RESPONSE OF WHEAT TO WATER AND NITROGEN

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INTRODUCTION

A project was initiated in November 1979 at the Yuma Mesa Agricultural Center to evaluate water and nutrient conservation using sprinkler irrigation on various agronomic and horticultural crops. A self-moving lateral sprinkler system was installed and modified to conduct irrigation and nitrogen management research studies. The system was modified to apply nine different water and nitrogen combinations and designed to determine statistically the crop response function (yield) to these variables.

The present study was conducted to evaluate the response of 13 wheat varieties to these nine combinations of water and nitrogen and to compare the performance of the varieties at the optimal treatment. Yield, protein content, percent hard and vitreous kernels, bushel weight, plant height and lodging were measured for each variety under all nine treatments.(1)

METHOD

The sprinkler system was designed to apply the nine different amounts of water and nitrogen specified by the statistical design. This is accomplished by using nozzles of different orifice sizes. The amount of water applied during each irrigation is determined by the speed of the system, and nitrogen applicators are adjusted by using different size metering orifices.

A central composite rotatable statistical design with two variables, water and nitrogen, was used to determine the crop response function for these two variables. Five water levels; 27, 34, 49, 69 and 77 inches, and five nitrogen levels; 78, 125, 235, 345 and 390 pounds were used and resulted in the application of nine different combinations of water and nitrogen.(1) The center treatment of 49 inches of water and 235 pounds of nitrogen was replicated five times. Each of the 13 plots was 30 feet in length and 5 feet wide. The plots were randomized down the crop row. The center 4 feet of each plot was harvested with a Hege small plot combine.

(1)See Forage and Grain, A College of Agriculture Report, P-54, September 1981, P-47-51.

RESULTS

Yields varied from 1.5 tons per acre to 4.5 and reflected the interaction between water and nitrogen. Yields were significantly lower with all varieties at the low nitrogen level of 78 pounds. Yields responded to nitrogen at the 125 pound level although yields increased only to the 34 inches of water level then began to drop with most varieties, reflecting the leaching of nitrates. Yields were again significantly increased with 235 pounds of nitrogen but only to the 49 inches of water level, where they either stayed the same or dropped. Two hundred thirty-five pounds of nitrogen appeared to be the optimum level as most varieties yielded no better with 345 or 390 pounds N at the 49 inches of water level.

The percent of hard and vitreous kernels was low with 78 pounds of nitrogen with all varieties. Percentages were also consistently low at the 125 pound N level only with 69 inches of water. Two hundred thirty-five pounds of nitrogen was still insufficient to offset the leaching of nitrates at the high water treatment of 77 inches. Three hundred forty-five pounds of nitrogen was sufficient, however, to offset nitrate leaching at the 69-inch level.

Protein levels correlated directly with the percentage of hard and vitreous kernels reflecting the same patterns of nitrogen availability. Bushel weight and lodging were not significantly affected by water and nitrogen levels in this test.

Plant height was significantly affected by water and nitrogen levels in five of the 13 varieties. Height was significantly lower in all cases under the low nitrogen level.

At the 49-inch water/235-pound nitrogen treatment, varieties were significantly different. Red varieties differed in yield, protein, hard and vitreous kernels, bushel weight and height. Durum varieties differed in yield, height and bushel weight.

Glennson, Yecora Rojo, WPB 911 and Probred significantly outyielded Super X, Nk 771 and Oslo. Aldura, Yavaros and 1000D outyielded Mexicali and WPB 881.

Yecora Rojo and Super X were significantly higher in protein than all other red wheats and Oslo and WPB 911 were significantly lower than Glennson in percentage of hard and vitreous kernels.

Glennson, Yecora Rojo and Super X were significantly higher in bushel weight than the other red wheats while 1000D was lowest among the durums.

Oslo, Super X and Glennson were significantly taller than the other reds and Mexicali was the tallest among the durums. Aldura was significantly the shortest.

All variety comparisons were made at the 49-inch water/235-pound nitrogen treatment. This treatment was the only one of the nine treatments that was replicated five times. Variety comparisons at all other treatments would be invalid due to the lack of replication or statistical significance.

