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PRODUCTION OF CUT CHRYSANTHEMUMS IN LOOSE ROCKWOOL

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Chrysanthemum cultivars 'Accent' and 'Hurricane' were grown in gravel (pea-size) and loose wettable rockwool (Hortiwool) with a constant nutrient feeding system. Plant Heights, biomass yield, and quality of cut flowers grown in rockwool were superior to those obtained from gravel medium. The loose rockwool provided for excellent plant growth in both the first and second cycle crops.

Introduction

Rockwool has become a popular root substrate for the production of greenhouse vegetables and cut flowers in Europe (1,8,9). As an inert, sterile medium, rockwool holds a large quantity of water while retaining adequate amount of air spaces within the substrate (7,10). Because of little buffering and cation exchange capacity, rockwool as a growing medium can best be used with a complete fertilizer solution applied as constant feed. Most European growers use the "bound" forms of non-wettable rockwool, such as cubes and slabs, in cut flower production (7,8). Loose rockwool can be used as an amendment (2), or as a sole source of growing medium (5,6) for selected pot plants. The objective of this study was to investigate the adaptability of the loose form of rockwool (Hortiwool, product of Rockwool Industries) as a growing medium for cut chrysanthemums.

Materials and Method

Hortiwool and pea-sized gravel were compared as growing media. A wood bench (42 inches wide, 36 ft. long, 8 inches deep) was divided into six individual compartments (each 60 inches long) and filled alternately with the loose rockwool and gravel. The bench also had 36 inch buffer plots at each end, filled with gravel. Superphosphate and ground lime were incorporated into the bench at rates of 5 lb/100 sq.ft. and 10 lb/100 sq.ft., respectively. The bench was steam pasteurized. Six 1 inch wide plastic trickle irrigation tubes (Chapin Twin-Wall IV) were installed 6 inches apart on the surface. These lines were connected to an automatic control unit and fertilizer injector. The greenhouse was covered with fiberglass (FRP) and had a temperature range from 63 °F night to 63-75 °F day (heated to 63 °F and cooled at 75 °F), depending on season.

Rooted cuttings of chrysanthemum 'Accent' and 'Hurricane' (Yoder Brothers) were planted at a 6" × 6" spacing on 1 Nov. 1985. Thirty plants of each variety were established in half of each medium compartment (total 360 plants, 30 plants/var. × 2 var./treat. × 2 treat./medium × 3 rep.). Thirty plants of each variety were planted in the buffer zones as guard plants. Plants in each medium were watered as needed with the Colorado State University carnation nutrient solution (composition meq/liter: 3 Ca^{2+}, 2 Mg^{2+}, 6 K^{+}, 2 NH_4^{+}, 10 NO_3^{-}, 2 SO_4^{2-}, 1 $H_2PO_4^{-}$, plus Hoagland micronutrients) as a constant feed until 20 Nov., after which they were watered twice per day until harvested. At each irrigation, excess water was applied.

Plants were pinched on 20 Nov. The greenhouse was lighted (10 p.m.-2 a.m.) from the time of plant establishment to 6 Dec., after which the natural short day condition resumed.

Results

Throughout the experimental period, plants grown in rockwool appeared to be more vigorous, being taller and

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showing greater stem diameters and larger leaf areas, as compared to those grown in the gravel medium. However, the time of flowering in each variety was not affected by the growing medium. The peak blooming periods were 7 to 10 Feb. for 'Accent' and 12 to 14 Feb. for 'Hurricane' in both growing media (**Fig. 1**). The final measurements of plant growth, taken on 20 February, showed that fresh and dry weights of plants grown in rockwool were greater than those obtained from the gravel medium for both cultivars (**Table 1**).

The quality of cut flowers harvested from the two different growing media varied, depending on cultivar. In general, plants grown in rockwool produced cut flowers with longer stem length, greater fresh weights, larger number of flower buds and open flowers per stem and thicker flower diameter, as compared to those obtained from the gravel medium (**Table 2**). These differences, however, were more evident in 'Accent' than in 'Hurricane'.

