Evaluation of Plant Growth Regulators on Wheat in Arizona, 1987

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ABSTRACT

Plant growth regulators are applied to small grains to decrease lodging, which can adversely affect crop growth and yield. Wheat is intensively managed in Arizona, and lodging can be a problem. Chlormequat and ethephon were applied at various rates and times in six studies in 1987 to evaluate their use on Arizona's semi-dwarf cultivars with respect to lodging, plant height, yield components and grain yield. The results indicated that growth regulators applied at the recommended rates and times may decrease plant height and decrease kernel weight. However, the influence of growth regulator treatments on tiller number, head number, kernel number, and grain yield was not demonstrated. The ambiguous results obtained suggest our efforts need to be directed toward documenting the extent of lodging in the state, studying the effects of lodging and predicting when lodging will occur.

INTRODUCTION

Plant growth regulators are used on crops for a variety of reasons. Ethylene-generation compounds are applied on tomatoes to facilitate ripening and on cotton to terminate growth. Plant growth regulators are applied to wheat to decrease lodging.

Wheat is grown primarily as a rotational crop with cotton and vegetables in Arizona. Most of the wheat in Arizona is produced in the low desert valleys in the central and southwestern portions of the state. Wheat is intensively managed, with 5 to 6 irrigations for a total of 25 to 35 inches of water, and nitrogen applications ranging from 150 to 300 lbs. N/A. Isolation from other production areas and low humidity result in relative freedom from insects and diseases.

Both hard red spring wheat and durum are grown in Arizona as winter annuals. Semi-dwarf cultivars were introduced in 1966 and resulted in tremendous increases in productivity. The state's average wheat yield is more than 90 bushels/A, the highest in the nation.

Lodging can occur in wheat throughout Arizona, but it can be particularly severe in the southwest where vegetable production is intensively practiced. The principal causes of lodging in Arizona have not been identified. An interaction of factors appears to contribute to lodging; predicting when lodging will occur is difficult. Factors which may contribute to lodging include: (1) cultivar characteristics; (2) nitrogen and water management; (3) plant population; (4) date of planting; (5) weed infestation; (6) diseases; (7) climatic conditioning; (8) wind; (9) time of irrigation; and (10) residual soil nitrogen.

Lodging can adversely affect crop growth and yield. Lodged plants may shade other plants and decrease photosynthesis. Transfer of sugars and other compounds may be restricted when the plant stems break. Due to its weakened condition, the lodged plant is more susceptible to disease and insect damage. The influence on crop yield depends on the severity of lodging, and when it occurs. Grain from lodged plants may have a lower test weight or lower kernel weight. Harvesting is more time-consuming and may be more costly for the producer. Despite the reports on the negative aspects of lodging, the loss in yield or income in Arizona has not been documented.

Ethephon (cerane) is currently registered in Arizona to reduce lodging in small grains. Ethephon acts by releasing ethylene in plant cells. Ethylene is a natural plant hormone known to inhibit growth. Ethylene may also increase the activity of enzymes that produce lignin and increase stem strength. Chlormequat (Cycocel, CCC) is commonly used to reduce lodging of small grains in Europe. Chlormequat inhibits growth of subapical meristems and may act against gibberellin, a natural plant hormone. Ethephon and chlormequat have been evaluated extensively in Europe. The purpose of the present study is to evaluate the use of these compounds on semi-dwarf cultivars grown in Arizona in terms of lodging, plant height, yield components, and grain yield.

MATERIALS AND METHODS

This study consisted of six tests designed to measure the effect of various rates and times of application of two plant growth regulators, ethephon and chlormequat, on wheat grown in Arizona. Tests 1 an 2 were conducted at Barkley Company Farms in the Yuma Valley; Test 3 was conducted at the University of Arizona Yuma Valley Agriculture Center; Tests 4 and 5 were conducted at the University of Arizona Maricopa Agriculture Center and Test 6 was conducted at Stuhr Farms in Roll, Arizona.

Crop History: Test 1

Location:	Barkley Company Farms, Yuma Valley, Arizona
Elevation:	120 ft.
Soil Type:	Clay Loam, <1% organic matter
Irrigation:	Total of 30 inches of Colorado River water was applied by flood irrigation in level basins in 6 irrigations of 5 inches per irrigation. Crop was planted dry and irrigated up.
Fertilizer:	290 lbs. of Nitrogen applied; 100 lbs. applied preplant; the rest applied in the irrigation water; 87 lbs. of P2O5 applied preplant.
Variety:	Yecora rojo
Seeding Rate:	140 lbs/A
Previous Crop:	Cotton
Planted:	December 26, 1986 - flat with a 12 ft grain drill
Herbicide:	2 pts of Buctril at tillering
Insecticide:	None
Plot Size:	30' x 20' (randomized complete block- 4 reps).
Treated:	F7 treatments on 02/12/87 F9 treatments on 02/27/87
Evaluated:	05/14/87
Harvested:	05/15/87 by hand with 1/10,000 acre grid. Threshed with Vogalthrasher
Application:	All treatments applied in 30 gpa spray volume with a Hudson compressed air backpack sprayer with a 5 foot boom an 8003 flat fan nozzles; 40 psi, 3 mph.

