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Improving The Performance of Vegetable Transplants With A Triazole Growth Retardant

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Abstract. **Vegetable crops grown in production greenhouses for early fall and spring planting in the Lower Rio Grande Valley of Texas develop excessive shoot growth if transplanting is delayed or if greenhouse light becomes limiting. Large shoots relative to the root mass result in greater transplant stress, slowed establishment, and decreased yields. Commercial pepper, muskmelon, tomato, and watermelon transplants were sprayed at the 2- to 3-leaf stage with 4, 8, and 12 parts per million (ppm) of uniconazole formulated as Sumagic, a triazole growth retardant, to control shoot growth. Seedlings were machine-planted 10 days after treatment. Uniconazole had effectively reduced seedling height of most varieties by the time of transplanting. The fruit yield of individual pepper, tomato, and watermelon cultivars was increased by treatment with uniconazole. Pepper and tomato transplants appeared to overcome the stunting within the first 60 days after transplanting. Muskmelon and watermelon seedlings remained stunted and failed to fully recover from the dwarfing treatment.**

Abstracto. **La producción de hortalizas en los invernaderos en el Valle Bajo del Rio Bravo de Texas para la siembra tempranera de verano y primavera, desarrolla excesivo crecimiento del tallo, si el trasplante es retrasado o si la luz en el invernadero es limitada. La proporción de tallos largos con respecto a la raíz provoca un mayor stress en el trasplante, un lento establecimiento, y una disminución en el rendimiento. Trasplantes comerciales de chile, melón, tomate, y sandía fueron rociados en la etapa de 2 a 3 hojas con 4, 8, y 12 partes por millón (ppm) con uniconazole formulado como Sumagic, un triazole retardador del crecimiento. Los retoños fueron plantados mecánicamente 10 días despues del tratamiento. El uniconazole disminuyó eficazmente el tamaño del retoño en la mayoria de las variedades a tiempo del trasplante. El rendimiento del fruto en las variedades de chile, tomate y sandía fueron aumentados con el tratamiento de uniconazole. Los trasplantes de chile y tomate parecen haber superado el enanismo el los primeros 60 días después del trasplante. Los retoños de melón y sandía permanecieron raquíticos y no se recuperaron completamente del tratamiento de enanismo.**

Shoot elongation which controls the height of seedling transplants can rapidly become the dominant form of growth in a nursery production system. High density populations, low light, high temperatures, repeated fertilization, constant moisture, and limited rooting volumes are more favorable for shoot growth than root development. Because of the relatively luxurious nursery environment, the seedling transplant develops an imbalance between the shoot and root mass. The mass of the shoot is more than the root system can efficiently support. Upon transplanting into a harsh field environment, the root system may no longer provide adequate moisture and nutrients required for shoot growth and seedling survival. The transplant enters into severe stress and either dies or remains severely stunted. Managing shoot development in the nursery production system offers the opportunity to produce a seedling with increased tolerance to transplant shock and improved survival which ultimately translates into higher yields and lower costs.

Uniconazole, a triazole growth retardant, has been successfully used to manage shoot growth in several commercial nursery products (Davis, 1988). Trials with tomatoes, lettuce, broccoli, muskmelon, and watermelon have demonstrated a range of both beneficial and detrimental responses to triazole growth retardants (Orzolek, 1988). The yields of lettuce and broccoli were reduced after treatment of the seedlings with uniconazole. In the same study, fruit size and yield of watermelon and muskmelon were decreased by the treatment with uniconazole. However, muskmelon seedlings treated with a related dwarfing chemical, paclobutrazol, produced more fruit of higher quality than untreated seedlings (Nerson et al., 1989). The paclobutrazol treatment increased root mass and reduced shoot height (Nerson et al., 1989) resulting in transplants with a more favorable root to shoot balance (Hobbs, 1984; Ritchie and Dunlap, 1980). Not only the growth habit is changed by treatment with triazole compounds but also the sensitivity of the plant to stress conditions (Fletcher and Hofstra, 1985). Bean (*Phaseolus vulgaris*) seedlings were more tolerant to water stress, high temperature stress, and chilling injury after treatment with a triazole growth retardant (Davis, 1988). Squash and cucumber treated with paclobutrazol were less susceptible to chilling injury (Wang, 1985).

In order to test the possible advantages of triazole application on vegetable transplants, tomato, pepper, watermelon, and muskmelon seedlings were treated with uniconazole prior to transplanting. Several cultivars were examined to identify genotypic differences in the responses to uniconazole treatments. Growth and yield data were used as a measure of the treatment responses.

