Effects of Planting on Beds vs. Flat Planting System in Durum Wheat and Barley

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Abstract

The purpose of this project was to compare different production systems for durum wheat and barley, identify and quantify potential economic savings for growers through reduced crop inputs and improved production efficiency. The project compares conventional method of planting on 'flat' *versus* 40 inch 'beds'. AZSCHED was used to schedule irrigation. Layflat polypipe with gates were used to irrigate plots and the amount of water was monitored with a water meter. Neutron probe moisture meter was used to measure actual moisture content, 'before' and 'after' irrigations. We measured protein content, biomass weight, stem nitrogen and yield. There were no significant differences for protein content, stem nitrate levels or test weights. However, planting on the flat produced 4961 lbs/ac (wheat); 5028 lbs/ac (barley) which were better than the planting on beds 4380 lbs/ac (wheat); 4629 lbs/ac (barley). Irrigation amounts and nitrogen use efficiency did not show any differences in the two planting systems.

Introduction

The cost of agricultural production has increased over the years and will likely continue; from land prices to fuel and water costs. The cost of fertilizers is very volatile and has risen sharply during the last few years. The rising energy prices have increased the cost of producing and delivering fertilizers. In small grain production, where fertilizer can make up a significant part of production costs, it is critically important to develop improved production systems that can reduce inputs or improve efficiency of their use. Arizona growers face another difficulty, determining their water allocations to ensure they have enough water to last the entire season. Water requirements have been increasing in urban, industrial, environmental, and recreational uses, reducing available water for agriculture (Fahong et al., 2003). In some instances, growers are unable to plant all available acreage because there is not enough water to go around. Producers also have environmental pressures being placed on them and are expected to produce more with fewer inputs. Existing research had demonstrated that with good management of resources and adoption of appropriate practices, including improved water conservation, production of quality, high-yielding crops is possible (Fahong et al., 2003). Our proposed research project will provide data on the potential for local implementation of cost-saving alternative practices that will reduce and more efficiently manage the most costly inputs for durum wheat and barley production in Arizona.

Historically in Arizona, the majority of wheat and barley has been planted on flat with flood irrigation. Flood irrigation on flat ground has been associated with low water use efficiency, soil degradation, and without proper nutrient management, it has led to nitrate pollution of surface and subsurface water (Fahong et al., 2003). Raised bed cultivation has been used in fields with side-fall or other water management issues, and has shown improved nutrient management and cultivation. There is currently no research data available on bed planting versus flat stands in Arizona. However, several studies in other regions have identified important yield and cost-saving benefits of bed planting for wheat and barley production. A study by Zhang et al. (2007) concluded that raised bed and mulched ridge planting decreased water consumption, increased water use efficiency, and had higher yields than flat planting in winter wheat. Freeman et al. (2007) found that bed planted wheat offered crop rotation opportunities and field-access flexibility for fertilizer application and weed control. They found no difference in grain yield for conventional flat stand versus raised beds. Farmers in the Yaqui Valley of Sonora, Mexico switched to bed planting with 2 or 3 rows of wheat on top of the beds that are 70-80cm (27-30 inches) wide with furrow irrigation as opposed to flat planting in solid stands and flood irrigation (Sayre and Moreno Ramos, 1997). By switching, they were able to reduce water requirements by 25%, offer more opportunity for mechanical weed control, reduce tillage, and reduce incidence of lodging. A study by Tripathi et al. (2005) also found that bed planted wheat varieties demonstrated over 50% less lodging compared with flat planting.

Materials and Methods

A randomized complete block design experiment with four treatments; 1) wheat-flat, 2) wheat-bed, 3) barley-flat, and 4) barley-bed and four replications was conducted at the Maricopa Agricultural Center in Maricopa, Arizona. 'Kronos' durum wheat and 'Baretta' barley were planted on November 28, 2011 at a rate of 150 lbs/acre for wheat and 120 lbs/acre for barley. The plots were planted with a grain drill for both the flat and bed system. For the bed system, the wheat and barley was also planted between the rows in the furrow. Each plot was 180 feet long and 20 feet wide (Figure 1). The beds were listed and mulched.