Discussion

The gravel medium has been extensively used at Colorado State University for growing many cut flower crops, including carnation, rose, and chrysanthemum. Both the gravel and rockwool media require a constant nutrient feeding system, but the former needs a more frequent watering cycle. During this experiment, irrigation was adjusted to satisfy needs of gravel culture, thus making the rockwool medium constantly wet. Obviously, this did not affect the healthy growth of the chrysanthemums, as evidenced by the superior quality of the cut flowers obtained from the rockwool medium. Similar results were found in the production of rose (3) and snapdragon (4). The root systems of

Fig. 1. Flowering plants of 'Hurricane' (white decorative) and 'Accent' (purple daisy) chrysanthemums grown in a raised bench containing gravel and rockwool media in alternate blocks.

Table 1. Influence of root medium on growth of 'Accent' and 'Hurricane' chrysanthemums[z].

	Growing Media	
	Gravel	Hortiwool
Plant Height (cm)		
Accent	75.7 ± 9.7	89.4 ± 8.7
Hurricane	87.7 ± 7.8	93.3 ± 8.5
Avg.	*81.7*	*91.4*
No. Branches		
Accent	3.1 ± 0.4	3.2 ± 0.5
Hurricane	3.2 ± 0.8	3.0 ± 0.7
Avg.	*3.2*	*3.1*
Stem Diam (mm)[y]		
Accent	5.0 ± 0.6	5.0 ± 0.6
Hurricane	5.6 ± 0.7	5.7 ± 0.7
Avg.	*5.3*	*5.4*
Fresh Weight (g)		
Accent	115.5 ± 21.2	114.2 ± 18.9
Hurricane	136.8 ± 18.7	152.9 ± 31.4
Avg.	*126.2*	*133.6*
Leaf Area (cm^2)		
Accent	775.6 ± 271.8	1015.4 ± 269.2
Hurricane	852.8 ± 182.5	1207.5 ± 345.1
Avg.	*814.2*	*1110.0*
Dry Weight (g)		
Accent	14.7 ± 7.1	19.3 ± 7.2
Hurricane	16.8 ± 7.5	20.7 ± 11.2
Avg.	*15.8*	*20.0*

[z] Plants were established on 11 Nov. 1985, and harvested on 20 Feb., 1986. All data are presented as mean ± the standard error.
[y] Data taken on Jan. 13, 1986.

Table 2. Influence of growing medium on cut flower quality of 'Accent' and 'Hurricane' chrysanthemums[z].

	Growing Media	
	Gravel	Hortiwool
Stem Length (cm)		
Accent	57.2	66.2**
Hurricane	63.4	72.3**
Fresh Weight (g)		
Accent	29.8	33.8*
Hurricane	55.7	57.2
Open Flowers/Stem (No.)		
Accent	2.8	3.4**
Hurricane	4.8	5.2
Buds/Stem (No.)		
Accent	1.8	2.4**
Hurricane	1.8	2.4*
Largest Flower Diam (cm)		
Accent	7.4	7.5
Hurricane	6.6	7.3**

[z] Averages of all cut flowers harvested.
* Significant difference at the 5% level, paired *t*-test.
**Significant difference at the 0.5% level, paired *t*-test.

chrysanthemums grown in rockwool were confined more in the upper layer of the medium during the early growing stage, but they reached the bottom of the bench by harvest time. No physiological or nutritional abnormalities were observed in plants grown in either medium. A second cycle of crops grown in rockwool in the same bench showed an excellent production of cut flowers similar to the first crop. The results of this research indicate that the loose form of rockwool, without amendments, can be used as a root substrate for the production of cut chrysanthemum flowers.

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THE HAZARDS OF POLITICS

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Imagine yourself transported back in time, say 10,000 or 20,000 years, to near the end of the Ice Age. Your name is Smt and you are the representative of the Smt Clan at the Pan European Cro-Magnon Congress.

Your job, like all Congressmen's, is to work for the betterment of your constituency and to govern the Cro-Magnon nation scattered across Central Europe.