Materials and Methods

Commercial cultivars of tomato, pepper, watermelon, and muskmelon (Table 1) transplants were grown under commerical management programs at the Alamo Transplant nursery production facility in Alamo, Texas. Seed were sown into Speedling trays (Speedling, Inc.) filled with a peat-perlite potting mix at a density used for the commercial production of each variety. Seedlings were grown to the 2- to 3-leaf stage of development and sprayed to run-off with 0, 4, 8, or 12 parts per million (ppm) of uniconazole prepared from Sumagic (Valent USA Corp., Walnut Creek, CA), a commercial formulation of 0.05% uniconazole. Treatment dilutions were prepared in distilled water. Hand-held spray bottles were used for chemical applications. The seedlings were measured then machine-planted 14 days after treatment on 13 Feb. 1990 using a rotary turret planter. Demonstration plots were established with replicated subsamples for each treatment. Ten individual pepper and tomato seedlings from each cultivar were identified and repeatedly sampled. Total fruit produced by individual melon cultivars were harvested and the number of plants determined from 50-foot plots. Plant spacing, culture, and harvest of each variety followed the common commercial practices for the Lower Rio Grande Valley of Texas.

Table 1. Summary of optimum treatment rates to enhance fruit yields and qualitative response ratings for varieties of pepper, tomato, watermelon, and muskmelon treated with uniconazole.

Crop	Variety	Optimum rate (ppm)	Height reduction[z] (%)	Size (g/fruit)	Fruit yield (#/plant)
Pepper	Early Jalapeno	12	21	+	+
	Hungarian Yellow	12	30	+	+
	Serrano	12	28	+	+
	Cubanella	0	33	NR	NR
	Jupiter	0	20	NR	NR
Tomato	Sunny	12	33	+	+
	Red Cherry	8	31	+	+
Watermelon	Summer Flavor	12	14	+	+
	Royal Sweet	0	20	−	NR
	TRI-X-313	0	24	−	−
	Huck Finn	0	17	−	+
Muskmelon	Alexandria	0	20	−	NR

[z]Average percent suppression of initial height for all Sumagic treatments. NR, no treatment response; +, increase; −, decrease.

Table 2. Growth and yield response of 'Early Jalapeno' pepper to a single foliar application of uniconazole.[z]

Rate (ppm)	Initial planting height (cm)	Final height (cm)	Final weight (g)	Fruit yield (#/plant)	Fruit yield (g/plant)
0	6	12.2 ab	0.0 a	0.0 a	0.0 a
4	5	11.9 a	1.4 ab	1.0 b	1.4 b
8	5	13.8 b	1.2 ab	0.8 b	1.0 b
12	4	13.4 ab	2.4 b	0.7 b	1.6 b

[z]Mean separation within columns by Duncan's multiple range test, P = 0.05.

Results

Favorable responses to Sumagic measured by increased fruit size and yield varied according to species and cultivar. Table 1 provides a summary of the varieties and their general response to treatment with Sumagic. The foliar treatment of 12 ppm increaed both fruit size and yield in the pepper cultivars 'Early Jalapeno', 'Hungarian Yellow', and 'Serrano'. However, the fruit development of two other cultivars, 'Cubanella' and 'Jupiter', was unaffected by Sumagic regardless of the concentration. The vegetative growth of all pepper cultivars was reduced by Sumagic as indicated by the 20% and 33% reduction of plant height. The number and size of fruit from 'Sunny' and 'Red Cherry' tomato cultivars were increased by the Sumagic treatment.

Height was suppressed by approximately 30% in both cultivars. Only the cultivar of watermelon, 'Summer Flavor', responded favorably to Sumagic. Fruit size of 'Royal Sweet', 'TRI-X-313 seedless', and 'Huck Finn' was reduced at all concentrations tested. 'Alexandria' muskmelon was negatively affected in the same manner as the latter three watermelon cultivars. The height of all melon cultivars was reduced by 14% to 24%.

In the following data we provide a more detailed description of the growth response measured in selected cultivars of pepper, tomato, and watermelon that responded favorably to the Sumagic treatments. The final height of 'Early Jalapeno' measured 7 weeks after transplanting was not reduced by treatment with Sumagic (Table 2). Surprisingly, some of the treated plants exhibited greater shoot elongation than the untreated control. However, all treatments with Sumagic set fruit earlier than the untreated control. Only immature fruit were available on control plants at a time when treated plants were producing harvestable fruit. Sumagic treatment had no measurable effect on fruit size or number.

