

Making more profit from Irrigated Grain Sorghum.

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In 2007 Pacific Seeds conducted a detailed irrigated trial with the aim to determine the most profitable use of irrigation water on grain sorghum.

The drive behind this trial was continuing restrictions on irrigation supplies; and high grain sorghum prices. Sorghum is well known for its drought tolerance and water efficiency, grain sorghum is well suited to limited irrigation or deficit irrigation and has the potential to provide good profits per mega liter of water.

Take Home Message.

By limiting stress and optimizing management; yield in grain sorghum is maximized. Which in this situation maximized the net return per ha. However total net profit on a farm basis would have been much higher, up to 60% higher, if the available water was spread across as much area as possible, as a pre-water treatment with optimized nitrogen.

In situations where irrigation water supply is limiting and not land; full irrigation is not the most profitable irrigation strategy.

The 2007 - 2008 season favored the pre-water treatment; the growing season was particularly cool and the potential crop water requirement was reduced by 15 % compared to the long term average. Maximum temperatures only averaged 28.5 degrees during flowering and only one day reached 35 degrees. However this treatment also carries the most risk. Effective rainfall in the growing period was 184mm which is 60% of the long term average, only 30 % of the rainfall fell post flowering

The pre-watered treatment suffered moderate stress at booting and was at risk of severe yield reduction, however timely rainfall of 53.5 mm fell at booting followed by another 53mm at the end of the soft dough stage.

In a hotter year, or a year without timely rainfall a more conservative approach may be the most profitable.

From this trial it could be theorized that the most profitable use of water on grain sorghum is to supply around 75% of potential water requirement for a given season and to time water applications to limit stress at the three key growth stages of; booting, flowering and early grain fill.

There was no heat stress in this trial, which can commonly occur during these critical growth stages, grain yield reduction due to moisture stress may be increased under hotter conditions, and more water may need to be supplied for the same yield outcome.

In hotter growing environments where the evapotranspiration demand is higher and/or soil water storage is low, applying more water per hectare and maximizing yield may be the most profitable strategy.

The water use efficiency of all treatments was very high, and compares extremely well with cotton and maize.

Trial Results;

Chart I.

Summary of yield by water treatment on Grain Sorghum
Plant population 10plants/m²

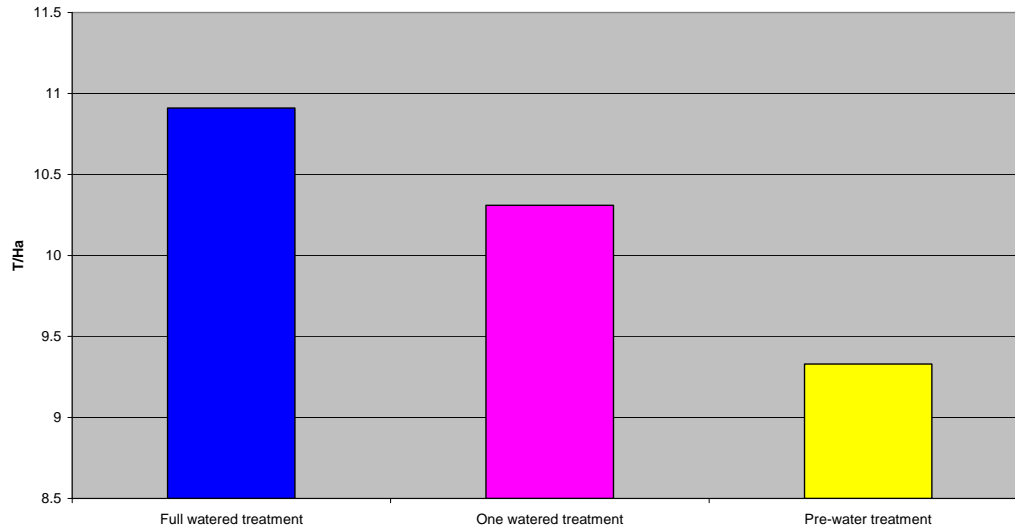


Table I.

Irrigation use efficiency and Total water use efficiency.

			<i>IWUE</i>		<i>TWUE</i>
	<i>Yield kg/ha</i>	<i>Irrigation mm</i>	<i>kg/mm</i>	<i>Total water mm</i>	<i>kg/mm</i>
High input	11160.5	275	40.6	482	23.2
Full Irrigation	10921.2	275	39.7	482	22.7
Partial Irrigation	10342.3	210	49.2	417	24.8
Pre-water	9166.7	100	91.7	307	29.9

Note; High input; 14 plants per meter under full irrigation.

