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ETHEPHON GROWTH REGULATOR AS A POTENTIAL TOOL FOR MANAGING EXCESSIVE HEIGHT IN SWEET CORN HYBRIDS

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Introduction

Producers of fresh market and processing sweet corn in New York State and other regions find difficulty in growing and handling some hybrids that are too tall. Due to excessive growth habits, these hybrids have a propensity to lodge, are difficult to harvest by machine or by hand, and cannot be planted at high densities to achieve maximum yields. Consequently, producers are often reluctant to grow these otherwise, high quality hybrids. A plant regulator that would reduce the height of theses hybrids at harvest without concurrently affecting critical yield characteristics would be beneficial. Ethephon [(Z-chloroethyl) phosphonic acid] is a growth regulator marketed either as EthrelTM (21.7 % active ingredient) or as CeroneTM (39.9% active ingregient). Ethrel is used on various crops to hasten maturity, and to promote uniform color and loosen fruit. Cerone is widely used as a single application on wheat and barley crops to reduce plant height, increase stalk strength, and reduce lodging. The use of plant regulators to alter the growth of corn plants has not been extensively investigated. Earley and Slife (1969) evaluated Ethrel on dent corn and found that it caused reductions in plant height, but also caused, detrimental effects on leaf area, leaf efficiency and yield of grain. They concluded that the use of this chemical on com produced no beneficial effects. Recently, the manufacturer of Cerone (Rhone-Poulenc Ag Company, Research Triangle Park, NC) has become interested in evaluating the effects and potential benefits of this chemical on sweet corn and popcorn, with the objective of obtaining data for registration.

Here I report results of field studies done on > sweet corn during 1987 and 1988, to determine the /optimum timing and dosages of Cerone treatments, and to evaluate treatment effects on plant height, ear height and yield characteristics.

Methods and Materials

1987 - 'Bellringer' (normal height) and 'Silver Queen" (tall) sweet corn was seeded, 20 Jun, in Tioga silt-loam soil at New Paltz, NY. Hybrids were seeded by tractor mounted planter in 4-row blocks 488 ft. long (36 in. rows; ca. 18,000 plants/acre), and replicated four times in a randomized block design. A seed-furrow application of 500 Ib/acre of 10-20-5 starter fertilizer was followed by 235 Ib/acre of ammonium nitrate (34%) when plants were 12 in. tall.

'Silver Queen' maturity was monitored at regular intervals by slitting the plant length-wise and measuring length of the embryonic tassel (EmT)(Luckmann and Decker, 1952), and subsequently by feeling for the emerging tassel still enveloped in whorl leaves (early green tassel, EGT)(Straub and VanKirk, 1987). To determine plant response to varying dosages of Cerone 4E, 'Silver Queen' was treated at 0,4,8 and 12 oz./acre (0, 0.125, 0.25, and 0.375 Ib Al/acre). Treatments were applied once as a foliar spray, when 50% of the plants in each block were at the 1 in.-EmT, 3 in.-EmT or EGT stage. Applications were made by high-clearance sprayer equipped with a 4-row hydraulic boom, delivering 43 gal/acre at 100 Ib/in2 pressure, through three D2-25 hollow cone nozzles/row. Untreated 'Bellringer' was used as a standard for comparison.

Treatment effects were evaluated when ears reached harvest maturity. Plant height was determined by measuring in inches, the distance from ground level to the tassel apex. Ear height was determined by measuring the distance from ground level to the tip of the primary ear. Measurements were taken on 50 plants per replicate, selected at random. Analysis of variance was performed on height measurements, with mean separation by Duncan's (1955) multiple range test.

1988 - To compare Cerone effects on multiple genotypes, 'Silver Queen[1] (su), Jubilee (SJI), "Crisp & Sweet[1] (sti2) and Tender Treat[1] (sejhybrids were planted 15 Jun, in a split-plot design with four replicates. Hybrids served as main-plots, and all combinations of dosage (0, 8 and 12 oz./acre)and treatment timing (1in.-EmT and EGT) served as sub-plots. Cerone was applied, by the methods described for the 1987 experiment, when 50 percent of the plants reached the appropriate maturity stage. 'Bellringer' was planted separately on 15 Jun, and used as the standard for comparison.