Crop History: Test 2

Location:	Barkley Company Farms, Yuma Valley, Arizona
Elevation:	120 ft
Soil Type:	Clay Loam <1% organic matter
Irrigation:	A total of 25 inches of Colorado River water applied in 5 irrigations of 5 inches per irrigation. Crop was planted dry and irrigated up.
Fertilizer:	290 lbs of Nitrogen applied; 100 lbs applied preplant; 87 lbs of P_2O_5 applied preplant; the remainder applied in the irrigation water.
Variety:	Yecora rojo
Previous Crop:	Cotton
Planted:	12/24/86 on 40" beds with a 12' grain drill
Herbicide:	2 pts of Buctril
Insecticide:	None
	Plot Size: 20 ft x 20 ft (randomized complete block - 4 reps).
Treated:	F5 treatments on 02/02/87
	F9 treatments on 02/27/87
Evaluated:	05/14/87
Harvested:	05/15/87 by hand with a 1/10,000 acre grid. Threshed with a Vogal thresher.
Application:	All treatments applied in 30 gpa spray volume with a Hudson compressed air backpack sprayer with a 5 foot boom and 8003 flat fan nozzles; 40 psi, 3 mph.

Crop History: Test 3

Location:	University of Arizona Yuma Valley Agriculture Center
Soil Type:	Silty clay Loam, <1% organic matter.
Irrigation:	25 inches of Colorado River water applied in 5 irrigations by flood irrigation in level basin in 5 irrigations of 5 inches per irrigation. Crop was planted dry and irrigated up.
Fertilizer:	A total of 225 lbs of Nitrogen were applied. 75 lbs applied preplant; 150 lbs in the irrigation water in 3 irrigations.
Variety:	Mexicali (durum)
Seeding Rate:	150 lbs/A
Previous Crop:	Wheat
Planted:	11/25/86 - flat with a 10 ft grain drill
Herbicide:	2 applications of Hoelon - total of 2.25 lbs + Bromoxinil
Insecticide:	None
Plot Size:	10 ft x 25 ft (randomized complete block - 4 reps).
Treated:	F5 treatments on 01/29/87
	F9 treatments on 02/09/87
Evaluated:	
Harvested:	05/19/87 with a 1/10,000 acre grid. Threshed with a Vogal thresher.
Application:	All treatments applied in 30 gpa spray volume with a compressed air Hudson backpack sprayer; 5 ft boom, 8003 tee jet nozzles.

Crop History: Test 4

Location:	University of Arizona Maricopa Agriculture Center, Maricopa, Arizona.
Soil Type:	Trix Clay Loam
Irrigation:	36 inches applied in 6 irrigations, rainfall of 2.85 inches in 9 rainstorms.
Fertilizer:	300 lbs of Nitrogen applied; 100 lbs preplant; 100 lbs in the first irrigation and 100 lbs in the 2nd irrigation.
Variety:	Yecora Rojo and WestBred 906R
Seeding Rate:	200 lbs/A
Previous Crop:	Sudan grass
Planted:	12/01/86
Herbicide:	None
Insecticide:	None
Plot Size:	10' x 12' (split plot - variety main plot - 4 reps).
Treated:	F5 treatments on 02/06/87 F9 (Yecora rojo) on 03/06/87 F9 (906R) on 03/09/87
Harvested:	06/04/87 small plot combine - plot size 4.5'x 10'.
Application:	All treatments applied in 30 gpa spray volume with a compressed air Hudson backpack sprayer. 5 ft boom; 8003 tee jet nozzles.

Crop History: Test 5

Location:	University of Arizona Maricopa Agriculture Center, Maricopa, Arizona.
Soil Type:	Trix Clay Loam
Irrigation:	36 inches applied in 6 irrigations, rainfall of 2.85 inches in 9 rainstorms.
Fertilizer:	400 lbs of Nitrogen applied; 100 lbs preplant, 200 lbs in the first irrigation, 100 lbs in the 2nd irrigation.
Variety:	Mexicali (durum)
Seeding Rate:	160 lbs/A
Previous Crop:	Fallow
Planted:	01/16/87
Herbicide:	None
Insecticide:	None
Plot Size:	15' x 18' (randomized complete block - 4 reps)
Treated:	F5 treatments 03/06/87 F7 treatments 03/16/87 F9 treatments 03/30/87
Harvested:	6/09/87 with small plot combine - plot size 4.5' x 15'.

