Research Report

Can Yield of Late-planted Small Grains be Compensated by Water and Nitrogen Rates, 2016?

AZ1717 December 2016

M. J. Ottman, M.D. Sheedy, and R.W. Ward
School of Plant Sciences, U. of A., Tucson, AZ

Summary

Wheat and barley are often planted later than optimum due to the timing of the previous crop or to reduce the risk of frost damage. It may be possible to partially compensate for lower yield potential of late plantings by increasing water and nitrogen rates beyond what would have an effect at more optimal plantings. The objective of this study is to evaluate the effects of nitrogen and water rates on late planted wheat and barley. A trial testing water and nitrogen rates for small grains planted late and at the optimal time was established at the Maricopa Ag Center. The experimental design was a split-split plot with main plots as input levels of water and nitrogen (low, medium, and high), subplots as varieties (Tiburon durum and Chico barley), sub-subplots as planting dates (15 December 2015 and 1 February 2016, and 3 replications. In this study, higher levels on inputs of water and nitrogen did not increase yield at later planting dates as we hypothesized. In fact, the highest yields were obtained at medium inputs of water and nitrogen regardless of planting date. The yields of the later planting date were not depressed as we expected due to unusually mild temperatures later in the spring which favored a later planting date this season.

Introduction

Wheat and barley are often planted later than optimum due to the timing of the previous crop or to reduce the risk of frost damage. The seeding rate of late planted small grains is often increased as a way to increase the number of stems and productive spikes per acre, but this practice does not always achieve the desired effect. The problems with late planting are that the growing season is shortened, temperature may be higher than optimum, and water stress may be difficult to avoid all of which contributes to lower yield potential.

It may be possible to partially compensate for lower yield potential of late plantings by increasing water and nitrogen rates beyond what would have an effect at more optimal plantings. Early plantings have time to recover from various stresses or the stresses may not be as acute (eg. water stress), but this is not the case with late plantings. Nitrogen fertilizer rates that may be excessive at early planting dates may be necessary to increase tillering at late plantings for potential yield. More frequent irrigations may be needed at late plantings to reduce water stress and maintain rapid crop growth. The objective of this study is to evaluate the effects of nitrogen and water rates on late planted wheat and barley.

Procedure

A trial testing water and nitrogen rates for small grains planted late and at the optimal time was established at the Maricopa Ag Center. The field was fallow the previous year and the soil texture is a sandy loam. Soil chemical properties from a sample taken before planting are listed in Table 1. Mono-ammonium phosphate (11-52-0) was applied preplant at a rate of 100 lb fertilizer/acre providing 11 lb N/acre and 52 lb P_2O_5/acre. Tiburon durum and Chico barley were planted in 40 ft x 800 ft strips separated by a 6.67 ft borders in benches 1-3 of Field 30. The seed was planted with a Great Plains grain drill with 7.5 inch spacing between rows. The seeding rate was approximately 150 lb/acre for the durum and 120 lb/acre for the barley. The experimental design was a split-split plot with main plots as 3 input levels of water and nitrogen (low, medium, and high), subplots as 2 varieties (Tiburon durum and Chico barley), sub-subplots as planting dates (15 December 2015 and 1 February 2016, and 3 replications. Irrigation and fertilization dates for the Dec 7 planting date are provided in Table 2 and for the Feb 1 planting date are provided in Table 3. The following data was collected: grain yield, test weight, seed weight, plant height, lodging, heading, physiological maturity, grain protein, and HVAC. Grain was harvested with a commercial combine on June 17 and yields are expressed on an "as is" moisture basis. Test weight was calculated from the weight of 1 pint of grain. Seed weight was determined from 200 seed. HVAC was determined from 10 g of seed. Grain protein was determined from total N multiplied by 6.25 for barley and 5.7 for durum and expressed on a 12% moisture basis. Physiological maturity is defined as when the glumes turn brown.

Results and Discussion

The effects of levels of inputs of nitrogen and water on yield and other plant characteristics are presented in Tables 4 and 5. The high input level had decreased test weight and increased lodging compared to the other two input levels. No differences due to planting date were detected except for straw N which was higher at the December 15 planting date. Chico barley had higher yield and straw N and lower test weight and kernel weight compared to Tiburon durum. There was no input x planting date interaction for any of the measured variables. However, there were other interactions that were detectable for yield but not the other plant characteristics. A planting date x variety interaction occurred where Chico had higher yield at the early rather than the later planting date, but the opposite occurred with Tiburon. An input x variety interaction was detected where yields of Chico were increased at the medium and high input levels more than that of Tiburon. An input x planting date x variety interaction was found where at the low input level the yields of Chico were highest at the later planting whereas the opposite was observed with Tiburon (Fig. 1). In this study, higher levels on inputs of water and nitrogen did not increase yield at later planting dates as we hypothesized. In fact, the highest yields were obtained at medium inputs of water and nitrogen regardless of planting date. The yields of the later planting date were not depressed as we expected due to unusually mild temperatures later in the spring which favored a later planting date this season.

