EFFECTS OF THREE GROWTH REGULATORS ON SELECTED CHARACTERS IN COTTON

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ABSTRACT

A series of three 2-year experiments were conducted in cotton (Gossypium hirsutum L.) under irrigated and dryland conditions to study the effects of foliar applications of the growth regulators RH-531 and ethrel, ethrel alone, and O.C.B., respectively, with several seed treatments in the latter experiment. The first 2-year experiments included three concentrations of ethrel as a foliar application and four of RH-531 on 'Westburn' cotton. The second 2-year experiments studied 10 concentrations of ethrel as a foliar application on the same cultivar. In the last set of 2-year experiments studied on O.C.B., experiments were conducted in 1978 using eight cotton cultivars ('Westburn M', 'Tamcot SP21', 'Deltapine Land 16', 'Stoneville 213', 'Paymaster 303', 'Tamcot 788', 'Coker 5110', and 'Acala 1517E-1) and three seed treatments (none, tap water, and O.C.B). In 1979, two cotton cultivars (Westburn M and Stoneville 213), six seed treatments (four concentrations of O.C.B. vs. tap water vs. none), and two foliar applications (none vs. O.C.B.) were studied.

Analyses of RH-531 effects detected several significant differences, but no consistent positive trends were noted as concentration of the chemical changed. In addition, production of the compound has been discontinued by its manufacturer. For those reasons, it cannot be recommended for use as a foliar spray on cotton.

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Ethrel in the first and second experiments affected several plant characters. At 5000 ppm, yield in several experiments was essentially zero. Therefore, that rate was omitted from these analyses. In 1975, 500 ppm of ethrel on dryland depressed plant height and lint yield; that rate increased T_1 fiber strength in 1974-1975 on dryland. Plant height decreased significantly in 1977 at low rates under irrigation without significantly depressing lint yields. Application of low rates of ethrel may hold some promise where excessive plant height and vegetative growth cause problems under irrigation. Higher rates of application did depress yields considerably under irrigation even though slight increases in fiber length were noted. Yields were affected on dryland in 1977, but no consistent trends in that data were evident. Ethrel application may also be useful under those dryland conditions where fibers with low micronaires are commonly produced.

Analyses of O.C.B. experiments in 1978 indicate that neither seed treatments nor interactions of seed treatments with cultivars were significant for any character. In 1979, seed treatments were significant only for micronaire, but no obvious trends were detected for that trait. Foliar application of O.C.B. resulted in a slight increase in picked lint percent under irrigation. Seed treatment by cultivar interactions were detected for uniformity index and T_1. Foliar application by cultivar interactions affected only T_1. The second-order interaction affected plant height, uniformity index under irrigation, and micronaire under irrigation. O.C.B. either does not have a growth promoting effect on cotton lint yield or its biological activity was inadvertently destroyed by some unknown factor(s) before or during experimentation.

Additional index words: *Gossypium hirsutum* L., RH-531, Ethrel, O.C.B., Foliar application, Seed treatment, Plant height, Lint yield, Lint percent, Fiber length, Fiber uniformity, Micronaire, Fiber strength.

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Effects of RH-531 and Ethrel on Selected Characters in Cotton

INTRODUCTION

Application of growth regulators to crops is becoming a more common management practice in agriculture. Growth regulators may be applied to increase yield; to improve fruit set; to induce fruit and flower shed (thereby increasing the size, quality, and uniformity of fruit remaining on the plant); and to modify vegetative growth and plant height.

Increasing production costs of cotton (*Gossypium hirsutum* L.) and that crop's continuing competition with synthetic fibers encourage efforts toward ever higher productivity. The use of growth regulators, other cultural practices, as well as plant breeding are all approaches which may be studied simultaneously toward achieving that goal. Excessive vegetative growth in cotton, triggered by mild temperatures and moist conditions (especially in the late growing season), may cause overlapping of branches between rows which can increase insect, disease, and mechanical-harvest problems. Excessive vegetative growth in short-season environments can also delay maturity, reduce yield, and lower fiber quality (particularly fiber strength and coarseness). Availability of substances to control vegetative growth and to maintain a more desirable type of canopy would be a significant achievement which, in turn, would allow the use of fertilizers to increase yield without fear of excessive growth.

Early flowering and shortening of plant height are desirable goals in indeterminate crops, such as cotton, which produce a fruit load of variable age and location on the plant (33). It is generally recognized that cotton should set fruit and terminate flowering as quickly as possible, particularly in short-season areas. Growth regulators can be used to eliminate late-season squares on the cotton plant after boll production has reached acceptable yield levels and to reduce late-season insect populations by eliminating their available food supply (23, 24). They can also be used for defoliation as a harvest-aid chemical (34).

Two growth regulators, RH-531 [sodium 1-(p-chlorophenyl) 1,2-dihydro-4,6-dimethyl-2-oxonicotinate (45)] and ethrel [2-chloroethylphosphonic acid (4)], were used in this research. The objectives of this study were to evaluate the effects of different concentrations of RH-531 and ethrel as foliar applications at the start of the flowering season on lint yield, plant height, lint percent, and selected fiber properties of cotton.

LITERATURE REVIEW

RH-531

RH-531 is produced by Rohm and Haas Co.; its chemical name is sodium 1(p-chlorophenyl) 1,2-dihydro-4,6-dimethyl-2-oxonicotinate (45). Biological activities of this substance include growth inhibition, increased fruiting, and modification of sex expression. It can be applied as a foliar spray, soil drench, or seed treatment; but dosage and time of application play critical roles in determining its degree and kind of activity (5).

Foliar application of RH-531 at the panicle stage in rice (Oryza sativa L.) reduced GA_3-induced internode elongation (19) and, in wheat Triticum aestivum L.), decreased fertility which resulted in a drastic reduction in yield (21). Plant height and spike length also were reduced (28). Application of 1.5 kg/ha of this chemical to barley (Hordeum vulgare L.) caused complete sterility (45).

RH-531 application to plants has produced a wide range of effects on flowering habits, depending on the time of application. One quarter to one pound/acre (0.28 to 1.12 kg/ha) application to three-inch tall (7.6 cm) pea plants (Pisum sativum L.) advanced flowering. Spraying of 0.03 to one pound/acre (0.03 to 1.12 kg/ha) prior to flowering increased fruit number (5). Treatment of 8-week old cotton plants with this chemical increased the number of bolls/plant as well as the number of seed/boll (5). It also increased the ratio of female to male flowers in cucurbits (5).

It would probably be appropriate at this point to mention that RH-531 is no longer available as it has been discontinued by Rohm and Haas Co. (27).

Ethrel

Ethrel is produced by Amchem Products, Inc., and its active ingredient is "Ethephon" or 2-chloroethylphosphonic acid (4). It is a synthetic compound of an endogenously produced growth regulator, ethylene, to which it is converted within the plant immediately after application (30, 31).

Ethylene is produced in apical tissues, especially in the flowers (40). It is suspected that ethylene is capable of being produced in *any* plant cell and that it might be transported to other areas within the plant by simple diffusion (1). A few parts of ethylene/thousand million are effective in a regulatory manner, but its actual effects are related to concentration and interactions with other growth regulators (40). The primary site of ethylene action is reported to be the leaf blade (9); only a single attachment site is known for this growth regulator (1). Ethylene effects can be competitively inhibited by CO_2 (1, 2).

Some symptoms of ethylene, as well as ethrel, may be undesirable for a particular crop in question; but they can be adjusted by altering the concentration of ethylene or by application of other growth regulators as auxins or gibberellins (32). Ethylene effects have been discussed by several investigators. The chemical can break dormancy (1), induce adventitious root and flower formation (1), promote fruit ripening (1), cause senescence and abscission (2, 40), inhibit leaf expansion (1, 40), improve germination and growth (32), release apical dominance (32), promote tillering (32), promote radial stem growth (32, 40), and participate in geotropic response (32, 40).

Production of ethylene has been reported in cotton flowers only one day old (13, 18, 20, 25, 37), in dehiscing bolls (18, 20, 25), and in cotton seed after imbibition (37). Ethylene production in cotton can be promoted by nutritional stress resulting from low light intensity which causes fruit shedding (15), by moisture stress which causes leaf and boll abscission (16, 22, 26, 35), by injection of an organic solvent which causes variation in membrane permeability, and by injection of ethylene synthesis precursors (17). Ethylene increases cotton square formation and abscission (20, 32), reduces or modifies auxin transport (8, 10, 34, 36), promotes dihiscence of mature cotton fruit (36), and hastens cotton cotyledon abscission (34). Ethylene also improves seedling vigor; enhances early-season branching and flowering; and promotes flower termination, boll opening, and defoliation (33).

Application of ethrel has been studied and recommended for use on numerous crops, vegetables, and fruit trees (6). One to four pounds/acre (1.12 to 4.48 kg/ha) of ethrel induced flowering in pineapple [Ananas comosus (L.) Merrill] (12); the induction was more pronounced with higher concentrations. The only apparent side effect was that the growth of treated plants was retarded. Application of this chemical accelerated development and fruit ripening of figs (<u>Ficus carica</u> L.) (7) and pears (<u>Pyrus communis</u> L.) (14), stimulated latex flow from rubber trees (<u>Ficus elastica</u> L.) (4, 11), and caused fruit abscission and defoliation in most plants (4).