Crop History: Test 6

Location:	Stuhr Farms, Roll, Arizona

RESULTS AND DISCUSSION

Test 1

The growth regulator treatments affected plant height, tiller number, kernel weight, and grain yield (Table 1). We were not able to measure any differences in head number or kernel number. Lodging did not occur in this study. Plant height was reduced compared to the control with chlormequat applied at 0.53 and 4.0 lb/A at Feekes 9 and with ethephon applied at 1.0 lb/A at Feekes 9. Differences in tiller number were not detected between the untreated and treated plots, but some differences were detected among various growth regulator treatments. In particular, chlormequat applied at 0.53 lbs/A at Feekes 9 and ethephon applied at 0.17 or 0.27 lb/A at Feekes 9 had lower tiller number than the following: 1) chlormequat applied at 0.33 lb/A at Feekes 9 or at 4.0 lb/A at Feekes 7; 2) ethephon applied at 1.0 lb/A at Feekes 7; and 3) ethephen and chlormequat applied at 0.17 and 0.33 lb/A at Feekes 7 or Feekes 9. Kernel weight was reduced by some growth regulator treatments, particularly chlormequat applied at 4.0 lb/A at Feekes 7 and ethephon applied at 1.0 lb/A at Feekes 7 or Feekes 9. Grain yield was reduced by an application of ethephon at 1.0 lb/A at Feekes 7 or Feekes 9.

Test 2

We were unable to measure any differences in tiller number, head number, kernel number, or grain yield due to the growth regulator treatments (Table 2). Lodging did not occur in this study. Plant height was reduced with ethephon applied at 0.38 and 0.76 lb/A at Feekes 9. Kernel weight of the treated plots did not differ from the control, but kernel weight with chlormequat applied at 1.2 lb/A at Feekes 5 was greater than chlormequat applied at 0.9 lb/A at Feekes 5 and ethephon and chlormequat applied at 0.38 and 0.76 lb/A at Feekes 9.

Test 3

We were not able to detect any differences in plant height, tiller number, head number, kernel number, kernel weight, or grain yield (Table 3). Lodging did not occur in this study. Conditions in this test may not be representative of most commercial farms, since the yield was approximately half the county average.

Test 4

Lodging and grain yield were not influenced by the growth regulator treatments (Table 4). However, plant height of the cultivar Yecora Rojo was decreased by an application of ethephon and chlormequat at 0.38 and 0.76 lb/A at Feekes 9.

Test 5

No differences in grain yield were detected (Table 5), but plant height was decreased by ethephon applied at 0.5 lb/A at Feekes 9 and by ethephon and chlormequat applied at 0.38 an 0.76 lb/A at Feekes 5, 7, or 9. Lodging did not occur in this study, due partially to the late planting date. Conditions in this test are not representative of most commercial farms since the yield was approximately one-third of the county average. The plants appeared to have suffered from water stress.

Test 6

Growth regulators were applied to ten wheat and durum cultivars; no differences in grain yields were detected. No cultivar x growth regulator interaction was measured indicating an absence of varietal difference in response to growth regulator treatment.

Instead of providing definitive answers, the six tests summarized in this report raise additional questions about use of growth regulators in wheat. These tests have indicated that growth regulators applied at the recommended rates and times may decrease plant height and decrease kernel weight. However, the influence of growth regulator treatments on lodging, tiller number, head number, kernel number, and grain yield was not demonstrated. Lodging occurred in only one of the six studies which complicates interpretation of these results.

Rather than studying the efficacy of plant growth regulators on wheat, perhaps we need to document the extent of lodging in the state and the damage it may cause under commercial conditions. Furthermore, we need to be able to predict when lodging will occur. Information concerning lodging and the use of plant growth regulators in wheat is required in order to recommend to growers under which conditions application of growth regulators may be beneficial.

Table 1. Results of Test 1

Growth Regulator	Rate	Growth Stage	Plant Height	Tiller Number	Head Number	Kernel Number	Kernel Weight	Grain Yield
	lb/A	Feekes	Inches	No/Plant	No/ft^2	Mo/head	lb/10,000	lb/A
Untreated	-	-	33.9	4.5	40.5	32.7	1.06	6050
Chlormequat	.33	7	33.0	4.5	44.2	29.5	0.99	5580
		9	33.9	5.0	43.2	30.4	0.98	5560
	.53	7	31.6	4.0	48.5	30.5	1.01	6470
		9	28.6	3.5	50.0	31.2	0.99	6580
	4.0	7	30.0	5.0	52.0	36.4	0.95	7000
		9	28.0	4.8	45.8	28.1	0.98	5270
Ethephon	.17	7	33.1	4.2	41.2	32.7	1.01	5740
		9	32.0	3.8	42.5	36.2	1.05	6940
	.27	7	30.5	4.5	44.2	32.4	1.03	6270
		9	30.0	3.5	46.8	36.6	0.99	6720
	1.0	7	30.8	5.2	50.0	21.7	0.94	4850
		9	24.0	4.0	49.2	25.6	0.90	4860
Ethephon & Chlormequat	.17 + .33	7	34.5	5.2	39.2	29.4	1.04	5200
		9	31.8	5.0	46.5	28.6	1.01	5710
	.27 + .53	7	32.8	4.9	44.5	29.6	1.09	6100
		9	30.4	4.2	47.0	32.1	1.02	6530
FLSD .05			4.22	1.09	NS	NS	0.059	1249

Table 2. Results of Test 2.

