ENHANCED SUGARCANE ESTABLISHMENT USING PLANT GROWTH REGULATORS

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ABSTRACT

Since sugarcane is vegetatively propagated, large amounts of seed cane are used in order to insure a good stand. Plant growth regulator compounds, often used as ripening agents, can cause sprouting at lower nodes. This response to growth regulators could lead to better stands at planting while possibly using less seed. Field studies were conducted over three years to determine the effectiveness of different plant growth regulator compounds and methods of application on emergence enhancement for several different sugarcane cultivars. In the first test, application of ethephon [(2-chloroethyl) phosphonic acid] or glyphosate [isopropylamine salt of N-(phosphonomethyl) glycine] to standing cane three weeks prior to cutting as seed had no effect, or decreased shoot counts in the sugarcane stand planted with this seed source. Ethephon application to the seed pieces in-furrow at planting at the standard seed cane planting rate tended to increase shoot counts in the new planting for the first four months, and stalk heights for five months after planting on some cultivars. In the second test, ethephon application in-furrow at planting at reduced seed cane planting rates increased shoot counts for up to nine months following planting but had very little effect on stalk heights, again only on some cultivars. In the third test in two commercial plantings, ethephon application had very little effect on shoot counts or stalk heights, but seed cane planting rates used by planting crews turned out to exceed recommended levels. Also, the two cultivars in these plantings may have been less responsive to ethephon than others used in the earlier tests. Even when seed cane planting rates in the commercial plantings were reduced by 32%, no differences in final shoot populations were found indicating that the planting rates used were much higher than necessary. Ethephon application to seed cane in-furrow at planting was effective in increasing tillering, but natural declines in shoot population when stalk growth rates were highest eliminated any benefit except where very low seed cane planting rates were used.

INTRODUCTION

Sugarcane is vegetatively propagated, therefore large amounts of seed cane are required for a new planting. The recommended planting rate is around 9 to 10 Mg ha^{-1}, but higher rates are often used. Fields used as a source of seed cane are lost for production that year, which takes out about 3% of all fields each year in Texas. While some sugarcane is planted mechanically, most is still planted by hand in Texas. Since a sugarcane crop will generally be grown for several years, it is important to insure a good stand. Therefore growers often plant very high rates of seed cane to make sure they have enough viable seed pieces for good field establishment.

Plant growth regulators (PGRs) act on sugarcane by modifying or retarding some aspect of cane growth (Alexander, 1973). PGRs are used to stimulate sugar accumulation in the stalk on mature cane. Ripening using various growth regulating compounds is a common practice on sugarcane around the world (Eastwood and Davis, 1997), but only glyphosate [isopropylamine salt of –(phosphonomethyl) glycine] is used in the United States for this purpose. A common side effect of PGR application has been the formation of sideshoots from lower nodes. Sprouting of additional buds would result in more shoots and a better stand from the seed cane planted. Studies have indicated that certain plant growth regulator compounds increase tillering in newly planted sugarcane in greenhouse tests, but responses varied with cultivar (Bischoff and Martin, 1986; Eiland and Dean, 1985; Wong-Chong and Martin, 1983). In South Texas, dipping of seed pieces in a solution of ethephon [(2-chloroethyl) phosphonic acid) enhanced tillering of cultivar NCo 310 (Wiedenfeld, 1988). While dipping seed pieces may be effective, a more practical and economical application method would be desirable.

The objective of this study was to determine the effectiveness of different plant growth regulator compounds and methods of application on sugarcane emergence enhancement for several different cultivars.

MATERIALS AND METHODS

Field studies were conducted over a three year period in the Lower Rio Grande Valley of Texas, an area with a subtropical, semiarid climate (average annual rainfall - 500 mm). Soils are alluvial, medium textured (typically sandy clay loam) and calcareous.