In barley during the tillering stage, application of ethrel increased the number of tillers without correlated yield increases. However, it did increase stiffness of straw which, in turn, reduced lodging (4). Application of one pound/acre (1.12 kg/ha) in the early tillering stage of oats (Avena sativa L.) had little effect on plant height, lodging, or yield; but the number of tillers increased. Application of this amount in later stages increased yield by 6-30% (4). Ethrel reduced stalk length in rye (Secale cereale L.) which was dependent upon the time of application (41). Foliar application of ethrel at a concentration of 300-600 ppm to the rice plant before transplanting increased tillering, and 3-12 pounds/acre (3.36 to 13.44 kg/ha) sprayed on soil during transplanting accelerated tillering (4). In greenhouse experiments (39), 550 ppm applied to triticale (X Triticosecale Wittmack) delayed pollination which resulted in a higher degree of sterility and also reduced plant height.

Foliar application of 50 ppm ethrel to 2-week old pinto beans (Phaseolus vulgaris L.) had no discernible effects, but concentrations greater than 125 ppm depressed apical growth and increased branching (4). Applying 1/2 to one pound/acre (0.56 to 1.12 kg/ha) to soybeans [Glycine max (L.) Merrill] in the 9-12 trifoliate stage, increased yield and decreased plant height (4). One to four pounds/acre (1.12 to 4.48 kg/ha) increased sugar content of sugarcane (Saccharum officinarum L.) (4).

Excessive ethrel application to cotton plants induced defoliation and immature green boll abscission; but one, two, and four pounds/acre (1.12, 2.24, and 4.48 kg/ha, respectively) foliar spray increased the number of mature bolls by 50, 20, and 20%, respectively, and inhibited vegetative growth about 20%. From these results, one may conclude that ethrel causes abscission of young fruit, flowers, and newly-formed squares on treated plants, but it does not cause abscission of mature bolls. Rather, it induces boll opening and maturity. Delinted cottonseed soaked in 10, 50, and 100 ppm ethrel for 1/2 hour exhibited accelerated and increased germination (4). Preplant seed retting and treatment of plants with optimal concentrations of ethrel stimulated fruit development and maturation (3). Dehiscence of cotton (G. aboreum L.) preceded the complete opening of the boll (associated with dehydration and rapid desiccation of tissues) when bolls were soaked in 500 ppm ethrel solution for 30 minutes. There were no adverse effects on lint and fiber quality (43). Foliar application of 200 to 2000 ppm ethrel in the course of maturation hastened boll ripening. The younger, rapidly growing bolls ceased to develop; their weight decreased; and they matured rapidly. Bolls less than 10 days old and all leaves abscissed (42).

MATERIALS AND METHODS

Two sets of experiments were conducted under irrigated and dryland conditions at Perkins, Okla., on a Teller loam soil (a fine-loamy, mixed, thermic Udic Argiustolls) during 1974-1975 (first study) and 1976-1977 (second study). The upland cotton cultivar, 'Westburn' (38), was planted in these experiments in rows 7.11 and 9.14 m long under irrigated and dryland conditions, respectively, with 1.02 m between rows and 15 cm plant spacing within the row. Treatments were arranged so as to have a buffer row of cotton plants between each plot to serve as a barrier to chemical drift. Growth regulators were applied to plants with a small, CO_2 plot sprayer based on an output of 200 liters of water /hectare.

In the first study (1974-1975), four experiments were conducted, each in a 3 X 4 factorial in a randomized complete-block (RCB) experimental design with four replications. Ethrel (at 0, 500, and 5000 ppm concentrations) was applied to the cotton plants at first bloom each year [near the last of July or first of August at this location (44)] and RH-531 (at 0, 200, 400, and 800 ppm concentrations) was applied to the plants at essentially the same time. Treatments were applied in the morning hours when wind speeds were at a minimum to reduce chemical drift.

Four experiments were conducted in the second study (1976-1977) including only ethrel (at 0, 250, 500, 750, 1000, 1250, 1500, 1750, 2000, and 5000 ppm concentrations) in RCB designs with four replications. The chemical was applied to plants in these experiments at the same growth stage and time of year as in the previous study.

Fifteen mature bolls were randomly sampled at harvest from plants in each plot, except those bordering alleys or skips within the row. Lint yield was determined by harvesting snapped cotton from the entire plot and converting its weight into lint yield in kg/ha. Picked lint percent was estimated as the ratio of lint to seedcotton weight, pulled line percent was calculated as the ratio of lint to snapped cotton weight, and both were expressed as percentages. Plant height in cm was measured on five competitive plants in the plot, i.e., they were not bordering alleys or skips. 2.5% span length was measured on the digital fibrograph in inches and converted to mm. Uniformity index was calculated as the ratio of 50% to 2.5% span length expressed as a percentage. Micronaire (i.e., fiber coarseness) was measured on the micronaire (an airflow instrument) and expressed in μg/in. Finally, fiber strength was measured on the stelometer at the 0- and 1/8-inch gauge setting (i.e., T_0 and T_1, respectively) in grams-force/tex converted into millinewtons /tex.

Lint yield in both studies was greatly depressed by the highest concentration of ethrel (5000 ppm). Therefore, that treatment was eliminated before any computations were undertaken. Analyses of variance were computed initially over all four experiments in each study (including both years under the Perkins irrigated and dryland locations); and their mean results were discussed *if* location by chemical rate, year by chemical rate, and location by year by chemical rate interaction(s) were not significant. Otherwise, each study was analyzed as a subset by year, by location, or both, to avoid or simplify the explanations of such interaction(s). An effort was made to group data as much as possible, yet avoid interactions. LSD comparisons were used in grouping treatment means. A regression line was fitted to each significantly affected character by ethrel application in 1976 and 1977 experiments.

RESULTS AND DISCUSSION

The effect of foliar application of RH-531 are shown in Table 1. The data are presented averaged over the maximum number of tests possible *without* significant interactions involving the chemical treatment with years, locations, or both. Significantly influenced characters were plant height under irrigation in 1975 (but not in 1974 nor on dryland over years), pulled lint percent under irrigation in 1974 (but not in 1975 nor on dryland over years), and uniformity index on dryland in 1974 (but not in 1975 nor under irrigation over years). The only obvious trend for RH-531 exhibited by any of those three characters was in pulled lint percent, and it was not consistent from one year to the next. Analyses for possible interactions between RH-531 and ethrel detected none for any of the plant characters studied (Table 2). RH-531 foliar application at flowering did not display any consistently positive effects on the characters of cotton studied. Lack of such desirable trends in its effects on cotton and discontinuation of the product by its manufacturer suggest that it not be recommended for use as a foliar spray on cotton at the initiation of flowering. The 500 ppm application rate of ethrel under dryland conditions significantly depressed plant height and lint yield in 1975 and increased T_1 fiber strength over both years (Table 3).

In the second study, the effects of ethrel foliar application at nine concentrations on selected characters of cotton are shown in Table 4. Plant height was significantly depressed at the 250, 500, 1000, and 1500 ppm application rates of ethrel under irrigated conditions in 1977. It was also lower at the other four application rates (though not significantly so). This trend (Fig. 1) tends to support previous observations that ethrel depresses vegetative and apical growth (4, 33, 39, 41). Significant differences in plant height were also noted in the 1976 irrigated experiment, but none of these observations differed significantly from the check. No differences in plant height were noted under dryland conditions.

Lint yield under irrigation was negatively influenced by foliar ethrel application above 1000 ppm in both years (Table 4, Fig. 2). The higher concentrations of ethrel application probably decreased yield because of leaf, square, and young fruit abscission (32, 42). Under dryland conditions, lint yield was not affected in 1976; and though significant differences were obtained on dryland in 1977, no obvious trends are evident from that data.

Pulled and picked lint percents were significantly affected by ethrel foliar application under irrigated conditions in 1976 but not in 1977 nor under dryland conditions (Table 4). Overall trends for both characters (Figs. 3 and 4, respectively) follow a decreasing pattern with increasing levels of ethrel. This corresponds well with the previous observation that lint yield and lint percent are positively correlated (29). 2.5% span length increased with higher ethrel concentrations under irrigated conditions in 1976 (Fig. 5), probably as a result of lint yield and lint percent depression in that experiment (29). Uniformity index displayed no significant differences. Micronaire increased significantly with increasing ethrel application rates under dryland conditions in 1976 and 1977 (Table 4, Fig. 6). No significant responses for micronaire were detected under irrigation. Significant responses were not obtained for T_0 or T_1 fiber strength.

Ethrel applications (at low rates) under irrigation tended to decrease plant height in 1977 without significantly depressing lint yields. Therefore, its application at those concentrations should be considered in irrigated areas where plant height and vegetative growth may cause serious problems in cultivation and harvesting of cotton. However, the chemical should be used with extreme caution because higher rates of application may depress yields considerably, even though slight increases in fiber length may be noted. Its application may hold some promise under those dryland conditions where low micronaire fibers are commonly produced.

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Fig. 6. Effect of ethrel foliar application on micronaire of cotton on dryland in 1976 and 1977.

Table 1. Effect of RH-531 foliar application on selected characters of cotton under irrigated and dryland conditions in 1974 and 1975.

