Madia elegans ssp. vernalis - New Crop Summary & Recommendations

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An Initial Exploration into the Horticultural Potential of *Madia elegans ssp. vernalis*

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INTRODUCTION

Taxonomy

Madia elegans, known as the Common Madia, is a member of the Asteraceae family. It has many known subspecies, including *densiflora, vernalis* and *wheeleri. Madia elegans* belongs to the common tarweed family, known for the fragrant oil exuded by it's foliage (Stevens, 2003).

Geographic Distribution

There is extensive documentation on the geographic range of *Madia elegans* "Common Madia" (Stevens, 2003; Hogan, 1998), but no definitive range of any of the subspecies has been established. While Common Madia can be found throughout California, Nevada, Washington, Oregon and Idaho (Steven, 2003), the only published location of Spring Madia is in the grasslands habitats of the San Joaquin Valley in California (Buck-Diaz et. Al, 2011). It is currently not known if this subspecies is found anywhere else within the greater Common Madia range. No Madia species are found native outside the US.

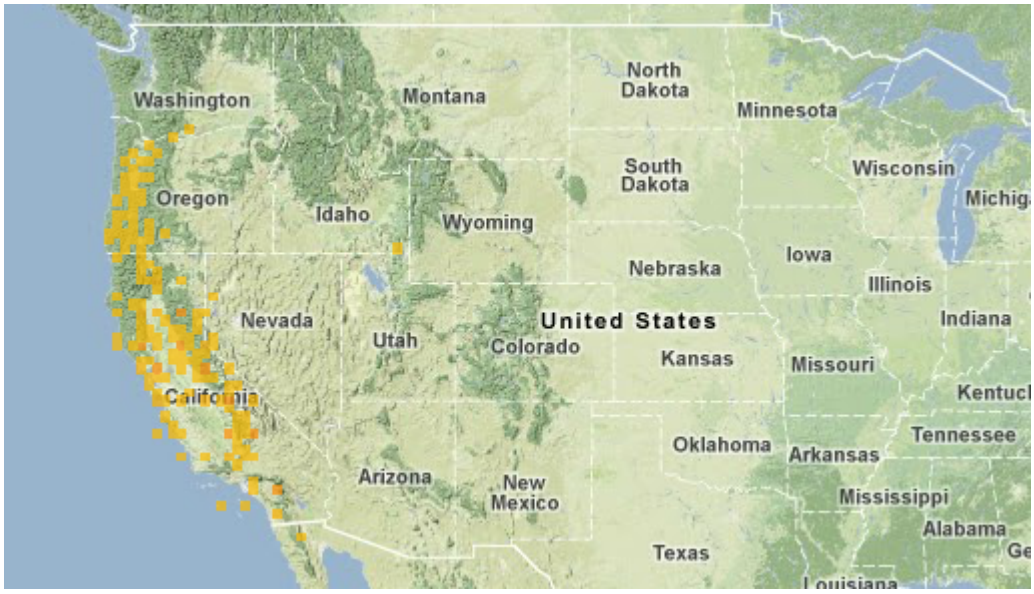

Figure 1. Range of *Madia elegans*.

Common Madia is not found at elevations above 3350 m (Steven, 2003). It has no published general climatic limitations, but is known to be found more frequently in areas of the San Joaquin Valley with serpentine-like soil (low in macronutrients), where competition from non-native grasses is not as fierce (Harrison, 1999).

Native Habitat

The San Joaquin Valley has a semiarid climate with hot, dry summers and up to 8 inches of precipitation annually. The precipitation often occurs in the cooler winters in the form of dense tule fog (Presser and Ohlendorf, 1987). Madias are known to coexist in grasslands with Lupinus formosus (Buck-Diaz et. Al, 2011).

Taxonomic Description

The following is a description from the USDA plant guide (Stevens, 2003): Common Madia is "…an annual herb, 1-2.5 dm tall, and strongly scented. The stems are simple to branched, often very leafy, softly hairy below, and with sparsely to densely stalked glandular sticky hairs above. Leaves are 2-10 cm long, linear, entire to serrate, soft-hairy to bristly, sometimes with glands. The floral heads are in open, flat-topped cymes with 5-21 yellow ray flowers and 25-30 yellow or maroon disk flowers with yellow or black anthers. The 2.5-5 mm fruits are black or dark brown achenes, sometimes mottled, and compressed or 3-angled." Common Madia flowers in summer and early autumn, and has no underground storage organ (Stevens, 2003).

