NH Horticultural Endowment 2016 Annual Report

NH Plant Grower's Association • New Hampshire Horticulture Endowment
The Grant-Making Resource for New Hampshire's Horticulture Industry

New Hampshire Horticulture Endowment Grant Update

Optimizing Herbaceous Perennial Cutting Physiology, Morphology, Callusing, and Rooting with Photosynthetic DLI and Root-zone Temperature during Propagation

INTRODUCTION

Over the past decade, the herbaceous perennial propagative material sector increased by 43% [$50 million USD (USDA, 2005 and 2015)]. Herbaceous perennials can be successfully and economically propagated by seed (Scoggins, 2006), however, many perennials can be vegetatively propagated by stem, basal, rhizome, or root cuttings. Rhizome and root cuttings rarely yield uniform results and are labor intensive (Scoggins, 2006); therefore, stem and basal cuttings are recommended for vegetative perennial propagation. Vegetative stem tip cutting propagation is the most common method utilized by the ornamental industry and offers the ability to quickly and economically produce large numbers of rooted cuttings (liners). In the U.S., propagation of unrooted herbaceous perennial cuttings occurs most often during the summer, but can also occur during the fall, winter, and spring (Owen and Lopez, 2015). Rooting herbaceous perennial cuttings year-round, under suboptimal ambient

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and rooting temperatures and photosynthetic propagation daily light integrals (PDLIs) affects uniformity, root initiation and development and finished liner quality. During winter and early spring, when ambient photosynthetic DLIs are low (Korczynski et al., 2002), the ability to produce a quality liner may be delayed or prevented.

Callus and root formation are independent of each other, however both are dependent upon similar physiological and environmental conditions. Successful callusing and rooting of vegetatively propagated herbaceous perennials depends on cutting physiology and the propagation environment. An integrative approach to optimize callusing and rooting of herbaceous perennials is to monitor and manipulate the propagation environment by providing the proper root-zone temperature, light quantity, moisture, and nutrition (Dole and Hamrick, 2006). However, the environmental parameters that support and influence the initiation of callusing as well as root initiation, growth, and development of herbaceous perennials are poorly understood. Therefore, our objectives were to identify and evaluate varying photosynthetic root-zone temperatures and PDLs on callusing and rooting of vegetatively propagated herbaceous perennial species.

MATERIALS AND METHODS

Unrooted herbaceous perennial shoot-tip cuttings of Gaillardia aristata Pursh 'Gallo Red' (blanketflower), Gaura lindheimeri Engelm. and A. Gray 'Siskiyou Pink' (wand flower), and Heuchera hybrida L. 'Black Beauty' (coral bells) were received from two commercial cutting suppliers. Two-hundred eighty-eight cuttings of each species were individually placed in 72-cell hexagon plug trays (30.7-mL individual cell vol.) filled with a propagation medium composed of (by volume) 50% soilless substrate and 50% coarse perlite. Cuttings were sprayed to runoff with a solution containing 300 ppm non-ionic surfactant (CapSil) so water did not accumulate on the foliage of cuttings.

Cuttings were placed in a glass-glazed greenhouse on insulated propagation benches with a root-zone heating system that circulated hot water across the bench-top. From a preliminary experiment, we determined uniform callus development of blanketflower, wand flower, and coral bells to occur 8, 3, and 5 days after placement in callusing environment, respectively, under a DLI of 5.0 mol·m–2·d–1, air temperature of 73 °F, root-zone temperature (RZT) of 75 °F, and relative humidity of 80%. Based on these results, cuttings were randomly placed on one of four propagation benches in a glass-glazed greenhouse under fixed shade cloth providing ≈56% shade under ambient daylight supplemented with a PPF of ≈35.4 µmol·m–2·s–1 at plant height, respectively, delivered from high-pressure sodium (HPS) lamps from 6:00 a.m. to 10:00 p.m. An automatic woven shade curtain was retracted when the outdoor light intensity reached ≈600 µmol·m–2·s–1 throughout the study. Mist was applied and controlled based on PDLI. Misting frequency was reduced 1 day after placement in the callusing environment.

