

# **Final Report**

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Determination of optimal planting configuration of low input and organic barley and wheat production in Arizona

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## Summary

*Markets for organic barley and wheat are expanding. A major problem growing organic barley and wheat is controlling the weeds. Organic barley and wheat were grown in conventional 6-inch drill spacing but also in 30 inch spacing so weeds could be cultivated in a study at the Larry Hart Farm near Maricopa. The weed pressure was moderate and the weed biomass was about 1 to 5% of the crop biomass near maturity. The primary weed was Palmer amaranth. Grain yields of the wheat (durum) were similar regardless of row spacing, but the barley grain yields were 3921 lbs/acre in the 6 inch spacing and 2530 lbs/acre in the 30 inch spacing.*

## Introduction

The demand for organic food in general and food products derived from organic barley and wheat in particular is increasing. The price premium received by the grower to produce organic wheat and barley can be 50 to 100% of conventional crops depending to market trends. However, the price premium for growing organic grains may be offset by lower yields as a result of not be able to apply chemical fertilizers and pesticides.

Weed control is one of the biggest challenges facing producers of organic barley and wheat in Arizona. Barley and wheat are very competitive with weeds in conventional production due to more vigorous growth as a result of chemical fertilizers, and if weeds do become a problem, chemical herbicides can be applied. To suppress weeds, organic producers can plant in drill rows or sow seeds at a higher rate than in conventional production. Another option is the use of cultivation, which requires that the seed be planted in rows about 30 inches wide so that a cultivator and tractor can pass through the crop. Planting barley or wheat in 30-inch rows would certainly decrease yield in conventional production compared to the typical 6-inch drill rows (Ottman, 2004). However, in organic production the yield potential is less than when using conventional practices, and the yield loss in wide rows may not be as great as expected. Furthermore, the ability to cultivate and control weeds in the 30-inch spacing may compensate for any yield loss in the wider rows. Other advantages of wider rows are reduced seed costs and decreased lodging (Ottman, 2004), and possibly savings in irrigation water.

Objectives: Determine if planting in 30-inch rows combined with cultivation reduces weed pressure compared to 6-inch drill rows in organic barley and wheat production. This is the second year of the study.

## Procedure

A row spacing study with organic barley and durum was conducted at Hart Farms, about 5 miles west of Maricopa, AZ. The crop was grown using organic methods which do not allow the use of chemical fertilizers or pesticides. The study was located in two 5-acre, level basin fields (205 ft wide x 1100 ft long). The previous crop was silage sorghum. No manure was applied due to the delay in field preparation. On January 11 2012, 'Cochise' barley and

'Kronos' durum were dry planted separately in each 5-acre field. First irrigation took place on 1/21/12. Two planting methods were used: 1) grain drill with 6 inch row spacing and a seeding rate of about 120 lbs/acre for barley and 132 lbs/acre for durum, and 2) row planter with 30 inch row spacing and a seeding rate of 70 lbs/acre for barley and 81 lbs/acre for durum. The seed was planted in strips the length of the field (1050 ft) and a width of 20 ft from the plot edges and 17.5 ft from the first to last row of each plot. The number of rows planted was 36 rows with the grain drill and 8 rows with the planter. The experimental design was a complete block design with 2 treatments (6 and 30 inch row spacing) and 5 blocks repeated for two crops (barley and durum).

The mechanical operations of planting (both drill and row planter) and cultivation were carried out with a 120 HP tractor equipped with an auto-pilot system enhanced with RTK quality GPS of sub-inch accuracy. To achieve vehicle navigation repeatability in these jobs we used the same A-B reference line saved in the internal memory of the computer display. To minimize side-drift during mechanical operations we closed the gap of the tractor sway-blocks and restrained the play of the 3-point hitch implement connections.

Weed pressure was very low for the most part of the growing season. Strips on rows were cultivated only once on March 23, 2012. The front toolbar was equipped with flat knives of 1/4" thickness, positioned 5 inches away from the seed-line. 6-inch wide "duck-feet" sweeps were used in the front tool-bar to cultivate the middles. Tooling depth was set to 3 inches for aggressive weed control. Rear tool-bar was equipped with rolling (Lilliston) cultivators for soil conditioning and two flat coulters for implement stability.

During the growing season, weed density and crop growth were measured between irrigations for a total of five sampling times. The measurements consisted of two samples of 18 inches of row for 2 rows for 6 inch spacing (3 ft<sup>2</sup>) and for 1 row for the 30 inch spacing (7.5 ft<sup>2</sup>). Weed density was determined by weighing weeds from the sampled areas. Crop growth was determined by 1) weighing plants sampled from the sampled areas, and 2) measuring light interception by the crop within 1 hr of solar noon.

