Oregon Department of Agriculture and Oregon Association of Nurseries
Nursery Research Project Proposal 2014

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Title: Developing novel, disease resistant forms of nursery crops

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Background

The Ornamental Plant Breeding Program at Oregon State University takes a broad approach to cultivar development. We breed a wide variety of plants in an attempt to address the needs of the robust and diverse Oregon Nursery Industry. Below is a brief explanation of 5 projects we are conducting to develop new cultivars that have improved phenotypes and/or disease or insect resistance.

Ribes sanguinuem. Flowering currant is native to the Pacific Northwest and is a favorite of proponents of native landscapes. It is attractive in spring when flowering and attracts pollinators. It tolerates poor soils and drought. However, flowering currant tends to be leggy and has a poor form in the landscape. There are varied forms with regard to flower color but our goal is to develop a line of cultivars that are compact and exhibit the range of flower colors available from white to pink to cherry red. Furthermore, we have significant aphid pressure in our plots and observed significant variation in the amount of damage between plants. Therefore, we will use aphid tolerance/resistance as a secondary selection criterion.

Galtonia candicans. Cape hyacinth or summer hyacinth is an herbaceous perennial propagated from bulbs with large, strap-like leaves that generally grow 2 to 3 ft high and 2 in wide. A large scape is produced bearing a loose raceme of 20 to 30 pendulous white flowers, each 1 to 2 in long. This species can have great impact due to the large size of flowers but the length of the scape over which flowers are dispersed is undesirable. A shorter inflorescence that concentrated the flowers over a shorter area would be a significant improvement over the wild type. To my knowledge, there are no cultivars of this species. A superior form has the potential to establish dominance in the market.

***Philadelphus* spp.** Mockoranges are woody shrubs grown largely for their fragrant flowers produced from May to June (July). Traits of particular interest are the varying fragrance, purple eyespot in flowers, variegated or yellow foliage, and double flowers. I believe the main improvements to be made by my program include developing a plant that is compact but vigorous, with elongated inflorescences (7-9 flowers), double flowers that are produced in great numbers, and improved fragrance. We are using a variety of species and cultivars to achieve this goal, including *P. mexicanus*, *P. lewisii* 'Blizzard', *P.* ×*virginalis* 'Miniature Snonwflake', and *P.* ×*lemoinei* 'Belle Étoile'. Since this project began in 2011, additional taxa have been added each year. In 2014, I plan to introduce *P. microphyllus* into the program.

Sarcococca confusa. Fragrant sweetbox is a shrub prized for its ability to thrive in dry shade, an exposure most plants will not tolerate. It has few pest and disease problems and requires little maintenance. Fragrant sweetbox also produces white flowers during winter and glossy black fruit later in the year that are persistent. It is more fragrant than *S. hookeriana* and more cold tolerant than *S. ruscifolia* (Dirr, 2009). Fragrant sweetbox also does not spread by rhizomes, therefore it will not spread into unwanted areas of the home garden and can be maintained more easily. The major breeding opportunity for fragrant sweetbox is the lack of diversity in this species. We have initiated a mutation breeding program to induce variation. A particular goal is to identify more compact forms that would serve as an intermediate between *S. confusa* and *S. hookeriana* var. *humilis* but would not spread as in the case of the latter.

***Syringa* spp.** Lilacs, particularly common lilacs (*Syringa vulgaris*; series *Syringa*), are prized for their prolific production of fragrant flowers. Unfortunately, common lilac is susceptible to bacterial blight but other species such as *Syringa meyeri* and *S. patula* in series *Pubescentes* often have better resistance. Another issue for many cultivars of common lilac is that they are too large for modern landscapes. This is another advantage that some small leaved lilacs exhibit along with disease resistance. Recent releases such as Bloomerang® that rebloom have had a major impact on the market. I envision several opportunities for improvement in lilacs including developing compact common lilacs with improved disease resistance, developing additional cultivars of the small-leaved species in Series *Pubescentes* that rebloom, and finally to combine these traits by interseries hybridization.

Project Objectives

The overall objective of the cultivar development portion of my program is to produce new cultivars for the Oregon Nursery Industry that are well adapted, have unique phenotypes, are amenable to propagation and production, and fit into modern landscapes.