Common Madia seeds have been used by the Hupa, Cahuilla, Digueño, Chumash, Costanoan, Kawaiisu, and Maidu tribes in California to make pinole (Stevens, 2003; Hogan, 1998). Stevens (2003) states that tribes would burn stretches of land to harvest the burnt seed, where it would be stored and eventually ground into flour.

Name and Description of Varieties/Cultivars on the Market

There is no known selective breeding of Common Madia, and thus no cultivars have been developed. Hogan (1998) states that seed collected from native Common Madia is available from selected native plant nurseries within it's range.

Product Specifications

If Common Madia is to be marketed as a commercial horticultural crop, it will need to have cultivars which possess guaranteed phenotypic traits to the consumer. Seed germination percentage will need to be high, and ideally the seed will not need special treatments like scarification or cold stratification to make sowing easier for the consumer. If random crosses do not result in major morphological inconsistencies, open pollination may be used while ensuring general crop uniformity.

If none of these traits seem possible with seed propagation, then vegetative propagation may need to be studied. Selective breeding may result in unique phenotypes, like dwarfing or flower color. If this is accomplished, then vegetative propagation will need to be used to ensure these traits to the consumer. A Common Madia ideotype would be a plant that is easily seed propagated with high germination rate and yield potential, tolerant in dry and sunny conditions, a large quantity of showy flowers per plant, appealing scent and open pollinated seed that can be stored well, resown or used as a food ingredient, mimicking how they were used in Native American cultures.

METHODS

Propagation Methods- Experiment

Propagation for this study was entirely from seed. No stock material was present for vegetative propagation. Seed was acquired from Neil Anderson on February 6th, 2012. Two experiments were conducted to determine germination requirements from seed. In the first experiment 72 cells of Common Madia were sown into a 288 plug tray of Gerber B-2 germination medium and placed into a mist house, and another tray of 72 cells was watered thoroughly, covered with a plastic moisture lid and put into a cool house. The mist house was irrigated every ten minutes and kept at a constant 21 degrees Celsius with 16 hours of 150 umols of light. The cool house was maintained at 4 degrees Celsius with no light, and was weekly irrigated under the moisture lid. Weekly germination counts were kept for 3 weeks for the mist house treatment and 5 weeks for the cool house treatment.

The other germination experiment involved studying the effect of gibberellic acid (GA) on germination of Common Madia seeds. Two GA treatments of 400 ppm, 200 ppm, 100 ppm and 0 ppm were prepared. Ten Common Madia seeds were soaked into each of the eight treatments. One of each 400 ppm, 200 ppm, 100 ppm and 0 ppm treatment was placed into a greenhouse kept at a constant 21 degrees Celsius with 16 hours of 150 umols of light, with each corresponding treatment put into a cool house maintained at 4 degrees Celsius with no light. Germination counts were taken daily for eleven days.

A comparison of mature plant height between germination temperatures and day length was also conducted. One flat of 18 mist house germinated Common Madia was transferred to short day length conditions 41 days after initial sowing, and plant height was documented on all treatments 63 days after initial sowing. Short day length conditions were 8 hours of 150 umols of light.

Flower bud initiation (FBI) was also documented between plants put under short day length and long day length conditions. 41 days after initial sowing, one flat of 18 Common Madias with no FBI was placed into a short day length greenhouse. Flower buds across all 18 plants were counted weekly between the short day length flat and a corresponding flat under long day length conditions.

Finally, six mature plants were chosen at random to start breeding trials. Disk florets were emasculated before anthers developed on opened flowers. It was impossible to emasculate without completely removing the florets, which possibly compromised the structural integrity of the ovaries after pollination. Plants were all cross pollinated and self-pollinated in order to determine self-compatibility.

RESULTS

Germination- Hot and Cold Conditions

Of the 72 seeds placed into the warm treated mist house, 27 were sprouted after one week, 43 sprouted after two weeks, and all seeds germinated after three weeks, resulting in a 38% 7-day

germination, 60% 14-day germination and 100% 21-day germination. Almost all seeds were in stage 4 of germination by the third week. In the cold treated conditions, germination percentages were as follows: week 1- 0%, week 2- 26%, week 3- 61%. No seeds were past stage 1 of germination. After week 3, the cold treated seeds were brought into the mist house, and after one day 79% of the seeds were germinated in stage 2. No more seeds germinated after that time.