One day you get up in the hollowed-out valley that serves as the house of the legislature, and make a speech regarding a vision that you had. You tell the assembled delegates that somehow you had a perception of the future, and you are very concerned.

You could see that, not too far off, the occupations of traditional Cro-Magnon people, namely, the man hunt and the women gather, will disappear. You see the end of the era of hunter/gatherers. Food will be gathered in other manners, of which you are not quite certain.

This, as you might imagine, causes quite an uproar. Your fellow Congressmen ask, "What do you mean, the end of hunting and gathering? Hunting and gathering is how we subsist.

"If the men didn't hunt and the women didn't gather, in a few months time we would all starve. In fact, even though everybody hunts and gathers all the time, starvation is just around the corner."

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You reply by saying that in the future two technologies will emerge. One is something called agriculture and the other is animal husbandry. Your astounded peers ask you to explain.

You reply by saying you're not exactly sure how it works, but *animal husbandry* means that instead of having to hunt animals, you will have the animals live with you and they will stay with you patiently while you feed them and eventually slaughter them for food.

Agriculture means that, rather than traveling far and wide to gather nuts, berries, acorns, underground tubers, and what have you, you will grow these things in little plots of land next to the huts and caves.

Your fellow delegates are astounded at this wildly fanciful and imaginary concept. Whoever heard of animals staying put, and who ever heard of digging the ground to grow food?

The body politic becomes so enraged that the members physically pick you up, throw you into a cave, and put a large rock in front of it so you can't get out and can do nothing but paint the walls. From time to time they feed you, but your political career is over.

Reincarnate yourself into the future. It is 1811, and you are MP Smythe from the Midlands of England, representing your district in the House of Commons. You make a speech and tell your fellow MPs that you had a dream and a vision of the future.

You can see a world of very few farmers. You state in your speech that, whereas now 80% of all Englishmen are farm-

ers, in 150 years or so, less than 3% of all of the people engaged in productive work will be farming.

Your fellow members of Parliament are outraged. "How can anyone suggest, with rampant starvation taking place every year in London and other major cities, that one day there will be an excess of farmers! We have trouble meeting our needs today," they go on to tell you.

"And it is going to get even worse," they say, "according to the eminent Reverend Malthus, who has predicted eventual worldwide famine because the population will outstrip the ability of the land to produce food."

You reply that agriculture will become so productive that most farmers won't be needed, and they will be working in factories. In fact, you tell them, your vision foresees that one day farmers will be paid *not* to farm.

At this, the entire House of Commons goes into an uproar. "How could anyone be so cruel, so heartless, and so inhumane as to even suggest that a government would actually pay people not to farm, when we know full well that people are starving and dying of hunger every day."

The Body gets so enraged that members physically carry you out of the Chamber, throw you into a Dickensonian insane asylum, chain you to a wall and, from time to time, throw you scraps of food. That effectively ends your political career.

Transport yourself one more time, into 1987. You are Congressman Smith and represent a district in New England. (Yes, Mr. Smith has finally gone to Washington.) You stand up in Congress and make a speech. You predict that in a hundred years there will be almost no need for manufacturing jobs as we know them today.

Just as farmers have essentially become so productive that vast numbers of them are no longer needed, so too will manufacturing follow that same course. We had better start preparing for that day, you state.

Your fellow members of Congress are outraged. "How could that be?" they shout. "Who will make our cars, VCRs, and Miller Lite, our satellite dishes, and our plastic garbage bags, all the things we need to survive? Somebody has to make things," they say.

"We cannot sit around and sell financial services to one another and merely sit at computer terminals and communicate. And besides, who is going to make all of those computer terminals and the wires through which they communicate if nobody is going to be making things?"

You reply that you are not sure how this is going to work but, in your vision of the future, life will be so different that we really won't need people to make things, and the problem will solve itself. The House members become so enraged they physically grab you, haul you out to Sunny Acres Farm, put you in a padded cell, and feed you from time to time. And that is the end of your political career.

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