

Whorled Sunflower (*Helianthus verticillatus*): A Potential Landscape Plant

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INTRODUCTION

Helianthus verticillatus or whorled sunflower is a recently designated endangered species found only on a few prairie remnants in Tennessee, Georgia, and Alabama. It is a perennial species that spreads via rhizomes (Mathews et al., 2002) and produces copious amounts of small, black or gray seeds if compatible genotypes are present. This sunflower species is self-incompatible (Ellis and McCauley, 2009).

Plants emerge in late winter in Tennessee as a basal rosette (Figure 1) and reach 3-4 meters by August (Figure 2). It flowers profusely in August and September, and through the middle of October or until a killing frost. The plants bear up to 20, 4-6 cm diameter yellow ray flowers with brown to black discs at the 20-30 cm of the termini of



Figure 1. *Helianthus verticillatus* emerging in the spring.

the stalks. The flowers attract over 30 species of potential pollinators, which include mostly native bees (Figure 3) and flies, and a variety of moths and butterflies. Inflorescences are

covered with pollination bags when brown and shriveled, and seeds collected in November after the flowers are thoroughly dried (Fig. 4). This sunflower also appears to be drought tolerant.

The specific aims of this research were to determine germination conditions for seeds and to develop clonal propagation methods that utilize tissue culture and rooted cuttings.



Figure 2. Rapid vegetative growth (early August) and prolific flowering on tall stalks of *Helianthus verticillatus* in September.



Figure 3. In the center of the flower is a native bee (*Bombus* sp.), a potential pollinator of *Helianthus verticillatus*.



Figure 4. Pollination bags covering multiple heads of *Helianthus verticillatus*. Seeds were harvested in November 2017.

MATERIALS AND METHODS

Seed viability and germination.

Seeds were collected from a 200-stem stand growing in Maryville, Tennessee in November 2017. Seeds were separated from somatic tissues, stored in glass vials at room temperature, and shipped via postal service to the University of Florida in early February 2018. Pre-germination and seed viability were assessed with 100 seeds using a tetrazolium staining method (Peters, 2005) over 18-24 hours. Seeds with embryos that evenly stained dark pink- to -red were considered viable (Figure 5).



Figure 5. Seed germination (left) and X-ray analysis for viability (right) in *Helianthus verticillatus*.

Germination of seeds was evaluated using four replications of 100 seeds (AOSA, 2016) each at the following four temperature regiments: 22/11^oC; 27/17^oC; 29/19^oC; and 33/24^oC with a 12- hour photoperiod. Tests were conducted over 28 days. Post-germination tetrazolium tests were performed on ungerminated seeds after 28 days and percent dormancy, total viability, and germination of viable seeds determined.

Clonal Propagation - Leaf culture.

Young, not fully expanded leaves of less than 0.5-meter tall plants were harvested in April and surface disinfested in 25% NaOCl for 10 min and then rinsed thoroughly with sterile distilled water. Dissected leaves were placed on Murashige and Skoog (MS) (1962) medium amended with a range of concentrations of various cytokinins with and without auxin and cultured at 22^oC with a 12-hour photoperiod. Explants were transferred to MS medium without growth regulators after two weeks and incubated under the same conditions for the next four weeks. Explants were assessed for callus, shoot, and root formation after six weeks.

Clonal Propagation - Nodes/Axillary buds.

Nodes, each with two or three axillary buds, were harvested from less than one-meter plants. Leaves were removed and the nodal segments surface disinfested in 25% NaOCl for 15 min and then rinsed in sterile distilled water. Nodes were transferred to 60 mm diameter plastic test tubes containing MS medium supplemented with a range of concentrations of various cytokinins. Cultures were incubated at 22^oC with a 12-hour photoperiod. Shoots were harvested after four weeks and rooting attempted on MS medium amended with auxin.

Clonal Propagation – Cuttings.

The terminal 15 cm of young plants were harvested in late May 2017 and either treated with IAA or water for 10 min. Shoots were then placed in Promix B. In a second experiment, the upper 45 cm of plants were harvested from plants in late June 2017. Three node cuttings were placed in Promix B after a 10 min treatment with either IAA or water. Cuttings were rooted in the greenhouse with mist. Rooting was determined four weeks after treatment.

RESULTS AND DISCUSSION

Seed viability and germination.

Greater than 98% of the seeds were viable (Figure 6). Seeds did not lose viability within 7 months of dry ambient storage.

Germination of seeds occurred in all treatments, but only about 77% of the seeds in the high-temperature treatment germinated within 28 days. In the other three treatments over 96% of the seeds germinated.

Fifty percent of the seed in the coldest treatment germinated within 7-8 days, whereas 50% of the seed in the three warmer treatments germinated within 1-2 days. Seeds are easy to germinate and will be critical in breeding efforts that combine resistance to powdery mildew and flower morphology.



Results

- Pre-germination (n=100)
 - TZ viability = 91% positively stained
 - X-ray analysis= 95% filled seed
- Germination (n=400)
 - High (96-99%) at 22/11, 27/17 and 29/19°C
 - Reduced (76%) at warmer temp (33/24 °C)
 - Fast germination rate: 50% germination was achieved by day 2 (27/17°C, 29/19, or 33/24°C) or day 7 (22/11°C)

Figure 6. Results of seed germination studies of *Helianthus verticillatus*.

Tissue culture. More than 50% of cultures became contaminated within ten days of culture initiation. Very few shoots were formed from explants cultured on medium containing cytokinin (Figure 7). However,

leaves cultured on MS without growth regulators formed numerous roots and some callus. More than 75% of the nodes cultured became contaminated with bacteria and fungi after two weeks and were discarded.

Clonal Production via Tissue Culture



From Axillary Buds



Figure 7. Clonal propagation by tissue culture using explants from axillary buds and leaves of *Helianthus verticillatus*.



From Leaves

On the remaining 25% of the cultures, axillary buds elongated on medium with or without cytokinins, but excised shoots failed to produce roots. Additional shoots did not form on nodes transferred to fresh medium. Preliminary results suggest that tissue culture propagation methods do not seem to be well suited to this sunflower, but additional studies are necessary. Besides controlling contamination, shoot proliferation appears to be very problematic.

Cuttings. Almost all (98%) of the cuttings harvested in late May formed robust root systems after four weeks when treated with auxin or water (Figure 8).

These plants grew well and flowered normally in September. Only about 20% of the three node cuttings harvested in late June produced roots in response to either water or auxin treatment. Only one surviving whole plant flowered in September. Propagation of plants by terminal cuttings harvested in late May is very efficient. Rooted cuttings typically produce as many as four additional shoots via rhizomes during the growing season.

All of these are clonal, which is essential for determining compatibility and controlled (not open pollination) breeding for desirable traits.



Figure 8. Clonal propagation by cuttings of *Helianthus verticillatus*.

Literature Cited

Association of Official Seed Analysts (AOSA). (2016). Rules for testing seeds. *16*:1-113.

Ellis J.R. and D.E. McCauley. (2009). Phenotypic differentiation in fitness related traits between populations of an extremely rare sunflower: conservation management of isolated populations. *Biol. Conservation* *142*: 1836-1843.

Matthews J.F., Allison J.R., Ware R.T., Sr., and Nordman C. (2002). *Helianthus verticillatus* Small (Asteraceae) rediscovered and redescribed. *Castanea* *67*: 13-24.

Murashige T. and Skoog F. (1962). A revised medium for rapid growth and bioassays with tobacco tissue cultures. *Physiol. Plant.* *15*:473-497.

Peters, J. (2005). Tetrazolium testing handbook. Association of Official Seed Analysts, Las Cruces, NM.