Germination- GA Treatments over Hot and Cold Conditions

Results of the GA treated seeds in hot and cold conditions are presented in figure 2. A few trends can be seen from this graph. First, the hot treated seeds almost all germinated faster than the cold treated seeds, with the exception of the 400 ppm GA treatment. Cold treated seeds reached similar germination levels, but were slower to germinate. This shows that cold stratification is not needed for germination of Common Madia seeds. Also, it seems that GA treatments at these levels inhibit seed germination, as the control and 100ppm treatments had the highest total germination percentages, regardless of temperature treatment.

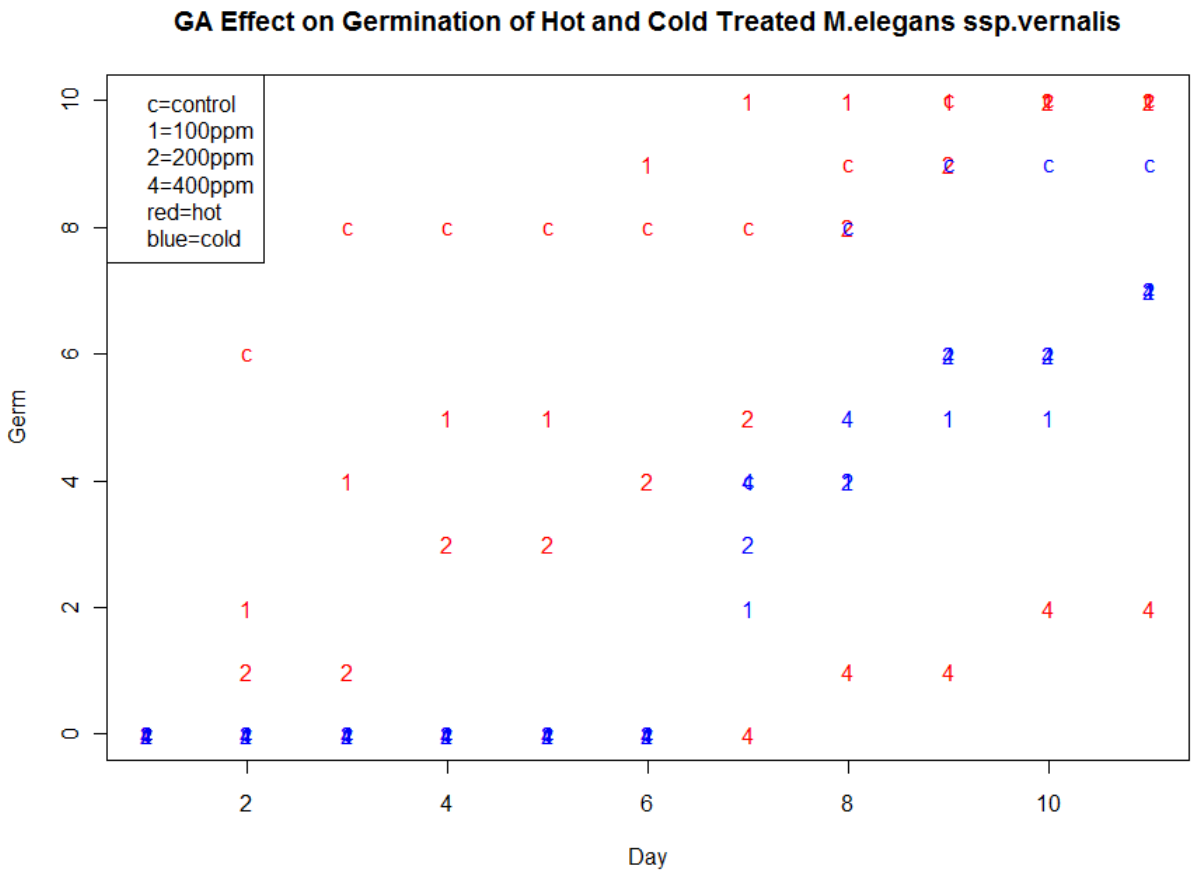

Figure 2. GA Treatments over Hot and Cold Conditions

Mature Plant Height of Seeds Germinated at Different Temperatures and Day Lengths

Results of the height experiment are shown in Figure 3. The mean mature height of the cold treated seeds was 8.875 inches, compared to the warm treated seeds, with a mature height of 24 inches. Running a t-test comparing the mean heights of the cold and hot treated plants, we get a p-value of 1.306034e-10. This shows there is a highly significant difference between mature heights of Common Madias germinated at optimal and near freezing temperatures.

