-irrigated and WSC crops of cv Fitzroy from mid-flowering to maturity.

Results and Discussion

	Conventional Irrigation (CI)				Wet Soil Culture (WSC)			
	Grain Yield g plant ⁻¹	Protein %	Grainfill N ^a mg plant ⁻¹	TNA ^b	Grain Yield g plant ⁻¹	Protein %	Grainfill N ^a mg plant ⁻¹	TNA ^b
Control	6.29	40.3	125	8.3	7.78	41.2	312	17.2
Reflector	9.14	42.1	345	18.6	8.42	41.0	341	35.0
Plant Removal	9.97	40.0	374	32.2	9.12	41.2	392	67.2
Leaflet Removal	7.34	39.9	213	13.6	6.95	40.1	271	19.0
Urea Spray	6.10	42.8	204	n.a.	7.86	43.5	338	n.a.
LSD (0.05)	1.29	n.s.	108	20.3				

^aN gain during grain development (i.e., treatment period)

^bTotal nodule activity (:moles C₂H₄ plant⁻¹ hr⁻¹) after 8 days treatment.

WSC increased grain yield (equivalent values 3.49 (CI) and 4.32 (WSC) t.ha⁻¹), and maintained protein content. During grain development N gain was 2.5 times that of CI, while DM gain and seed DM gain were 46% and 24% greater respectively. Nodule activity has been shown to decline rapidly during grain development in conventional crops (2,4) but to be maintained in WSC (2).

N enhancement had relatively little effect on grain yield, DM and N accumulation, and nodule activity. Light enhancement increased all four attributes, particularly with CI. The similarity between WSC plants and light-enriched CI plants suggests that the WSC response is largely a result of increased photosynthesis, which has a dual expression in nodule activity(i.e.N gain)and DM :rain.

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