After 3, 5, or 8 days of callusing [fast (wand flower), moderate (coral bells), and slow (blanketflower) rooting species), cuttings were transferred to a rooting environment in a glass-glazed greenhouse and placed in DLI and root-zone heating treatments. Cuttings were placed under fixed shade cloth providing ≈86, 62, or 26% shade or no shade under ambient daylight supplemented with a PPF of ≈19, 48, 102, or 125 µmol·m–2·s–1 at cutting height, respectively, delivered from HPS lamps from 6:00 a.m. to 10:00 p.m. to create low, medium, high, and very high PDLI treatments. Each propagation bench was programmed and controlled individually to provide RZT of 68, 75, or 82 °F. Target greenhouse air temperature and relative humidity set points were 68 °F and 60%, respectively. From transfer to 8 days after transfer, mist was applied and adjusted for each root-zone heating and PDLI treatment. Cuttings were irrigated daily with acidified tap water supplemented with a water-soluble fertilizer and micronutrient supplement at each irrigation event providing (ppm): 60 N, 5 P, 39 K, 9 Ca, 5.1 Mg, 1.4 B, 2.33 Cu, 8.0 Fe, 8.13 Mn, 0.43 Mo, 13.0 S, and 4.63 Zn.

For each propagation environment, precision thermistors measured canopy and rooting medium temperatures. Amplified quantum sensors measured PPF under each PDLI treatment. Fixed mounted infrared thermocouples measured leaf surface temperature. Measurements were recorded every 30 s and the average of each sensor was logged every 15 min by a data logger.

The experiment was designed in a randomized complete block design in a factorial arrangement, with species (3 levels), PDLI (4 levels), and RZT (3 levels) as factors. There were two replications per PDLI and RZT treatments over time throughout the summer and fall propagation season. There were 8 samples (individual cuttings) per PDLI per RZT per replication for destructive whole-plant measurements.

RESULTS AND DISCUSSION

BLANKETFLOWER. Biomass accumulation of blanket flower cuttings propagated at each RZT increased with PDLIs as DAT increased, though to different magnitudes (Fig. 1). For example, at 14 DAT, the leaf dry mass (LDM) of cuttings propagated under low to very high PDLIs at RZT set points of 68, 75, or 82 °F increased by 78% (71.5 mg), 41% (31.6 mg), and 98% (72.7 mg), respectively. Increased SDM was observed beginning at 2 DAT when

cuttings were propagated at 82 °F RZT under increasing PDLIs, whereas at 68 and 75 °F RZTs, shoot dry mass (SDM) accumulation occurred at 8 DAT (6 d later) onward and increased across all PDLIs. From –1 to 5 DAT, RDM was unaffected by PDLI at 75 °F RZT and increased linearly by 88% (2.6 mg) at 8 DAT to 255% (17.2 mg) at 14 DAT, respectively, as PDLI increased from low to very high. Root biomass of cuttings propagated at RZT set points of 68 and 82 °F was unaffected by PDLI from –1 to 8 DAT and increased by 110% (4 mg) and 195% (6.1 mg) at 11 DAT to 395% (14.2 mg) and 295% (17 mg) at 14 DAT, respectively, as PDLI increased from low to very high.