Figure 1. Left- Flat Planting System. Right- Bed Planting System. (Photo: Loper)

Layflat polypipe hose 10" diameter with 2.5" gates were used to irrigate plots and the amount of water was monitored with an inline water meter. There were 5 gates for each plot. The hose was secured to a hydrant off a 6" diameter alfalfa valve. Flood irrigation was used in the flat and furrow irrigation used in the bed system. Soil water content and water use (evapotranspiration, ET) was determined using a neutron probe moisture meter, in conjunction with AZSCHED (Arizona Irrigation Scheduling System). Management allowed deficiency was chosen to be 50%, irrigation efficiency was 75%. The amount of water applied to each treatment was based on the soil moisture content. In most cases we had to irrigate the plots longer than estimated based on soil water depletion and assumed irrigation efficiency in order to provide a uniform irrigation.

During the growing season, stem nitrate levels were measured. Stem tissue samples were also collected periodically (once a month for January and February, and then every other week in March), then dried and analyzed for NO3-N content. Plots were harvested on June 4, 2012. Grain yield, grain protein content, and test weight were also determined.

Economic water use efficiency was determined by ratio of total gallons of water used and grain yield.

WUE = Total volume of water used to irrigate (gal)/Grain yield (lbs)

Fertilizer applications were determined according to soil testing and plant need and were the same for all treatments. Nitrogen use efficiency was determined by dividing grain yield by unit of N applied.

Results and Discussion

There were a total of 9 irrigations for wheat plots, and depth of each irrigation ranged from 2.4 inches to 3.8 inches (Table 2). Precipitation was very low, there were 2 rainy days, 0.3 inches in December and 0.2 inches in March. The wheat plots, both 'beds' and 'flat', had a total of 27 inches of water during the course of the study. There were 8 irrigations for barley, and depth of each irrigation ranged between 3.2 inches and 3.6 inches, for a total of 23.7 inches. We had to increase the run time of most irrigations in both treatments, for both crops in order to evenly irrigate and prevent any dry spots in the far end of the plots. While irrigating the plots we noticed that in 'Beds', both wheat and barley, water tended to move along the outside furrows first and then filled up the remainder of the plot. The middle three furrows filled up later during the irrigation. To prevent this from unevenly irrigating the field we had added couple of checks in the outside furrows, which helped to divert the water into the plot. We did not notice this in the 'flat' treatment.

Economic 'Water Use Efficiency' (WUE) was the best in barley flat at 153 gallons (data not shown) followed by barley bed at 166 gallons per pound of grain; Wheat flat at 172 gallons was better than wheat bed which needed 209 gallons to produce a pound of grain.

For the statistical analysis, we compared wheat and barley separately.

<u>Yield</u>

In wheat there was a significant difference in yield. 'Flat' had a yield of 4700 lbs/acre compared to 'bed' with yield of 4150 lbs/acre (Table 1). Barley also had a significantly higher yield in flat (4763 lbs/acre) than bed planting system (4385lbs/acre) (Table 1).

Test Weight and Protein

There were no significant differences measures between the flat versus bed planting system for both wheat and barley for test weight and protein content (Table 1).

Table 1. Wheat results for yield, protein content, and test weight.

Treatment	Grain Yield (lbs/acre)		Grain Protein (%)		Test Weight (lbs/bu)	
Wheat, Flat	4961	a	13.05	a	62.20	a
Wheat, Bed	4380	b	12.58	a	59.93	a
Barley, Flat	5028	a	13.18	a	50.90	a
Barley, Bed	4629	b	13.05	a	50.43	a

Stem Nitrate

There were also no statistically significant differences between stem nitrate levels for barley (Figure 4) despite apparent numerical differences at certain sampling dates. In wheat only one instance of statistically significant difference shows on March 1st; bed treatment had NO_3 value of 4965 and flat treatment was 3599 (Figure 4). Before and after that there were no significant differences in stem nitrate for wheat.

