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Use of Growth Retardants to Improve Ripening Uniformity and Yield of Processing Tomatoes

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Abstract. **After the major fruit set period was completed, aqueous sprays of 1000 ppm dikegulac, 66 ppm ancymidol, 1000 ppm maleic hydrazide (MH), and 1 kg·ha^{-1} RSW 0411 were applied to processing tomato (*Lycopersicon esculentum* Mill) plants. Dikegulac, RSW 0411, and ancymidol visually reduced vegetative growth, whereas MH had no apparent influence. None of the compounds reduced the number of flower clusters or flowers per cluster on the late-season growth, but dikegulac and RSW 0411 did reduce the percentage of fruit set in the terminal regions. The partial reductions in late vegetative and/or reproductive growth from the chemical treatments did not enhance uniformity of fruit maturity. Only the dikegulac treatment decreased the yields and percentage of green fruit from the harvest. Chemical names used: 2,3:4,6-bis-*O*-(1-methylethylidene-d-L-*xylo*-2-hexulofuranosonic acid (dikegulac); α-cyclopropyl-α-(4-methoxyphenyl)-5-pyrimidinemethanol (ancymidol); 1,2-dihydro-3,6-pyridazinedione [maleic hydrazide (MH)]; and β-(cyclohexylmethylene-α-(1,1-dimethylethyl)-1*H*-1,2,4-triazole-1-ethanol (RSW 0411).**

A proper balance of growth is necessary throughout the entire season to ensure high, early, concentrated yields of processing tomatoes for machine harvest. Once the majority of fruit has set, subsequent reproductive growth produces fruit that does not contribute to usable yield. The late vegetative and reproductive growth competes with the maturing fruit for assimilates and delays the maturity of the early set fruit (5, 6, 10). We have conducted preliminary field research removing late vegetative growth by hand, but it was very laborious and was uneffective in improving ripening uniformity. A growth regulator could provide a cost-effective method to reduce late-season growth. This study was conducted to evaluate the effectiveness of several growth regulators in decreasing late-season growth and improving ripening uniformity. Four levels of N fertilizer were used to promote different levels of late-season growth.

Six-week-old greenhouse-grown seedlings of 'Heinz 722', a determinate cultivar, were transplanted on 27 May 1983 at the Ohio Agricultural Research and Development Center, Wooster. The soil was a fine-loamy, mixed, mesic Typic Fragiudalf with 3% organic matter and a pH of 6.8. The experimental design was split-plot with N as the main plots and chemical treatments as subplots using four replications.

The seedlings were planted with a single-row commercial transplanter in plots 9 m long and 1.5 m wide with plants spaced 0.3 m within the rows. Seventy-nine kg P/ha and 186 kg K/ha were broadcast and incorporated prior to planting. Four rates of N (0, 84, 140, and 224 kg·ha^{-1}) as NH_4NO_3 were applied broadcast as the main plots. The recommended N application for this soil type is 50–85 kg·ha^{-1}.

A preliminary greenhouse and field experiment suggested the application rates of each growth regulator that would give the best plant response. Treatments and application dates used in this study were: a) control; b) dikegulac at 1000 ppm (5 Aug.); c) RSW 0411 at 1.0 kg·ha^{-1} (5 Aug.); d) ancymidol at 66 ppm (12 Aug); and e) maleic hydrazide (MH) at 1000 ppm (12 Aug). The major fruit set period was completed by the time of treatment applications. The chemi-

Table 1. Influence of growth regulators on the flowers per cluster, clusters per terminal, and fruit set on late-season growth of 'Heinz 722' tomato.

Treatmet	No. flowers/ cluster	No. clusters/ terminal	Late-season fruit set (%)
Control	3.5	1.5	17.0
Ancymidol (66 ppm)	3.4	1.4	10.8
Maleic hydrazide (1000 ppm)	3.2	1.5	18.2
Dikegulac (1000 ppm)	3.5	1.4	4.1
RSW 0411 (1 kg·ha^{-1})	3.3	1.4	9.0
LSD, 5%	NS	NS	6.3

NSNot significant.

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Table 2. Influence of growth regulators on the yield performance of 'Heinz 722' tomato.