The difference between plant heights grown under different day length conditions was less distinct. The mean height for long day length Common Madias was 24 inches, while short day length was 16 inches. This still seems like a noticeable difference, but it is not statistically significant, with a p-value of 0.8562681.

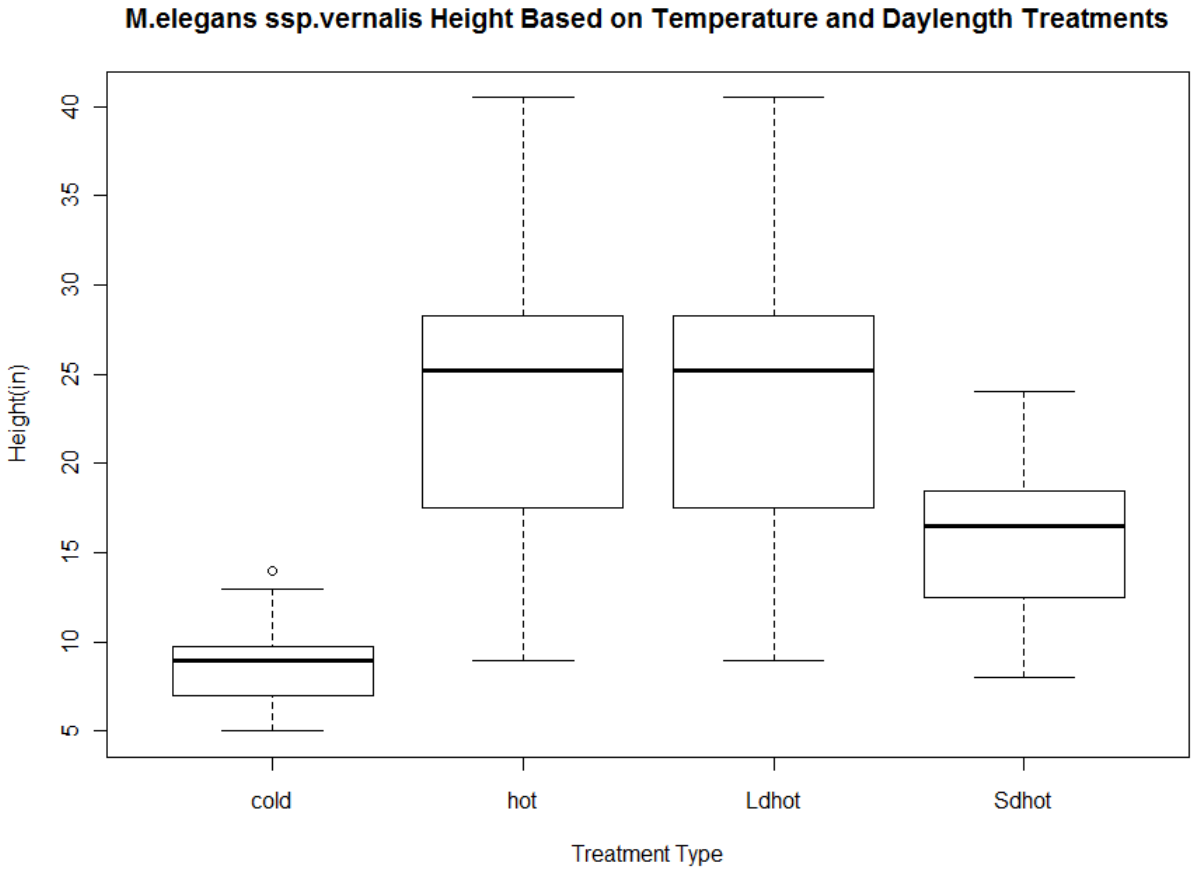

Figure 3.

Flower Bud Initiation

FBI was documented under short and long day length conditions. No statistical analysis was conducted because of a lack of data points. Results are shown in Figure 4. FBI initiation occurred in both treatments, but the long day length treatments had noticeably more initiation than short day, 91 to 19.

It also took two more weeks for FBI to occur under short day length conditions, so we can initially construe that *Madia elegans* is a facultative long day crop. More vigorous studies on flowering restrictions should be taken.