During the first two years, tests were conducted on a Raymondville clay loam soil (Fine, mixed, hyperthermic Vertic Calciustolls) with a pH of 8.2. Treatments were applied to 5 sugarcane cultivars: CP70-321, CP71-1240, CP72-1210, CP80-1827 and TCP87-3388; and were applied in plots 6.1 m wide (4 rows spaced 1.5 m apart) by 9.1 m in length in randomized block designs with 6 replications. Treatments in the first year consisted of an untreated check, application of ethephon [(2-chloroethyl) phosphonic acid, Ethrel®, Rhone-Poulenc] or glyphosate [isoropylamine salt of N-(phosphonomethyl) glycine, Roundup®, Monsanto] to standing cane 3 weeks prior to cutting for seed cane, or application of ethephon in-furrow to the seed cane at planting (Table 1). Ethephon was applied at the rate of 119 g a.i./ha, and glyphosate was applied at the rate of 301 g a.i./ha. Seed cane planting rate was double stalk overlap plus about 25%, or approximately 3900 pieces 1.5 m long per ha, which is the recommended rate for South Texas (Rozeff, 1998).

Treatments the second year consisted of an untreated check or application of ethephon in-furrow to the seed cane at planting at the above rate, with seed cane planted at 2 different densities - single and double stalk overlap (Table 1). Cultivar CP80-1827, used the first year, was replaced with cultivar CP81-1405 the second year due to lack of response to treatments and because CP80-1827 is not widely grown while CP81-1405 was thought to have potential for use in the Lower Rio Grande Valley of Texas. The amount of seed cane planted was measured in the second year by weighing all cane planted in each plot.

The third year tests were conducted in two commercial plantings. The Hiler location was on a

Hidalgo sandy clay loam soil (Fine-loamy, mixed, hyperthermic Typic Calciustolls, pH 8.3) using cultivar TCP87-3388, and the Beckwith location was on a Harlingen clay soil (Very-fine, montmorillonitic, hyperthermic Entic Chromusterts, pH 8.1) using cultivar CP70-1133. Treatments consisted of an untreated check or ethephon application at the above rate applied to the normal rate of seed cane being planted by the commercial crews, or to a reduced cane planting rate (Table 1). The reduced rate was achieved by asking the commercial planting crews to plant at half of the normal rate. Treatments were applied in plots 1.5 m wide (1 row) by 30.5 m in length in randomized block designs with 3 replications at both locations. The third year, all seed cane planted was weighed in two 3 m sections of row in each plot.

Tests were furrow irrigated as required, and received herbicide application and mechanical cultivation for weed control each year. Shoot population counts were made by counting all shoots in two 3 m sections of row in each plot. Counts were initiated about 8 weeks following planting and continued periodically for a total of 10 to 16 counts until mid-August each year. Stalk height was measured on 3 stalks per plot in the first and second years, and on 2 stalks per plot in the two commercial tests the 3rd year. Stalk measurements were taken between 5 and 13 times in each study depending on the year. All data were analyzed statistically by cultivar using Analysis of Variance and Duncan's multiple range test.

RESULTS AND DISCUSSION

During each growing season shoot counts generally increased until a peak was reached, typically when maximum stalk growth rates were occurring, then tended to decline thereafter (Figs. 1-3). Highest average stalk growth rates approached 3.9 cm per day. Some differences in shoot counts and growth rates between cultivars were observed.

Ethephon application in-furrow tended to be the most effective at increasing shoot counts and heights in 1998 (Fig. 1). When a significant treatment effect occurred on shoot counts (20 out of 65 cultivar x date combinations) and plant heights (6 out of 25 cultivar x date combinations, Table 2), in-furrow ethephon application increased shoot counts 25% of the time, and increased stalk heights 67% of the time. Glyphosate application to standing cane appeared to have a detrimental effect on shoot counts at some dates. Where statistically significant treatment effects are indicated in Table 2, glyphosate application caused a reduction in shoot counts 95% of the time, and a reduction in stalk heights 50% of the time. Ethephon application to standing cane appeared to have very little effect. Treatment effects on shoot counts tended to disappear after about 4 months following planting. Treatments effects in this first test were most pronounced on cultivars CP70-321, CP70-1240 and CP72-1210; and were less evident or nonexistent on CP80-1827 and TCP87-3388. Amount of seed cane used in the first experiment was not measured, but planting rate was based on the "standard" recommendation which results in about 9 Mg/ha being planted. It was concluded that ethephon application in-furrow at planting was the treatment that showed the most promise based on the results obtained this first year. It was also observed that shoot numbers rose and then declined to an equilibrium level later in the season, indicating that the beneficial effects of ethephon on shoot emergence might be maximized at reduced planting rates.