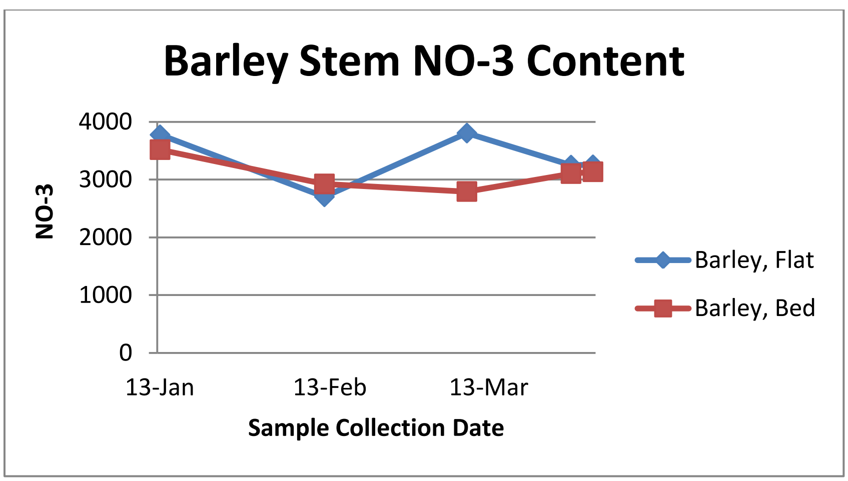

Figure 3. Stem nitrate results for barley on flat planting system versus bed

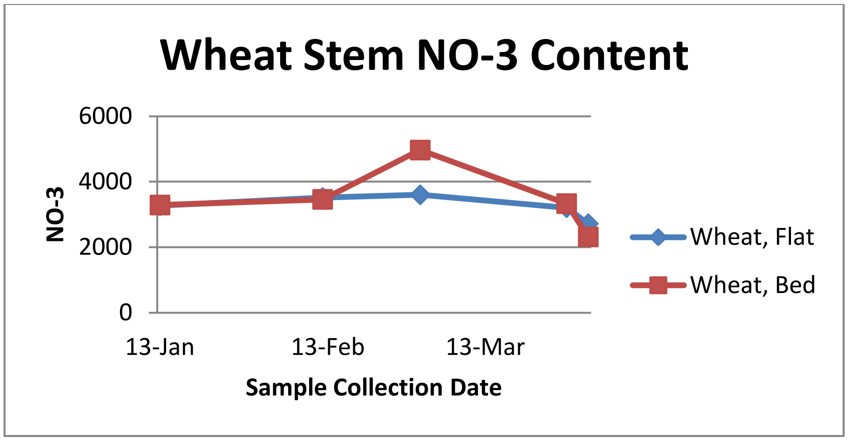

Figure 4. Stem nitrate results for wheat on flat planting system versus bed

Nitrogen Use Efficiency

Nitrogen use efficiency was determined from grain yield per unit N applied. Since our yields were higher for the flat planting system then it shows that the flat also had higher nitrogen use efficiency.

Conclusion

Based on the current results, some considerations for future work would be to look at bed spacing and skip planting in the furrows. Narrower beds could improve water use efficiency and not planting in the furrows would allow easy access which would enable post emergence N band application.

Literature Cited

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Table 2. Bed V. Flat Trial.

Investigators: Shawna Loper

Test Description

Location

County:	Maricopa
Longitude:	111963837
Latitude:	33.062827
Elevation:	1184.4 ft
Soil name:	Casa Grande sandy loam
Soil depth:	>60"

Test Design

	Barley	Wheat
Replications:	4	4
Plot length:	180 ft	180 ft
Rows per plot:	4	4
Row spacing:	40 in	40 in
Harvested rows:	2 rows 180 ft long	2 rows 180 ft long
Seed rate:	120 lbs/ac	150 lbs/ac
Alleys:	10ft	10ft

Management Practices:

	Barley	Wheat
Planting date:	29-Nov	28-Nov
Harvest date:	04-Jun	04-Jun

Production Inputs

Fertilizer:	Rate	Date
Nitrogen	170 lbs	01-Feb
Nitrogen	310 lbs	24-Feb
Nitrogen	200lbs	28-Mar
Herbicides:		
Glyphos	2.34 Gal	24-Feb
Insecticides:		
None		

Growing Conditions:

	Av Temp	Precip	Irrigation
	F	in	in
Nov (11)	57	0.55	0
Jan	52	0	3.75
Feb	55	0	8.89
Mar	60	0.25	8.9
Apr	71	0.07	5.08
May	80	0.1	6.78
Jun	90	0	
Total Precip		0.13 in	
Irrig		5.56 in	