Treatment effects were evaluated when ears reached harvest maturity. Plant height was determined by the method described for the 1987 experiment. Additionally, ear weight was determined by harvesting 25 mature ears at random and weighing on a portable field balance. Ear length was determined by measuring those same ears after the husks were removed, and percent marketable ears was determined by visual assessment of length, diameter, missing kernels, tip fill and husk cover of the ear tip. Split-plot analysis of variance was performed on all measurements, with mean separation by Duncan's (1955) multiple range test.

Results and Discussion

"Silver Queen' plants treated with Cerone were significantly (E<0.05) shorter than untreated plants (Table 1). There was a significant negative relationship between plant height and dosage (Fig. 1): height decreased on the average by 5.39 in. per each 4 oz. incremental increase in dosage. A negative relationship between treatment timing and plant height was less strong, but generally the later the application in relation to plant maturity, the shorter the plants produced.

'Bellringer' is a very popular fresh market hybrid, and presumably represents a desirable height of approximately 76 inches. Given the objective to reduce 'Silver Queen[1] to the stature of 'Bellringer', the optimum dosage-timing was 12 oz./acre applied at 3 in.-EmT. Apparently however, the height status of 'Bellringer[1] could be closely approximated by an application at 8 oz./acre during any period between 1 in.-EmT and EGT, which would yield an average plant height of approximately 80 in.

Although ear height is not a critical corn plant characteristic, it is important to producers who harvest by hand; the nearer the ground the ears, the more difficult would be harvesting. 'Silver Queen' plants treated with Cerone produced ears that were significantly (E<0.05) lower than untreated. No treatments however, resulted in ears that were lower than those of the standard 'Bellringer[1].

Results of 1987 trials clearly showed that Cerone treatments to 'Silver Queen' are effective in reducing plant height without detrimental effects on ear height. Experiments were continued in 1988 to investigate the effects of Cerone on the growth and yield characteristics of two 'normal' and two 'supersweet' hybrids (Table 2). Treatment effects were averaged across all hybrids and compared to untreated. Effects on plant height were similar to those of the previous yearTable 1). and the same conclusions would apply. Ear weight and length were reduced to the greatest extent (£<0.05) by applications at 1 in.-EmT, the earliest application timing. Since ear initiation in a typical midseason hybrid begins at approximately 30 d from emergence (Arnold, 1959), an application at 1 in.-EmT (31 d from emergence) might be expected to influence ear measurements to a greater degree than an application at EGT (52 d from emergence), because primary ear initiation would be more nearly complete at the latter stage of growth. For all hybrids and treatments however, ear weight was reduced <1 oz., and ear length <1 in., suggesting that the impacts on yield would be negligible. Cerone applications at EGT, regardless of dosage, significantly (£<0.05) reduced the number of

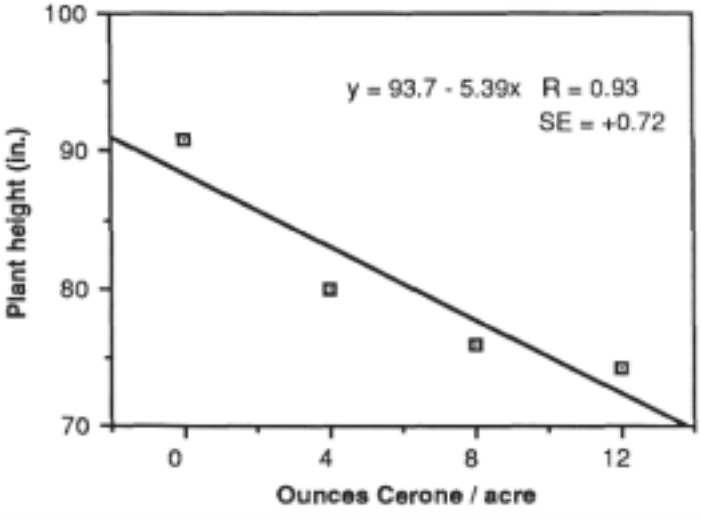

Figure 1. Regression of plant height of 'Silver Queen' on dosage. Data were averaged across three treatment timings (1 in.-EmT,3 in.-EmT and EGT).