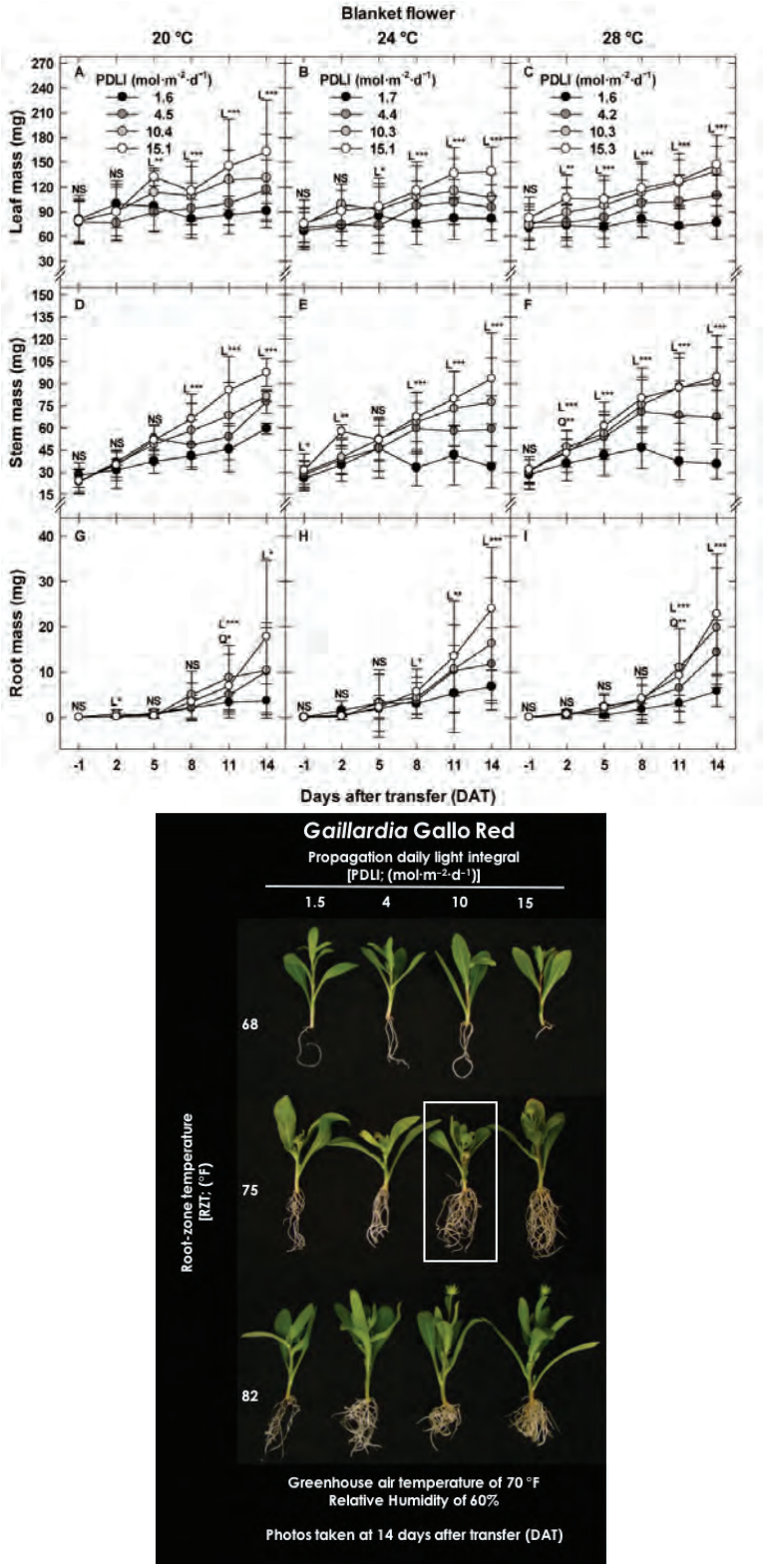
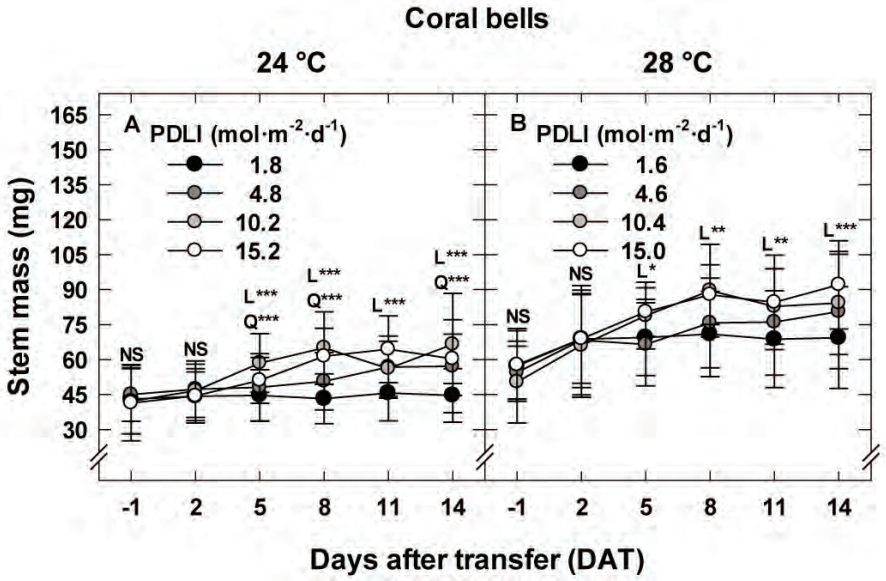