Methods and Time Line

Ribes sanguineum. Seed were treated in late-2011 with ethyl methanesulfonate (EMS) and have been growing since then. This generation was field planted in Spring 2013. We have selected several forms that have potential for release including a cut-leaf form that has been distributed to 8 Oregon nurseries for trialing. We have begun selecting the most highly branched and compact plants from the M1 and will continue in the M2 generation. Aphid pressure will be evaluated in 2014. With an additional year of field data, I hope to release the cut-leaf form in late 2014 or 2015 (**Figure 1**).

***Galtonia candicans*.** This project is similar to the fragrant sweetbox and flowering currant work in that we are using non-targeted chemical mutagenesis through the application of varying concentrations of EMS. There was much greater mortality associated with increased EMS rate, as expected. Plants were field planted Spring 2013 and most plants are flowering and setting seed. Seed will be collected from this M1 population to grow the M2 generation. Variation in the next generation will be assessed and the most compact 5% will be maintained as parents for future progeny. Several selections are showing promise to be more compact and exhibit more concentrated flowering, an example of which may be seen in **Figure 2**.

***Philadelphus* spp.** The mockorange project has been viewed as a long term program. Fragrance is a notoriously difficult trait to breed for and it often takes several generations of backcrossing to recover fragrance and combine it with even a single other trait. Additionally, we are breeding for complex traits such as inflorescence length and plant height and vigor. These are quantitative traits and small gains are often seen with each generation, therefore, to recover a plant with traits that are significantly improved over cultivars available in the industry, it is likely to take many years. However, we are trying to grow out the largest number of seedlings possible each year to give us the best chance of finding the rare seedling that may show recombination. In 2013, we planted nearly 500 seedlings from crosses made in 2012. Only a single seedling flowered in 2013, thus extending the duration of selection since plants will require 2 years before flowering can be evaluated. Crosses from 2012 will be fully evaluated in 2014 at which time we will begin selection and rogueing to remove inferior individuals.

Sarcococca confusa. This project has a similar time line and methods as the *Ribes sanguineum* project. Seed were treated at the same time and many our plants flowered during Winter 2012-13. All plants were field planted in Spring 2013 under shade for extensive evaluation. Fruit were collected from a subset of the population and are being grown. The most compact plants from M1 generation were propagated in 2013 and are being evaluated. A number of selections show great promise as introductions that exhibit compact growth and alternate leaf shape that is much more narrow than the wild type (**Figure 3**).

Lilacs. We have collected 5 cultivars of common lilac that are reported to have superior resistance to bacterial blight (*Pseudomonas*). In 2013, we began hybridizing these with more compact varieties that lack disease resistance. We will discard plants that grow beyond a threshold height (shortest 5-10% of population) and then subsequently evaluate for disease resistance. In series *Pubescentes*, we have been hybridizing several superior cultivars. In 2012, we made several hundred crosses between 'Miss Kim', 'Palibin', and Bloomerang®. These crosses yielded several hundred seedlings that are being grown. In 2013, we made over 10,000 crosses that included intraspecific hybridization among cultivars of *Syringa vulgaris* as described above. We also made additional crosses within series *Pubescentes* among 'Miss Kim', 'Palabin', and Bloomerang® to assure we have all combinations represented. Finally, we made large numbers of interseries crosses between *S. vulgaris* and series *Pubescentes*. A large number of seed were recovered from intersectional crosses and we have used embryo culture in attempts to recover seedlings. We are optimistic that we will identify a media that will be successful at inducing germination; we have several seed that are showing promise (**Figure 4**).

Budget Summary

Salary

Faculty Research Assistant (33% FTE)	$11,551
Other Payroll Expenses (OPE)	$7,276
(OSU health benefits, insurance, retirement)	
Total	**$18,827**

Benefit to Nursery Industry

New cultivars create excitement among consumers. The Ornamental Plant Breeding Program at OSU is attempting to support the diversity of the industry by breeding varied crops that fill as many niches as possible. The goal of the program is to utilize industry funding to develop superior new cultivars that can then be licensed to all Oregon growers wishing to produce them.

