Growth and Drought Response of Chrysanthemum (Morifolium) to Plant Based (Soy) Hydrolysate and Animal Based (Collagen) Drench Applications.

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Abstract

Growers are continually reaching for optimum plant development within the environment of soil or soilless growing environments. Additionally, growers are facing abundant challenges related to plant stresses associated with weather impacts. Plant and Animal derived protein-based biostimulants have shown potential to increase the germination, productivity, and quality of a wide range of horticultural and agriculture crops. These biostimulants have also shown promise in improving growth and mitigating the negative effects of plant stress including drought.

An important consideration in using biostimulants is the mode of application and the corresponding efficiency related to plant health. This ten-week study trialed the effectiveness of using water soluble plant and animal-based biostimulant substrate drenches on container chrysanthemums. The study hypothesized that the applications would have a significant positive impact on mum growth and drought tolerance.

Introduction

Chrysanthemum container growers face multiple challenges in the quest to produce vigorous plants. From transplant to finish container chrysanthemums are grown during the summer for fall retail. Generally, container grown crops present challenges as the plants available moisture and nutrients reside only in the pot. Specifically, container grown chrysanthemums are heavy feeders regarding nutrients and due to their large leaf mass are susceptible to water loss through transpiration. Wilting during the production months of summer can restrict root formation and branching. On days of excessive temperatures and through periods of drought growers often will rely on daily and sometimes multiple daily irrigation events to maintain their crop. These multiples of irrigation events can be problematic as available nutrients can be washed out through the pot and need to be replaced. Impacts of increasing temperature also stress plants and make it critically important for growers to manage that plants don’t reach wilting point.

Biostimulants are generally defined as biological or biologically derived ingredients that are used to stimulate plant growth. They differ from traditional fertilizers because they provide different nutrients, and contain more complex compounds, as well as living organisms to aid in plant growth. Biostimulants can be used to increase crop yields, but unlike traditional fertilizers, they don’t have the same impact on biological ecosystems. Fertilizer runoff can lead to algae blooms and water pollution, but the usage of biostimulants can reduce the usage of traditional fertilizers, and thus, reduce the impact of horticulture on the environment.

Multiple studies from the vegetable and succulent growing industry sectors has shown that the application of plant derived protein hydrolysates (PHs) have been extremely beneficial in improving root development, nutrient uptake, as well as improving drought tolerance. The transfer of information regarding hydrolysate application rates and timing from the vegetable and succulent studies would be difficult to mimic as mums have different needs. This study used the product (Biomin N) a soy-based plant hydrolysate and suggested application rates for general agriculture crops: Every two-week application at 1gallon to 100-gallon injection ratio. This study also used granular collagen dissolved in water and applied every two weeks at the same 1gallon to 100-gallon injection ratio. The application method was hand drenching the pot. The applied drenches were an addendum to normal fertilization schedules that were applied through drip irrigation to all study groups.

The study also compared the relative drought tolerance of the study groups at the completion of the ten-week growth period. It is hypothesized that the application of the protein hydrolysate and collagen drenches would show measurable gains in chrysanthemum growth and drought tolerance.

Literature Review

A study investigating the use of protein hydrolysates on succulents reported significant gains on all important test measurements. The study reported significant increase in leaf counts, vegetative and root weight, and number of flowers. “The application of hydrolyzed proteins in plant cultivation and in succulents, allows higher quality standards of the product, higher resistance to biotic and abiotic stress, increased growth rate.” (Prisa, p.1.)

(Baglieri, et.al, 2014), reported similar results using plant derived hydrolysates on field grown beans, tomatoes, and peppers.

These substances were isolated and applied separately to a loamy–sandy soil for tomato and red pepper (in greenhouse cultivation.) The soluble substances were found to enhance leaf chlorophyll content, and to improve plant growth and fruit ripening rate and yield over the crop production cycle, significantly more than the sourcing compost and the co-produced insoluble residue. The increases amounted to 90% for the precocious crop yield, to 66% for the total crop production, and to 17% for the per fruit weight. (p.1)

Numerous mechanisms regulate the benefits for improved plant health with the application of these protein hydrolysates. Recent studies are uncovering that PHs could be stimulating carbon and nitrogen metabolism and interfering with hormonal activity.

Indirect effects could also play a role as PHs could enhance nutrient availability in plant growth substrates and increase nutrient uptake and nutrient-use efficiency in plants. Moreover, the beneficial effects of PHs also could be due to the stimulation of plant microbiomes. Plants are colonized by an abundant and diverse assortment of microbial taxa that can help plants acquire nutrients and water and withstand biotic and abiotic stress. The biostimulant activity observed in response to the application of PHs could be acting, at least in part, indirectly through a microbially mediated enhancement of plant health. ([Colla et al., 2014](https://www.frontiersin.org/articles/10.3389/fpls.2017.02202/full#B26), p.3)

A tomato plant study found significant improvement in root growth associated with using PHs as root drench. “The application of legume-derived PH especially as a substrate drench enhanced method. The increase in plant biomass was associated to the stimulation of the root growth, thus inducing a “nutrient acquisition response” that favors N uptake and translocation.” (Francesco Sestili, p.12)

A study using gelatin based biostimulant capsules reflected significant gains in growth parameters of various vegetable plants.