Fig. 1. Leaf (LDM), stem (SDM), and root (RDM) dry masses of blanketflower (Gaillardia aristata 'Gallo Red') cuttings propagated at root-zone temperature (RZT) set points of 68 (A), 75 (B), and 82 °F (C) at –1, 2, 5, 8, 11, and 14 days after transfer (DAT) from a callusing environment (–1 d) into a rooting environment (2–14 d) and placed under one of four propagation daily light integrals (PDLIs). Each symbol represents a mean of 20 samples, and error bars represent SE. Linear (L) and/or quadratic (Q) regression response within each day is indicated and non-significant (NS) or significant at P≤ 0.05 (*), 0.01 (**), or 0.001 (***).

CORAL BELLS. Leaf dry mass increased for all cuttings regardless of PDLI from –1 to 11 DAT at 68 °F RZT and –1 to 8 DAT at RZT set points of 75 and 82 °F (data not shown). Stem dry mass of cuttings propagated at 68 °F RZT increased by 26% (19.8 mg) from –1 to 14 DAT (data not shown), but were unaffected by different PDLIs. From 5 to 14 DAT, SDM of cuttings increased by 49% (21.9 mg) and 33% (22.7 mg) as PDLI increased from low to high at 75 °F RZT and at 82 °F RZT, respectively (Fig. 2). Root dry mass increased by 1,404% (3.2 mg), 809% (1.9 mg), and 459% (1.2 mg) for all cuttings regardless of PDLI from 2 to 14 DAT at RZT set points of 68, 75, and 82 °F, respectively. While RDM data were not compared among RZTs, we generally observed a decrease in RDM as RZT set points increased from 68 to 82 °F.

WAND FLOWER. The LDM, SDM, and RDM of wand flower cuttings propagated at all RZTs increased with PDLIs throughout rooting, though to different magnitudes (Fig. 3 and 4). For example, at 14 DAT, the LDM of cuttings propagated under increasing PDLIs at RZT set points of 68, 75, and 82 °F increased by 92% (57.7 mg), 140% (81.1 mg), and 129% (83.8 mg), respectively. Stem dry mass of cuttings propagated under increasing PDLIs at RZT set points of 68, 75, and 82 °F at 14 DAT increased by 66% (14.7 mg), 185% (42.1 mg), and 202% (47.2 mg), respectively. As PDLI increased at RZT set points of 68, 75, and 82 °F, RDM of wand flower cuttings increased by 157% (2.2 mg), 143% (4.3 mg), and 400% (6.8 mg) at 5 DAT to 142% (19 mg), 602% (26.5 mg), and 762% (19.8 mg) at 14 DAT, respectively.