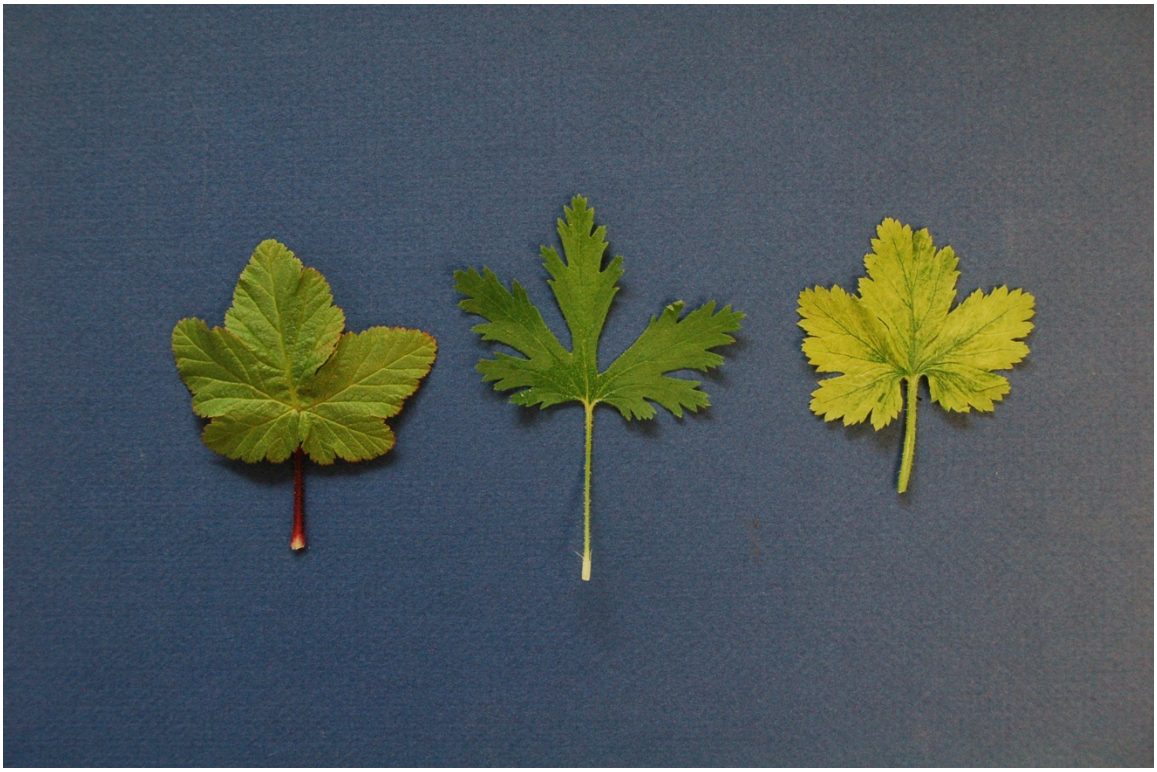

Figure 1. Leaves of wild type (left), cut-leaf (center) and variegated (right) *Ribes sanguineum*. The wild type leaf resulted from control (0%) treatments, while the cut-leaf and variegated forms resulted from EMS treatment of seed at varying concentrations.

Figure 2. *Galtonia candicans* seedling treated with 0.2% EMS for 24-h with no pre-treatment.

Figure 3. Leaves of *Sarcococca confusa* treated with 0.2% EMS for 24-h (top), 0.2% EMS for 48-h (center), or 0% EMS for 48-h (bottom). Plants resulting from 0.2% treatment that exhibit this altered leaf morphology are also more compact with shorter internodes compared to controls (0%).