RH-531	Plant height: Irrigated 1974	Plant height: Irrigated 1975	Plant height: Dryland (Over years)	Lint yield: Irrigated (Over years)	Lint yield: Dryland (Over years)	Pulled lint: Irrigated 1974	Pulled lint: Irrigated 1975	Pulled lint: Dryland (Over years)	Picked lint (Over locs. and years)	2.5% span length (Over locs. and years)	Uniformity index: Irrigated (Over years)	Uniformity index: Dryland 1974	Uniformity index: Dryland 1975	Micronaire (Over locs. and years)	Fiber strength T_0 (Over locs. and years)	Fiber strength T_1: Irrigated (Over years)	Fiber strength T_1: Dryland (Over years)
ppm	cm			kg/ha		%				mm	%			µg/in	mN/tex		
0	91 a*	75 ab	72 a	406 a	715 a	21.2 b	27.1 a	28.5 a	35.6 a	25.5 a	44.9 a	47.2 a	48.6 a	3.9 a	372.8 a	181.9 a	190.3 a
200	93 a	68 c	73 a	346 a	697 a	23.9 a	26.1 a	27.7 a	35.1 a	25.9 a	45.4 a	45.5 c	48.9 a	3.9 a	370.1 a	186.4 a	192.3 a
400	87 a	77 a	72 a	351 a	758 a	22.9 a	26.7 a	27.9 a	35.6 a	26.1 a	45.7 a	46.3 b	49.2 a	3.9 a	376.7 a	183.4 a	187.3 a
800	88 a	73 b	72 a	414 a	678 a	23.9 a	26.2 a	27.5 a	35.0 a	26.1 a	45.7 a	46.8 a	48.4 a	3.9 a	371.8 a	184.4 a	193.3 a

*Means within a column followed by the same letter were not significantly different at the 0.05 level of probability.

Table 2. Effect of RH-531 and ethrel foliar applications on selected characters of cotton under irrigated and dryland conditions in 1974 and 1975.

RH-531	Ethrel	Plant height	Lint yield	Pulled lint	Picked lint	2.5% span length	Uniformity index	Micronaire	Fiber strength T_0	Fiber strength T_1
ppm		cm	kg/ha	%		mm	%	µg/in	mN/tex	
0	0	78 a*	599 a	26.6 a	35.9 a	25.5 a	46.4 a	3.9 a	372.0 a	184.2 a
0	500	78 a	572 a	26.0 a	35.2 a	25.5 a	46.4 a	3.8 a	372.5 a	187.4 a
200	0	77 a	540 a	26.6 a	35.5 a	25.9 a	46.4 a	3.9 a	374.9 a	187.4 a
200	500	76 a	545 a	26.1 a	34.7 a	25.8 a	46.1 a	3.9 a	366.2 a	191.6 a
400	0	77 a	590 a	26.6 a	35.9 a	26.0 a	46.9 a	3.9 a	377.1 a	184.0 a
400	500	77 a	562 a	26.1 a	35.1 a	26.2 a	46.5 a	3.8 a	375.8 a	186.3 a
800	0	77 a	589 a	26.6 a	35.3 a	25.9 a	46.9 a	4.0 a	370.0 a	188.6 a
800	500	75 a	562 a	26.0 a	34.7 a	26.3 a	46.4 a	3.8 a	373.8 a	188.5 a

*Means within a column followed by the same letter were not significantly different at the 0.05 level of probability.

Table 3. Effect of ethrel foliar application on selected characters of cotton under irrigated and dryland conditions in 1974 and 1975.

Ethrel	Plant height			Lint yield			Pulled lint		Picked lint	2.5% span length	Uniformity index		Micronaire	Fiber strength		
	Irrigated	Dryland		Irrigated	Dryland		Irrigated	Dryland			Irrigated	Dryland		T_0	T_1	
															Irrigated	Dryland
	(Over years)	1974	1975	(Over years)	1974	1975	(Over years)	(Over years)	(Over locs. and years)	(Over locs. and years)	(Over years)	(Over years)	(Over locs. and years)	(Over locs. and years)	(Over years)	(Over years)
ppm	cm			kg/ha			%			mm	%		µg/in	mN/tex		
0	82 a*	64 a	82 a	422 a	672 a	802 a	25.1 a	28.1 a	34.7 a	25.8 a	45.6 a	47.8 a	3.9 a	373.8 a	184.4 a	187.4 b
500	81 a	65 a	78 b	429 a	675 a	709 b	24.4 a	27.7 a	35.9 a	26.0 a	45.4 a	47.4 a	3.8 a	371.8 a	183.4 a	194.2 a

*Means within a column followed by the same letter were not significantly different at the 0.05 level of probability.

Table 4. Effect of ethrel foliar application on selected characters of cotton under irrigated and dryland conditions in 1976 and 1977.

Ethrel	Plant height Irrigated 1976	Plant height Irrigated 1977	Plant height Dryland (Over years)	Lint yield Irrigated 1976	Lint yield Irrigated 1977	Lint yield Dryland 1976	Lint yield Dryland 1977	Pulled lint Irrigated 1976	Pulled lint Irrigated 1977	Pulled lint Dryland (Over years)	Picked lint Irrigated 1976	Picked lint Irrigated 1977	Picked lint Dryland (Over years)
ppm	cm			kg/ha				%					
0	57 a-d*	104 a	55 a	679 a	472 a	516 a	726 bc	29.3 a	33.6 a	29.6 a	37.9 a	33.6 a	37.4 a
250	56 b-d	90 ef	56 a	703 a	519 a	509 a	860 a	30.0 a	34.1 a	29.7 a	38.0 a	34.1 a	37.6 a
500	51 d	86 f	54 a	647 a	501 a	505 a	836 ab	29.0 ab	34.4 a	29.4 a	37.1 ab	34.4 a	37.2 a
750	52 cd	98 a-e	52 a	617 a	423 ab	518 a	647 c	27.8 bc	33.9 a	29.6 a	35.9 bc	33.8 a	37.4 a
1000	59 ab	94 b-f	53 a	623 a	469 a	446 a	808 ab	27.4 cd	34.1 a	29.3 a	35.1 cd	34.1 a	37.0 a
1250	57 a-d	103 ab	54 a	451 b	339 b	454 a	800 ab	26.2 de	33.3 a	29.8 a	33.7 d	33.3 a	37.8 a
1500	58 a-c	94 b-f	54 a	300 c	360 b	454 a	820 ab	25.5 e	33.2 a	29.4 a	33.7 d	33.2 a	37.5 a
1750	62 ab	101 a-d	59 a	261 cd	189 c	439 a	724 bc	25.5 e	32.5 a	28.8 a	33.9 d	32.8 a	36.9 a
2000	63 a	102 a-c	55 a	151 d	219 c	312 a	776 ab	25.7 e	32.4 a	29.0 a	34.1 d	32.4 a	36.8 a

Ethrel	2.5% span length Irrigated 1976	2.5% span length Irrigated 1977	2.5% span length Dryland (Over years)	Uniformity index (Over locs. and years)	Micronaire Irrigated (Over years)	Micronaire Dryland 1976	Micronaire Dryland 1977	Fiber strength T_0 Irrigated (Over years)	Fiber strength T_0 Dryland 1976	Fiber strength T_0 Dryland 1977	Fiber strength T_1 (Over locs. and years)
ppm	mm			%	µg/in			mN/tex			
0	24.4 d	27.3 a	24.4 a	45.4 a	4.3 a	4.5 cd	4.8 cd	349.2 a	352.2 a	402.2 a	183.4 a
250	24.2 d	27.2 a	24.1 a	45.7 a	4.6 a	4.5 cd	4.7 d	350.2 a	357.1 a	413.0 a	186.4 a
500	24.8 d	27.1 a	23.7 a	45.1 a	4.5 a	4.2 d	4.9 b-d	357.1 a	349.2 a	393.4 a	188.4 a
750	25.0 c	26.8 a	23.6 a	44.8 a	4.3 a	4.2 d	5.0 a-d	355.1 a	361.0 a	419.9 a	191.3 a
1000	26.0 c	27.4 a	23.5 a	45.3 a	4.4 a	4.5 cd	5.2 ab	344.3 a	364.0 a	405.2 a	183.4 a
1250	26.5 bc	27.0 a	23.9 a	45.0 a	4.4 a	4.7 bc	5.3 a	346.3 a	338.4 a	411.0 a	183.4 a
1500	27.3 ab	26.4 a	24.0 a	45.0 a	4.4 a	4.7 bc	5.0 a-d	355.1 a	354.1 a	401.2 a	184.4 a
1750	27.6 a	26.9 a	24.0 a	45.0 a	4.4 a	5.1 a	5.0 a-d	346.3 a	357.1 a	401.2 a	187.4 a
2000	27.0 ab	27.3 a	24.0 a	45.3 a	4.4 a	5.0 ab	5.1 a-c	349.2 a	367.9 a	387.5 a	190.3 a

*Means within a column followed by the same letter were not significantly different at the 0.05 level of probability.