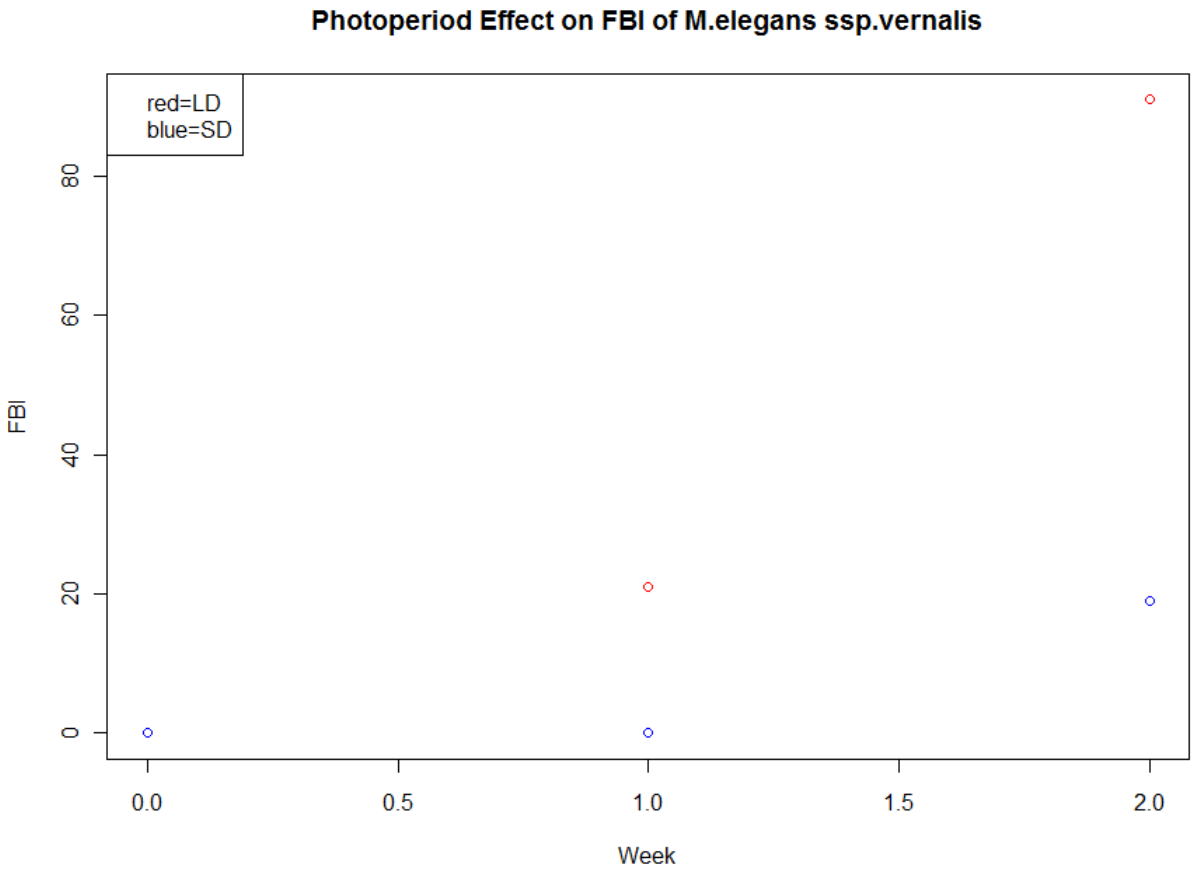

Figure 4.

Breeding Trials

Plants have yet to set seed at the time this report is written.

DISCUSSION

Propagation Methods

Based on the results, initial conclusions can be made on propagation techniques for *Madia elegans*. No vegetative propagation experiments have been conducted, but from the data obtained in this study, propagation by seed is a viable production method. As the bred plants from this study have yet to set seed, the number of seeds per flower is not currently known. Temperature germination tests indicate that there is no seed dormancy period to overcome, scarification is unnecessary, and GA treatments inhibit, rather than expedite, the germination process. Germination temperature is

dependent upon desired height of mature plants. For maximum height ($\bar{x}$=24 inches), germination should occur in covered, moist conditions at 21 degrees Celsius. For dwarfed height plants ($\bar{x}$ = 8.875 inches), germination should occur in covered, moist conditions at 4 degrees Celsius for 3 weeks before being transferred to normal conditions (21 degrees Celsius).