Table 3. Growth and yield response of 'Red Cherry' tomato to a singular foliar application of uniconazole.[z]

Rate (ppm)	Initial planting height (cm)	Average fruit weight (g)	Fruit yield (#/plant)	Fruit yield (g/plant)
0	13	17.4 a	32.4 a	564 a
4	10	17.2 a	38.1 a	650 a
8	9	18.0 a	39.9 a	718 b
12	8	16.9 a	48.8 b	824 b

[z]Mean separation within columns by Duncan's multiple range test, P = 0.05.

Table 4. Growth and yield response of 'Summer Flavor' watermelon to a single foliar application of uniconazole.[z]

Rate (ppm)	Initial planting height (cm)	Average fruit weight (kg)	Fruit yield (#/plant)	Fruit yield (kg/plant)
0	5.5	7.0 a	0.9 b	6.2 b
4	5.0	7.2 a	0.5 a	3.7 a
8	5.0	7.1 a	1.1 b	7.6 b
12	4.0	7.4 a	1.3 c	9.4 c

[z]Mean separation within columns by Duncan's multiple range test, P = 0.05.

The initial height of 'Red Cherry' tomato transplants progressively decreased with increasing concentrations of Sumagic (Table 3). The fruit weight at harvest was unaffected by the chemical treatments. The number of fruit and total fruit weight from plants treated with 12 ppm increased nearly 50% over the untreated control. This suggests that the increase in fruit number was not accompanied by any reduction in fruit size.

Only one of the watermelon cultivars, 'Summer Flavor' exhibited a positive response to the Sumagic treatments. The yield and/or fruit size of 'Huck Finn', 'Royal Sweet', and 'TRI-X-313 seedless' were suppressed or reduced at all concentrations of Sumagic. Individual fruit weight was not affected by the Sumagic treatments, with total fruit number and weight increased at 12 ppm (Table 4). Growth and yield of the one muskmelon cultivar examined in this study, 'Alexandria', was inhibited by treatment with Sumagic (data not presented). Similar observations with two other cultivars have subsequently confirmed the negative responses to Sumagic in muskmelon.

Discussion

Sumagic treatments inhibited the shoot growth of all vegetable cultivars in the test (Table 1). However, the effect on fruiting and yield varies among species and cultivar. The most dramatic increases in yield occurred in the pepper and tomato cultivars. The increase in yield of 'Early Jalapeno' resulted from earlier fruit set in the treated seedlings. Sumagic acts in plants by inhibiting the production of the gibberellin hormones (Davis, 1988). These hormones are important regulators of vegetative growth, particularly internode elongation. The inhibition of vegetative growth by limiting the production of gibberellins may encourage the early differentiation and development of reproductive structures and, consequently early flowering and fruit set. In tomatoes and watermelons, the increase in yield resulted from a greater number of fruit set on each plant. The size indicated by weight was not increased by treatment with Sumagic. Therefore, the increase in total yield was purely a function of more fruit produced by each plant. The increase in fruit may have resulted from an increase in the number of receptive flowers or a higher frequency of fertilization. The design of this study did not provide the information needed to identify the reproductive mechanism responsible for greater yields.

The pepper and tomato cultivars used in our study appeared to overcome the initial dwarfing effects of Sumagic by the time of harvest. The melon cultivars were unable to reverse the initial seedling treatment and were visually smaller throughout the growing period (data not presented). Orzolek (1988) reported similar observations on watermelon and muskmelon treated with either uniconazole or paclobutrazol. In contrast to our results, an Israeli study with two cultivars of muskmelon found yield increases of 15% to 20% after treatment of seedling transplants with paclobutrazol, a dwarfing chemical closely related to uniconazole (Nerson et al., 1989). The increase in yield resulted from an increase in fruit size rather than number. Hickman et al. (1989) found that uniconazole effectively controlled the height of tomato seedlings transplants (cv 'Royal Flush') but failed to enhance fruit yields. However, seedling treatments with uniconazole increased fruit yield of 'Summer Flavor' tomatoes grown under greenhouse conditions (Wang and Gregg, 1990). Considering the variability between cultivars in our study, the use of only one tomato cultivar may not be sufficient to assess the response to uniconazole. Despite the stunting of seedling heights in all species, there appears to be no advantage in survival or establishment over untreated seedlings (data not presented).

Our results with the Sumagic treatments imply certain production advantages associated with yield increases in peppers and tomatoes. The response varies among cultivars and cannot be generalized across all genotypes within a crop. The response is related to the initiation of flowering in response to decreased production of gibberellins. Although the production advantages are obvious, uniconazole (Sumagic) is only approved for use on non-food crops. Other gibberellin inhibitors such as paclobutrazol may offer a possible alternative to uniconazole and should be pursued as a management tool in vegetable seedling production.

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