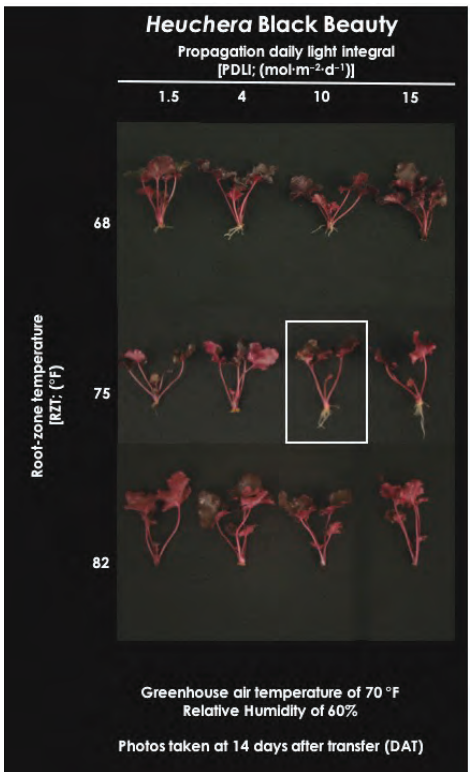


Fig. 2. Stem dry mass (SDM) of coral bells (Heuchera hybrida 'Black Beauty') propagated at root-zone temperature (RZT) set points of 75 (A) and 82 °F (B) at –1, 2, 5, 8, 11, and 14 days after transfer (DAT) from a callusing environment (–1 d) into a rooting environment (2–14 d) and placed under one of four propagation daily light integrals (PDLIs). Each symbol represents a mean of 20 samples, and error bars represent SE. Linear (L) and/or quadratic (Q) regression response within each day is indicated and non-significant (NS) or significant at P≤ 0.05 (*), 0.01 (**), or 0.001 (***).