The treatment with two gelatin capsules placed adjacent to each seed increased the shoot dry weight of cucumber, pepper, broccoli, tomato, arugula, and field corn, by 138, 244, 50, 45, 41, and 18 percent, respectively. In an experiment with cucumber alone, there was a positive linear relationship between the number of gelatin capsules from 0 to 3 capsules on plant growth and plant nitrogen content. (Wilson, et.al., 2018, p.1)

This study below demonstrated that hydrolysates derived from bovine collagen mitigated stress in corn.

As for the drought and hypoxic stresses, hydroponically grown plants treated with the PH exhibited an increased growth and absorption area of the roots compared with those treated with inorganic nitrogen. In the case of Fe deficiency, plants supplied with the PH mixed with FeCl3 showed a faster recovery from deficiency compared to plants supplied with FeCl3 alone. (Ambrosini, ET.AL.,2021, P.1)

Materials and Methods

The plants used in this study were thirty chrysanthemums (Chelsey Yellow Plugs) and were planted in 8” mum pans on raised benches using drip lines.

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Procedures

Each study group, **Blue** (Hydrolysate Substrate Drench), **Green** (Collagen Solution Foliar Drench), **Red** (Control), were randomized across outside growing benches. Study began in Week 26 (June 25) and completed Week 36. (August 28)

All plants received 20/10/20 or 15/0/15 fertilizer to align with the target EC of 1.5 during rooting, 2.0 during growth, and 1.0 toward finishing in week 34. Protein Hydrolysate drench and Collagen drench is applied every two weeks starting in week 26 through week 34 for the two study groups.

Measurement

For each plant group, the recorded height and chlorophyll reading is taken every two weeks: Week 26, 28, 30, 32, 34. One plant from each group is taken in week 30 and 34 and measured dry weight is recorded. In week 35 (3) plants from each study group were separated out and fully saturated. Observations recorded for the following 3 days as plants received no moisture.

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Protein Hydrolysate -Biomin N -Label

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Biomin N, 5-0-0 is an [OMRI Certified](https://www.arbico-organics.com/category/omri-certified-organic-products) liquid fertilizer with 5% nitrogen that's made to supply crucial nitrogen to plants. Nitrogen is key to overall plant health; it is a fundamental component of enzymes, proteins and photosynthesis as well as being essential to plant and leaf growth and seed and fruit production. This organic fertilizer is not made with any animal products or by-products; it is derived from non-GMO hydrolyzed soy proteins that are sourced in an environmentally friendly manner. These vegetable proteins help create a fertilizer that is water soluble (to readily supply the nitrogen to the plants) with a high amino nitrogen content and a lower salt index.

Collagen- Quick Dissolve Collagen Peptides Label

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Results

As hypothesized the application of the protein hydrolysates had significant contribution to height, chlorophyll content, and biomass compared to the control. (See Figure 1,2,3) We found in the first four weeks in establishment of plugs a significant gain of an inch in height of the substrate groups compared to control. In the last four weeks of study there were comparative gains in height of both the plant hydrolysate and collagen groups compared to control. As would be expected the readings reflected similar gains compared to control.

In total biomass the gains of both the plant hydrolysate and collogen compared to control were significant. After the first four weeks of study the biomass of the protein hydrolysate application groups increased 20% over control. In the following four weeks those gains continued with biomass gains of plant hydrolysate group at 30% and biomass gains of collogen solution group 24% over control.

Figure 4 Week 35 observations of drought tolerance during a three-day period of high temperatures reflected wilting initiation began with control group plant in first 24 hours. Wilting began in collagen group in the second 24 hours. The plant hydrolysate representative sample showed slight willing in the second 24 hours on two branches.

Figure 5 reflects substantial gains in root formation of plant hydrolysate group sample compared to both the collagen and control group sample.



*Figure 1. Height*

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*Figure 2. Chlorophyll Measurement*

*Figure 3 Biomass*

A group of plants in pots

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A group of plants with roots

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*Figure 5. Root Development*

Summary and Conclusions

Nursery and greenhouse growers want to grow beautiful and vigorous plants that not only sell but do well once planted. Growers are looking for (1) improved plant root development and growth (2) increased quality and quantity of flowers/fruits (3) improved nutrient and water intake (4) increased resistance to stress, root disease and transplant shock. This initial study showed that the use of protein hydrolysates as an amendment to the substrate can have positive benefits respective to the above goals.

The significant increases in plant establishment and growth in the first four weeks using the PHs reduced the transplant stress and improved the initial establishment of plants compared to control. These initial benefits reflected stronger root establishment and supported continued improved growth and tolerance of increasing temperature stress in summer growing period. The study suggests that the plant hydrolysate was more beneficial in root establishment and vigorous growth in comparison to collogen applications. The ability of both the hydrolysate groups to withstand drought tolerance was comparatively significant. The hydrolysate groups with the larger mass of shoot development should have transpired moisture at more rapid rates then other groups. This relative improvement in drought tolerance would pay dividends in maintaining crop for growers and improve performance for customers.

As only one crop was studied future studies should include other ornamental crops. Animal and plant-based hydrolysates should be evaluated during the production process.

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