Evaluation of 14 Butterfly Bush Taxa Grown in Western and Southern Florida: II. Seed Production and Germination

Sandra B. Wilson[1, 3], Mack Thetford[2], Laurie K. Mecca[1], Josiah S. Raymer[2], and Judith A. Gersony[1]

ADDITIONAL INDEX WORDS. **exotic plants, invasive, ornamentals, butterfly bush, *Buddleja davidii*, *Buddleja japonica*, *Buddleja lindleyana*, *Buddleja* ×*weyeriana***

SUMMARY. **Because of its weedy nature, extensive use in the landscape, numerous cultivars, and history as an invasive plant in other countries, butterfly bush (*Buddleja*) was an appropriate candidate to evaluate for seed production and germination in Florida. Seed production was quantified for 14 butterfly bush taxa planted in western Florida (Milton) and central southern Florida (Fort Pierce). Each of the 14 taxa evaluated produced seed. In Fort Pierce, japanese butterfly bush (*B. japonica*) had the greatest capsule weight and 'Gloster' butterfly bush (*B. lindleyana*) had the second greatest capsule weight as compared to other taxa. In Milton, 'Gloster' had the greatest capsule weight and japanese butterfly bush and 'Nanho Alba' butterfly bush (*B. davidii* var.**

This project was funded by the Florida Department of Environmental Protection and the University of Florida–IFAS Invasive Plant Working Group. Authors gratefully thank Patricia Frey for technical support. Florida Agricultural Experiment Station journal series R-10029.

[1]University of Florida, Institute of Food and Agricultural Sciences, Department of Environmental Horticulture, Indian River Research and Education Center, Fort Pierce, FL 34945.

[2]University of Florida, Institute of Food and Agricultural Sciences, Department of Environmental Horticulture, West Florida Research and Education Center, Milton, FL 32583.

[3]To whom reprint requests should be addressed; e-mail: sbwilson@mail.ifas.ufl.edu

***nanhoensis*) had the second greatest capsule weights as compared to other taxa. The shape and number of seed capsules per infructescence varied with cultivar. Seeds were cleaned and germinated in germination boxes with and without light at 20/10, 25/15, 30/20 and 35/25 °C (68.0/50.0, 77.0/59.0, 86.0/68.0 and 95.0/77.0 °F). Regardless of temperature or cultivar, light was required for germination. At each temperature, 'Nanho Blue' butterfly bush (*B. davidii* var. *nanhoensis*) and 'Moonlight' butterfly bush (*B. ×weyeriana*) had highest germination rates (63-74%) as compared to other taxa.**

Florida is the second largest producer of ornamental plants in the U.S. with estimated $9.908 billion total industry sales during 2000 (Hodges and Haydu, 2002). While most intentionally introduced species remain in their cultivated settings, some escape cultivation and invade natural areas. An invasive plant is defined as a non-indigenous species that has the ability to establish self-sustaining, expanding populations and may cause economic and/or environmental harm (National Invasive Species Council, 2001; Vitousek et al., 1995). Of the 124 plant species listed as invasive by the Florida Exotic Pest Plant Council (FLEPPC), 67% were introduced as ornamentals (FLEPPC, 2003). The Tampa Bay Wholesale Growers, Florida Nurserymen and Growers Association, and American Nursery and Landscape Association Boards of Directors were among the first in the nation to adopt voluntary codes of conduct (invasive plant best management practices) for the nursery industry (Baskin, 2002; Missouri Botanical Garden, 2001). The codes of conduct involve adoption of risk assessment methods that consider plant characteristics and prior observations or experience with the plant elsewhere in the world. This requires nursery professionals to work with regional experts to determine which species in a given region are either currently invasive or may become invasive. Prolific seed production, short juvenile periods, and aggressive growth rates are several of a suite of traits that invasive plants characteristically may share (Reichard, 1997; Rejmánek and Richardson, 1996). Still, since many ornamental species are hybridized and selected for an array of color, form and functionality, it is not appropriate to label a wild type species as invasive without evaluation of cultivars. Wilson and Mecca (2003) evaluated eight cultivars and the wild type form of mexican petunia (*Ruellia tweediana*), a FLEPPC Category I invasive, and found that seed production, germination, and relative growth rate were highly variable among cultivars.

While it is important to evaluate species that are considered invasive in a given state, it is also important to evaluate species that show potential to become invasive. Williamson and Fitter (1996) suggest that the probability of an established or naturalized species becoming a pest is one in ten. In a survey of 235 invasive and 114 non-invasive, woody non-indigenous species in North America, Reichard and Hamilton (1997) found that 54% of the successful invaders were also invasive in other places. History of prior invasive habit in combination with other invasive traits can be used as warning signals for the threat of potential invaders. Some of the similar properties that constitute a great landscape plant (i.e., long flowering period, adaptability to a range of environmental conditions, ease of propagation, and high vigor) often predispose it as a potentially invasive plant in certain geographical locations.