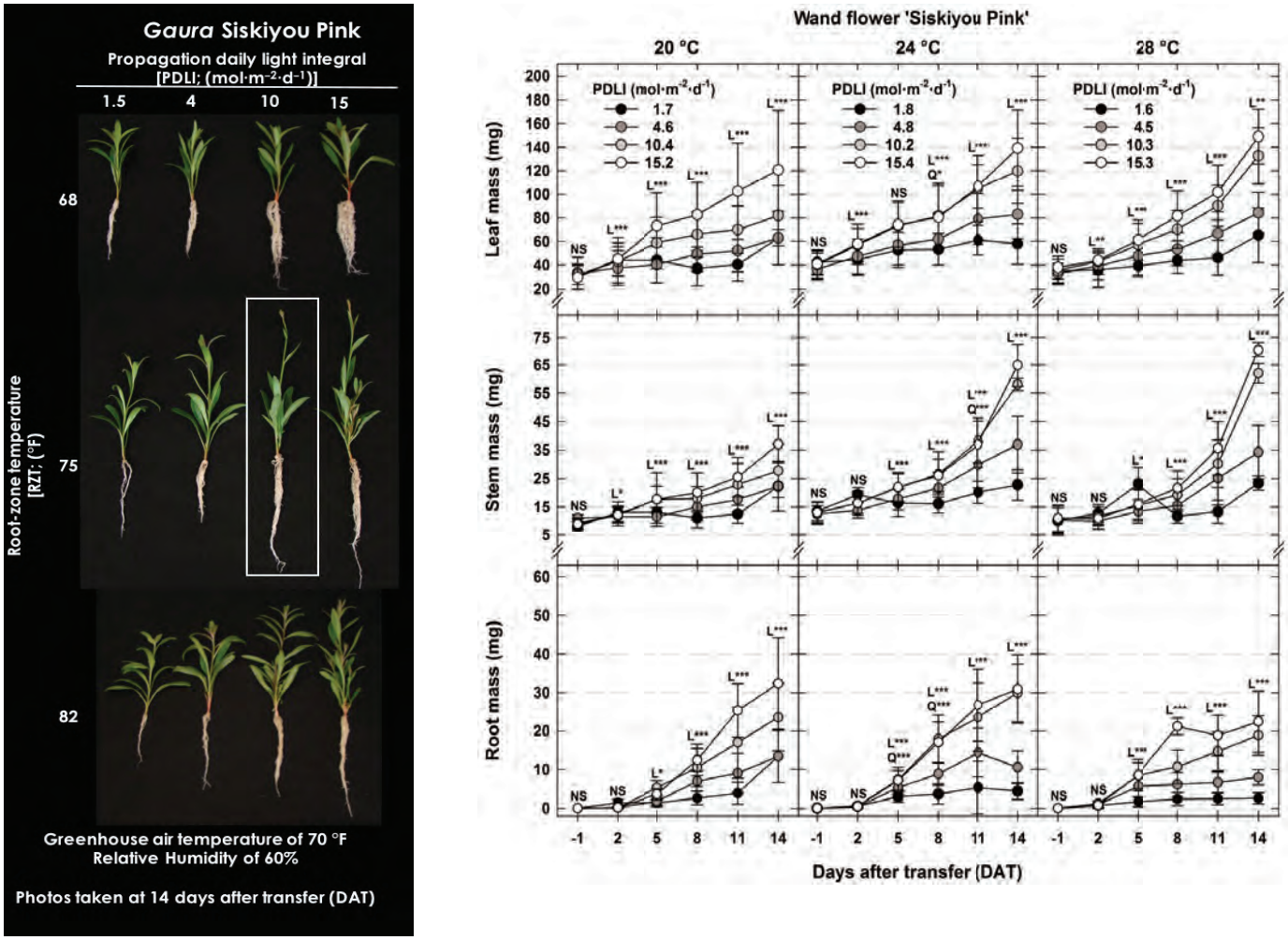


Fig. 3. Leaf (LDM), stem (SDM), and root (RDM) dry of wand flower (Gaura lindheimeri 'Siskiyou Pink') cuttings propagated at root-zone temperature (RZT) set points of 68 (A), 75 (B), and 82 °F (C) at –1, 2, 5, 8, 11, and 14 days after transfer (DAT) from a callusing environment (–1 d) into a rooting environment (2–14 d) and placed under one of four propagation daily light integrals (PDLIs). Each symbol represents a mean of 20 samples, and error bars represent SE. Linear (L) regression response within each day is indicated and non-significant (NS) or significant at P≤ 0.05 (*), 0.01 (**), or 0.001 (***).

CONCLUSIONS AND FUTURE DIRECTIONS

Results of these experiments determined species-specific responses to increasing PDLIs at 68, 75, and 82 °F RZTs throughout adventitious root formation (ARF). Our research provides evidence that providing a PDLI of 10 mol·m–2·d–1 during root development when propagating unrooted perennial cuttings can increase the total, shoot, and root dry mass and overall finished rooted cutting quality. When our results are combined for all the species we have investigated, we recommend providing a PDLI of 5 mol·m–2·d–1, RZT of 75 °F and air temperature of 73 °F during callusing and PDLI of 10 mol·m–2·d–1, RZT of 75 °F and air temperature of 68 °F during rooting. Much of the increased growth and reduced developmental time may be attributed to elevated photosynthesis for cuttings propagated under increasing DLIs. The reduced propagation time allows producers to increase the number of crop turns in their production facility. Furthermore, our results on the influence of DLI and RZT during propagation will enable producers to make better-informed decisions for managing light and temperature throughout rooting. Overall, our study shows how biomass accumulation of herbaceous perennial cuttings is primarily affected by PDLI during ARF. The species-specific responses shown here provide new literature regarding developmental changes during ARF. Further research is needed to determine how air temperature during rooting might interact with RZT to produce a more compact and toned rooted cutting.

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ACKNOWLEDGEMENTS

W. Garrett Owen (wgowen@msu.edu) is a Floriculture Outreach Specialist and Roberto Lopez (rglopez@msu.edu) is an Assistant Professor and Extension Specialist in Controlled Environment and Floriculture Production at Michigan State University. We gratefully acknowledge Josh Craver, Madeline Olberg and Kyle Martin for greenhouse and laboratory assistance. We would like to thank Ball Horticultural Co. and Dümmen Orange for plant material; Sun Gro Horticulture for substrate; Ludvig Svensson for shade cloth; J.R. Peters, Inc. for fertilizer; and the Fred C. Gloeckner Foundation, Inc. and the New Hampshire Plant Growers Association for financial support.

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2016 NH HORTICULTURE ENDOWMENT FINANCIAL REPORT

Checking Account balances: 1/1/16
$6,893.79

Income:

Grant Monies from NH Charitable Foundation	$9,500.00
Sun Grow	$360.00
UVT	$103.89
Donations from NHPGA Members	$1,250.00

Expenses:

Grant Check Univ. of Michigan	$10,000.00
Ann Hilton Secretary	$295.00
NHFB	$340.41

Income less Expenses: $578.48

Checking Account Balances 12/31/2016
$7,472.27

MFA Mutual Fund Value 1/1/16		$26,313.52	
MFA Mutual Fund Value 12/31/16		$28,646.56	
Income			**$2,333.04**
NH Charitable Foundation:	1/1/16	$128,637.27	
Net Investment Return		$9,221.75	
Foundation Fees		($888.39)	
Ending Balance: 12/31/16		$136,970.65	
Net gain (loss)			**$8,333.36**

Total Assets as of 1/1/16 $161,884.58

Total Assets as of 12/31/16
$173,089.48

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