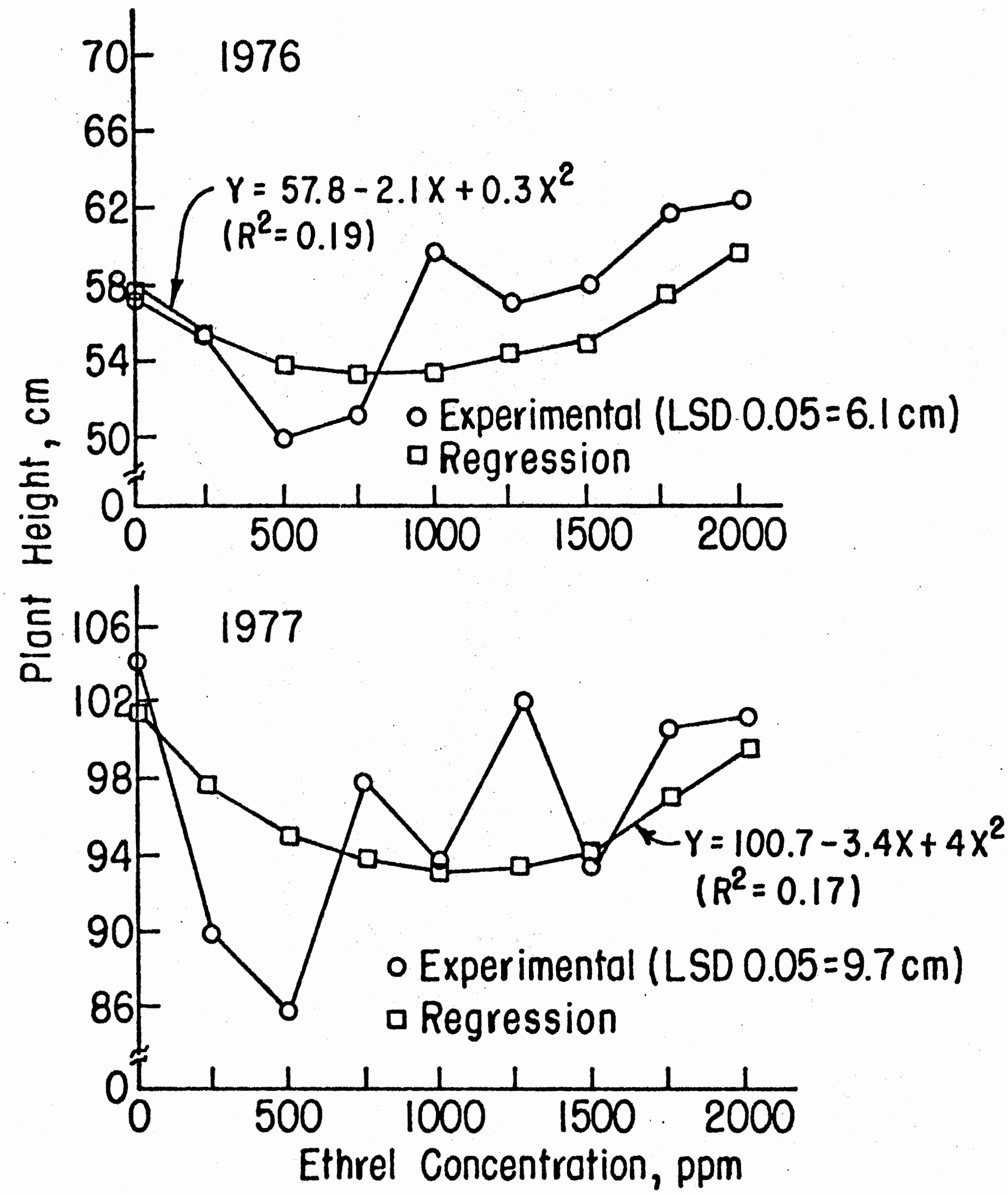

Figure 1. Effect of ethrel foliar application on plant height of cotton under irrigation in 1976 and 1977.

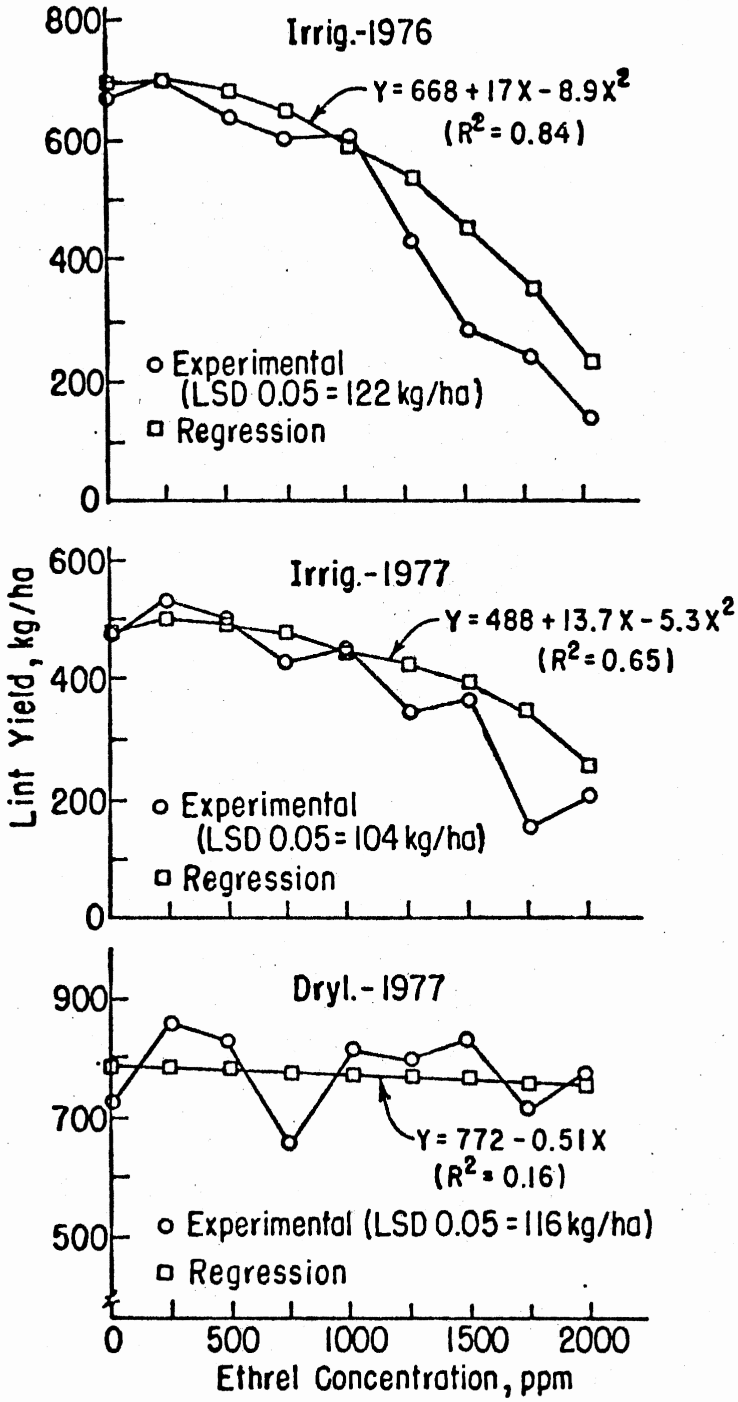

Figure 2. Effect of ethrel foliar application on lint yield of cotton under irrigation in 1976 and 1977 and on dryland in 1977.

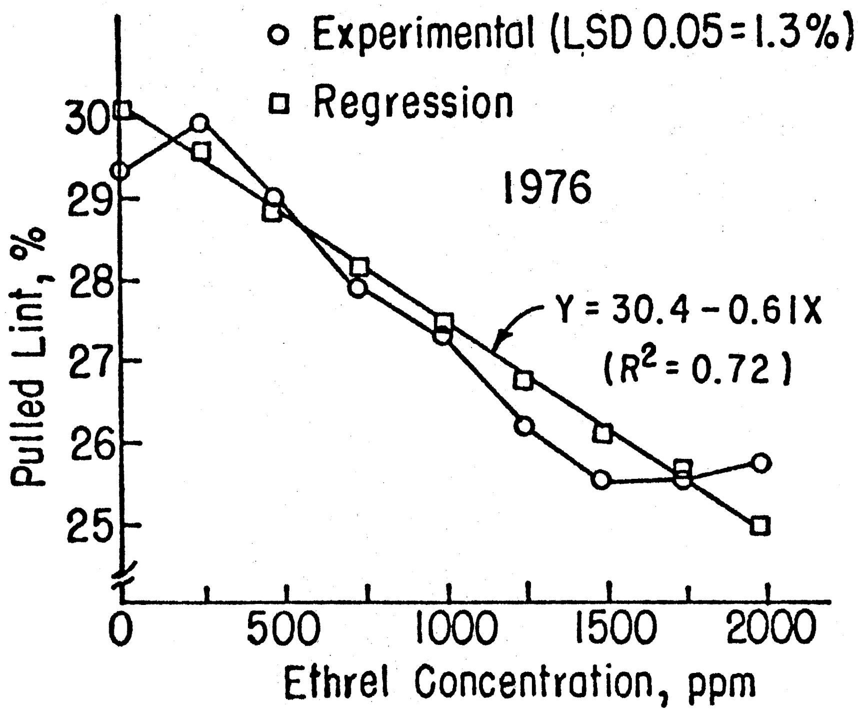

Figure 3. Effect of ethrel foliar application on pulled lint percent of cotton under irrigation in 1976.

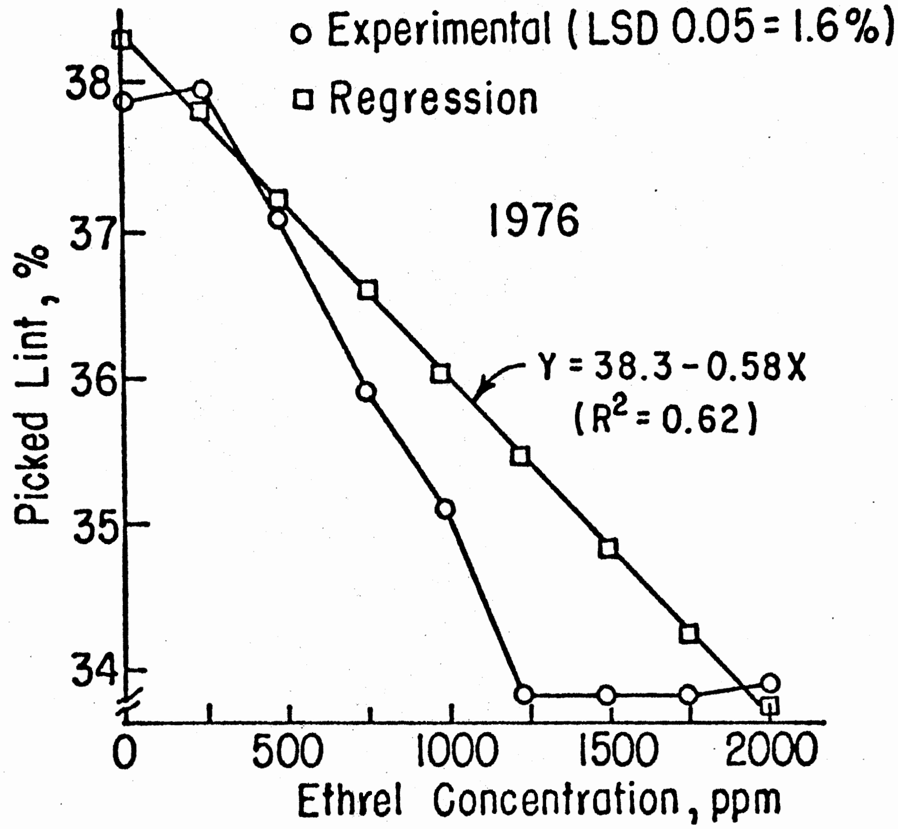

Figure 4. Effect of ethrel foliar application on picked lint percent of cotton under irrigation in 1976.