Harvest was carried out on June 12 with a conventional combine of 20 feet wide header. This grain combine was retrofitted with a yield monitor for electronic recording of instantaneous yield across the field. A differential-correction GPS was connected to the computer display of the yield monitor to geo-reference yield data. At harvest, grain yield, test weight, yellow berry (durum only), and protein content were determined. The plots on the outside of the experiment near the borders were much lower yielding than the rest of the field, so there were excluded from the analysis for yield, test weight, protein and yellow berry.

## Discussion

Weed pressure was not very severe this year and weed biomass was less than 10% of the crop biomass (Table 1). Nevertheless, cultivation in the 30 inch row spacing was effective in reducing the weed populations to low levels, although light interception and crop growth were delayed in the 30 inch row spacing (Table 1).

At the first sampling time on March 4 at the tillering stage, light interception in the 6 inch row spacing was 24% of incident for barley and 6% for durum, compared to 16% for barley and 4% for durum in the 30 inch row spacing. Light interception was substantially higher at the second sampling time on March 25. Full cover had been reached by the third sampling time on April 15 near heading, and light interception in the 6 inch spacing was 87% for barley and 78% for durum compared to 64% for barley and 60% for durum in the 30 inch row spacing. Similar results were obtained for light interception measurements on April 29 during the grain fill stage. The 30 inch row spacing intercepted only 56 to 57% of the incoming light at solar noon, compared to 69 to 88% for the 6 inch spacing.

Plant biomass at the March 4 sampling at tillering was reduced by about a third in the 30 inch compared to the 6 inch row spacing. This reduction in yield is undoubtedly related to the reduction in light interception in the wider rows. At the later sampling dates, we were not able to detect differences in plant biomass due to row spacing for either barley or durum.

Cultivation in the 30 inch rows reduced the weed biomass substantially, generally to about a quarter or less of the weed biomass in the 6 inch spacing. At the March 4 sampling time, the weeds were virtually non-existent, so the effect of cultivation on weed biomass had not been realized by this time. However, by the Mar 25 sampling time, weed biomass increased and had been substantially reduced in the 30 inch row spacing by cultivation, and the

reduction in weed biomass in the 30 inch row spacing was maintained through the end of the season. The primary weed was Palmer amaranth, but there was some little mallow.

Planting in 30 inch rows resulted in a yield reduction of about 35% for barley, but resulted in similar yields to 6 inch row spacing for wheat (Table 2). In the first year of the study, the barley yield reduction in 30 inch rows was 25%, and row spacing had no effect on the durum similar to the results this year. Test weight, grain protein, and HVAC were not affected by row spacing for the barley or durum.

The yield maps show clear strips for the barley and wheat planted in different row spacings (Figs. 1 and 2). The north end of the field had higher yield potential than the south end, and the advantage of the 6 inch row spacing was more pronounced at the north end. The yield maps do not seem to correspond to the map of apparent soil electrical conductivity (Fig. 3), which is related to soil properties that affect water retention, soil texture in particular.

The barley produced more grain yield than wheat in 6 inch relative to 30 inch rows possibly because 1) the barley in 6 inch rows either had less weed pressure or was more competitive with weeds, 2) the barley has a lower nitrogen requirement than wheat and elimination of weeds in the 30 inch spacing for competing for nitrogen was not as much of an advantage for barley compared to wheat.

### **Acknowledgments**

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### **References**

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- Sullivan, Preston. 2003. Organic small grain production. [www.attra.ncat.org](http://www.attra.ncat.org).

Table 1. Row spacing effect on light interception and plant and weed biomass at several sampling dates for barley and durum crops grown organically at the Larry Hart Farm in Maricopa, AZ in 2012.

Sampling Date	Crop	Row Spacing	Light interception	Plant biomass	Weed biomass
		inches	% of incident	lbs/acre	lbs/acre
Mar 4	Barley	6	24	676	0
		30	16	468	0
Mar 25	Barley		NS	*	---
		6	6	331	0
	30	4	209	0	
	Durum		NS	NS	---
Apr 15	Barley	6	84	2,578	82
		30	53	2,519	20
	Durum		**	NS	*
		6	55	2,086	117
Apr 29	Barley	30	58	1,724	9
			NS	NS	*
	Durum	6	87	6,853	143
		30	64	6,848	130
May 27	Barley		**	NS	NS
		6	78	6,769	469
	30	60	6,188	64	
	Durum		+	NS	NS
May 27	Barley	6	88	10,472	452
		30	56	9,850	121
	Durum		**	NS	NS
		6	69	9,388	547
May 27	Barley	30	55	9,851	89
			NS	NS	+
	Durum	6	---	13,305	120
		30	---	12,305	469
May 27	Barley		---	NS	*
		6	---	13,412	736
	30	---	14,696	309	
	Durum		---	NS	NS

NS, +, \*, \*\* = Not significant at the 10% probability level, and significant at the 10%, 5%, and 1% probability levels, respectively.