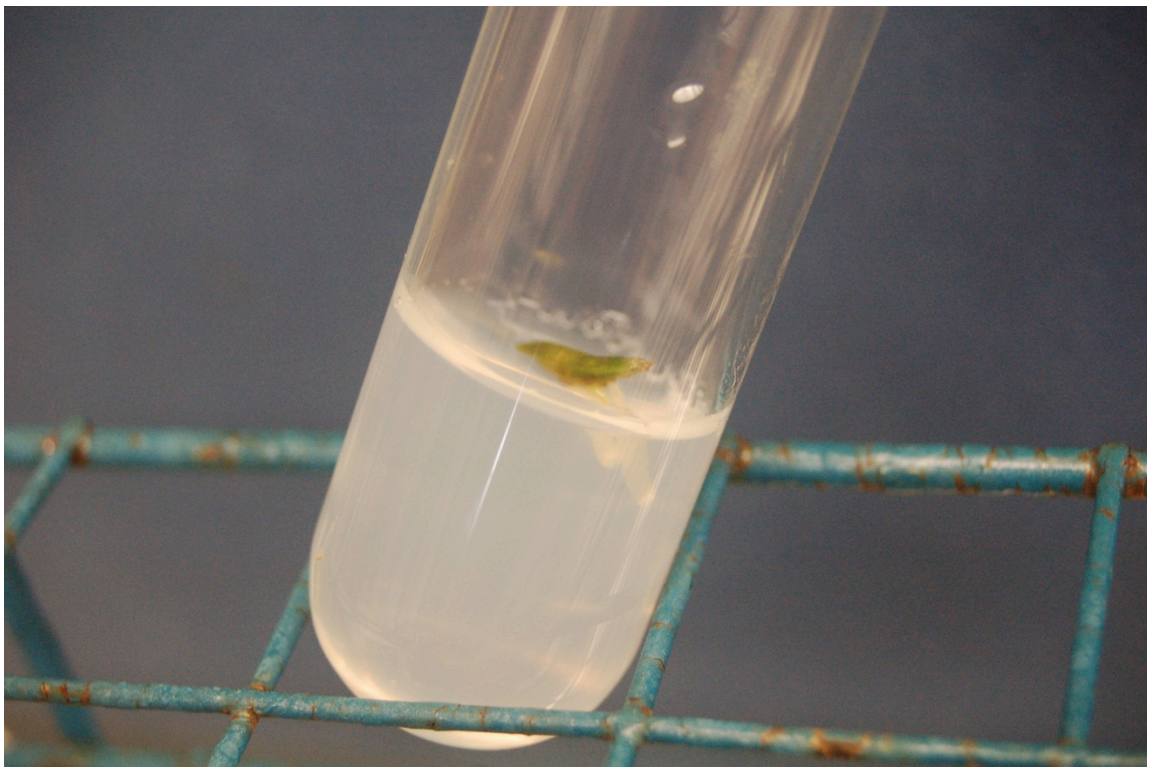

Figure 4. Apparent radicle emergence from a seed resulting from a cross between *Syringa vulgaris* and *S.* Bloomerang®.

Final Report on Activities
29 December 2014

- ***Ribes sanguinuem***
    - The cultivar *Ribes sanguineum* 'Oregon Snowflake' (Figure 5) was released on March 31, 2014. To date, Blue Heron Farms and Heritage Seedlings are licensed or in the process of obtaining licenses. A plant patent has been applied for.
    - A release document to be published in HortScience will be prepared.
    - Ann Murphy of OAN is preparing a display for the 2014 Farwest show to promote this release and get more growers licensed.
    - **It is a non-exclusive release for which there is a lower licensing fee for Oregon growers due to the fact that its development has been supported by this grant program.**
    - We have made crosses between 'Oregon Snowflake' and 'King Edward' and 'Pokey's Pink' to try and develop a line of cut-leaf cultivars with red and pink flowers to compliment the white version. Data on seedling germination are in Table 4. There is variability among seedlings for degree of leaf dissection; however, only crosses with 'White Icicle' (possible self-pollination of 'Oregon Snowflake' appear to show the severely dissected leaf. We will self-pollinate this generation of hybrid seedlings when they flower to try and recover this trait.
    - Data on aphids and cold damage from the severe weather of 2013-14 winter (-2 °F at Lewis-Brown Farm) were documented. Thus far, no difference among treatments is apparent.
- ***Galtonia candicans***
    - Graduate student, Kim Shearer-Lattier, is conducting a portion of her thesis work on this project. We collected detailed data on flowering date (including duration), scape height, rachis length, flower number, seed set, germination, leaf length, and leaf width. These data are being analyzed and will be used in selecting superior parents to use in the next generation. Scape height showed significant reduction with increased EMS% (Fig. 7). We have selected approximately nine (9) plants that show superior form and flowering in the field. These selections are being propagated for further evaluation (Fig. 8).
    - An M2 population will be grown to evaluate our EMS treatments in 2015. Seed have been collected from the first generation and sown. An additional finding is that with increased EMS%, we reduced fertility such that none of our surviving 0.4% treatments produced any seed (Table 5). We feel seedlessness will be a valuable trait in future cultivars to reduce potential for weediness.
- ***Philadelphus* spp.**
    - We have been very successful in hybridizing a number of species and cultivars of mockorange during 2013-14. We have field planted two years of F1 seedlings and have begun selection from. Two selections are shown below in Figure 6. These selections were propagated by stem cuttings and will be placed in replicated trials at our farm and at commercial nurseries.
    - I have collected seed to grow out an F2 population from the best F1 plants.
    - Based on my observations on our rate of improvement, I feel confident in a release by 2016.
- ***Sarcococca confusa***
    - Our entire M1 population was killed during the -2F event of 2013-14 winter except 9 plants that have been dug and may be a source of additional cold hardiness/winter desiccation resistance.
    - However, during 2013 we propagated a number of the superior selections identified in the proposal above. These are being grown in containers.