All other treatments compared at 10 plants per meter

Table 2.

Irrigation timing and crop stage.

Treatment	Irrigation 1	DAP	Crop Stage	Irrigation 2	DAP	Crop Stage
Full Irrigation	12/11/2007	55	Flag leaf visible	17/12/2007	90	Soft Dough
Partial	19/11/2007	62	Booting	-	-	-
Pre-Water	-	-	-	-	-	-

Yield loss from moisture stress at booting.

Chart2.

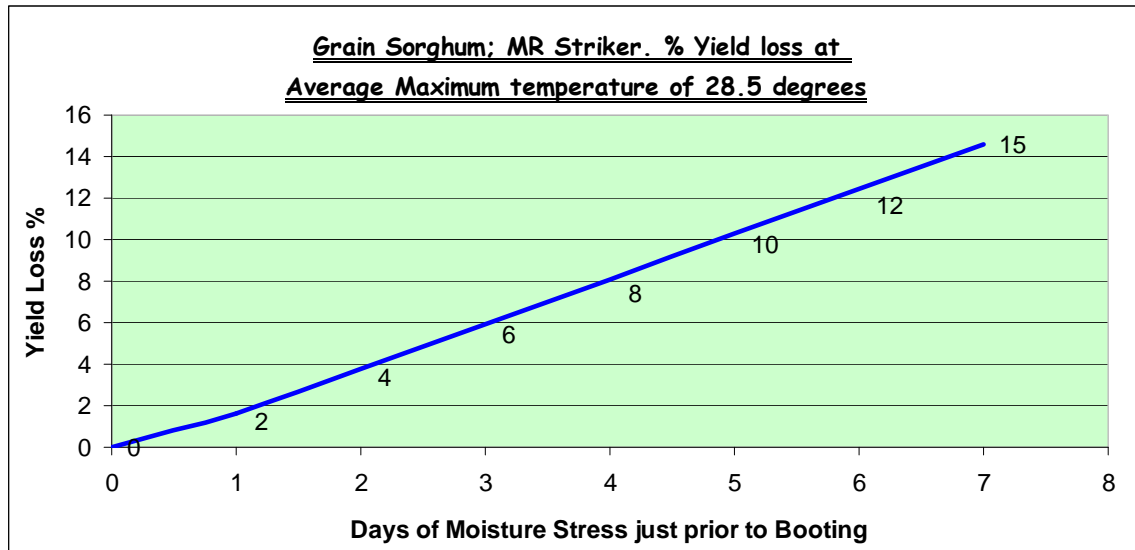


Chart 3.

Estimated Water Stress. Irrigated Grain Sorghum Trial 2007-08.

