CONCENTRATING TOMATO MATURITY WITH GROWTH REGULATORS

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ABSTRACT

The growth regulators Alar, Cycocel, Ethrel and Maleic Hydrazide were tested for concentrating fruit set. Alar and Ethrel when applied to young seedlings effectively concentrated fruit set to provide larger once-over harvest yields than untreated plants. Seedlings treated with Ethrel produced single harvest yields over 50% greater than the largest single harvest from control plants. Yields from plants treated with combinations of Alar, Cycocel and Maleic Hydrazide were not statistically better than untreated plants. In most cases, effective chemical treatment of seedlings reduced apical dominance, increased stem diameter, induced branching, delayed and concentrated flowering, increased single harvest yields and fruit size, and reduced total yields. Timing of application of some chemicals was critical. Ethrel applied to fruit before or after harvest initiated and speeded fruit ripening.

INTRODUCTION

Florida's fresh market tomato industry, plagued with increasing competition from Mexico and serious labor problems, is moving toward mechanization of cultural practices, harvesting and bulk handling of the crop to improve efficiency and reduce costs. Yield concentration for once-over harvest of the crop is necessary for efficient mechanized tomato harvest in Florida (3). Increased plant populations have concentrated once-over harvest yield and increased total marketable yield of fresh market tomatoes (1, 2). Plant breeders are actively working toward development of cultivars with multiple disease resistances, concentrated fruit set and numerous other characteristics to facilitate mechanized harvest of fresh market tomatoes (8, 9). Alar (succinic acid 2, 2 dimethylhydrazide) and Cycocel (chlorocholine chloride) have been shown to improve total yields of processing tomatoes (5, 6) and Ethrel (2-chlorethyl phosphonic acid) has effectively shortened the time required to ripen green tomatoes (4, 7).

In preliminary experiments in 1967, Alar applied to seedlings resulted in shorter internodes, larger stem diameters, intensification of green foliage color and delayed blooming when compared to untreated plants. Multiple Alar applications to seedlings were more effective at concentrating yield than a single application. Preharvest application after fruit set provided a “cut-off” spray to abscise existing flowers and delay formation of new fruit so those already formed could develop without competition from younger fruit.

EXPERIMENTAL METHODS

Randomized complete block experiments with 3 replications were conducted on Rockdale soil at the University of Florida IFAS Sub-Tropical Experiment Station at Homestead in 1968 and 1969. All fertilizer was applied and rototilled into preformed flat top beds 4 feet wide with centers 6 feet apart after which polyethylene mulch was applied over the beds. Soil moisture was kept at a desirable level by sprinkler irrigation. Two rows were planted per bed and plant spacing in the row was 18 inches providing plant density of 9,700 plants per acre. Eight plants per plot were used. One or more of the following cultivars or breeding lines were used in the experiments: 'Homestead-24' (HS-24), 'Tropi-Gro', 'Walter', 'Tropi-Red' and 407-D3-D1-BGBk (with jointless pedicel). Two harvests were made. The first harvest included only marketable fruit with color (maturity 1) and the second harvest included all fruit of marketable size which were sorted into ripe (maturity 2), pink (maturity 3) and mature green fruit (maturity 4). These maturity classes were considered equivalent to first, second, third and fourth harvests, respectively. Fruit in each category was counted and weighed. “Once-over harvest” refers to yield from one maturity stage and highest once-over harvest refers to the treatment and maturity stage with the largest yield in the experiment.

Alar, Cycocel (CCC), Ethrel and maleic hydrazide (MH) were the growth regulators tested.
Treatments were applied with a hand sprayer to seedlings or transplants in peat pots or larger plants in the field. Double application at the 2 and 4 leaf stage refers to 2 times of application when the plants had 2 true leaves (TL) and again when plants had 4 TL at least one inch long. "Preharvest stage" refers to plants with a number of days before harvest. "Preharvest stage" refers to plants with a number of days before harvest. "Preharvest stage" refers to plants with a number of days before harvest.

Double seedling applications of Alar and a single application at the preharvest stage were made on 'HS-24' and 407-D3 tomatoes in Experiment 1. In Experiment 2, double applications of Alar, CCC, MH and their combinations were applied to 'Tropi-Red' seedlings. Ethrel was applied to 'HS-24', 'Tropi-Gro' and 407-D3 seedlings (Experiment 3).

In ripening tests, Ethrel was sprayed on plants in the field before any fruit reached the pink stage (Experiment 4) or green fruit were dipped in aqueous solutions of Ethrel plus 0.1% Tween-20 surfactant (Experiment 5). Twenty-five or more fruit were dipped for 30 seconds in each Ethrel concentration and kept at 70° in a laboratory for periodic color evaluation.