- Additionally, we collected seed from many of the M1 plants and are growing on a sizeable M2 population. These are in containers as well. Possibly field planted in spring 2015.
- We have one chartreuse selection that we stabilized (Fig. 9). During some times of the year it is remarkable, other times less so. Additionally, we have several compact selections with altered leaf morphology as described above that have been propagated for advanced replicated trials.

- ***Lilacs***
  - During 2013-14 we made over 10,000 crosses (Tables 1-3).
  - We changed our focus based on our findings more toward using series *Villosae* as a bridge between *Syringa* and *Pubescentes*
  - We will start working on a linkage map in 2015 to assist in identifying markers associated with reblooming in lilacs. A population of seedlings from crosses between 'Palibin' x Bloomerang were developed that will be used to track the reblooming trait and identify any associated marker(s).

Figure 5. *Ribes sanguineum* ‘Oregon Snowflake’.

Figure 6. Two selections of hybrid mockorange that are improvements over available cultivars based on 2014 observations. They are both compact but the selection on the right is dwarf. Both selections have fragrance of *P. mexicanus* (to me smells of grape soda). The selection on the left has branched inflorescences, a trait it received from 'Blizzard'. Both selections are being propagated for replicated trials.

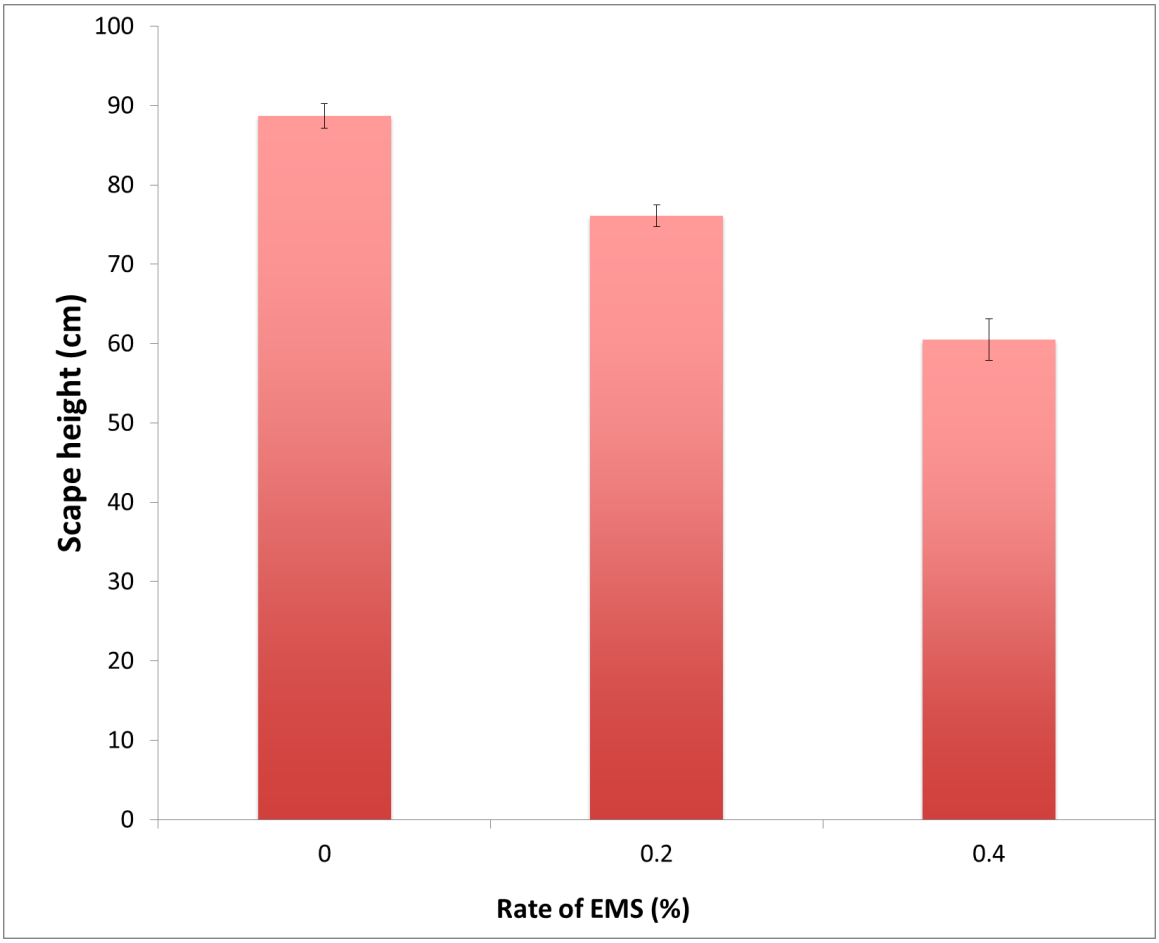

Fig. 7. Effect of EMS% on scape height of *Galtonia candicans.*

Fig. 8. A selection of *Galtonia candicans* showing reduced scape height and increased inflorescence number compared to untreated controls (not pictured).