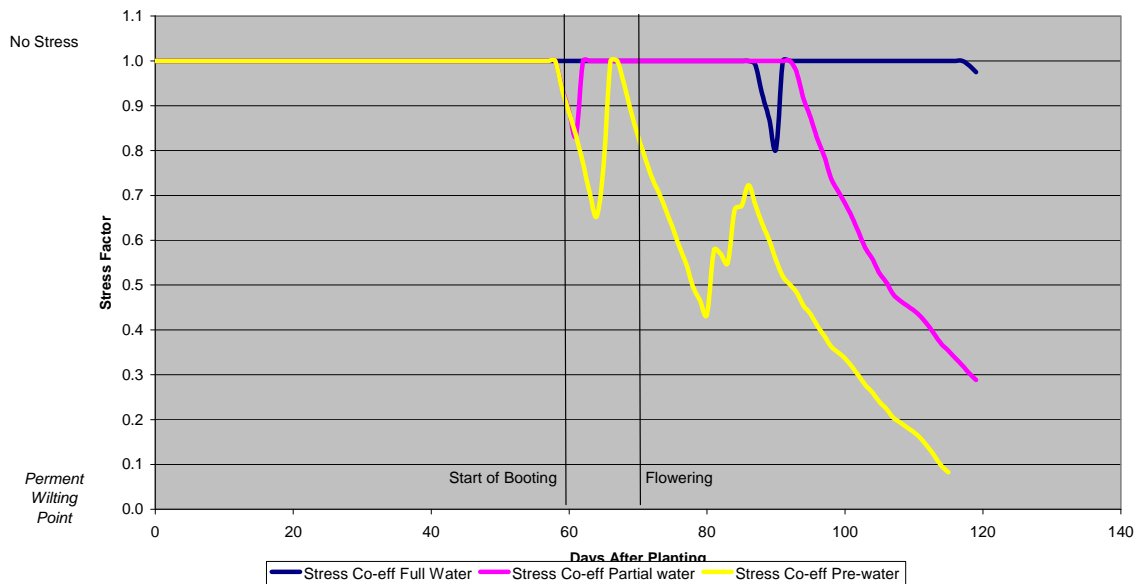


Chart 3. Visual stress began in the crop when 50% of plant available water was depleted, this occurred when 100mm of stored water was used. Chart 3 describes the level of stress that occurred and what crop stage it occurred for each of the water treatments. A score of 1 represents no moisture stress, and a score of 0 is permanently wilted. The Pre-watered treatment (yellow line) experienced moderate stress at booting and looked like it would fail to flower until it received 55mm of rainfall.

Plant Population by Water Treatment analysis
Chart 4.

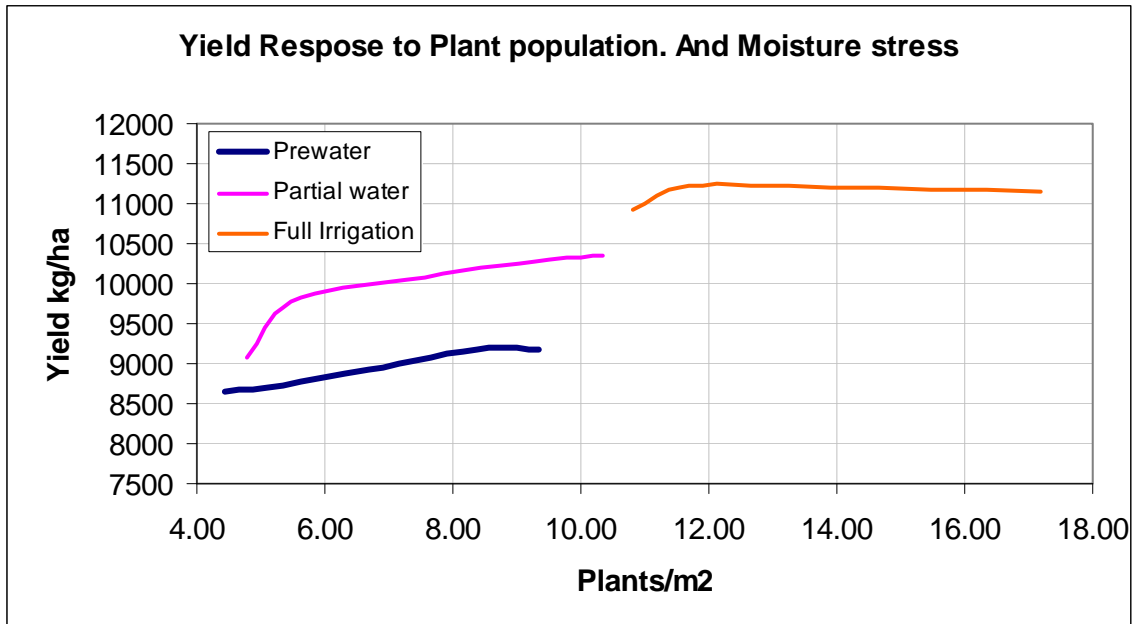
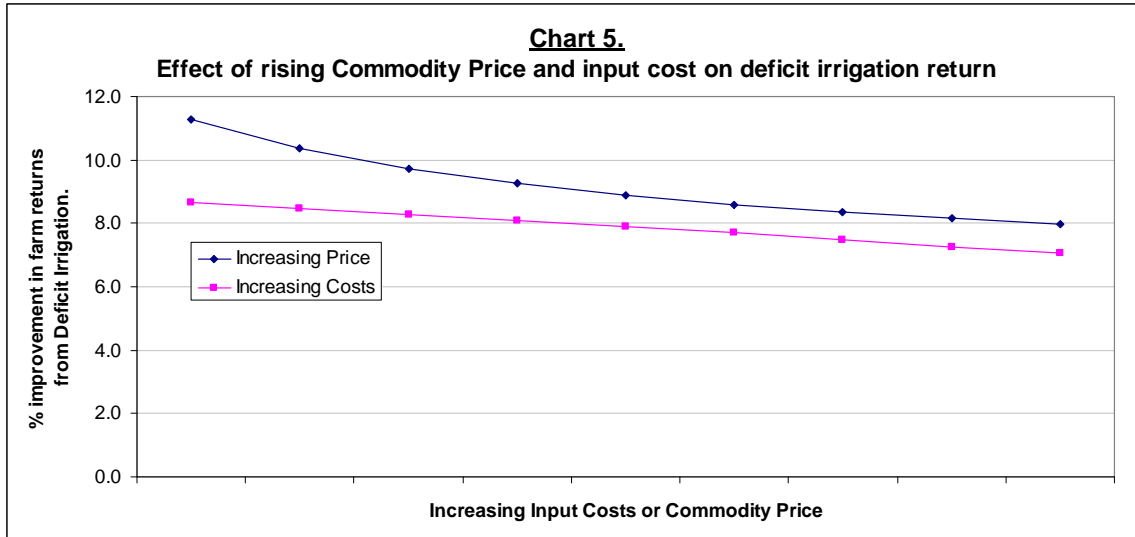


Table 3;
Irrigated Grain Sorghum Profit analysis.

	<u>Yield</u> <u>kg/ha</u>	<u>Gross</u> <u>Income</u>	<u>Total</u> <u>irrigation</u> <u>water ML</u>	<u>Water</u> <u>cost/Ha</u>	<u>Variable</u> <u>costs/Ha</u>	<u>Total</u>	<u>Net</u> <u>Income</u>	<u>Nett</u> <u>\$/Irrigated</u> <u>ML</u>	<u>Water</u> <u>Available</u>	<u>HA</u>	<u>Total Net</u> <u>return</u>
High input	11160	2455.31	2.75	150	375	525	1930.31	701.9	275	100	193030.9
Full Irrigation	10921	2402.66	2.75	150	369.95	519.95	1882.71	684.6	275	100	188270.9
Partial Irrigation	10342	2275.30	2.1	82.88	369.95	452.83	1822.47	867.8	275	131	238656.6
Pre-water	9166	2016.68	1	36.88	369.95	406.83	1609.85	1609.8	275	275	442708.4
Pre-water and optimize Nitrogen	9166	2016.68	1	36.88	291.95	328.83	1687.85	1687.85	275	275	464158.75

Table 3, Details the Gross and net income of the different management treatments, Potential farm returns explores the options available given a set irrigation allocation. Price of the grain was set at \$220/t on Farm. On this farm this season returns are maximized under the pre-water treatment with optimized Nitrogen (PWTON). Farm net profit increases by 60% under the PWTON, even though net income per Ha is maximized under the High input management treatment.



Increasing costs or commodity prices reduces the extra profit provided by deficit irrigation. In less reliable areas where yields are likely to be more variable under deficit irrigation, full irrigation may provide the best returns especially if prices are high.

Key Findings.

- Grain sorghum appears to be very responsive to deficit irrigation; applying water at critical growth stage to avoid stress, but limiting available water to as low as 60% of the seasonal requirement.
- Grain Yield was highest at 14 plants/m or 5.3 cm inter plant spacing, under full irrigation.
- Highest water use efficiency (kg/mm) was the pre-water treatment at a plant population of 8.5 plants/m or 8.8 cm interplant spacing.
- Highest net return/ha was the highest yielding treatment, full water at 14 plants/m
- Highest total net farm return for this particular season would have been; to pre-water as much area as possible and plant 8.5 plants/m see Table 3.
- Response to plant populations depends on the timing of water stress,
 - Water stress pre-flowering favors lower plant populations and the response curve is quite flat.
 - Water stress post flowering favors higher populations and responses to population increase are minimal from 12 plants/m² onward
- Water and population affect on seed size and weight is a complex relationship, comprising of seed number, stress and timing.
 - Stress pre-flowering and during flowering can reduce seed number, allowing adequate grain fill to occur even under water stress at grain fill. It appears that preferential filling occurs on the main head, as moisture stress increases grain size reduces on the tillers.
 - Where seed set is maximized, moisture stress occurring late during grain fill appears to reduce seed size the higher the yield.

- Where limited stress occurs, populations and yield seem to have little effect on grain quality.