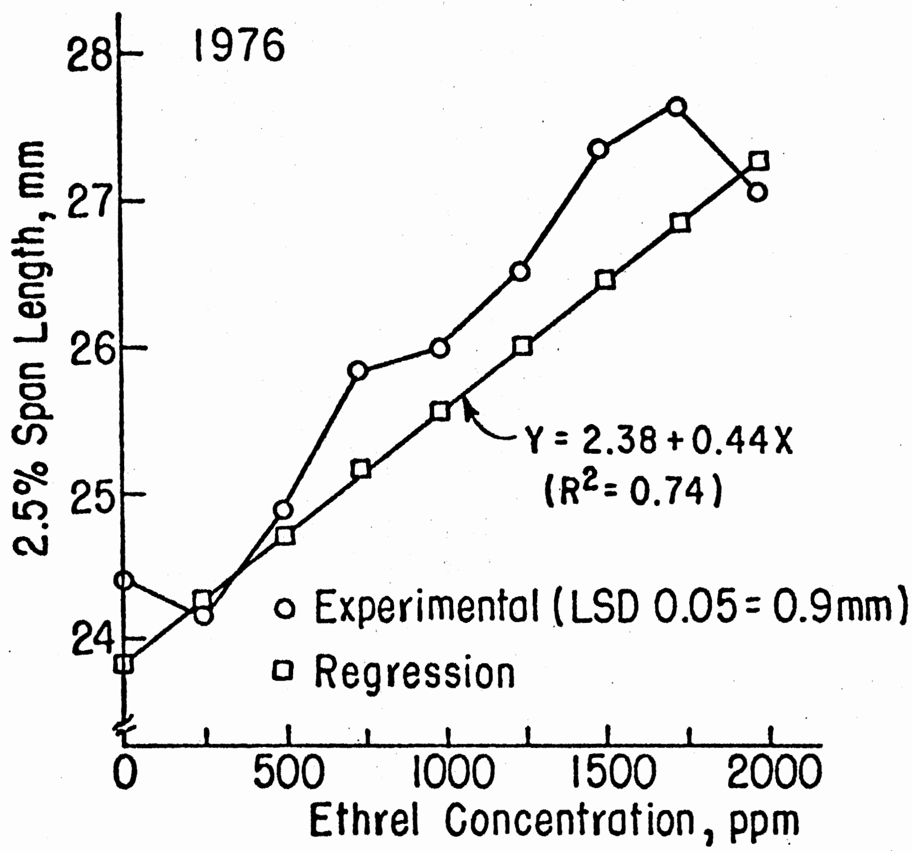

Figure 5. Effect of ethrel foliar application on 2.5% span length of cotton under irrigation in 1976.

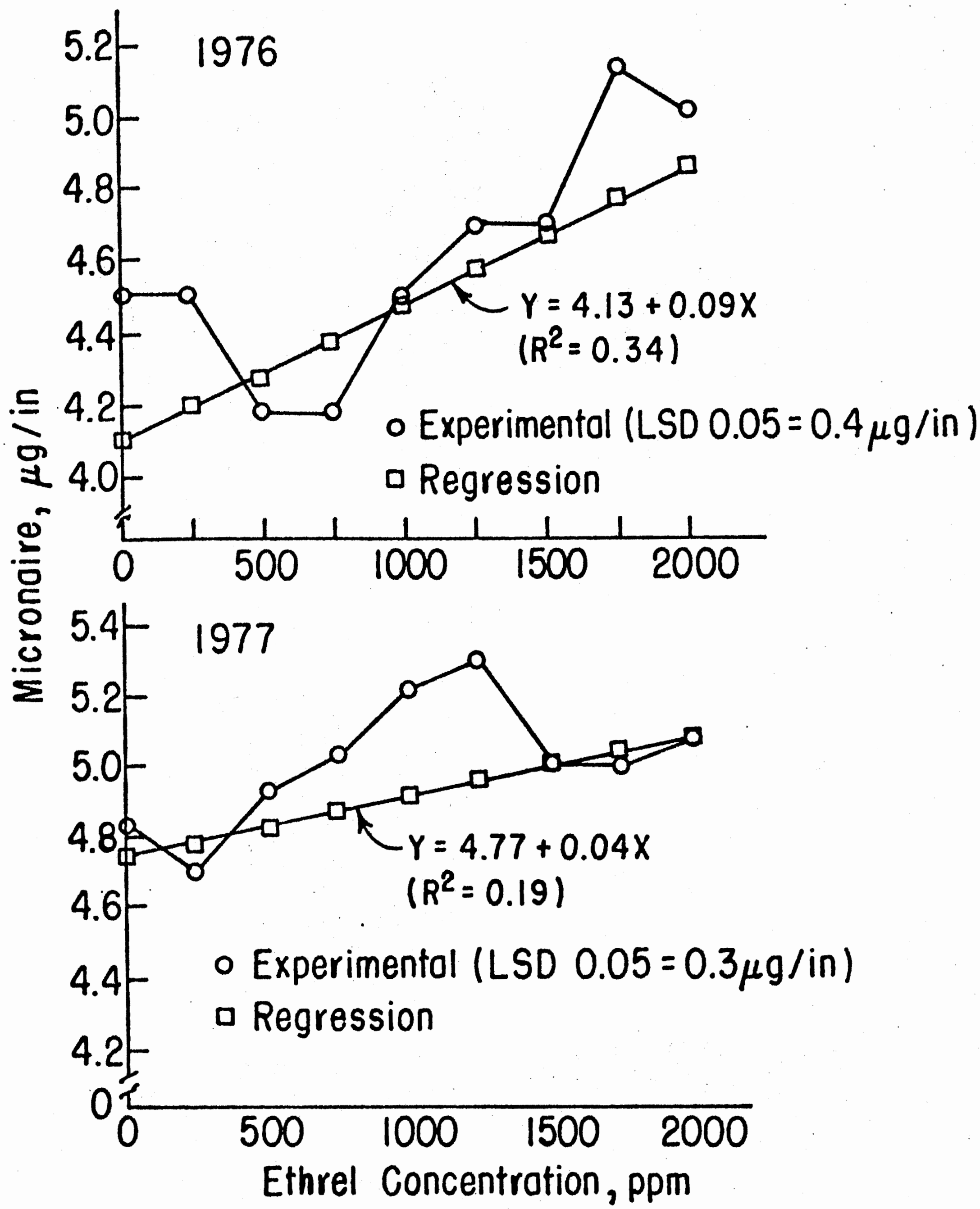

Figure 6. Effect of ethrel foliar application on micronaire of cotton on dryland in 1976 and 1977.

B

Effects of O.C.B. on Selected Characters in Cotton

INTRODUCTION

Increasing demands for agricultural products encourage the investigation of many possible methods to achieve higher crop production per unit of production input. In recent years, considerable attention has been given to substances which may stimulate rapid emergence and growth of plants (thereby escaping insect and disease damage), which may produce deep and extensive root systems (thus more efficiently withdrawing moisture and nutrients from the soil profile), and which may build stronger plants with greater leaf area (thereby intercepting more sunlight to increase yield and product quality).

"O.C.B." is reputably a growth substance discovered by Ohmoto, formerly of Taiwan (9). The chemical is described as being similar to coconut (Cocos nucifera L.) milk [whose physiological actions have been discussed by van Overbeek (10)]. O.C.B. contains RNA, DNA, and their derivatives; ferments and hydrolysis products; and organic-inorganic material. The substance is soluble in water, insoluble in alcohol, and remains effective if stored in a dark place with a temperature of -1 to -5 C (9). O.C.B. is quite sensitive to sunlight, and its application when the sun is shining is discouraged. Pesticides should not be used with this substance, but they can be applied a day after O.C.B. application; or O.C.B. should be applied after pesticide residues have completely dissipated (9). O.C.B. is not toxic to man or his domestic animals. After application, O.C.B. remains in the plants until harvest (9).

O.C.B. has been applied to many field crops, horticultural plants, and fruit trees over a 10-year period; and in every case, their yield was increased "without fail" (8). Rice (Oryza sativa L.) seed soaked for 3 days produced longer roots, stronger plants, and an increased yield of 20-40%. Foliar application to 1-2 inch (2.54 to 5.08 cm) rice sprouts and to plants 4-5 days before transplanting produced longer leaves and roots and increased yield 20-40% (9). Corn (Zea mays L.) seed soaked for 12 hours increased yield 30% (8). Foliar spray of O.C.B. on new buds and leaves of green beans (Phaseolus vulgaris L.), peas (Pisum sativum L.), soybeans [Glycine max (L.) Merr.] , and peanuts (arachis hypogaea L.) produced larger fruits and increased yield 30-50%.