MEXICALI

	Inches Water	Pound Nitrogen	Ht (in)	Lodging %	Yield (T/Acre)	Protein %	% Hard Vitreous	Bu Wt (lbs)
1	27	235	37	0 a	2.5 ab2	13.6 b	100 a	62.0
2	34	125	38	0 a	3.0 c	9.2 a	94 ab	62.5
3	34	345	39	0 a	3.3 c	13.5 b	99 ab	63.5
4	49	78	34	0 a	2.1 a	8.1 a	0 d	59.0
5	49	235	39	.6a	3.8 d	13.1 b	95 ab	62.2
6	49	390	39	0 a	2.9 bc	13.4 b	99 ab	62.5
7	69	125	38	0 a	3.3 c	8.9 a	13 c	61.5
8	69	345	40	50b	3.0 c	13.5 b	93 b	61.5
9	77	235	39	0 a	3.2 c	13.4 b	0 d	60.5
$S_{\bar{x}}$			N.S.	.632	.118	.357	1.58	N.S.

GEM

1	27	235	32	0	3.1 ab	13.8	99	62.5
2	34	125	33	0	3.4 ab	13.3	100	63.5
3	34	345	31	10	3.4 ab	13.1	100	62.5
4	49	78	34	0	2.9 a	8.3	5	60.5
5	49	235	33	6	4.2 c	12.3	83	63.2
6	49	390	35	0	3.6 bc	12.8	99	65.0
7	69	125	32	0	3.7 bc	9.2	5	62.0
8	69	345	34	0	4.1 c	12.8	100	64.0
9	77	235	31	0	3.3 ab	8.8	10	62.0
$S_{\bar{x}}$			N.S.	N.S.	.147	N.S.	N.S.	N.S.

WPB 881

1	27	235	33	0	3.0 ab	13.8 b	100 a	63.0
2	34	125	32	0	3.0 ab	15.3 b	100 a	59.0
3	34	345	34	0	3.5 bc	15.1 b	100 a	62.0
4	49	78	32	0	2.7 a	8.9 a	15 b	60.0
5	49	235	35	0	4.1 cd	13.3 b	93 a	62.0
6	49	390	37	0	3.9 cd	14.2 b	100 a	61.0
7	69	125	32	0	3.6 bc	9.4 a	30 b	61.5
8	69	345	35	0	4.3 d	13.9 b	100 a	62.5
9	77	235	34	0	3.6 bc	8.8 a	10 b	61.0
$S_{\bar{x}}$			N.S.	N.S.	.161	.78	6.89	N.S.

ALDURA

1	27	235	30	0	3.7 ab	13.3	100 a	65.5
2	34	125	31	0	4.3 c	13.2	100 a	64.0
3	34	345	28	0	4.1 bc	13.8	100 a	64.5
4	49	78	28	0	3.4 a	8.6	10 b	62.5
5	49	235	29	2	4.5 c	12.4	87 a	64.6
6	49	390	32	0	4.5 c	13.3	99 a	64.0
7	69	125	28	0	3.8 ab	9.1	10 b	64.5
8	69	345	30	0	4.1 bc	13.1	100 a	64.0
9	77	235	28	0	3.8 ab	8.8	15 b	63.0
$S_{\bar{x}}$			N.S.	N.S.	.112	N.S.	12.1	N.S.

2 Means followed by the same letter are not significantly different at the 5% level, by Duncans Multiple Range Test.

NK 771

	Inches Water	Pound Nitrogen	Ht (in)	Lodging %	Yield (T/Acre)	Protein %	Vitreous %	Bu Wt (lbs)
1	27	235	26	0	3.3 c	11.1	100 a	56.0
2	34	125	25	0	2.5 b	9.4	60 cb	57.0
3	34	345	26	0	3.1 bc	14.9	100 a	56.0
4	49	78	20	0	1.5 a	8.6	20 c	56.0
5	49	235	28	14	3.3 c	11.7	91 ab	56.4
6	49	390	29	0	3.8 c	12.4	100 a	58.0
7	69	125	24	0	2.5 b	9.2	25 c	58.0
8	69	345	29	0	3.4 c	10.3	70 ab	58.0
9	77	235	27	0	3.4 c	12.4	95 ab	56.0
$S_{\bar{x}}$			N.S.	N.S.	.176	N.S.	8.80	N.S.