Treatment	Yield				
	Ripe fruit		Green fruit		Total[z]
	(t·ha^{-1})	(%)	(t·ha^{-1})	(%)	(t·ha^{-1})
Control	56.0	77.3	15.6	20.7	72.9
Ancymidol (66 ppm)	55.9	78.3	14.4	19.6	71.8
Maleic hydrazide (1000 ppm)	55.1	79.1	14.1	18.7	70.7
Dikegulac (1000 ppm)	55.1	80.7	12.1	16.8	68.8
RSW 0411 (1 kg·ha^{-1})	54.7	78.9	13.9	19.3	69.8
LSD, 5%	NS	NS	2.3	2.6	NS

[z]Total include rotten fruit.
[NS]Not significant.

cals were applied with a CO_2 compressed-air hand sprayer with 560 liters of water/ha. Maleic hydrazide was applied late in the day and ancymidol was applied at dusk, since ancymidol may be degraded by ultraviolet (UV) light (D.G. Ortega, personal communication).

At the time of treatment applications, six random terminal shoots containing unopened flowers were tagged per plot. On 6 Sept., the percentage of fruit set, number of clusters that reached anthesis, and the number of flowers per cluster were determined from these shoots. Tomato fruit were hand-harvested when a majority of the 84 kg·ha^{-1} N control plants were ripe (7–9 Sept.). Since the chemicals responded similarly at all N levels, the results from the growth regulator treatments will be presented as an average of all N levels.

Although no quantitative data were taken on the gross morphology, several visual differences existed among the chemical treatments when compared to the control. The new terminal shoots of plants treated with RSW 0411 had dark green foliage, shorter internodes, and smaller and thicker leaves than those not treated. Ancymidol-treated plants had a slight darkening of the foliage and reduced internode length. Ancymidol is an inhibitor of gibberellin synthesis (4). The primary mode of action for RSW 0411 is the inhibition of gibberellin synthesis, but it also interferes with sterol biosynthesis (K. Lurssen and W. Reiser, unpublished data). Stem elongation is reduced with these types of compounds because cell expansion and division are inhibited, but radial expansion is increased (3, 7). The dikegulac treatment caused a range of responses. The young leaves developed interveinal chlorosis, and some of these leaves became distorted as growth resumed. The mosaic leaf appearance lasted for only a few weeks. Terminal stem growth was suppressed for 2 weeks, but several lateral shoots developed along each major stem section at the end of the season. Dikegulac is translocated in minute amounts to active meristems and inhibits DNA synthesis (1). The inhibition of DNA synthesis is likely the cause for dikegulac's numerous responses. No visual differences could be detected between the MH-treated plants and nontreated plants. Shoene and Hoffman (9) found that stem growth was inhibited 73% with a 1000-ppm MH application on young tomato plants. Mature tomato plants may require increased doses to retard growth because of the larger plant size.

It is essential to inhibit both late vegetative and reproductive growth if improved ripening uniformity is to be achieved. None of the growth regulators reduced the number of flower clusters or flowers per cluster, but some treatments reduced the percentage of fruit set in the terminal portions (Table 1). The dikegulac and RSW 0411 were the most effective treatments in reducing terminal fruit set. Dikegulac has been used commercially to inhibit flowering and fruit set for certain ornamentals (8, 11). The partial reduction of late vegetative and reproductive growth did not improve ripening uniformity of tomatoes (Table 2). Apparently, these reductions in growth were not severe enough to alter the source–sink relationships. The reduced terminal fruit set did decrease the yields and percentage of green fruit from the dikegulac-treated plants. This reduction decreased the number of green fruits that would have to be sorted from the harvester. Bocion et al. (2) reported an increase in tomato yields after applying a 2000-ppm dikegulac solution during the breaker stage of the first developing fruit. They did not discuss the reasons for the increased number of ripe fruit, but an inhibition of late-season growth probably decreased metabolite competition and increased fruit maturity.

An effective growth regulator to reduce late-season growth and thereby enhance fruit uniformity is still elusive. Perhaps higher concentrations and/or earlier applications of these compounds could increase their effectiveness.

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