Therefore, a standard double stalk overlap and a reduced single stalk overlap planting rate were used in the second test (Table 3) with and without in-furrow ethephon application. The beneficial effects of ethephon application occurred most dramatically at the reduced planting rate, increasing shoot counts in some cases up to the levels obtained at the higher planting rate without ethephon application in this study (Fig. 2). Where treatment effects were statistically significant on shoot population (32 of 50 cultivar x date combinations, Table 4), 41% of those were due to ethephon application. Stalk heights were affected by treatment on only 6 of the possible 35 cultivar x date combinations, but on 5 of those 6 occasions the effect was due to ethephon application. Where significant treatment effects occurred on the parameters measured not attributable to ethephon application, the effect was due to differences in the amount of seed cane planted. Also, treatment effects on shoot counts persisted for 9 months after planting (Table 4). Cultivars CP71-1240 and CP72-1210 showed the greatest response to the ethephon treatment, as in the previous trial. TCP87-3388 shoot counts were affected by treatments applied in the second experiment, but the effect was almost entirely due to amount of seed cane planted. Differences between sugarcane cultivars in responses to PGR's has been routinely observed, making it necessary to calibrate PGR applications based on the response desired for each cultivar.

The rate of seed cane planted turned out to be higher than "recommended rates" in both commercial fields used in the 3rd experiment (Table 3). Some treatment effects on shoot counts were observed (Fig. 3) at one of the two locations up to almost 4 months after planting, but none were observed thereafter (Table 5). The cultivar TCP87-3388 used at the Hiler location showed little response to ethephon application in the prior tests while cultivar CP70-1133 used at the Beckwith location had not been tested in the first two years of this study.

CONCLUSIONS

This study indicates that ethephon application in-furrow at planting on sugarcane seed pieces does increase shoot counts and stalk heights on some cultivars, in particular CP71-1240 and CP72-1210. However, since shoot numbers in sugarcane tend to increase rapidly early during growth but then decline to an equilibrium level later in the season when the most rapid growth rates occur, the beneficial effects of the increased shoot counts that were caused early in the season tend to disappear. Only where substantially reduced planting rates are used does the benefit of the increased shoot counts persist through the entire growing season.

Another possible benefit of increased early season shoot counts and stalk heights would be to cause quicker canopy cover providing better competition over weeds. While glyphosate would not work for this purpose, ethephon may be a viable candidate for this use, although it would be necessary to determine whether the magnitude of the response would be adequate to provide the desired benefit.

Where reduced planting rates were used in the commercial sugarcane fields, no reduction in final shoot counts were obtained compared to the growers' standard planting rates regardless of ethephon treatment, indicating that these growers were using substantially more seed cane than is necessary to obtain maximum stands.

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Table 1. Description of treatments, planting densities, and cultivars evaluated vs variables in 3 experiments.

Season	Treatments	Plant densities	Cultivars	Planting dates
1998	untreated control	n.a.	CP70-321	7,8 Jan 98
	ethephon @ 119 g/ha (3 wks prior to cutting seed)		CP71-1240	
	ethephon @ 119 g/ha (in-furrow to seed)		CP72-1210	
	glyphosate @ 301 g/ha (3 wks prior to cutting seed)		CP80-1827	
			TCP87-3388	
1999	untreated control	single overlap	CP70-321	14-17 Dec 98
	ethephon @ 119 g/ha (in-furrow to seed)	double overlap	CP71-1240	
			CP72-1210	
			CP81-1405	
			TCP87-3388	
2000-01	untreated control	commercial	TCP87-3388	12 Aug 00
	ethephon @ 119 g/ha (in-furrow to seed)	reduced	CP70-1133	24 Aug 00

Table 2. Statistical significance of treatment effects on mean shoot population (pop) and height (hgt) measured for 5 sugarcane cultivars on various days after planting (DAP) in the first year.