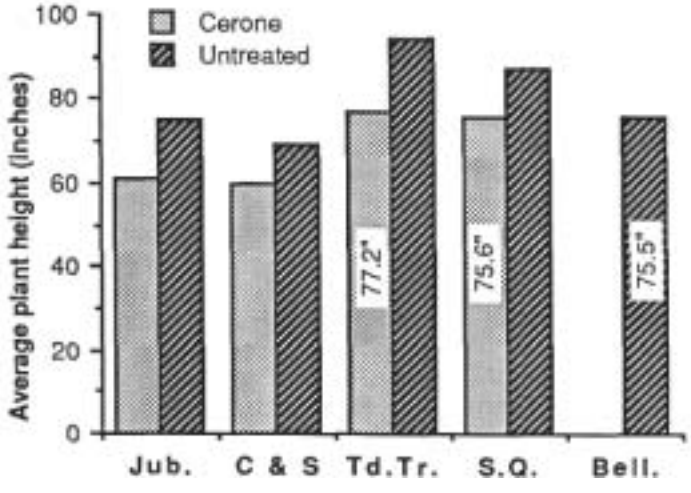

Figure 2. Plant height of four sweet corn hybrids untreated and treated with Cerone growth regulator, compared to untreated 'Bellringer'. Data were averaged across two dosages (8 and 12 oz/acre) and two treatment timings (1 in.-EmT and EGT).

marketable ears. This result gives cause for concern, and is further addressed in the ensuing discussions on hybrid effects.

The response of four hybrids to Cerone (treatments is shown in Table 3. Effects were averaged across all dosages and treatment timings, and compared to untreated. The height of 'Tender Treat' plants was reduced to a significantly greater extent (£<0.05) than was 'Silver Queen'. Tender Treat' and 'Silver Queen' are tall sweet corns (94.4 and 87.1 in., respectively), and both were reduced to the approximate stature of the standard 'Bellringer' (Fig 2). Cerone treatments to all hybrids caused only slight reductions in ear weight and ear length.

Cerone treatments to 'Jubilee' and 'Crisp & Sweet[1] caused significant(£<0.05) reductions in the numbers of marketable ears, primarily due to extention of the cob tip beyond the husk covering. This result yields an unsightly ear that is unacceptable by fresh market quality standards, and can also contribute to increased damage by birds and insects (Dolbeer et al., 1982; Straub, 1989). Further examination of this effect (Table 4) showed that it was limited to 'Jubilee' and 'Crisp & Sweet', when Cerone was applied (regardless of dosage) at EGT. 'Tender Treat' and "Silver Queen' were not affected, suggesting that abnormal elongation of the cob due to Cerone treatment is specific to certain genotypes. Since both 'Jubilee' and 'Crisp & Sweet' are relatively short (Fig 2). Cerone treatments to these hybrids provide no apparent cultural advantage, but may produce detrimental effects when applied close to tassel emergence. Although significant (£<0.01) hybrid x treatment effects were shown, these studies provided no evidence that Cerone treatments had differential effects on 'normal' and 'supersweet' types.

Summary

Cerone growth regulator was shown to be an effective means of reducing the excessive growth of some sweet corn hybrids. When applied at 8 oz./acre, between the 1 in.-EmT and EGT plant growth stages, treatments reduced the tall hybrids 'Tender Treat' (94.4 in.) and 'Silver Queen' (87.1 in.) to the approximate stature of 'Bellringer' (75.5 in.). The following findings

Table 1. Effects of Cerone treatments on plant and ear height characteristics of Silver Queen, New Paltz, NY, 1987.

Rate (ounces/acre)	Treatment timing*	Plant ht. in cm (in.)**	Ear ht. in cm (in.)**
Untreated 'S. Queen'	-	230.6 (90.8) a	115.8 (45.6) a
4	1 in.-EmT	209.3 (82.4) b	101.6 (40.0) bc
4	3 in.-EmT	201.9 (79.5) bc	97.5 (38.4) cde
4	EGT	198.4 (78.1) bc	105.4 (41.5) b
8	1 in.-EmT	199.4 (78.5) bc	92.5 (36.4) d
8	3 in.-EmT	195.1 (76.8) bcd	92.3 (37.5) cde
8	EGT	183.6 (72.3) de	98.8 (38.9) bcd
12	1 in.-EmT	195.8 (77.1) bcd	90.4 (35.6) e
12	3 in.-EmT	192.0 (75.6) cd	101.6 (40.0) bc
12	EGT	177.6 (69.9) e	97.5 (38.4) cde
Untreated 'Bellringer'	-	192.5 (75.8) cd	84.1 (33.1) f
	SEM =	1.74	0.90

* 1 in.- and 3 in.-EmT, when embryonic tassel is 1 and 3 in. length, respectively; EGT, early green tassel stage when emerging tassel can be felt within the whorl.
** Means followed by the same letter are not significantly different (P<0.05; Duncan's [1955] multiple range test).

