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The Effects of Daminozide on Flower Production and Sex Ratios in Hydroponic Greenhouse Cucumbers (*Cucumis sativus*)

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Plant growth regulators have been used to manipulate flowering in cucumber fruit and seed production. The objective of our research was to investigate the effect of early applications of daminozide, a plant growth regulator, on plant growth, flower production and sex ratios in hydroponically grown cucumbers. Cucumber plants were grown in Hailstorm, a recycled plastic media, irrigated by a closed hydroponic system. The plants were subjected to differing growth regulator treatments. The treatment groups consisted of: 1) one application of daminozide (3750 ppm) at the two true leaf stage, 2) one application of daminozide (1875 ppm) at the two true leaf stage, 3) two applications of daminozide (1875 ppm) at the two true leaf stage and then again at the six leaf stage, and 4) no application of daminozide . Leaf numbers and vine heights were measured weekly throughout the experiment. Upon commencement of flowering, the number and sex of the flowers were recorded weekly for a period of three weeks. The application of daminozide decreased vine length as expected, but did not significantly affect the ratio of pistillate to staminate flowers. However, daminozide did decrease the overall number of pistillate flowers due to lower overall flower production.

Cucumis sativus /Plant Physiology

Hydroponic greenhouse cucumbers are gaining in popularity as a fresh market specialty product. This has resulted in an increased demand for improved production efficiency practices. A lot of space is needed in greenhouse cucumber production with the average cucumber plant requiring five to seven feet of growing space (Hochmuth, 1990). The most commonly practiced method of physically training a plant is the “umbrella system” which consists of the practice of growing the plant vertically by the means of wire or string (Vandre, 1990). Growth regulators are also commonly used in high value horticultural crops to alter growth form, increase yield, and enhance the quality of the crop (Davies, 1995; Latimer,1992). There have been multiple studies that link synthetic growth regulators to increased yields in cucumber plants by manipulating their sex expression and fruit development. (Sinha and Mandal,2000; Hossain et al. 2002; Batlang et al. 2006) Not only can growth regulators alter sex and growth patterns, but there is also the potential for secondary gains such as lowered susceptibility for chilling, increased root mass, and improved plant hardiness in response to water and heat stress through the use of growth regulators (Wang, 1985; Nerson et al. 1989; Fletcher and Hofstra,1985). Stefanski and Phillips (2008) investigated the production potential of greenhouse cucumbers under multiple physical and chemical training methods. Flower production and yields were evaluated in plants trained with either a vertical wire support system or metal wire support cages, and different levels of daminozide (N-dimethylamino-succinamic acid). Despite significant differences in vine length between the physical and chemical training methods, the flower numbers and fruit yields were similar among the different training treatments (Stefanski and Phillips, 2008).

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Their findings indicated the potential to produce a more compact cucumber plant producing yields comparable to those vertically trained through the use of the growth regulator, daminozide. This could potentially lead to increased space efficiency in greenhouse cucumber production. However, with daminozide being an ethylene inhibitor, we wanted to assess its effects on flower sex ratios. These are important questions due to the predominance of gynoecious cultivars in greenhouse cucumber production, and the potential consequences of unwanted staminate flower production. We hypothesized that daminozide applications would decrease the pistillate to staminate flower ratio in treated plants while having no effect on the total number of flowers produced.

Materials and Methods

Seeds were planted in Rockwool and germinated on a bottom-heated (21°C) automated mist table in the greenhouse. When the majority of seedlings exhibited one true leaf, they were transplanted into closed-loop hydroponic system. The system consisted of STG Hail Storm growing media in Bato Buckets with individual drip emitters to each plant. The plants were trained vertically on nylon string. A standard fertilizer regime was used (Ionic Grow, Ionic Bloom, and Ionic Micro). The experiment was set up as a Completely Randomized Design (CRD) with four treatments with six replications each. The treatments were; 1) one application of daminozide (3750 ppm) at the two true leaf stage, 2) one application of daminozide (1875 ppm) at the two true leaf stage, 3) two applications of daminozide (1875 ppm) at the two true leaf stage and then again at the six leaf stage, and 4) no application of daminozide . Border plants were not included in the study to minimize the edge effect. Data was collected beginning 60 days after sowing. Weekly measurements of vine length, leaf number, flower number, and sex of flower, were taken for three weeks. The collected data were subjected to analysis of variance using SAS. Means separations were tested using Tukey's HSD.

Results

Vine length decreased with increasing daminozide rates with untreated vines having a mean length of 147 cm after 74 days compared to 112, 74, and 59 cm in the vines subjected to the daminozide applications (Fig.1) Leaf production exhibited a similar response to the growth regulator applications with the untreated plants having a higher mean number of leaves (36.5) in comparison to those treated (27, 24.5, and 22) (Fig. 2). While the pistillate to staminate flower ratio did not differ among treatments, the mean number of female flowers was significantly higher in the untreated vines after 10 weeks of growth (Figs. 3 and 4). The total number of flowers per plant was also higher in the untreated plants after 10 weeks of growth (Fig. 5).