Seed treatment of watermelon [Colocynthis citrullus (L.) O. Kuntze], for 12 hours or a foliar spray twice on new leaf buds produced larger fruits, earlier ripening, a longer fruiting time, and increased yields by 30-50%. The sugar content of the watermelon was also increased. Green vegetables (Sci. names not given), cabbage (Brassica oleracea L.), turnip (Brassica rapa L.), onion (Allium cepa L.), garlic (Allium sativum L.), and leek (Allium porrum L.) yields were increased 30-50%, and they were more resistant to disease.

Seed of sweet potato [Ipomoea batatas (L.) Lam.] and Irish potato (Solanum tuberosum L.) soaked for 2 hours increased yield 30-50 %. Soaking sugarcane (Saccharum officinarum L.) cuts in a tank of diluted solution for 3 minutes promoted budding rate, increased plant height, and increased sugar content. Application of O.C.B. on 1 inch (2.54 cm) tobacco (Nicotiana spp.) seedlings resulted in stronger roots, enlarged leaves, and better leaf quality.

A diluted solution of O.C.B. applied to new buds of pineapple [Ananas comosus (L.) Merrill] and banana (Musa spp.) advanced fruiting, produced larger fruits, increased sugar content, and increased yield by 30%. Orange (Citrus spp.), shaddock (Citrus decymanus L.), litchi (Litchi chinensis Sonner.), louquat (Eriobotrya japonica Lindl.), plum (Prunus domestica L.), and grape (Vitis vinifera L.) foliar sprays increased fruit production, earliness of maturity, fruit size, sugar content by 2-3%, and yield by 20-30%. Application of this substance to new buds of ornamental flowers, such as chrysanthemum (Chrysanthemum spp.), lily (Lilium spp.), and tulip (Tulipa gesneriana L.), resulted in stronger stems, leaves, and roots and in larger flowers (9).

The objectives of the studies reported herein were to evaluate the effects of recommended rates and methods of O.C.B. application on selected cultivars of cotton (Gossypium hirsutum L.) to compare the effects of O.C.B. as a seed treatment vs. a foliar application on the cotton plant, and to examine the possibility of O.C.B.'s commercial use.

MATERIALS AND METHODS

Two experiments with O.C.B. (one under irrigated and the other under dryland conditions) were conducted in 1978 and two in 1979 at Perkins, Okla., on a Teller loam soil (a fine-loamy, mixed, thermic Udic Argiustolls).

In 1978, the two experiments were conducted in an 8 X 3 split-plot arrangement superimposed on a randomized complete-block experimental design with four replications. Main plots were eight cotton cultivars ['Westburn M' (4), 'Tamcot SP21' (5), 'Deltapine Land 16' (1), 'Stoneville 213' (1), 'Paymaster 303' (3), 'Tamcot 788' (1), 'Coker 5110' (2), and 'Acala 1517E-1' (6)]. Subplots were composed of seed soaked in a 1/120 dilution of O.C.B. for 6 hours, seed soaked in tap water for 6 hours, and unsoaked seed. Commercially available, delinted, and fungicide-treated seed were washed as free as possible from fungicide prior to soaking in O.C.B. The seed were planted immediately after treatment. Each experimental plot consisted of one row 7.11 m long and 1.02 m wide with a plant spacing of approximately 15 cm. Because no foliar sprays were applied in this experiment, buffer rows between plots were considered expendable and were not used.

In 1979, the two experiments were conducted in a 2 X 6 X 2 split-split-plot pattern in a randomized complete-block experimental design with four replications. These experiments included two of the cotton cultivars utilized in the previous year's experiments (i.e., Westburn M and Stoneville 213) as main plots, six seed soaking treatments (seed soaked with 1/30, 1/60, 1/90, and 1/120 dilution of O.C.B. for 6 hours, seed soaked in tap water for 6 hours, and unsoaked seed) as subplots, and two foliar sprayings (no spraying vs spraying with a 1/500 dilution of O.C.B.) as subsubplots. In these experiments, delinted seed that had *not* been previously treated with a fungicide were soaked in different concentrations of O.C.B., dried in the shade away from direct sunlight, and then treated with a fungicide prior to planting. Experimental plots were arranged in alternate rows with a buffer row of cotton between plots as a barrier to prevent chemical drift between plots when spraying. O.C.B. was applied to plants in the 4-5 true-leaf stage with a small, CO_2 plot sprayer based on a liquid output of 200 liters/hectare. Plot sizes, row widths, and plant spacings within the row were the same as in the previous year.

In these experiments, 15 mature bolls were randomly sampled from plants in each plot at harvest, except from those bordering alleys or skips within the row. Lint yield was determined by harvesting snapped cotton from the entire plot and converting its weight into lint yield in kg/ha. Picked lint percent was calculated as the ratio of lint to seedcotton weight, and pulled lint percent was estimated as the ratio of lint to snapped cotton weight. Both were expressed as percentages. Plant height in cm was determined by measuring five competitive plants in each plot; those plants bordering alleys or skips were not measured. 2.5% span length was measured on the digital fibrograph in inches and then converted into mm. Uniformity index was computed as the ratio of 50% to 2.5% span length expressed as a percentage. Micronaire (i.e., fiber coarseness) was measured on the micronaire (an airflow instrument) in μg/in. Fiber strength was measured on the stelometer at the

0- and 1/8-inch gauge settings (i.e., T_0 and T_1, respectively) in grams-force/tex converted into millinewtons/tex.

Analyses of variance were computed jointly for the irrigated and dryland experiments within each year, and results for a character have been expressed as averages over these two locations if the location by O.C.B. treatment interaction for that trait was not significant. If that interaction was significant, the experiments were analyzed and reported individually for each location in that year for that character. LSD comparisons were used in grouping treatment means.

RESULTS AND DISCUSSION

Significant differences were noted among cultivars used in these experiments for all characters (Table 1). Because the cultivars were purposely chosen from across the Cotton Belt to sample a wide array of germplasms and environmental adaptations, such differences were expected. Analyses of variance detected no significant differences among seed treatments for any character in 1978 (Table 2). Finally, no seed treatment by cultivar interactions were detected for any character studied. Though the seed were washed thoroughly before treatment, enough residual chemical may have remained on the seed to inactivate the compound. Also, seed in this experiment were soaked for only 6 hours [compared to the 12-24 hours recommended for most crops by Nakazava (8)]. It was necessary to suspend soaking at that time because the seed sprouted when soaked longer than 6 hours.

In the 1979 study, the two cultivars, Westburn M and Stoneville 213, performed differently for all characters except picked lint percent on dryland, T_0 over both locations, and T_1 on dryland (Table 3). Again, these cultivars were chosen to represent very different types of cottons, i.e., the Plains-vs. Delta-types . . . thus, the differences detected between them were not surprising.

Seed unsoaked vs. soaked in tap water or different concentrations of O.C.B. resulted in no significant differences for any characters except micronaire (under both irrigated and dryland conditions) (Table 4). However, no obvious trends in micronaire response could be detected across seed treatments. No O.C.B treatment was superior to soaking in tap water alone. Foliar application of a 1/500 dilution of O.C.B. did not affect any characters in these experiments except for a slight increase in picked lint percent under irrigation (Table 5). Uniformity index and T_1 fiber strength were significantly affected by seed treatment by cultivar interactions (Table 6). The significant responses for uniformity occurred under irrigation; given a specific seed treatment, significant differences for uniformity between Westburn M and Stoneville 213 occurred only where no seed treatments were applied. Given the specific cultivar, Westburn M, only one significant difference was observed; but no pattern of response was apparent. Given Stoneville 213, no seed treatment gave the most uniform fiber with tap water and the low concentration of O.C.B. slightly lower and with the higher concentrations of O.C.B. lower still. For T_1, the only significant difference was between the two cultivars at the 1/60 dilution rate of the chemical. Fiber strength (T_1) was the only trait affected by foliar application by cultivar interactions (Table 7). Westburn M gave a significantly higher response without foliar application, whereas Stoneville 213 was higher with application. Only plant height displayed a significant seed treatment by foliar application interaction (Table 8). Given a specific seed treatment, foliar application increased plant height for only the seed treatment soaked in tap water. It significantly reduced the height of those plants from seed treated at the most diluted O.C.B. rate. Without foliar application, the shorter plants were those at the most concentrated O.C.B. seed treatment rates. No seed treatment (along with the more dilute O.C.B seed treatments) tended to give taller plants if no foliar applications were applied.

When such applications were made, soaking seed in tap water gave the taller plants; and the most concentrated O.C.B. seed treatment gave the shorter plants.

Plant height, uniformity index under irrigation, and micronaire under irrigation were significantly affected by seed treatment by foliar application by cultivar interactions (Table 9). With no seed treatment, Stoneville 213 (no foliar application) had taller plants than the Westburn M treatments; and Westburn M (with no foliar application) had the shortest plants. With the tap water seed treatment, Westburn M (no foliar application) had the shorter plants. At the two lowest concentrations of O.C.B., the Westburn treatments were significantly shorter than those for Stoneville 213. At the 1/60 dilution rate, no significant differences in plant height were detected. At the 1/30 dilution rate, Stoneville 213 (treated with foliar application of O.C.B.) had significantly taller plants than did the other treatments.