YECORA ROJO

1	27	235	29 d	0	2.7 b	12.9	100 a	63.5
2	34	125	23 b	0	3.1 bc	11.7	55 b	60.0
3	34	345	25 bc	0	3.6 cd	15.0	100 a	59.0
4	49	78	17 a	0	1.5 a	9.0	45 b	58.0
5	49	235	27 cd	5	3.8 d	12.7	93 a	63.3
6	49	390	28 cd	0	4.0 d	12.3	100 a	65.0
7	69	125	24 b	0	2.8 bc	9.5	55 b	64.0
8	69	345	28 cd	0	3.4 cd	11.4	100 a	64.5
9	77	235	28 cd	0	4.0 d	12.4	100 a	64.0
$S_{\bar{x}}$			0.775	N.S.	.163	N.S.	6.89	N.S.

SUPER X

1	27	235	34 b	0	2.3 b	12.9 d	96 a	64.0
2	34	125	35 bc	0	3.1 c	9.9 c	33 b	63.5
3	34	345	35 bc	1	3.2 cd	12.8 d	100 a	62.5
4	49	78	27 a	0	1.6 a	7.9 a	0 c	62.0
5	49	235	38 c	32	3.5 d	13.8 e	95 a	61.9
6	49	390	38 c	40	3.5 d	13.8 e	97 a	62.5
7	69	125	34 b	0	2.5 b	8.3 b	0 c	62.0
8	69	345	36 bc	0	3.5 d	13.9 e	100 a	62.0
9	77	235	38 c	0	3.1 c	13.8 e	23 b	63.0
$S_{\bar{x}}$			.922	N.S.	.087	.092	1.77	N.S.

WPB 911

1	27	235	25 b	0	3.2 b	12.1	65	61.0
2	34	125	25 b	0	3.6 bc	8.8	35	60.0
3	34	345	28 c	0	3.6 bc	14.1	95	59.0
4	49	78	17 a	0	1.5 a	8.2	5	58.0
5	49	235	28 c	12	3.9 c	11.5	72	57.7
6	49	390	29 c	0	4.1 c	12.4	95	59.0
7	69	125	27 bc	0	3.2 b	7.9	15	60.0
8	69	345	37 d	0	3.4 bc	11.4	10	59.0
9	77	235	27 bc	0	3.60 bc	9.0	20	60.0
$S_{\bar{x}}$			.05	N.S.	.153	N.S.	N.S.	N.S.

OSLO

	Inches Water	Pound Nitrogen	Ht (in)	Lodging %	Yield (T/Acre)	Protein %	% Hards Vitreous	Bu Wt (lbs)
1	27	235	34 cd	0	3.1 b	12.3	100	58.0
2	34	125	32 c	0	3.1 b	9.8	5	59.0
3	34	345	35 cd	0	2.2 a	15.2	75	56.5
4	49	78	22 a	0	1.6 a	8.6	0	55.5
5	49	235	36 cd	8	3.4 b	12.1	74	58.1
6	49	390	37 d	0	3.6 b	13.0	100	59.0
7	69	125	32 c	0	2.2 a	8.3	0	59.0
8	69	345	27 b	0	3.1 b	9.7	50	59.0
9	77	235	34 cd	0	3.0 b	9.7	35	59.0
$S_{\bar{X}}$			1.05	N.S.	.180	N.S.	N.S.	N.S.

GLENNSON

1	27	235	33 b	0	3.0 b	12.3	100 a	63.0
2	34	125	33 b	0	3.3 bc	9.4	80 b	62.5
3	34	345	37 d	0	4.0 d	14.3	100 a	63.0
4	49	78	23 a	0	1.5 a	10.5	100 a	64.0
5	49	235	36 cd	18	3.8 cd	11.4	97 a	62.1
6	49	390	38 d	0	3.9 d	12.0	100 a	62.0
7	69	125	35 c	0	2.9 b	8.9	75 b	63.0
8	69	345	24 a	0	3.3 bc	8.6	100 a	63.5
9	77	235	37 d	0	4.0 d	14.5	100 a	63.0
$S_{\bar{X}}$			.387	N.S.	.136	N.S.	1.83	N.S.