		CP70-321		CP71-1240		CP72-1210		CP80-1827		TCP87-3388	
Date	DAP	pop	hgt	pop	hgt	pop	hgt	pop	hgt	pop	hgt
Mar 2	55	***	-	***	-	*	-	***	-	ns	-
16	68	***	-	***	-	**	-	*	-	ns	-
30	82	***	-	**	-	*	-	ns	-	ns	-
Apr 14	97	*	-	*	-	s	-	ns	-	ns	-
27	110	s	-	*	-	*	-	ns	-	*	-
May 11	124	*	-	*	-	ns	-	ns	-	ns	-
25	138	ns	-	ns	-	ns	-	ns	-	ns	-
Jun 8	152	ns	*	ns	ns	ns	*	ns	ns	ns	ns
22	166	ns	ns	ns	ns	ns	*	ns	ns	ns	ns
Jul 8	182	ns	ns	ns	*	ns	ns	ns	ns	ns	ns
20	194	ns	ns	ns	*	ns	s	ns	ns	ns	ns
Aug 3	208	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns
19	224	ns	-	ns	-	ns	-	ns	-	ns	-

Differences between treatments means were statistically significant at the 10% (s), 5% (*), 1% (**) or 0.1% (***) level; or were not significantly different (ns).

Table 3. Seed cane planting rate for the different planting densities in the 2nd and 3rd years of the study.

Season	Location	Sugarcane Cultivar	Seed piece density[1] low	Seed piece density[1] high
			------- Mg/ha -------	
1999		CP70-321	3.6	7.0
		CP71-1240	4.5	9.1
		CP72-1210	4.4	9.1
		CP81-1405	4.5	8.8
		TCP87-3388	3.8	8.2
2000-01	Hiler farm	CP70-1133	9.0	13.4
	Beckwith farm	TCP87-3388	9.4	13.8

[1]Planting densities used in the 1999 crop were single (low) and double (high) overlap; and in the 2000-01 crop were a reduced (low) and a commercial (high) rate.

Table 4. Statistical significance of treatment effects on mean shoot population (pop) and height (hgt) measured for 5 sugarcane cultivars on various days after planting (DAP) in the second year.

		CP70-321		CP71-1240		CP72-1210		CP81-1405		TCP87-3388	
Date	DAP	pop	hgt	pop	hgt	pop	hgt	pop	hgt	pop	hgt
Feb 9	54	**	-	***	-	s	-	ns	-	***	-
Apr 12	116	*	-	***	-	***	-	ns	-	***	-
27	131	ns	-	***	-	**	-	ns	-	***	-
May 13	147	ns	-	***	-	**	-	ns	-	***	-
24	158	-	ns	-	*	-	ns	-	ns	-	ns
Jun 9	174	ns	ns	***	ns	***	s	ns	ns	**	ns
23	188	ns	ns	***	ns	***	ns	ns	ns	**	ns
Jul 7	202	ns	ns	***	ns	***	s	s	ns	*	ns
22	217	ns	ns	***	*	***	ns	ns	ns	ns	ns
Aug 4	230	ns	ns	***	ns	***	ns	ns	ns	**	ns
28	285	ns	ns	***	ns	***	ns	ns	s	*	ns

Differences between treatments means were statistically significant at the 10% (s), 5% (*), 1% (**) or 0.1% (***) level; or were not significantly different (ns).

Table 5. Statistical significance of treatment effects on mean shoot population (pop) and height (hgt) measured at 2 locations on various days after planting (DAP)in the third year.