With no seed treatment or foliar application, Westburn M had significantly more uniform fiber than Stoneville 213. With the tap water seed treatment, both Westburn M treatments (with or without foliar application) were more uniform than both Stoneville 213 treatments. At the 1/120 dilution rate seed treatment, Westburn M (without foliar application) was significantly more uniform than Stoneville 213 (with application). At the 1/90 dilution rate, only Stoneville 213 (without foliar application) differed from the other treatments. At the 1/60 dilution rate, Westburn M (without) and Stoneville 213 (with foliar application) were significantly different from the other two treatments. At the most concentrated seed treatment rate of O.C.B., Westburn M (with foliar application) had significantly more uniform fiber than the other three treatments.

With no seed treatment, Westburn M (with foliar application) had significantly coarser fiber than Stoneville 213 (with or without). Soaked in tap water, the 1/120 dilution, and the 1/90 dilution rate of O.C.B., no significant differences were detected. At the 1/60 dilution rate, Westburn M (without foliar application) had significantly coarser fiber than Westburn M (with) or Stoneville 213 (without). At the 1/30 dilution rate, the Westburn M treatments had a significantly coarser fiber than the Stoneville 213 treatments. How many of the above significant effects are Type I errors is open to conjecture.

No obvious patterns were evident in these studies (particularly for lint yield) which would relate to the spectacular claims made for use of O.C.B. in Ohmoto's studies (9). Based on these results, no positive statements can be made regarding the desirability of O.C.B. application to cotton. Either this chemical is not effective on cotton as a seed treatment or as a foliar spray (at least in the ways it was used in these experiments) or it was inadvertently inactivated prior or during this study by some unknown factor or factors.

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LIST OF TABLES

Table 1. Performance of eight cotton cultivars over locations in 1978.

Cultivar	Plant height	Lint yield	Pulled lint	Picked lint	2.5% span length	Uniform-ity index	Micro-naire	Fiber strength T_0	Fiber strength T_1
	cm	kg/ha	%	%	mm	%	μg/in	mN/tex	mN/tex
Westburn M	57 bc*	349 e	29.4 b	36.9 d	25.1 d	46.9 d	4.8 cd	407.1 de	192.3 cd
Tamcot SP21	62 a	409 bc	30.0 a	40.0 a	25.1 d	47.2 cd	4.8 cd	414.0 cd	191.3 c-e
Deltapine Land 16	58 b	422 ab	28.8 c	37.9 c	27.1 b	47.7 c	5.1 b	399.3 ef	195.2 c
Stoneville 213	57 bc	445 a	29.7 ab	39.3 b	26.3 c	48.5 b	5.4 a	391.4 f	187.4 de
Paymaster 303	54 c	390 cd	28.7 c	38.0 c	25.3 d	47.0 d	4.7 d	421.8 c	185.4 e
Tamcot 788	60 ab	363 de	27.1 d	36.8 d	26.3 c	47.6 c	4.4 e	467.9 b	215.8 b
Coker 5110	62 a	382 cd	28.8 c	38.3 c	27.2 b	47.6 c	4.9 c	410.1 c-e	193.3 cd
Acala 1517E-1	62 a	264 f	24.6 e	35.7 e	27.9 a	49.2 a	4.8 cd	499.3 a	246.2 a

*Means within a column followed by the same letter were not significantly different at the 0.05 level of probability.

Table 2. Effect of O.C.B. seed treatment on selected characters of cotton under irrigated and dryland conditions in 1978.

Seed treatment	Plant height	Lint yield	Pulled lint	Picked lint	2.5% span length	Uniform-ity index	Micro-naire	Fiber strength T_0	Fiber strength T_1
	cm	kg/ha	%	%	mm	%	μg/in	mN/tex	mN/tex
None	59 a*	392 a	28.4 a	37.8 a	26.4 a	47.6 a	4.9 a	426.7 a	200.1 a
Tap water	59 a	393 a	28.3 a	37.7 a	26.3 a	47.6 a	4.9 a	423.8 a	201.1 a
O.C.B.	59 a	383 a	28.4 a	37.9 a	26.3 a	47.9 a	4.9 a	429.7 a	201.1 a

*Means within a column followed by the same letter were not significantly different at the 0.05 level of probability.

Table 3. Performance of two cotton cultivars over locations in 1979.

Cultivar	Plant height		Lint yield	Pulled lint	Picked lint		2.5% span length	Uniformity index	Micronaire	Fiber strength		
										T_0	T_1	
	Irri.	Dryl.	(Over locs.)	(Over locs.)	Irri.	Dryl.	(Over locs.)	(Over locs.)	(Over locs.)	(Over locs.)	Irri.	Dryl.
	cm		kg/ha	%			mm	%	µg/in	mN/tex		
Westburn M	77 b*	50 b	593 a	25.0 a	33.5 a	35.5 a	27.9 b	47.5 a	4.1 a	417.9 a	183.4 b	200.1 a
Stoneville 213	86 a	54 a	414 b	23.1 b	32.2 b	35.9 a	28.5 a	46.5 b	3.9 b	414.0 a	190.3 a	194.2 a

*Means within a column followed by the same letter were not significantly different at the 0.05 level of probability.

Table 4. Effect of O.C.B. seed treatment on selected characters of cotton under irrigated and dryland conditions in 1979.

Seed treatment	Plant height	Lint yield	Pulled lint	Picked lint	2.5% span length	Uniformity index	Micronaire		Fiber strength	
									T_0	T_1
	(Over locations)						Irri.	Dryl.	(Over locations)	
	cm	kg/ha	%	%	mm	%	µg/in	µg/in	mN/tex	mN/tex
None	67 a*	515 a	25.2 a	34.5 a	28.1 a	47.0 a	3.6 a	4.3 b	415.9 a	193.3 a
Tap water	68 a	496 a	25.2 a	34.3 a	28.3 a	47.3 a	3.5 ab	4.6 a	415.9 a	192.3 a
1/120 dil. O.C.B.	66 a	516 a	25.3 a	34.3 a	28.3 a	46.8 a	3.4 b	4.6 a	415.0 a	191.3 a
1/90 dil. O.C.B.	69 a	502 a	25.0 a	34.2 a	28.3 a	46.9 a	3.4 b	4.3 b	411.0 a	190.3 a
1/60 dil. O.C.B.	66 a	519 a	25.0 a	34.1 a	28.1 a	47.0 a	3.5 ab	4.4 b	420.8 a	192.3 a
1/30 dil. O.C.B.	64 a	472 a	24.9 a	34.1 a	28.3 a	47.6 a	3.6 a	4.4 b	416.9 a	191.3 a

*Means within a column followed by the same letter were not significantly different at the 0.05 level of probability.

Table 5. Effect of O.C.B. foliar application on selected characters of cotton under irrigated and dryland conditions in 1979.

Foliar application	Plant height	Lint yield	Pulled lint	Picked lint		2.5% span length	Uniformity index	Micronaire	Fiber strength	
	— (Over locations) —			Irri.	Dryl.	— (Over locations) —			T_0	T_1
	cm	kg/ha	— % —			mm	%	μg/in	— mN/tex —	
None	66 a*	514 a	25.1 a	32.6 b	35.7 a	28.2 a	46.9 a	4.0 a	415.3 a	192.3 a
1/500 dil. O.C.B.	67 a	592 a	25.1 a	33.0 a	35.7 a	28.2 a	47.1 a	4.0 a	416.4 a	191.4 a

*Means within a column followed by the same letter were not significantly different at the 0.05 level of probability.

Table 6. Characters influenced by seed treatment by cultivar interactions under irrigated and dryland conditions in 1979.

Seed treatment	Cultivar	Plant height	Lint yield	Pulled lint	Picked lint	2.5% span length	Uniformity index		Micro-naire	Fiber strength	
		(Over locations)					Irri.	Dryl.	(Over locations)	T_0	T_1
		cm	kg/ha	%	%	mm	%	%	µg/in	mN/tex	mN/tex
None	Westburn M	65 a*	609 a	26.1 a	34.9 a	27.9 a	46.7 b	48.2 a	4.1 a	414.0 a	192.3 ab
	Stoneville 213	70 a	422 a	24.4 a	34.1 a	28.4 a	48.1 a	48.4 a	3.9 a	416.9 a	194.2 ab
Tap water	Westburn M	66 a	568 a	25.7 a	34.2 a	27.9 a	46.1 b-d	48.3 a	4.1 a	424.8 a	195.2 ab
	Stoneville 213	70 a	423 a	24.8 a	34.3 a	28.6 a	46.9 b	48.2 a	4.0 a	406.1 a	189.3 ab
1/120 dil. O.C.B.	Westburn M	63 a	592 a	25.9 a	34.6 a	27.9 a	46.6 bc	47.4 a	4.1 a	411.0 a	190.3 ab
	Stoneville 213	70 a	439 a	24.6 a	34.0 a	28.8 a	47.0 b	48.1 a	3.9 a	417.9 a	191.3 ab
1/90 dil. O.C.B.	Westburn M	66 a	586 a	25.8 a	34.3 a	27.9 a	46.0 b-d	46.9 a	3.9 a	416.9 a	191.3 ab
	Stoneville 213	72 a	417 a	24.3 a	34.2 a	28.7 a	45.5 d	47.2 a	3.8 a	406.1 a	190.3 ab
1/60 dil. O.C.B.	Westburn M	65 a	622 a	25.8 a	34.4 a	27.9 a	45.4 d	47.5 a	4.1 a	419.9 a	187.4 b
	Stoneville 213	68 a	416 a	24.3 a	33.9 a	28.3 a	45.6 cd	47.0 a	3.8 a	421.8 a	197.2 a
1/30 dil. O.C.B.	Westburn M	60 a	580 a	25.9 a	34.7 a	27.9 a	46.6 bc	47.2 a	4.1 a	417.9 a	192.3 ab
	Stoneville 213	69 a	365 a	23.8 a	33.6 a	28.6 a	45.8 cd	47.3 a	3.8 a	415.9 a	191.3 ab

*Means within a column followed by the same letter were not significantly different at the 0.05 level of probability.

