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Multi-species Evaluation of the use of Hydretain for Enhancing Plant Survival and Resistance to Drought

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Introduction

Twenty-two percent of the U.S. is currently experiencing a water shortage and 15% is considered in a serious drought situation. This situation is not limited just to crop-land, but also greatly affects the entire horticultural industry. As water becomes more and more of a precious resource, finding a way to reduce water consumption while maintaining optimum plant quality is a goal for many horticulturalists. The purpose of this trial was to determine if a single application of granular or liquid Hydretain results in enhanced tolerance and recovery of several plant species to extreme drought.

Materials and Methods

The experiment was conducted at the University of Illinois Department of Crop Sciences St. Charles Horticulture Research Center located in St. Charles, IL. Experimental subjects were seeded on 2/2/2016 with the exception of turfgrass which was seeded on 3/23/16. Plants used for study were tomato (*Lycopersicon esculentum* L. 'Big Beef'), bell pepper (*Capsicum annuum* L. 'Rampart'), and a mixture of Kentucky bluegrass (*Poa pratensis* L. 'Freedom III', 'Arc') and perennial ryegrass (*Lolium perenne* L. 'Ragnar II', 'Palmer III'). Turfgrass seeded at a rate of 4 lbs./M and was maintained at a 2.75-inch height of cut. Vegetable plants were seeded into 72-cell trays and irrigated regularly until the first set of true leaves had developed. Any time irrigation was applied it contained 100 ppm of 20-20-20 fertilizer. After the first set of true leaves had developed, transplants were moved to 1-gallon containers for the remainder of the experiment. The soil used for cultivation was a standard greenhouse sphagnum peat moss-based potting soil "Flat and Pack Mix" (Midwest Trading, Virgil, IL).

Treatments consisted of liquid (2 oz./gallon), or granular (OC or ES; 1 lb./ft^3 of planting medium) Hydretain or an untreated control applied on 4/1 (tomato and bell pepper) or 4/17 (turfgrass). Liquid Hydretain was applied in solution via a hand-held watering can. Granular Hydretain was applied as a top-dressing by hand with a hand held spreader consisting of a mason jar fitted with a perforated lid. After initial application, treatments were incorporated into the root-zone with irrigation until field-capacity was reached. Plants were watered daily until considered established and as needed after establishment prior treatment application. After treatment application, irrigation of plants was withheld until severe wilting (i.e., leaf folding, bluish coloring; for visual representation see results of Report A) of experimental subjects was observed. Post-wilt irrigation was applied with and quantified via a graduated cylinder. When irrigation was applied, plants were watered until field capacity was reached.

Turfgrass was evaluated weekly for both color (1-9; 1 being poorest or dead and 9 being outstanding) and quality (1-9; 1 being light green and 9 being dark green). To ascertain the effect of Hydretain treatment on turfgrass growth and development, turfgrass was clipped weekly and maintained at 2.75-inch height of cut. Resultant clippings were oven dried (150 F) for 24-h prior to weighing. At the conclusion of the study, the turf was clipped to soil level with the resulting clippings dried and weighed as for weekly clipping yield.

To quantify the effect of Hydretain treatment on plant growth, dry matter yield of both tomato and pepper was obtained by cutting the aboveground portion of the plants from the root system with scissors at the conclusion of the experiment. Resultant clippings were oven dried (150 F) for 24-h prior to weighing.

The experiment was concluded on 6/6 due to inability to cool the greenhouse to acceptable temperatures conducive to plant growth.

The experimental design used was completely randomized with two replications. Data analysis was carried out using the MIXED procedure of SAS statistical analysis software.

Results and Discussion

Pepper

Hydretain treated peppers were generally much greener, greater in height, had many more leaves, and used significantly less water than untreated plants (Table 1.). Both granular formulations resulted in a large increase in dry mass over that of the control, with granular QD and OC increasing dry mass by 82 and 91%, respectively. Liquid Hydretain application resulted in a comparatively lower increase in dry mass compared to the granular formulations resulting in 36% larger plants than the control. A similar trend was found for water use in that Hydretain treated plants used significantly less water than the control. In regard to water use, Hydretain granular OC treated plants used 33% less water than the control and 8% less water than granular QD and liquid ES plus, respectively. Hydretain QD and liquid ES plus treated plants used approximately 28% less water than the control plants throughout the experiment. Additionally, Hydretain treated peppers used 47-65% less water than controls per gram of dry matter produced at the conclusion of the trial. There was no difference between formulations of Hydretain for this parameter. At no time were any negative effects of Hydretain observed on treated plants.