Acknowledgments

Financial support for this project was received from the Arizona Grain Research and Promotion Council. John Walker provided custom combining services. The technical assistance of Mary Comeau is greatly appreciated. Seed of Chico was donated by Barkley Seed, Inc.

Table 1. Soil chemical analysis preplant for a small grain planting date by input level trial at the Maricopa Ag Center, 2016.

Chemical measurement	Unit	Value	Unit	Value
Total Exchange Capacity	(meq/100 g)	22.78	---	---
pH	(pH)	8.4	---	---
Organic Matter	(%)	1.22	---	---
Estimated Nitrogen Release	(lb N/acre)	44	---	---
NO_3-N	(ppm)	50.9	---	---
NH_4-N	(ppm)	8.1	---	---
S	(mg/kg)	30	---	---
P	(mg/kg)	10	---	---
Ca	(mg/kg)	3399	(%)	74.6
Mg	(mg/kg)	246	(%)	9
K	(mg/kg)	912	(%)	10.27
Na	(mg/kg)	163	(%)	3.11
Fe	(mg/kg)	5	---	---
Mn	(mg/kg)	13	---	---
Cu	(mg/kg)	2.14	---	---
Zn	(mg/kg)	1.31	---	---

Table 2. Irrigation and fertilization schedule for the Dec 7 planting date for a small grain planting date by input level trial at the Maricopa Ag Center, 2016.

Low input			Medium input			High input		
Date	Irrigation	Fertilizer	Date	Irrigation	Fertilizer	Date	Irrigation	Fertilizer
	inches	lb N/acre		inches	lb N/acre		inches	lb N/acre
12/07	4.6	11	12/07	4.6	11	12/07	4.6	11
2/01	5.3	50	2/01	5.3	100	2/01	5.3	100
3/04	6.1	41	2/23	2.8	50	2/16	3.2	50
3/22	4.3	53	3/10	3.5	44	3/04	6.1	41
4/10	4.2		3/22	4.3	53	3/10	3.5	44
			4/04	4.1		3/22	4.3	53
			4/18	3.7		3/31	2.2	53
						4/10	4.2	
						4/18	3.7	
Sum	24.4	156		28.2	258		37.1	353

Table 3. Irrigation and fertilization schedule for the Feb 1 planting date for a small grain planting date by input level trial at the Maricopa Ag Center, 2016.

Low input			Medium input			High input		
Date	Irrigation	Fertilizer	Date	Irrigation	Fertilizer	Date	Irrigation	Fertilizer
	inches	lb N/acre		inches	lb N/acre		inches	lb N/acre
2/01	5.3	11	2/01	5.3	11	2/01	5.3	11
3/04	6.1	41	2/23	2.8	100	2/16	3.2	100
3/22	4.3	53	3/10	3.5	44	3/04	6.1	41
4/10	4.2	53	3/22	4.3	53	3/10	3.5	44
4/29	6.3		4/04	4.1	27	3/22	4.3	53
			4/18	3.7	27	3/31	2.2	53
			5/04	5.9		4/10	4.2	27
						4/18	3.7	27
						5/04	5.9	
Sum	26.2	159		29.5	261		38.4	356

Table 4. Effect of level of inputs of nitrogen and water on yield and other plant characteristics of Chico barley and Tiburon durum planted on December 15 and February 1 for a small grain planting date by input level trial at the Maricopa Ag Center, 2016.