Hiler farm TCP87-3388				Beckwith farm CP70-1133			
Date	DAP	pop	hgt	Date	DAP	pop	hgt
Oct 24	73	ns	-	Oct 24	61	ns	-
Dec 7	117	*	-	Dec 11	109	ns	-
Jan 2	143	*	-	Jan 2	131	ns	-
23	164	ns	ns	23	152	ns	-
Feb 6	178	ns	s	Feb 6	166	ns	-
Mar 1	201	ns	ns	Mar 1	189	ns	-
15	215	ns	ns	15	203	ns	-
26	226	ns	ns	Apr 2	221	ns	-
Apr 2	233	ns	ns	May 1	250	ns	ns
May 1	262	ns	ns	16	265	ns	ns
16	277	ns	ns	Jun 1	281	ns	ns
Jun 1	293	ns	ns	12	292	ns	ns
12	304	ns	ns	27	307	-	ns
27	319	ns	ns	28	308	ns	-
Jul 18	340	ns	ns	Jul 18	328	ns	ns
27	349	ns	ns	27	337	ns	ns
Aug 9	362	ns	ns	Aug 9	350	ns	ns

Differences between treatments means were statistically significant at the 10% (s) or 5% (*) level, or were not significantly different (ns).

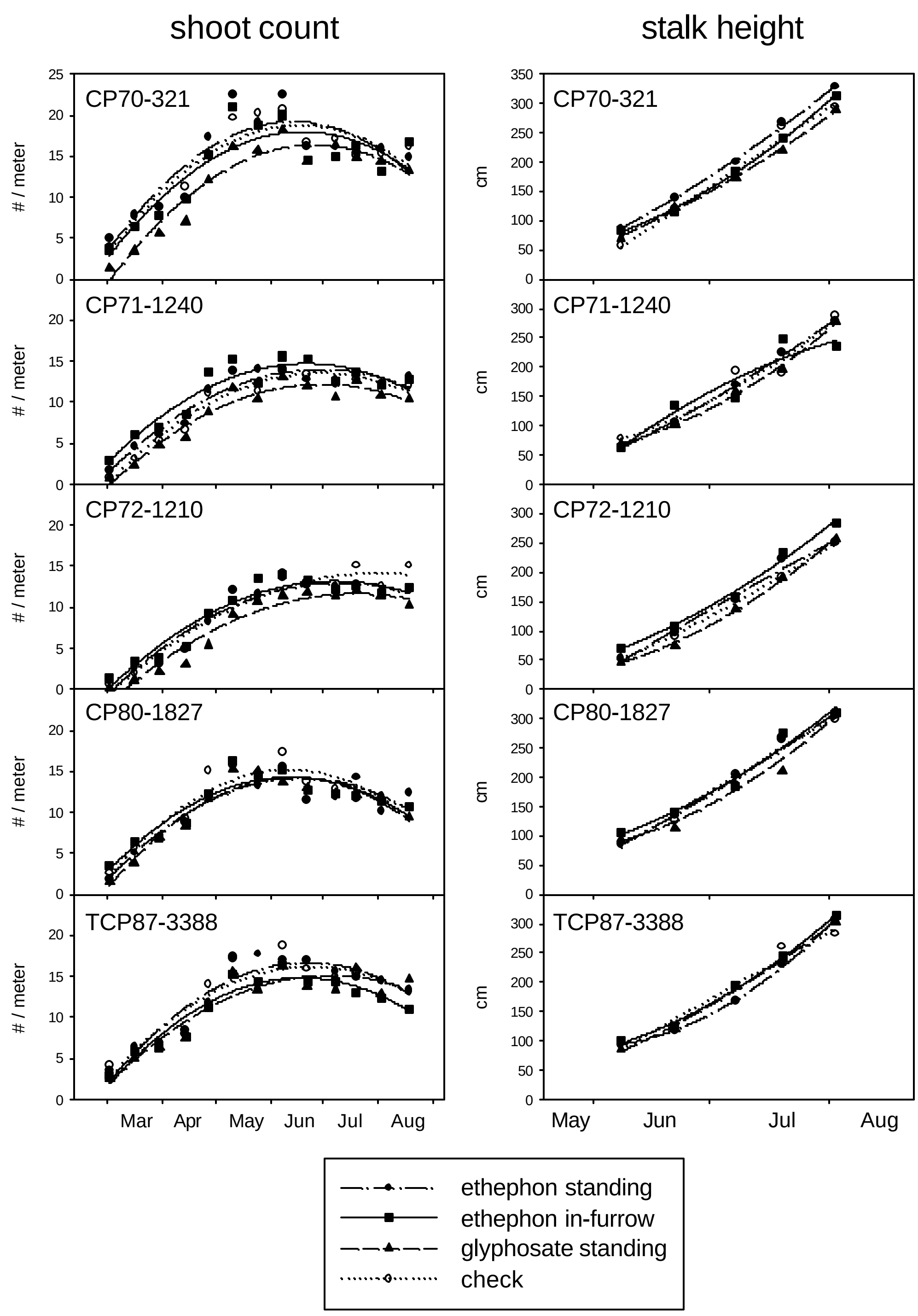

Figure 1. Sugarcane shoot counts and heights over time for different cultivars showing the effect of ethephon and glyphosate on standing cane and ethephon application in-furrow vs. a check in the 1st year of the study.