Market Niche

Common Madia can be marketed as a drought tolerant mid to late Spring crop that flowers throughout the summer. Because of its wild status, Common Madia would be ideal for gardeners attempting to mimic a native prairie/grassland landscape on their property while adding bright yellow flower power. As prairie restoration becomes more popular, so will the marketability of this crop. The strong aromatic oils present in the foliage and flowers can lend an added bonus to consumers- walking through a densely packed plot of Common Madias smells like strolling through a grove of lemon trees. The strong scent of Common Madia would also make it an attractive cut flower for indoor mixes, and cool germinated 'dwarf' Common Madias would make an attractive houseplant. Warm germinated Common Madia should be sold in seed packets only, as their immense size would make shipping difficult and unprofitable.

Marketing Common Madia for specific dates offers interesting marketing possibilities. The 4th of July would be a possible holiday to push Common Madia- the sunflower qualities are reminiscent of childhood summers, and the plant is native in the United States, and could be marketed as a patriot plant for the patriot holiday. As a food crop, Common Madia seed packets can come with recipes for Pinole or other Native American traditional dishes that include Common Madia seeds. This would extend the crop's marketability into the Fall, as the flowers begin to close and set seed. It is conceivable that with appropriate marketing and extensive breeding, Common Madia can become a major horticultural crop due to it's unique versatility.

Possible limitations of Spring Madia would be breeding difficulties, lack of name recognition and competition with plants in the same family with larger flowers. Breeding is possible with Common Madia, but anthers begin to grow hours after ray florets expand, making the timing of emasculation critical. Since no previous breeding has been attempted or documented, there are no unique cultivars that differ from the wild species. Since Common Madia has not been marketed outside of it's native region in California, name recognition is low, and it may be difficult to sway consumers into buying a 'smaller sunflower', regardless of its other benefits.

Anticipated Cultural Requirements

From it's native geographic range, we can initially assign Common Madia Winter hardiness up to zone 7a (Stevens, 2003). Further study will be needed to assess Common Madia's maximum level of hardiness. Due to this study's findings, we know that Common Madia can handle temperatures down to 4 degrees Celsius during germination and up to 21 degrees Celsius for optimal growth. Photoperiod is not necessary for FBI, but long day length conditions do increase average number of flowers per plant, making it a facultative long day plant. Plants showed no signs of nutrient deficiency with a constant liquid feed of 125 ppm 15-5-15 plus calcium and magnesium in Sunshine LC8 growth medium, and a pH

of 6.2-6.9. No Plant Growth Regulators were used on any treatment, no fungicides were needed, and no insect damage was observed on any of the plants, though an occasional thrip was seen on ray florets. Container requirements are discussed in the production schedule below.

Production Schedule

	Week 1	Week 2	Week 3	Week 4
Madia elegans ssp. vernalis- Normal size	Sow into 288 plug tray, cover with coarse vermiculte, place in misthouse, 70 degrees F	take germination count	Remove from misthouse, place on capillary mat in LD greenhouse, 65 degrees F, early morning DIF to 50 degrees F if possible	Transplant 1 plant/ 4" pot, CLF at 15-5-15 with Calcium and Magnesium
Madia elegans ssp. vernalis- 'Dwarf' size	Sow into 288 plug tray, irrigate thoroughly, cover with coarse vermiculte and moisture lid, place in 4 degrees C cooler	take germination count		Remove from cooler, place on capillary mat in LD greenhouse, 65 degrees F, early morning DIF to 50 degrees F if possible
Week 5	Week 6	Week 7		
Apply PGR if transportation requirement is less than 24 inches mature size	FBI	Plants should be flowering and at saleable size		
Transplant 1 plant/ 4" pot, CLF at 15-5-15 with Calcium and Magnesium	FBI	Plants should be flowering and at saleable size		

Experimental results relating to the design of this production schedule are discussed in the above section.

Needs Assessment for Genetic Improvement

Selective breeding can lead to several key morphological improvements, including flower size and color, plant height and temperature tolerances, if needed.

CONCLUSION

Madia elegans "Common Madia" is a versatile crop that shows promise for horticultural development. Wild seeds have a high germination rate, do not need scarification or GA treatments, grow quickly and initially do not appear to be susceptible to most common greenhouse pests. Final plant size can be altered by initial germination temperature- thus 'dwarf' plants can be induced without use of PGRs.

REFERENCES

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