Table 7. Characters influenced by foliar application by cultivar interactions under irrigated and dryland conditions in 1979.

Foliar application	Cultivar	Plant height	Lint yield	Pulled lint	Picked lint	2.5% span length	Uniformity index	Micronaire	Fiber strength T_0	Fiber strength T_1
		cm	kg/ha	——— %	———	mm	%	μg/in	——— mN/tex	———
None	Westburn	63 a*	600 a	25.8 a	34.5 a	27.9 a	47.5 a	4.1 a	415.9 a	193.3 a
	Stoneville 213	69 a	586 a	24.4 a	33.9 a	27.9 a	47.6 a	3.8 a	419.9 a	189.3 b
1/500 dil. O.C.B.	Westburn M	65 a	429 a	25.9 a	34.6 a	28.5 a	46.4 a	4.0 a	415.0 a	191.3 b
	Stoneville 213	70 a	399 a	24.3 a	34.1 a	28.6 a	46.6 a	3.9 a	413.0 a	193.3 a

*Means within a column followed by the same letter were not significantly different at the 0.05 level of probability.

Table 8. Characters influenced by seed treatment by foliar application interactions under irrigated and dryland conditions in 1979.

Seed treatment	Foliar application	Plant height Irri.	Plant height Dryl.	Lint yield	Pulled lint	Picked lint	2.5% span length	Uniformity index	Micronaire	Fiber strength T_0	Fiber strength T_1
		(Over locations)									
		cm	cm	kg/ha	%	%	mm	%	µg/in	mN/tex	mN/tex
None	None	83 c-e*	51 a	512 a	25.1 a	34.3 a	28.0 a	47.0 a	3.9 a	413.0 a	1[illegible]1.2 a
	1/500 dil. O.C.B.	84 cd	52 a	519 a	25.4 a	34.7 a	28.3 a	47.0 a	4.0 a	417.9 a	192.3 a
Tap water	None	80 fg	51 a	504 a	25.2 a	34.2 a	28.3 a	47.3 a	4.1 a	411.0 a	193.3 a
	1/500 dil. O.C.B.	89 a	51 a	487 a	25.2 a	34.3 a	28.2 a	47.2 a	4.0 a	419.9 a	191.3 a
1/120 dil. O.C.B.	None	81 ef	53 a	545 a	25.4 a	34.3 a	28.3 a	46.9 a	4.0 a	416.9 a	192.3 a
	1/500 dil. O.C.B.	78 gh	54 a	587 a	25.2 a	34.3 a	28.3 a	46.3 a	4.0 a	412.0 a	190.3 a
1/90 dil. O.C.B.	None	85 bc	53 a	518 a	24.9 a	33.9 a	28.2 a	46.8 a	3.9 a	4.2.0 a	192.3 a
	1/500 dil. O.C.B.	87 ab	51 a	485 a	25.1 a	34.6 a	28.4 a	47.1 a	3.8 a	411.0 a	188.4 a
1/60 dil. O.C.B.	None	80 fg	51 a	525 a	25.3 a	34.4 a	28.2 a	46.9 a	4.0 a	418.9 a	191.3 a
	1/500 dil. O.C.B.	82 d-f	52 a	512 a	24.8 a	33.9 a	27.9 a	47.1 a	3.9 a	423.8 a	193.3 a
1/30 dil O.C.B.	None	77 h	51 a	482 a	24.8 a	34.0 a	28.1 a	46.7 a	4.0 a	419.9 a	190.3 a
	1/500 dil. O.C.B.	77 h	52 a	464 a	25.0 a	34.2 a	28.4 a	47.4 a	4.0 a	414.0 a	193.3 a

*Means within a column followed by the same letter were not significantly different at the 0.05 level of probability.

Table 9. Characters influenced by seed treatment by foliar application by cultivar interactions under irrigated and dryland conditions in 1979.

Seed treatment	Foliar application	Cultivar	Plant height	Lint yield	Pulled lint	Picked lint	2.5% span length	Uniformity index		Micronaire		Fiber strength T_0	Fiber strength T_1
			(Over locations)					Irri.	Dryl.	Irri.	Dryl.	(Over locations)	
			cm	kg/ha	%	%	mm	%	%	μg/in	μg/in	cN/tex	cN/tex
None	None	Westburn M	63 g-k[a]	590 a	26.0 a	34.6 a	27.8 a	47.0 a-e	48.2 a	3.6 a-d	4.5 a	409.1 a	193.2 a
		Stoneville 213	71 a-c	435 a	24.2 a	33.9 a	28.2 a	45.9 c-g	46.8 a	3.5 b-d	4.1 a	417.9 a	194.2 a
	1/500 dil. O.C.B.	Westburn M	66 d-h	628 a	26.2 a	35.1 a	28.0 a	46.5 a-f	48.2 a	3.9 a	4.3 a	419.9 a	191.3 a
		Stoneville 213	70 a-d	409 a	24.6 a	34.3 a	28.6 a	46.3 b-g	47.1 a	3.5 b-d	4.3 a	415.9 a	193.2 a
Tap water	None	Westburn M	62 h-k	602 a	25.5 a	34.0 a	28.1 a	48.2 a	48.4 a	3.5 b-d	4.7 a	420.8 a	196.2 a
		Stoneville 213	69 a-e	407 a	24.9 a	34.3 a	28.5 a	45.5 d-g	47.3 a	3.4 cd	4.5 a	401.2 a	190.3 a
	1/500 dil. O.C.B.	Westburn M	69 a-e	535 a	25.8 a	34.4 a	27.8 a	48.0 ab	49.4 a	3.5 b-d	4.5 a	429.7 a	195.2 a
		Stoneville 213	71 a-c	439 a	24.7 a	34.2 a	28.6 a	45.4 e-g	47.0 a	3.4 cd	4.5 a	410.1 a	187.4 a
1/120 dil. O.C.B.	None	Westburn M	63 g-k	609 a	25.9 a	34.6 a	27.8 a	46.5 a-f	47.6 a	3.3 d	4.8 a	413.0 a	194.2 a
		Stoneville 213	71 a-c	490 a	24.8 a	34.1 a	28.9 a	45.9 c-g	47.7 a	3.4 cd	4.4 a	421.8 a	190.3 a
	1/500 dil. O.C.B.	Westburn M	64 f-g	575 a	26.0 a	34.6 a	28.0 a	45.7 c-g	49.0 a	3.5 b-d	4.8 a	410.1 a	187.4 d
		Stoneville 213	69 a-e	399 a	24.4 a	34.0 a	28.7 a	44.9 fg	47.2 a	3.5 b-d	4.3 a	415.0 a	193.3 a
1/90 dil. O.C.B.	None	Westburn M	66 d-h	621 a	25.7 a	34.1 a	27.8 a	47.3 a-c	47.9 a	3.5 b-d	4.5 a	417.9 a	195.2 a
		Stoneville 213	72 ab	415 a	24.2 a	33.7 a	28.6 a	44.6 g	47.5 a	3.3 d	4.3 a	406.1 a	190.3 a
	1/500 dil. O.C.B.	Westburn M	66 d-h	552 a	25.8 a	34.5 a	28.1 a	46.6 a-f	48.4 a	3.4 cd	4.3 a	416.9 a	187.4 a
		Stoneville 213	73 a	419 a	24.4 a	34.7 a	28.8 a	46.7 a-e	46.6 a	3.4 cd	4.2 a	405.2 a	190.3 a
1/60 dil. O.C.	None	Westburn M	64 f-j	611 a	26.1 a	34.7 a	27.9 a	47.2 a-d	47.1 a	3.8 a	4.6 a	416.9 a	189.3 a
		Stoneville 213	67 c-g	439 a	24.4 a	34.1 a	28.6 a	45.8 c-g	47.5 a	3.4 cd	4.1 a	420.8 a	193.3 a
	1/500 dil. O.C.B.	Westburn M	66 d-h	632 a	25.5 a	34.1 a	27.9 a	46.1 c-g	47.8 a	3.3 d	4.6 a	422.8 a	186.4 a
		Stoneville 213	68 b-f	392 a	24.1 a	33.7 a	28.0 a	47.4 a-c	47.0 a	3.6 a-d	4.1 a	423.8 a	190.3 a
1/30 dil. O.C.B.	None	Westburn M	62 h-k	567 a	25.7 a	34.6 a	27.8 a	46.1 c-g	48.1 a	3.7 ab	4.5 a	416.9 a	193.3 a
		Stoneville 213	66 d-h	397 a	23.9 a	33.5 a	28.4 a	46.1 c-g	46.5 a	3.3 d	4.3 a	421.8 a	187.4 a
	1/500 dil. O.C.B.	Westburn M	58 k	593 a	26.1 a	34.7 a	28.0 a	48.0 ab	48.1 a	3.8 a	4.5 a	418.9 a	190.3 a
		Stoneville 213	71 a-c	334 a	23.8 a	33.8 a	28.8 a	45.5 d-g	48.1 a	3.4 cd	4.3 a	410.1 a	195.2 a

[a]Means within a column followed by the same letter were not significantly different at the 0.05 level of probability.

2

VITA

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