Table 2. Row spacing effect on grain yield, test weight, grain protein, and HVAC for barley and durum crops grown organically at the Larry Hart Farm in Maricopa, AZ in 2012.

Crop	Row spacing	Grain yield	Test weight	Grain protein	HVAC
	inches	lbs/acre	lbs/bushel	%	%
Barley	6	3,921	52.1	13.3	---
	30	2,530	51.6	12.8	---
		**	NS	NS	---
Durum	6	3,421	61.0	17.6	99.8
	30	2,976	61.1	16.9	99.9
		NS	NS	NS	NS

NS, \*\* = Not significant at the 5% probability level, and significant at the 1% probability levels, respectively.

Fig. 1. Grain yield map for barley grown organically at the Larry Hart Farm in Maricopa, AZ in 2012. The vertical strips represent different row spacing starting with 6 inch on the left (west) alternating with 30 inch.

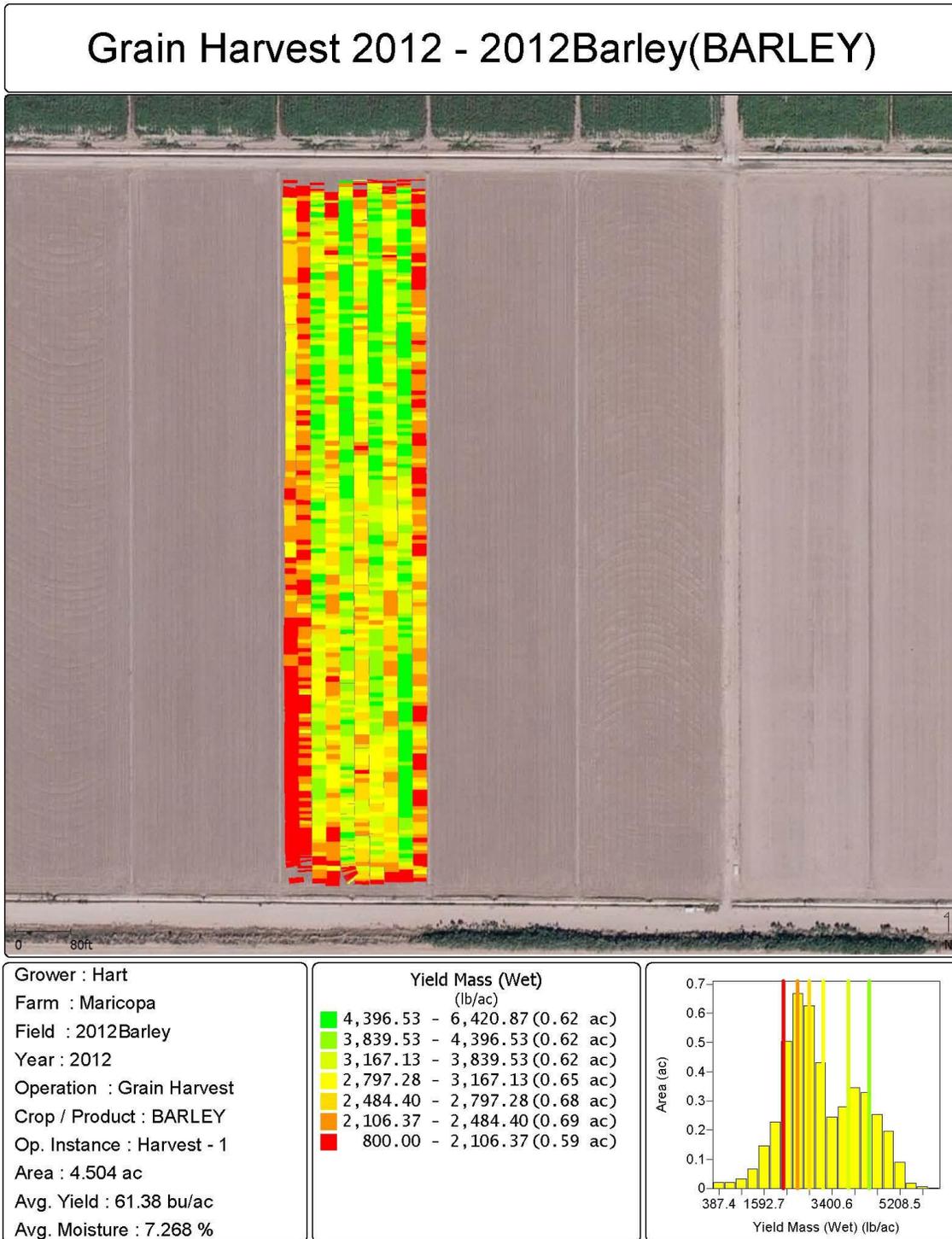


Fig. 2. Grain yield map for durum (wheat) grown organically at the Larry Hart Farm in Maricopa, AZ in 2012. The vertical strips represent different row spacing starting with 6 inch on the left (west) alternating with 30 inch.