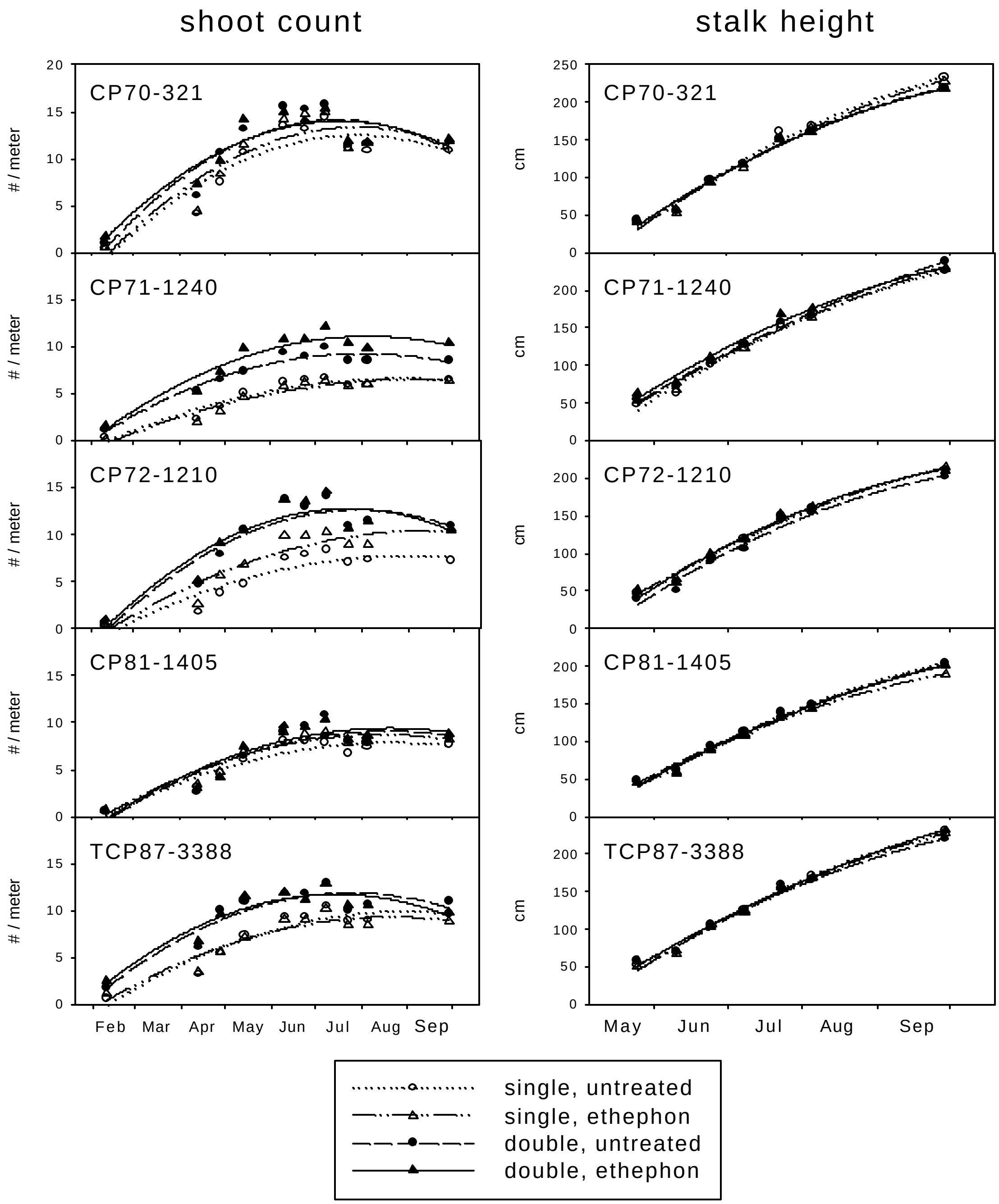

Figure 2. Sugarcane shoot counts and heights over time for different cultivars showing the effect of ethephon vs. untreated at single and double overlap planting rates in the 2nd year of the study.