Growth Regulator	Rate	Growth Stage	Plant Height	Tiller Number	Head Number	Kernel Number	Kernel Weight	Grain
	lb/A	Feekes	Inches	No/plant	No/ft^2	Mo/head	lb/10,000	lb/A
Untreated	-	-	26.0	4.2	47.2	25.5	0.98	5010
Chlormequat	0.6	5	27.0	4.2	46.0	31.3	1.00	6116
	0.9	5	27.2	4.2	49.5	29.5	0.94	6425
	1.2	5	26.8	4.0	48.0	24.2	1.02	4950
Ethephon	0.38	9	24.2	4.0	47.0	27.3	0.96	5290
Ethephon & Chlormequat	0.38 + 0.76	9	23.0	4.2	48.8	29.1	0.95	5830
FLSD .05			1.59	NS	NS	NS	0.065	NS

Table 3. Results of Test 3.

Growth Regulators	Rate	Growth Stage	Plant Height	Tiller Number	Head Number	Kernel Number	Kernel Weight	Grain Yield
	lb/A	Feekes	Inches	No/plant	No/ft^2	No/head	lb/10,000	lb/A
Untreated	-	-	36.0	3.2	35.0	18.1	1.16	3090
Chlormequat	0.6	5	35.8	3.2	34.8	20.9	1.16	3600
	0.9	5	35.2	3.5	33.8	18.1	1.15	2920
	1.2	5	34.5	3.0	33.0	19.1	1.13	3050
Ethephon	0.38	9	32.8	3.5	32.8	18.2	1.11	2920
Ethephon & Chlormequat	0.38 + 0.76	9	33.8	3.2	31.8	21.9	1.07	3170
FLSD .05			NS	NS	NS	NS	NS	NS

Table 4. Results of Test 4.

Cultivar	Growth Regulator	Rate	Growth Stage	Lodging	Plant Height	Grain Yield
		lb/A	Feekes	%	Inches	lb/A
Yecora Rojo	Untreated	-	-	20	29.8	5700
	Chlormequat	0.6	5	18	29.2	6010
	Chlormequat	1.2	5	10	29.5	5810
	Ethephon	0.38	9	6	28.8	5970
	Ethephon & Chlormequat	0.38 + 0.76	9	5	26.8	5700
Westbred 906R	Untreated	-	-	38	33.8	5700
	Chlormequat	0.6	5	38	33.3	6010
	Chlormequat	1.2	5	35	32.5	5540
	Ethephon	0.38	9	11	32.2	5720
	Ethephon & Chlormequat	0.38 + 0.76	9	38	32.2	6000
FLSD .05				NS	1.74	NS

Table 5. Results of Test 5.

Growth Regulator	Rate	Growth Stage	Plant Height	Grain Yield
	lb/A	Feekes	Inches	lb/A
Untreated	-	-	31.0	1900
Chlormequat	0.6	5	28.8	1900
		7	29.5	1800
		9	29.5	2110
	1.2	5	30.5	2090
		7	29.8	1970
		9	29.5	2300
Ethephon	0.38	5	31.0	1630
		7	29.2	1650
		9	27.0	2050
	0.50	5	30.5	1760
		7	29.0	2300
		9	25.2	1960
Ethephon & Chlormequat	0.38 + 0.76	5	28.0	1150
		7	27.8	2010
		9	26.2	2340
FLSD .05			2.44	NS

Table 6. Results of Test 6.

Growth Regulator	Rate	Growth Stage	Wheat Cultivars					Durum Cultivars					
			Probrand 775	Probred	Westbred 811	Yecoro Rojo	Topaz	Gem	Westbred 881	Aldura	Yavaros	Turbo	All
	lb/A	Feekes	Grain yield, lb/A										
Untreated	-		5990	5450	5060	5500	6260	5830	5230	5610	4570	6040	5550
Chlormequat	0.9	5	5880	5560	5230	5550	6210	5720	5120	5720	4680	5770	5540
	1.2	5	6040	5860	5520	5660	5170	5770	5390	5770	5170	5660	5600
Ethephon	1.0	9	5990	5390	4950	5120	5990	5660	5390	5170	4790	5880	5430
FLSD .05			NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS