EFFECTS OF A FOLIAR APPLIED CYTOKININ ON SUGARBEET

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The initial interest in manipulating plant hormones for agronomic benefit probably coincides with their discovery. Crop science journals have documented numerous attempts to increase productivity through hormone application or alteration. These efforts have attempted to alter every developmental phase from germination to senescence. While this research has encompassed a wide variety of crop species, environments, and objectives, growth regulator (hormone) usage remains minimal in commercial field crop production.

The success of applied growth regulators in sugarbeet (*Beta vulgaris* L.) generally parallels that of other agronomic crops. Akeson et al. (1981) found that growth regulators alone did not improve field emergence of sugarbeet. Papakosta-Tasopoulou and Sficas (1978) concluded that the yield increases resulting from gibberellin applications were too small to be of economic benefit. The effect of gibberellins on bolting can be used to manipulate flowering (Gaskill, 1957). Hepler (1973) reported that growth retardants applied late in the growing season had less impact upon sugarbeet quality than proper soil nitrogen management. Soil injected ethylene gas did not increase productivity in Arizona (Francl et al., 1977).

Cytokinins' ability to influence cell division and enlargement suggests a possible influence on root yield and/or sucrose concentration. TRIGGRR[1] (Westbridge Agricultural Products, San Diego, CA) is a cytokinin containing plant growth regulator produced by a propriety process utilizing microbial fermentation. In world wide tests, it reportedly increased yields in 86 to 100% of the trials, depending upon crop species. Increases were observed in 11 of 13 species examined. Among the responses observed were: increased root development, increased fruit size, increased sugar content, enhanced stress tolerance, increased height and leaf area index, and increased photosynthesis (Salk and Parker, 1987; Parker and Salk, 1988).

This study examines the potential of TRIGGRR as a growth regulator for enhancing sugarbeet productivity in the Red River Valley. Yield and storage characteristics were evaluated in a three-year field trial.

Materials and Methods

Field trials were conducted in Cass County, North Dakota in 1988, 1989, and 1990. Plots were established using conventional tillage practices and commercial hybrid seed. All plots consisted of six rows 9.1 m long and 56 cm apart. Within row spacing was 20 cm. The experimental design was a randomized complete block with five replications per year. The

[1] Mention of a proprietary product name is for identification purposes only, and does not imply a warranty or an endorsement to the exclusion of other products that may be similar.

treatments consisted of seven TRIGGRR rates (0, 0.146, 0.292, 0.584, 1.168, 2.336, and 4.672 L ha^{-1}). The center four rows of each experimental unit received three applications of one of the seven rates. Treatments were broadcast at the 2-, 4-, and 6-leaf stage with a bicycle-wheel plot sprayer that delivered 158 L ha^{-1} at 276 kPa. In late September, the center two rows of each plot were defoliated with a commercial sugarbeet defoliator and harvested with a modified one-row mechanical sugarbeet harvester. A random 10-beet sample from each plot was sent to American Crystal Sugar Co. quality laboratory in East Grand Forks, Minnesota for quality analysis. All yield and quality data were reported on a fresh weight basis. Respiration rate was determined in a manner similar to that described by Dilley et al. (1969). Thirty days after harvest approximately 10 beets from each plot were placed in 23 L sealed containers. A constant flow of outside air was provided. After 36 to 48 hours an air sample from the exit tube of each container was obtained, CO_2 concentration determined, and respiration rate calculated. Roots were evaluated for response to two important storage rot fungi (*Phoma betae* (Oud.) Frank and *Botrytis cinerea* Pers. ex Fr.) after being stored at 5°C for 80 days. Blocks of root tissue were placed in petri dishes containing agar cultures of the rot fungi, incubated for 14 days, and visually rated (Bugbee, 1979). The percentage of the tissue invaded by the fungi was estimated.

Results and Discussion

Year effects were significant for all traits reported. Average root yields ranged from 41.8 Mg ha^{-1} in 1989 to 50.1 Mg ha^{-1} in 1990 (Table 1). Sucrose concentration was also low in 1989 and, as a result, recoverable sucrose yields for 1989 were 20% less than 1991 yields and 30% less than 1990 yields. 1989 was relatively dry, plus subsoil moisture had been depleted by the extreme drought the previous year. Ample rainfall in June and less extreme conditions throughout the remainder of the growing season produced more "typical" conditions in 1990 and 1991. Storage respiration rate was lower in 1991 than in 1990, in contrast to storage rots, which were more detrimental in 1991 than 1990. There is no obvious explanation for these differences in storability; however, year to year differences have been reported in other studies. TRIGGRR application rate **X** year interactions were nonsignificant for all traits, indicating a similar response pattern in all years. Nonsignificant treatment effects indicated that

Table 1. Year means of sugarbeet receiving seven rates of a foliar applied cytokinin, Cass County, North Dakota.

Year	Root yield	Sucrose	Recoverable sucrose	Respiration rate	Botrytis	Phoma
	Mg ha^{-1}	g kg^{-1}	kg ha^{-1}	$ml CO_2 kg^{-1} h^{-1}$	---- % ----	
1989	41.8b*	150c	5427c	----	--	--
1990	50.1a	172b	7695a	10.48a	70b	64b
1991	44.0b	177a	6726b	4.62b	72a	77a
Mean	44.6	166	6616	7.55	80	71

* Means within a column followed by the same letter are not significantly different ($LSD_{.05}$).

TRIGGRR application rate had no effect upon sugarbeet productivity (Table 2). The zero treatment rate (check) was neither consistently higher nor lower than any other treatment for root yield, sucrose concentration, or sucrose yield. Because of the absence of any indication of a treatment response pattern, regression analysis did not seem appropriate. There was no indication that TRIGGRR application affected storability of sugarbeet.

Table 2. Treatment means of sugarbeet treated with a foliar cytokinin, Cass County, North Dakota, 1989-1991.

Rate	Root yield	Sucrose	Recoverable sucrose	Respiration rate	Botrytis	Phoma
L ha^{-1}	Mg ha^{-1}	g kg^{-1}	kg ha^{-1}	$mlCO_2kg^{-1}h^{-1}$	----- % -----	
0.000	46.2	164	6651	7.52	78	71
0.146	43.9	170	6558	7.47	81	71
0.292	45.6	166	6667	8.44	76	69
0.584	44.6	168	6592	7.47	82	69
1.168	45.3	165	6585	7.56	82	74
2.336	45.1	165	6522	6.98	83	74
4.672	46.3	165	6735	7.38	80	68

The lack of a discernible response to TRIGGRR suggested that either foliar applied TRIGGRR does not increase sugarbeet productivity or that it should be applied differently. Results similar to those reported here were obtained in a 1988 study that differed from this study only in the rates applied. In addition, the photosynthetic rate was not affected by TRIGGRR in the 1988 trials. In another 1988 field trial, there appeared to be no benefit when application of the 0.584 L ha^{-1} rate was delayed, with applications continuing up to the 14-leaf stage. Foliar applied TRIGGRR also failed to increase hard red spring wheat yields at a nearby site (Spilde, 1988). This lack of response appears inconsistent with the 10.4% increase in recoverable sugar yield reported by Salk and Parker (1987). In some crops, TRIGGRR appeared to enhance stress tolerance. We did not observe a unique response pattern in 1988 or 1989, both unusually dry years. In conclusion, we found no basis for recommending foliar applied TRIGGRR on sugarbeet or continuing this research. This does not preclude the possibility that changing application procedures or timing might ellicit a response from TRIGGRR.

References

Akeson, W. R., A. H. Freytag, and M. A. Henson. 1981. Improvement of sugarbeet seed emergence with dilute acid and growth regulator treatments. Crop Sci. 21: 307-312.

Bugbee, W. M. 1979. The effect of plant age, storage moisture, and genotype on storage rot evaluation of sugarbeet. Phytopathology 69: 414-416.

Dilley, R. D., D. H. Dewey, and R. R. Dedolph. 1969. Automated system for determining respiratory gas exchange of plant materials. J. Am. Soc. Hort. Sci. 94: 138-141.

Francl, L. J., R. E. Dennis, D. K. Parsons, and A. H. Freytag. 1977. Effect of soil injected ethylene on sugarbeet (*Beta vulgaris* L.) yield parameters. J. Am. Soc. Sugar Beet Technol. 19: 331-335.

Gaskill, J. O. 1957. A preliminary report on the use of gibberellic acid to hasten reproductive development in sugarbeet seedlings. J. Am. Soc. Sugar Beet Technol. 9: 521-528.

Hepler, P. R. 1973. A field study of three growth retardants on sugarbeet. J. Am. Soc. Sugar Beet Technol. 17: 315-318.

Papakosta-Tasopoulou, Despo and A. G. Sficas. 1978. Bolting,fresh root yield, and soluble solids of sugarbeets as affected by sowing date and gibberellin treatment. J. Am. Soc. Sugar Beet Technol. 20: 115-126.

Parker, L. W. and P. L. Salk. 1988. Foliar TRIGGRR and soil TRIGGRR, new plant growth regulators to increase cotton yields. Beltwide Cotton Production Conference Proceedings, 1988.

Salk, P. L. and L. W. Parker. 1987. Soil TRIGGRR and foliarTRIGGRR: plant growth regulators containing cytokinin. Proceedings of the Plant Growth Regulator Soc. of Am. 14: 369-376.

Spilde, L. A. 1988. Hard red spring wheat response to TRIGGRR. *In* Annual Agricultural Short Course and Trade Show. North Dakota Agricultural Association, Fargo. pp 351-353.