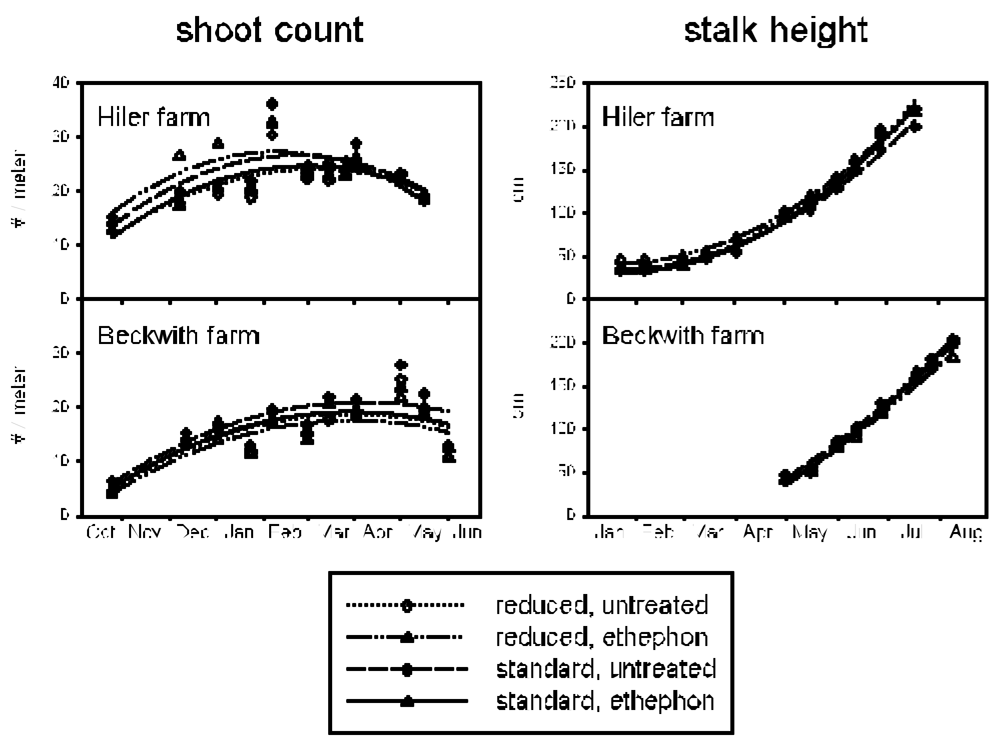

Figure 3. Sugarcane shoot counts and heights over time for two different locations and cultivars showing the effect of ethephon vs. untreated at reduced and standard planting rates in the 3rd year of the study.