Reduced Irrigation Amounts on Durum and Barley

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Introduction: An ongoing research project has been investigating the effects of reduced irrigation amounts on durum and barley grain yield and quality. This project has been conducted at the Nesson Valley Research and Development site since 2010. Four irrigation amounts are being investigated: 100%, 67%, 33%, and 0% of the amount recommended by the NDAWN checkbook method (Table 1). The irrigation amounts were fine-tuned based on weekly soil moisture measurements. These differing irrigation amounts were applied throughout the growing season via a linear-move overhead sprinkler system equipped with a GPS-regulated variable rate irrigation control system.

Table 1: Amount of water (9-year average) received via irrigation and rain.

	Durum		Barley	
Irrigation amount	Irrigation	Irrigation + rain	Irrigation	Irrigation + rain
	---------- inches ----------			
100%	6.4	14.3	5.5	13.4
67%	4.3	12.2	3.7	11.6
33%	2.1	10.0	1.8	9.7
0%	0.0	7.9	0.0	7.9

Rain amounts (May 15 to August 15) varied from year to year and ranged from 5.2 inches in 2017 to 11.3 inches in 2011. The 9-year average was 7.9 inches, which was very close to the 30-year normal value of 8.0 inches. Irrigation amounts also varied from year to year. For the durum 100% treatment, the amounts ranged from 3.2 inches in 2013 to 11.3 inches in 2017, and averaged 6.4 inches. For the barley 100% treatment, the amounts ranged from 3.5 inches in 2018 to 9.5 inches in 2015, and averaged 5.5 inches. The proportion of water from irrigation in the 100% treatments averaged 44% for durum and 41% for barley.

Results: Reduced amounts of irrigation decreased durum yields and test weights but increased protein levels (Table 2). Although an increase in durum protein is economically beneficial, the price premium for increased protein content may not compensate for the revenue loss from the decreased yield.

Table 2: Durum yield, protein, and test weight achieved with various irrigation amounts.

Irrigation amount	Yield	Protein	Test Wt.
	bu/a	*%*	*lb/bu*
100%	79	15.7	60.3
67%	71	16.2	59.8
33%	63	16.9	59.2
0%	49	17.7	58.2

Table 3: Number of years out of nine when durum yield, protein, and test weight were not affected by reduced irrigation amounts.

Irrigation amount	Yield	Protein	Test Wt.
	---------- *years* ----------		
67%	5	7	8
33%	3	5	6
0%	0	2	5

The magnitude and frequency of reduced yields, test weights, and plumpness and increased protein content were directly related to the reduced irrigation percentages (Tables 2 & 3).

The effect of reduced irrigation on barley was similar: reduced irrigation decreased yield, test weight, and kernel plumpness and increased protein (Table 4). Note that because high-protein content is undesirable in malt barley, increased protein levels in barley may be disadvantageous.

Table 4: Barley yield, protein, test weight, and kernel plumpness achieved with various irrigation amounts.

Irrigation amount	Yield	Protein	Test Wt.	Plump kernels
	bu/a	*%*	*lb/bu*	*%*
100%	96	12.1	52.0	89.4
67%	91	12.5	51.7	87.9
33%	83	12.7	51.0	88.5
0%	73	13.1	50.4	86.0

Table 5: Number of years out of nine when barley yield, protein, test weight, kernel plumpness were not affected by reduced irrigation amounts.

Irrigation amount	Yield	Protein	Test Wt.	Plump kernels
	---------- *years* ----------			
67%	8	7	9	8
33%	5	6	8	7
0%	1	4	5	4

As with durum, the magnitude and frequency of the effects of reduced irrigation on barley increased as the size of the irrigation reduction increased (Tables 4 & 5).

Discussion: Reducing irrigation amount by one-third (i.e., to the 67% rate) had a modest effect on durum yield and a near-negligible effect on durum quality and barley yield or quality. Durum yield, protein, and test weight were unaffected 5, 7, and 8 years out of 9, respectively. Barley yield, protein, test weight, and kernel plumpness were unaffected 8, 7, 9, and 8 years out of 9, respectively. Durum yields were reduced by 10% and barley yields were reduced by 5%. Protein, test weight, and kernel plumpness all were changed by less than 3%. Water savings achieved by reducing irrigation amounts by one-third may help farmers comply with water restrictions or expand irrigated acreage without increasing total water demand. This project will be continued to more fully understand why reduced irrigation affects yield, protein, test weight, and kernel plumpness some years and not others.