N and water input	Planting date	Variety	Grain yield	Test weight	Kernel weight	Lodging	Plant height	HVAC	Grain protein	Straw N	Stems
			lb/acre	lb/bu	mg	%	inches	%	%	%	ft^{-2}
Low	12/15	Chico	5596	48.5	31.0	3	24	---	12.8	1.49	64.5
		Tiburon	6070	61.0	51.1	10	28	100	13.7	1.06	48.2
	2/1	Chico	6570	49.2	33.0	0	24	---	13.1	1.32	65.2
		Tiburon	5528	57.7	45.4	10	25	98	13.3	0.77	66.8
Medium	12/15	Chico	7954	49.5	35.0	17	29	---	14.6	1.36	64.4
		Tiburon	6142	59.1	50.7	17	36	100	12.7	1.00	59.7
	2/1	Chico	7252	48.7	32.4	27	26	---	11.2	1.24	54.0
		Tiburon	7502	60.0	48.1	7	34	95	12.4	1.04	50.7
High	12/15	Chico	7547	49.0	34.7	43	35	---	13.9	1.53	64.0
		Tiburon	5574	56.0	44.8	83	44	100	14.7	1.30	59.4
	2/1	Chico	6799	48.1	29.9	67	32	---	14.1	1.38	68.1
		Tiburon	6528	55.4	38.3	70	39	100	12.5	1.14	58.8
$LSD_{.05}$			637	ns	ns	ns	---	ns	ns	ns	ns
Low	12/15	Avg	5833	54.7	41.1	7	26	100	13.3	1.28	56.4
	2/1		6049	53.4	39.2	5	25	98	13.2	1.04	66.0
Medium	12/15		7048	54.3	42.9	17	33	100	13.7	1.18	62.0
	2/1		7377	54.4	40.3	17	30	95	11.8	1.14	52.4
High	12/15		6560	52.5	39.7	63	40	100	14.3	1.42	61.7
	2/1		6663	51.7	34.1	68	36	100	13.3	1.26	63.5
$LSD_{.05}$			ns	ns	ns	ns	---	ns	ns	ns	ns
Low	Avg	Chico	6083	48.8	32.0	2	24	.	13.0	1.41	64.9
		Tiburon	5799	59.3	48.2	10	27	99	13.5	0.91	57.5
Medium		Chico	7603	49.1	33.7	22	28	.	12.9	1.30	59.2
		Tiburon	6822	59.6	49.4	12	35	98	12.5	1.02	55.2
High		Chico	7173	48.5	32.3	55	34	.	14.0	1.46	66.0
		Tiburon	6051	55.7	41.5	77	42	100	13.6	1.22	59.1
$LSD_{.05}$			402	ns	ns	ns	---	---	ns	ns	ns
Avg	12/15	Chico	7032	49.0	33.6	21	29	.	13.8	1.46	64.3
		Tiburon	5929	58.7	48.9	37	36	100	13.7	1.12	55.8
	2/1	Chico	6874	48.7	31.8	31	27	.	12.8	1.31	62.4
		Tiburon	6519	57.7	43.9	29	33	98	12.7	0.98	58.8
$LSD_{.05}$			520	ns	ns	ns	---	---	ns	ns	ns

Table 4 (con'd). Effect of level of inputs of nitrogen and water on yield and other plant characteristics of Chico barley and Tiburon durum planted on December 15 and February 1 for a small grain planting date by input level trial at the Maricopa Ag Center, 2016.

N and water input	Planting date	Variety	Grain yield	Test weight	Kernel weight	Lodging	Plant height	HVAC	Grain protein	Straw N	Stems
			lb/acre	lb/bu	mg	%	inches	%	%	%	ft^{-2}
Low	Avg	Avg	5941	54.1	40.1	6	25	99	13.2	1.16	61.2
Medium			7212	54.3	41.6	17	31	98	12.7	1.16	57.2
High			6612	52.1	36.9	66	38	100	13.8	1.34	62.6
$LSD_{.05}$			ns	1.2	ns	12	---	ns	ns	ns	ns
Avg	12/15	Avg	6480	53.8	41.2	29	33	100	13.7	1.29	60.0
	2/1		6697	53.2	37.8	30	30	98	12.8	1.15	60.6
Signif.			ns	ns	ns	ns	---	ns	ns	**	ns
Avg	Avg	Chico	6953	48.8	32.7	26	28	100	13.3	1.39	63.4
		Tiburon	6224	58.2	46.4	33	34	99	13.2	1.05	57.3
Signif.			**	**	**	ns	---	ns	ns	**	ns
Avg			6589	53.5	39.5	30	31	99	13.3	1.22	60.3
CV (%)			7.7	3.0	12.8	58.0	---	3.8	12.2	10.8	21.7
Input (I)			ns	*	ns	**	---	ns	ns	ns	ns
Variety (V)			**	**	**	ns	---	---	ns	**	ns
I x V			*	ns	ns	ns	---	---	ns	ns	ns
Planting date (P)			ns	ns	ns	ns	---	ns	ns	**	ns
I x P			ns	ns	ns	ns	---	ns	ns	ns	ns
P x V			*	ns	ns	ns	---	---	ns	ns	ns
I x P x V			**	ns	ns	ns	---	---	ns	ns	ns

Table 5. Effect of level of inputs of nitrogen and water on heading, flowering, and maturity dates of Chico barley and Tiburon durum planted on December 15 and February 1 for a small grain planting date by input level trial at the Maricopa Ag Center, 2016.