RESULTS AND DISCUSSION

Plants treated with Alar were shorter, stems were thicker and foliage was darker green at transplanting than untreated plants (Experiment 1). Alar applied at the 2 and 4 TL stages with a preharvest "cut-off" spray concentrated yields in both cultivars in maturity 2 (Table 1). Application at the 4 and 8 TL stages with a preharvest spray was effective with cultivar 407. Fruit size was slightly smaller in treatments showing the greatest yield concentration than with other treatments.

In Experiment 2, Alar effects on seedlings were similar to those mentioned above. Seedlings treated with CCC had chlorosis and necrosis of leaf margins one week after application and plants were shorter at transplanting than untreated plants. Plants treated with combination Alar and CCC were shorter and darker green than those treated with Alar alone. These effects were further intensified by the combination of Alar, CCC and MH. Applications of Alar, CCC or combinations of Alar and CCC were not effective in concentrating yield (Table 2). All chemical treatments delayed or reduced early harvest. Maleic Hydrazide combinations produced lower total yields than other chemical treatments and did not effectively concentrate Tropi-Red yields.

One day after Ethrel was sprayed on seedlings with 1 to 4 TL the plants developed epinasty which increased in intensity with increasing rates. Two weeks after application adventitious roots formed on stems up to 3 inches above the soil. More adventitious roots formed on Tropi-Red than on 2144 plants and plants treated at the 4 TL stage had more roots than those treated at the one TL stage. Six weeks after seeding, plants treated with 5000 ppm Ethrel at the one TL stage were shorter (4 inches) than the control plants (11 inches). Plants treated at the 4 TL stage were 7 inches high 6 weeks after seeding. The small plants resulting from Ethrel application were easier to handle in the transplanting process than the long control plants.

Ethrel applied to seedlings in the 1 to 2 TL stage was very effective at concentrating yield of the three varieties tested in 1968 (Figure 1).

<table>
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<th>Chemical (ppm)</th>
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Table 1. Effect of double application on marketable yield and size of two tomato "cultivars" at 9700 plants/acre. Experiment 1.
The high rate of Ethrel reduced total yield but concentrated yield for once-over harvest. The 395 cwt/A average accounts for 75% of the crop and is 51% higher than the largest single “harvest” (261 cwt/A) from untreated plants. The 1250 ppm Ethrel treatment presents the possibility of a hand harvest at “harvest 2” preceding a destructive machine harvest at “harvest 4”. Fruit size at “harvest 2” was smaller with increasing Ethrel concentration, but at “harvest 4” size was largest at the 1250 ppm rate. Average fruit size for total yield decreased from .29 pound per fruit for untreated plants to .25 pound per fruit at 5000 ppm Ethrel.

The difficulty with using Ethrel as a seedling spray for concentrating fruit set is that timing of application is critical. Ethrel (2500 ppm) applied to Tropi-Red plants at the one TL or at the 4 TL stages in 1969 resulted in largest once-over “harvests” of 282 and 77 cwt/acre respectively, compared to 236 cwt/acre for untreated plants. Total marketable yields were 678 and 291 cwt/acre respectively, compared to 620 cwt/acre for control plots. This extreme yield reduction due to late treatment application would limit seedling application to very early (1 to 2 TL) stages to attain effective yield concentration for once-over harvest.

Preharvest Ethrel sprays induced abscission of existing flowers and delayed formation of new flowers which usually do not produce marketable fruit during the normal harvest period. Elimination of young flower competition and initiation of fruit ripening processes are possible explanations of 1969 results which showed that preharvest Ethrel sprays increased fruit size and induced earlier ripening of fruit compared to unsprayed plants (Figure 2). Estimation of optimum harvest time to benefit from preharvest sprays would be 4 to 7 days after Ethrel application when a portion of the fruit are between the breaker and pink color stages. The time of most rapid increase in fruit diameter after reaching the breaker stage was changed from 7 to 11 days for the control to between 0 and 4 days from the Ethrel treatment. This early increase in fruit diameter following treatment with Ethrel may be due to earlier attainment of the climacteric as the fruit approaches maturity just before color break.

Harvested fruit dipped in Ethrel solutions ripened more uniformly and about 10 days earlier than undipped fruit (Fig. 3). This further demonstrates the potential of growth regulators to concentrate maturity by speeding up the ripening processes, a feature which might serve to prevent loss of quality from dehydration or disease development and which might also speed the flow of harvested fruit to the consumer.

In summary, seedling and preharvest applications of chemicals were shown to control plant development, concentrate maturity to provide larger once-over harvests for mechanical harvesting or combination hand and machine harvesting. Lower total yields resulted with some growth regulators than from multiple harvests from untreated plants. However, improved efficiency from once-over machine harvest and bulk handling of the crop may offset the effect of total yield reduction.

LITERATURE CITED

Figure 2.—Effect of preharvest Ethrel on color development and diameter increase of attached ‘Walter’ fruit. (Experiment 4).

Figure 3.—Post-harvest Ethrel effect on ‘Walter’ fruit ripening. (Experiment 5).