Table 2. Alteration of plant growth and yield characteristics of four sweet corn hybrids by applications of Cerone plant regulator, New Paltz, NY, 1988.

		Percent reduction relative to untreated*				
Rate (oz./acre)	Application timing**	Plant ht.	Ear ht.	Ear wt.	Ear lth.	Marketable ears
8	1 in.-EmT	14.6 b	9.9 b	6.0 b	5.6 a	1.3 c
12	1 in.-EmT	18.7 a	11.9 a	7.6 a	4.3 b	9.8 b
8	EGT	14.5 b	4.1 c	3.4 c	0.7 c	25.0 a
12	EGT	17.2 a	5.3 c	3.6 c	0.6 c	28.4 a
	SEM =	2.40	1.64	1.53	1.59	6.42

* Data averaged across four hybrids. Means followed by the same letter are not significantly different (P<0.05; Duncan's [1955] multiple range test).
** 1 in.-EmT, when embryonic tassel is 1 in. long; EGT, early green tassel stage when emerging tassel can be felt within the whorl.

Table 3. Alteration of plant growth and yield characteristics of four sweet corn hybrids by applications of Cerone growth regulator, New Paltz, NY, 1988.

	Percent reduction relative to untreated*				
Hybrid**	Plant ht.	Ear ht.	Ear wt.	Ear lth.	Marketable ears
'Jubilee'	17.7 ab	21.2 b	6.2 a	3.0 a	21.9 a
'Crisp & Sweet'	15.8 bc	28.4 b	6.0 a	2.6 ab	32.2 a
'Tender Treat'	18.3 a	47.2 a	3.5 a	1.0 b	9.0 b
'Silver Queen'	13.2 c	28.0 b	4.9 a	4.6 a	1.3 b
SEM =	3.49	4.06	3.30	2.16	16.7

* Data averaged across two dosages(8 and 12 oz.) and two treatment timings(1 in.-EmT and EGT). Means followed by the same letter are not significantly different (P<0.05; Duncan's [1955] multiple range test).
** 'Jubilee' and 'Silver Queen', su; 'Crisp & Sweet', sh_2; 'Tender Treat', se.

Table 4. Effects of Cerone growth-regulator applications on 'husk-cover' characteristic of four sweet corn hybrids, New Paltz, NY, 1988.

		Percent ears with cob tip extending from husk (corrected for untreated effects)*				
Rate (oz./acre)	Treat. timing**	'Jubilee'	'Crisp & Sweet'	'Tender Treat'	'Silver Queen'	Avg.
12	EGT	50.0	45.2	0.0	1.4	24.2 a
8	EGT	32.5	46.6	2.7	1.4	20.8 a
12	1 in-EmT	2.5	32.9	0.0	0.0	8.9 b
8	1 in.-EmT	1.3	0.0	0.0	0.0	0.3 c
	Avg. =	21.6 a	31.2 a	0.7 b	0.7 b	

* Corrected by formula: *treated % - untreated % / 1 - untreated %* . Column and row means followed by the same letter are not significantly different (P<0.05; Duncan's [1955] multiple range test).
** 1 in.-EmT, when embryonic tassel is 1 in. length; EGT, early green tassel stage when emerging tassel can be felt within the whorl.

are pertinent to conclusions about the performance of Cerone growth regulator when applied to sweet corn:

1. Dosage was generally a more important factor in reducing plant height than was application timing. Height decreased on the average by 5.39 in. per each 4 ounce incremental increase in dosage.
2. Treatments reduced the height of ears from ground level, but did not produce ears lower than those of 'Bellringer'.
3. Ear weight and ear length of some hybrids was reduced, but not by more than 1 oz./ear or 1 in./ear. The earlier the plant growth stage at application, the greater the reduction.
4. Treatments caused a significant number of ears in which the cob tip grew beyond the husk covering. This factor was characteristic of 'Jubilee' and "Crisp & Sweet', and was produced only by applications at the EGT growth stage.
5. Treatments had no differential effects on 'normal' and 'supersweet' sweet corn types.

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