N and water input	Planting date	Variety	Heading	Flowering	Maturity
Low	12/15	Chico	3/20	3/20	4/25
		Tiburon	3/18	3/25	4/28
	2/1	Chico	4/17	4/17	5/14
		Tiburon	4/04	4/10	5/14
Medium	12/15	Chico	3/20	3/20	4/28
		Tiburon	3/21	3/28	5/06
	2/1	Chico	4/14	4/14	5/16
		Tiburon	4/12	4/19	5/17
High	12/15	Chico	3/21	3/21	4/28
		Tiburon	3/25	3/28	5/06
	2/1	Chico	4/15	4/15	5/20
		Tiburon	4/12	4/19	5/20
Low	12/15	Avg	3/19	3/22	4/26
	2/1		4/10	4/13	5/14
Medium	12/15		3/20	3/24	5/02
	2/1		4/13	4/16	5/16
High	12/15		3/23	3/24	5/02
	2/1		4/13	4/17	5/20
Low	Avg	Chico	4/03	4/03	5/04
		Tiburon	3/26	4/02	5/06
Medium		Chico	4/01	4/01	5/07
		Tiburon	4/01	4/08	5/11
High		Chico	4/02	4/02	5/09
		Tiburon	4/03	4/08	5/13
Low	Avg	Avg	3/30	4/02	5/05
Medium			4/01	4/04	5/09
High			4/02	4/05	5/11
Avg	12/15	Avg	3/20	3/23	4/30
	2/1		4/12	4/15	5/16
Avg	Avg	Chico	4/02	4/02	5/06
		Tiburon	3/30	4/06	5/10
Avg	Avg	Avg	4/01	4/04	5/08

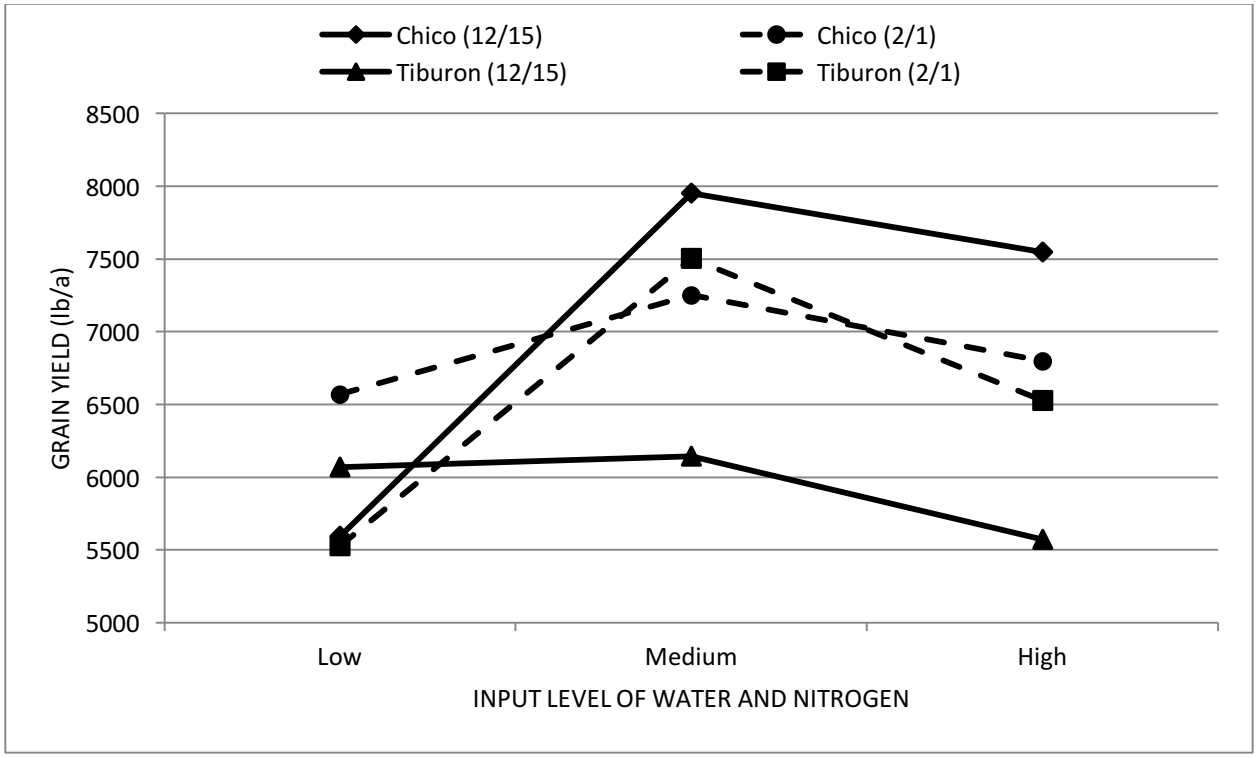

Fig. 1. Effect of level of inputs of nitrogen and water on grain yields of Chico barley and Tiburon durum planted on December 15 and February 1 for a small grain planting date by input level trial at the Maricopa Ag Center, 2016