Fig. 9. Rooted cuttings from a chartreuse selection of *Sarcococca confusa* developed using EMS treatment of seed.

Table 1. Cross compatibility in 2013 lilac hybrids.

Section	Female Parent	Male Parent	Pollinated flowers	Seed	Seedlings per pollinated flower
Syringa	*S. vulgaris* 'Angel White'	*S. vulgaris* 'Ludwig Spaeth'	319	204	0.17
Syringa	*S. vulgaris* 'Ludwig Spaeth'	*S. vulgaris* 'Angel White'	138	222	1.35
Syringa	*S. vulgaris* 'President Grevy'	*S. vulgaris* 'Sensation'	129	16	0.01
Syringa	*S. vulgaris* 'Sensation'	*S. vulgaris* 'President Grevy'	147	1	0.00
Pubescentes	*S. meyeri* 'Palabin'	*S. pubescens* 'MORjos 060F' Josee™	355	40	0.05
Pubescentes	*S. meyeri* 'Palabin'	*S. pubescens* 'Penda' Bloomerang® Purple	239	398	1.16
Pubescentes	*S. meyeri* 'Palabin'	*S. pubescens* 'Bailbelle' Tinkerbelle®	206	155	0.65
Pubescentes	*S. pubescens* 'Miss Kim'	*S. meyeri* 'Palabin'	601	900	0.25
Pubescentes	*S. pubescens* 'Miss Kim'	*S. pubescens* 'MORjos 060F' Josee™	210	0	0.00
Pubescentes	*S. pubescens* 'Miss Kim'	*S. pubescens* 'Penda' Bloomerang® Purple	380	58	0.15
Pubescentes	*S. pubescens* 'MORjos 060F' Josee™	*S. meyeri* 'Palabin'	122	82	0.52
Pubescentes	*S. pubescens* 'MORjos 060F' Josee™	*S. pubescens* 'Penda' Bloomerang® Purple	246	158	0.53
Pubescentes	*S. pubescens* 'MORjos 060F' Josee™	*S. pubescens* 'Bailbelle' Tinkerbelle®	145	42	0.19
Pubescentes	*S. pubescens* 'Bailbelle' Tinkerbelle®	*S. meyeri* 'Palabin'	253	58	0.12

Table 2. Attempted pollinations, recovered seed, and in vitro germination rates from intersectional lilac hybrids in 2013. All seed collected from green capsules and cultured on cultured on Monnier's medium as described by Zhou et al. (7).