Table 1. Effect of Hydretain treatment on bell pepper

Treatment	Dry matter yield (g)	Water use (mls.)	Water use efficiency (mls. H_20/g biomass)
Hydretain ES Plus	7.5ab†	3237.5b	431.7a
Hydretain ES Plus Granular QD	10.0a	3232.5b	323.3a
Hydretain ES Plus Granular OC	10.5a	2990.0a	284.8a
Control	5.5b	4487.5c	816.0b
LSD‡	4.4	14.2	274.6

†Data reported as a mean of two replications

‡LSD, least significant difference ($P < 0.05$)

Tomato

Similar to bell pepper, response to Hydretain treatment by tomato resulted in greater dry matter yield and a significantly lower water use requirement compared to the controls (Table 2.). Both Hydretain ES plus and granular OC formulations resulted in 186% greater dry matter production compared to the control. Likewise, granular QD treated tomatoes produced 129%

more dry matter yield compared to untreated tomatoes. A corresponding reduction in water use in Hydretain treated tomatoes relative to the controls was also realized. Hydretain treated plants used on average approximately 30% less water than the controls. Taken together the measurements of dry matter yield and water use, there was a clear advantage to the use of Hydretain in enhancing plant growth while using much less water than control plants to generate plant tissue. In this regard, Hydretain treated tomatoes used 67-74% less water compared to controls per gram of dry matter produced. For this parameter, there was no difference among formulations of Hydretain. Additionally, at no time during the experiment were any deleterious effects of Hydretain observed on treated plants.

Table 2. Effect of Hydretain treatment on tomato

Treatment	Dry matter yield (g)	Water use (mls.)	Water use efficiency (mls. H_20/g biomass)
Hydretain ES Plus	10.0a†	3450.0a	345.0a
Hydretain ES Plus Granular QD	8.0a	3400.0a	425.0a
Hydretain ES Plus Granular OC	10.0a	3413.0a	341.3a
Control	3.5b	4500.0b	1285.8b
LSD‡	3.4	288.8	298.0

†Data reported as a mean of four replications

‡LSD, least significant difference (*P* < 0.05)

Turfgrass

Like bell pepper and tomato, a corresponding increase in dry matter yield coupled with a lower water requirement was observed for turfgrass treated with Hydretain (Table 3.). Additionally, Hydretain treated turf exhibited significantly greener color and turf quality than untreated controls. In this regard, Hydretain increased both turfgrass color and quality 45% relative to untreated controls. In terms of dry matter yield, Hydretain granular OC was 145% greater than untreated turf, and approximately 24% greater compared to both granular QD and liquid formulations of Hydretain. The latter produced 90 and 80% greater dry matter yield than untreated turf. Unlike dry matter yield, there was no difference in water use regarding Hydretain formulation and Hydretain treatment decreased water use comparative to the control by turf by about 13%. Hydretain treated turfgrass, irrespective of formulation, used 52-65% less water than controls per gram of dry matter produced. At no time during the experiment were any negative effects of Hydretain observed on treated plants.

Table 3. Effect of Hydretain treatment on turfgrass

Treatment	Color (0-9)	Quality (0-9)	Dry matter yield (g)	Water use (mls.)	Water use efficiency (mls. H_20/g biomass)
Hydretain ES Plus	8.0a†	8.0a	36.0b	3480.0a	96.8a
Hydretain ES Plus Granular QD	8.0a	8.0a	38.0b	3477.5a	91.5a
Hydretain ES Plus Granular OC	8.0a	8.0a	49.0a	3487.5a	71.2a
Control	5.5b	5.5b	20.0c	4010.0b	200.5b
LSD‡	1.12	1.13	2.25	79.6	44.7

†Data reported as a mean of four replications

‡LSD, least significant difference (*P* < 0.05)

Overall Results

This research demonstrates the efficacy of Hydretain to reduce water use in tomato, bell pepper, and turfgrass. Additionally, Hydretain was found to increase plant growth as expressed by dry matter production relative to untreated plants. This effect is presumably due to a better functioning root system in conjunction with increased solvent (water) and resulting solute (nutrient) concentration in treated soils. As such, this research shows that Hydretain is a safe, biodegradable substance that is beneficial to plant growth. This is especially evident in the experimental results reported here. The extreme droughty conditions experimental subjects were exposed to in this research represent a "worst case scenario" for water availability. This suggests that Hydretain can be effective under the most extreme of conditions in improving plant performance and survival. Simply put, under the conditions reported here, Hydretain allows for normal plant development with a much lower water requirement than untreated plants.

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