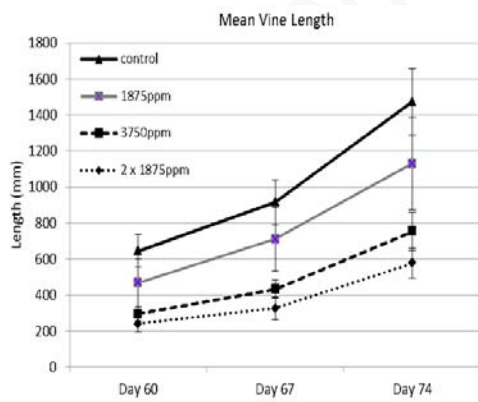

Figure 1. Mean vine lengths (mm) for each treatment over three dates during the growing period. Standard error bars are shown

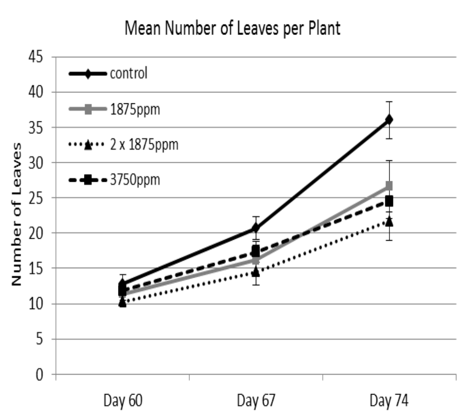

Figure 2. Mean number of leaves produced for each treatment over three dates during the growing period. Standard error bars are shown.

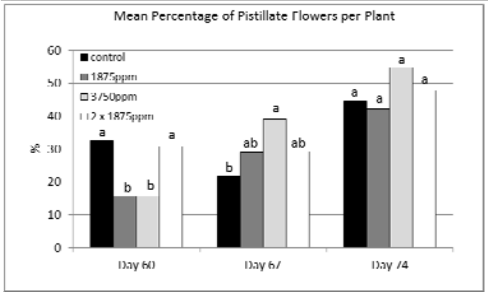

Figure 3. Mean percentage of pistillate flowers produced per plant for each treatment over three dates during the growing period. Data were arsin transformed prior to analysis and means comparisons. Treatment means for each date, denoted by the same letter are not significantly different at α=0.05 (Tukey's HSD).

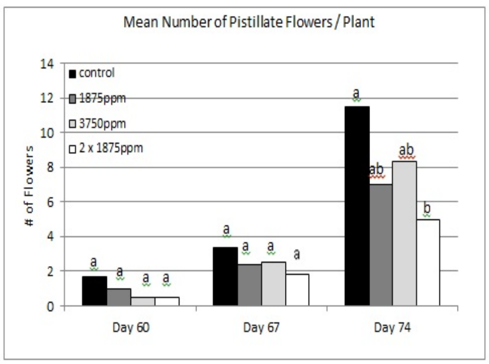

Figure 4. Mean number of pistillate flowers produced per plant for each treatment over three dates during the growing period. Treatment means for each date, denoted by the same letter are not significantly different at α=0.05 (Tukey's HSD).

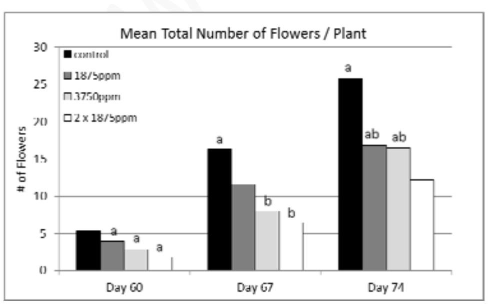

Figure 5. Mean number of all flowers of both sex produced per plant for each treatment over three dates during the growing period. Treatment means for each date, denoted by the same letter are not significantly different at α=0.05 (Tukey's HSD).

Discussion and Conclusions

Our hypothesis that daminozide applications would not affect the total number of flowers produced was unsupported by the data. The untreated control plants produced a significantly higher number of flowers in comparison to those treated with daminozide. These results conflicted with the results found in the earlier study conducted by Stefanski and Phillips (2008). There are several reasons that could explain the differing results including cultivar differences, length of data collection period, and/or experimental error. Our hypothesis that the daminozide treated plants would exhibit a lower pistillate to staminate flower ratio compared to the untreated plants was also not supported by the data. In fact, the highest pistillate flower ratios were seen in plants treated with the higher levels of daminozide. This phenomenon has been previously reported in *Ricinus communis,* and was linked with the node position of the first female flower (Chauhan et al.1987). Further research should include node position data to gain a clearer view of this observed fact. At this point, the potential benefit of increased pistillate flower production in daminozide treated plants is outweighed by the decrease in total flower numbers in the same treated plants. At least for this cultivar, it seems unlikely that fruit production would be enhanced by treating plants with daminozide. Further studies would be needed to confirm our results and evaluate the cultivar-specific responses to daminozide application on greenhouse cucumbers.

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