Female Parent	Male Parent	Pollinated flowers	Seed	Germinated In vitro
S. vulgaris 'Ludwig Spaeth'	*S. pubescens* 'Penda' Bloomerang® Purple	2206	18	0
S. oblata	*S. pubescens* 'Penda' Bloomerang® Purple	547	0[z]	0
S. meyeri 'Palabin'	*S. oblata*	179	6	0
S. meyeri 'Palabin'	*S. vulgaris* 'Angel White'	91	0	0
S. meyeri 'Palabin'	*S. vulgaris* 'Sensation'	197	39	0
S. pubescens 'Miss Kim'	*S. oblata*	223	0	0
S. pubescens 'Miss Kim'	*S. vulgaris* 'President Grevy'	408	0	0
S. pubescens 'MORjos 060F' Josee™	*S. oblata*	138	77	0
S. pubescens 'Penda' Bloomerang® Purple	*S. vulgaris* 'Ludwig Spaeth'	2098	21	3[y]

[z]Early abortion of 238 fruit occurred 6 weeks post pollination

[y]Radicle, hypocotyl, and cotyledons emerged; seedlings failed to grow post germination and tissues subsequently converted to callus.

Table 3. Fruit set from intraspecific, interspecific, and intersectional lilac hybridizations in 2014.

Female Parent	Male Parent	Pollinated flowers	Fruits	Fruit per pollinated flower
S. vulagris 'Elsdancer' Tiny Dancer™	*S. vulgaris* 'Angel White'	56	0	0.00
S. vulagris 'Elsdancer' Tiny Dancer™	*S. vulgaris* 'Sensation'	36	15	0.42
S. vulgaris 'Monore' Blue Skies®	S. *vulagris* 'Elsdancer' Tiny Dancer™	47	35	0.74
S. vulgaris 'Monore' Blue Skies®	*S. vulgaris* 'President Grevy'	238	82	0.34
S. vulgaris 'Prarie Petite'	*S.* ×*hyacinthiflora* 'Old Glory'	20	0	0.00
S. vulgaris 'Prarie Petite'	*S. vulgaris* 'Sensation'	74	33	0.45
S. vulgaris 'President Grevy'	*S.* ×*hyacinthiflora* 'Old Glory'	176	59	0.34
S. vulgaris 'President Grevy'	*S.* ×*prestoniae* 'Miss Canada'	22	0	0.00
S. vulgaris 'President Grevy'	*S. pubescens* 'Penda' Bloomerang® Purple	68	27	0.40
S. vulgaris 'President Grevy'	S. vulagris 'Elsdancer' Tiny Dancer™	304	3	0.01
S. vulgaris 'President Grevy'	*S. vulgaris* 'Angel White'	182	4	0.02
S. vulgaris 'President Grevy'	*S. vulgaris* 'President Lincoln'	81	0	0.00
S. vulgaris 'President Grevy'	*S. vulgaris* 'Sensation'	111	60	0.54
S. vulgaris 'President Lincoln'	*S. vulgaris* 'Angel White'	135	27	0.20
S. vulgaris 'President Lincoln'	*S. vulgaris* 'President Grevy'	126	0	0.00
S. vulgaris 'Sensation'	*S.* ×*hyacinthiflora* 'Old Glory'	73	73	1.00
S. vulgaris 'Sensation'	*S.* ×*prestoniae* 'Miss Canada'	48	5	0.10
S. vulgaris 'Sensation'	S. *vulagris* 'Elsdancer' Tiny Dancer™	95	12	0.13
S. vulgaris 'Sensation'	*S. vulgaris* 'President Grevy'	229	14	0.06
S. ×*hyacinthiflora* 'Old Glory'	*S. pubescens* 'Penda' Bloomerang® Purple	35	0	0.00
S. ×*hyacinthiflora* 'Old Glory'	S. *vulagris* 'Elsdancer' Tiny Dancer™	102	20	0.20
S. ×*hyacinthiflora* 'Old Glory'	*S. vulgaris* 'Angel White'	195	57	0.29
S. ×*hyacinthiflora* 'Old Glory'	*S. vulgaris* 'Sensation'	82	0	0.00
S. ×*prestoniae* 'Miss Canada'	*S. pubescens* 'Penda' Bloomerang® Purple	425	80	0.19
S. ×*prestoniae* 'Miss Canada'	*S. vulgaris* 'Sensation'	142	0	0.00
S. ×*prestoniae* 'Redwine'	*S. pubescens* 'Penda' Bloomerang® Purple	617	56	0.09
S. ×*prestoniae* 'Redwine'	*S. pubescens* 'MORjos 060F' Josee™	602	174	0.29
S. sweginzowii	*S. pubescens* 'SMSJBP7' Bloomerang® Dark Purple	237	22	0.09
S. tigerstedii	*S. pubescens* 'SMSJBP7' Bloomerang® Dark Purple	130	12	0.09
S. villosa	*S. pubescens* 'SMSJBP7' Bloomerang® Dark Purple	219	0	0.00
S. wolfii	*S. pubescens* 'Penda' Bloomerang® Purple	176	0	0.00
S. yunnanensis	*S. pubescens* 'SMSJBP7' Bloomerang® Dark Purple	163	0	0.00
S. emodii	*S. pubescens* 'Penda' Bloomerang® Purple	97	0	0.00
S. emodii	*S. pubescens* 'SMSJBP7' Bloomerang® Dark Purple	82	21	0.26
S. josikaea	*S. meyeri* 'Palabin'	58	0	0.00
S. josikaea	*S. pubescens* 'MORjos 060F' Josee™	149	6	0.04
S. josikaea	*S. pubescens* 'Tinkerbelle'	135	10	0.07
S. julianae	*S. pubescens* 'SMSJBP7' Bloomerang® Dark Purple	64	16	0.25
S. meyeri 'Palabin'	*S. pubescens* 'Miss Kim'	522	24	0.05
S. meyeri 'Palabin'	*S. pubescens* 'MORjos 060F' Josee™	351	9	0.03
S. pubescens 'MORjos 060F' Josee™	*S.* ×*prestoniae* 'Miss Canada'	500	82	0.16
S. pubescens 'MORjos 060F' Josee™	*S.* ×*prestoniae* 'Redwine'	150	1	0.01