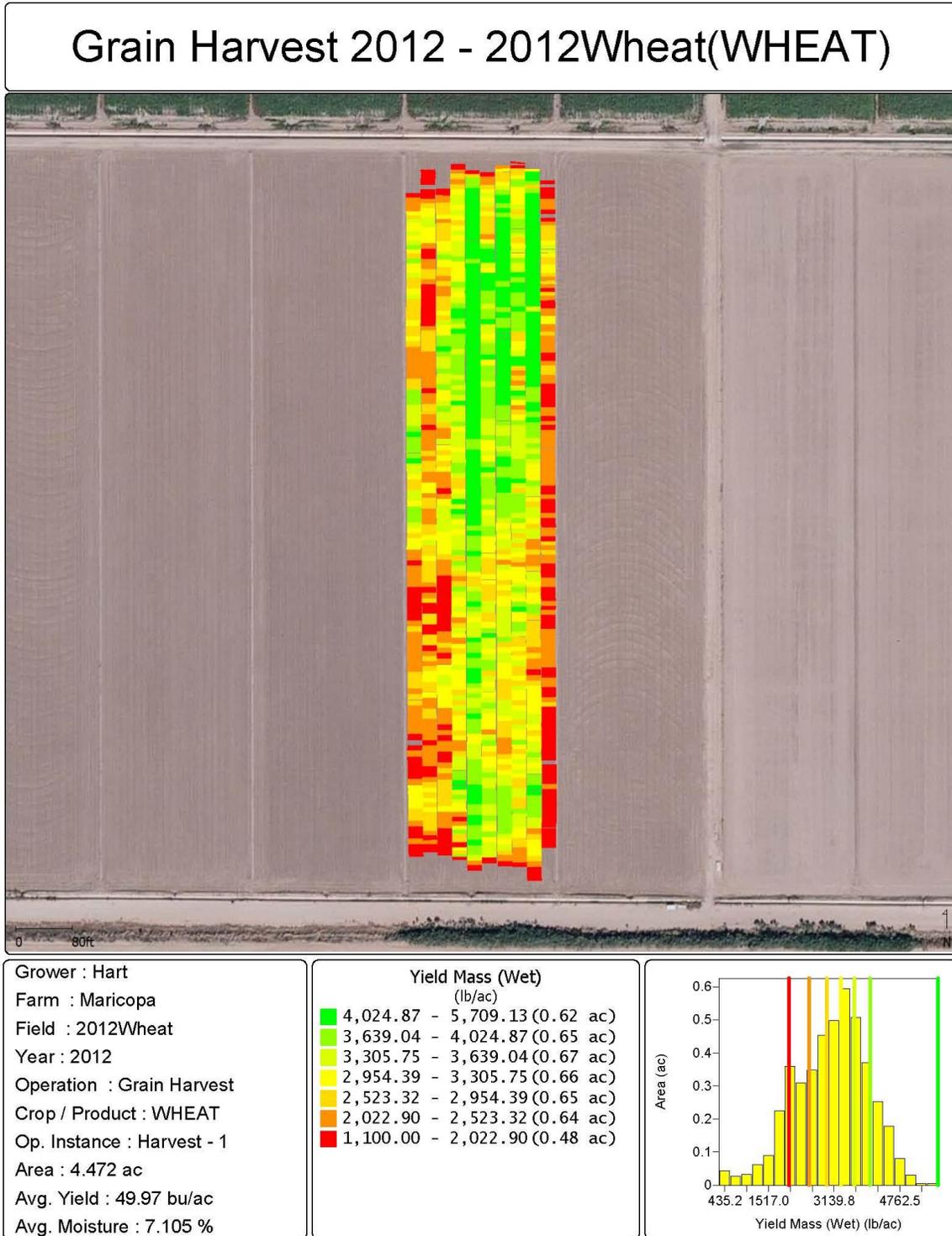


Fig. 3. Soil apparent electrical conductivity (EC) map prior to planting barley and durum crops to be grown organically at the Larry Hart Farm in Maricopa, AZ in 2012.