PROBRED

1	27	235	28	0	3.2 b	11.7	100 a	59.0
2	34	125	25	0	3.2 b	9.5	85 a	64.0
3	34	345	24	0	3.8 c	14.6	100 a	62.0
4	49	78	20	0	1.5 a	8.7	30 b	63.5
5	49	235	27	18	3.9 c	11.7	93 a	58.6
6	49	390	29	0	4.0 c	13.6	100 a	59.0
7	69	125	25	0	3.0 b	9.8	50 b	58.5
8	69	345	27	0	3.8 c	11.3	100 a	59.0
9	77	235	27	0	3.9 c	12.4	100 a	59.0
$S_{\bar{X}}$			N.S.	N.S.	.136	N.S	6.89	N.S.

YAVAROS

1	27	235	33	0	3.1 a	13.3 bc	100 a	63.5
2	34	125	35	0	3.8 bc	13.2 bc	100 a	64.0
3	34	345	30	0	3.5 ab	13.8 c	100 a	63.0
4	49	78	33	0	3.2 a	9.0 a	25 b	63.0
5	49	235	32	4	4.3 d	12.3 b	92 a	63.6
6	49	390	31	0	4.3 cd	12.4 b	100 a	64.0
7	69	125	31	0	3.5 ab	9.0 a	15 b	64.0
8	69	345	34	0	3.9 bcd	13.3 bc	99 a	64.0
9	77	235	32	0	4.1 cd	9.6 a	35 b	64.0
$S_{\bar{X}}$			N.S.	N.S	.126	.326	5.55	N.S.

WPB 1000D

	Inches Water	Pound Nitrogen	Ht (in)	Lodging %	Yield (T/Acre)	Protein %	% Hard Vitreous	Bu Wt (lbs)
1	27	235	34	0	3.4 b	14.4	100	57.0
2	34	125	36	0	3.6 bc	14.3	100	56.0
3	34	345	35	0	4.0 cd	14.3	100	57.0
4	49	78	33	0	2.5 a	8.6	5	57.5
5	49	235	36	0	4.3 d	12.9	76	57.7
6	49	390	38	0	4.3 d	13.5	80	57.0
7	69	125	34	0	3.8 bcd	9.0	0	56.0
8	69	345	37	0	3.5 bc	14.4	95	56.0
9	77	235	36	0	3.4 b	10.3	15	58.0
$S_{\bar{x}}$			N.S.	N.S.	.147	N.S.	N.S.	N.S.

RED WHEAT VARIETY PERFORMANCE UNDER THE 49 IN. WATER/ 235 LB. NITROGEN TREATMENT

Glennson	36 b	18	3.8 b	11.4 a	98 b	62.1 c
Yecora Rojo	27 a	5	3.9 b	12.7 ab	93 ab	63.3 c
WPB 911	28 a	12	4.0 b	11.5 a	72 a	57.7 ab
Probred	27 a	18	4.0 b	11.7 a	93 ab	58.6 b
Super X	38 b	32	3.5 a	13.9 b	95 ab	61.9 c
NK 771	28 a	14	3.4 a	11.7 a	91 ab	56.4 a
Oslo	36 b	8	3.4 a	12.1 a	74 a	58.1 b
$S_{\bar{x}}$	0.638	N.S	.10	0.497	7.02	0.492

DURUM WHEAT VARIETY PERFORMANCE UNDER THE 49 IN. WATER/235 LB. NITROGEN TREATMENT

1000 D	36 c	0	4.4 cd	12.9	76	57.7 a
WPB 881	35 cd	0	4.1 ab	13.4	93	62.0 b
Mexicali	39.6 e	0	3.9 a	13.1	95	62.2 bc
Gem	33.4 bc	6	4.2 bc	12.4	83	63.2 cd
Aldura	29.8 a	2	4.5 d	12.4	87	64.6 e
Yavaros	32.6 b	4	4.4 cd	12.4	92	63.6 de
$S_{\bar{x}}$	0.572	N.S	0.087	N.S.	N.S.	0.346