S. pubescens 'MORjos 060F' Josee™	*S. oblata* var. *alba*	329	1	0.00
S. pubescens 'MORjos 060F' Josee™	*S. pubescens* 'Miss Kim'	137	4	0.03
S. pubescens 'Penda' Bloomerang® Purple	*S. ×prestoniae* 'Miss Canada'	482	17	0.04
S. pubescens 'Penda' Bloomerang® Purple	*S. pubescens* 'Miss Kim'	175	2	0.01
S. pubescens 'Penda' Bloomerang® Purple	*S. pubescens* 'MORjos 060F' Josee™	141	28	0.20
S. pubescens 'Penda' Bloomerang® Purple	*S. pubescens* 'Tinkerbelle'	133	0	0.00
S. pubescens 'Tinkerbelle'	*S. oblata*	271	0	0.00
S. pubescens 'Tinkerbelle'	*S. pubescens* 'Miss Kim'	124	0	0.00
S. pubescens 'Tinkerbelle'	*S. pubescens* 'MORjos 060F' Josee™	199	0	0.00
S. pubescens 'Tinkerbelle'	*S. pubescens* 'Penda' Bloomerang® Purple	290	20	0.07

Table 4. Results of crosses between *Ribes sanguineum* 'Oregon Snowflake', 'White Icicle', 'Pokey's Pink', and 'King Edward IV'.

Female	Male	Flowers	Fruit	Seedlings
Oregon Snowflake	White Icicle	12	6	55
White Icicle	Oregon Snowflake	19	3	33
Oregon Snowflake	King Edward IV	11	5	70
King Edward IV	Oregon Snowflake	11	5	72
Oregon Snowflake	Pokey's Pink	6	5	18
Pokey's Pink	Oregon Snowflake	56	48	289

Table 5. Seed production of *Galtonia candicans* treated with varying concentrations of EMS.

EMS Rate (%)	Mean seed per capsule (±Standard Error)
0	17.2 ± 1.3
0.2	3.7 ± 0.6
0.4	0