Butterfly bush is a widely cultivated, extremely popular, flowering shrub with attractive foliage and a range of flower colors. Wilson et al. (2004) assessed landscape performance of 14 butterfly bush taxa planted in western and southern Florida and found visual quality and flowering to vary by month, cultivar and location. Several cultivars maintained high visual quality and flowering throughout the study. However, before recommending specific cultivars for the Florida landscape or before selecting specific cultivars for breeding programs, additional studies are warranted since the species *Buddleja davidii* has escaped from gardens in other parts of the world and is considered a serious weed in New Zealand (Kay and Smale, 1990), Australia (Csurhes and Edwards, 1998) and Great Britain (Crawley, 1987). In the U.S., it has escaped cultivation in 19 states and Puerto Rico [U.S. Department of Agriculture (USDA), 2003) and can be found commonly along roadsides, streamsides and other disturbed areas of its growing range. In Hawaii, *B. davidii* is becoming increasingly problematic (Staples et al., 2000). Having evaluated 50 butterfly bush taxa for seed production and germination at Longwood Gardens (Kennett Square, Pa.), Anísko and Im (2001) recommended nursery professionals to consider species other than *B. davidii*. In Florida, there are no vouchered specimens that document the escape of *B. davidii* into natural areas (Wunderlin and Hansen, 2003), although it is commonly utilized in landscapes of the northern and central part of the state. A related species, lindley's butterfly bush (*B. lindleyana*) has escaped cultivation in two counties in Florida (Wunderlin and Hansen, 2003) as well as eight other states (USDA, 2003). The current study was conducted to determine how 14 butterfly bush taxa perform in western and southern Florida with relation to seed production, seed germination, and seed viability.

Materials and methods

Plant material and site conditions. Selection of butterfly bush taxa (Table 1) was based on availability, popularity, and performance in the landscape. Specific botanical descriptions and experimental conditions were previously reported (Wilson et al., 2004). Briefly, each cultivar was clonally propagated, transferred to 3.8-L (1 gal) pots, and fertilized with 15N–3.9P–10K Osmocote Plus (Scotts Co., Marysville, Ohio) prior to planting. The experiment was conducted at Fort Pierce (USDA Zone 9B) and Milton (USDA Zone 8B) where nine uniform plants of each cultivar were planted (4 June 2002) 2.4 m (8 ft) on center on raised beds covered with polyethylene mulch. Plants were watered by seep (Fort Pierce) or drip (Milton) irrigation as needed.

Data collection. Plants were harvested after 25 weeks by severing the primary shoots at crown level (base of the soil). Infructescences were isolated from the shoots. Seed capsules were separated from panicle inflorescences and weighed. Capsule to flower ratios were calculated by dividing total capsule weight by total flower weight. To estimate total seed production per plant, 10 representative capsules of each cultivar were selected, from which seeds were isolated and counted.

Seed germination and viability. Germination studies were conducted on seed collected from 14

Table 1. Fruit and seed morphology and seed quantity of 14 butterfly bush taxa evaluated after 25 weeks in western Florida (Milton) and southern Florida (Fort Pierce).

Common name	Species	Cultivar	Fruit and seed morphology[z]	Avg no. seeds per capsule[y] (n = 10)	Avg approx no. of seeds per plant (1000x)[x]
Pink delight butterfly bush	*Buddleja davidii*	Pink Delight	Seed capsules elliptical, elongated with pointed ends; light to medium brown in color; 5.5 mm long × 1.4 mm wide. Seeds rounded inside winged sheath, very fine.	18.4	144–555
White profusion butterfly bush	*B. davidii*	White Profusion	Seed capsules slender with pointed ends; reddish medium brown in color; 8.4 mm long × 1.3 mm wide. Seeds rounded inside winged sheath, fine.	51.5	282–1094
Black knight butterfly bush	*B. davidii*	Black Knight	Seed capsules slender with pointed ends; dark brown in color; 5.6 mm long × 1.2 mm wide. Seeds rounded inside winged sheath, very fine.	41.6	281–973
Nanho white butterfly bush	*B. davidii* var. *nanhoensis*	Nanho Alba	Seed capsules slender with pointed ends; brown in color; 8.0 mm long × 1.1 mm wide. Seeds rounded inside winged sheath, fine.	39.5	236–2116
Nanho blue butterfly bush	*B. davidii* var. *nanhoensis*	Nanho Blue	Seed capsules slender with pointed ends; medium brown in color; 6.1 mm long × 1.2 mm wide. Seeds rounded inside winged sheath, very fine.	81.7	236–1337
Nanho purple butterfly bush	*B. davidii* var. *nanhoensis*	Nanho Purple	Seed capsules elliptical, elongated with pointed ends; brown to dark brown in color; 5.1 mm long × 1.1 mm wide. Seeds rounded inside winged sheath, very fine.	65.1	1096– 2821
Japanese butterfly bush	*B. japonica*		Seed capsules rounded, slightly oblong; greenish brown in color; 5.1 mm long × 3.8 mm wide. Seeds un-winged, shapes varied and irregular.	140.3	877–1351
Lindley's butterfly bush	*B. lindleyana*		Seed capsules oblong with rounded ends; greenish brown in color; 5.63 mm long × 2.50 mm wide. Seeds un-winged, shapes varied and irregular.	94.1	319–581
Gloster butterfly bush	*B. lindleyana*	Gloster	Seed capsules rounded, slightly oblong; greenish brown in color; 5.2 mm long × 3.0 mm wide. Seeds un-winged, shapes varied and irregular.	125.5	639–2358
Honeycomb butterfly bush	*B. ×weyeriana*	Honeycomb	Seed capsules rounded to oblong; grouped in clusters; grayish brown to light brown in color; 4.1 mm long × 2.8 mm wide. Seeds un-winged, light brown to medium brown, shapes varied with many being narrow and bent, fine.	2.2	0.81–1.10
Moonlight butterfly bush	*B. ×weyeriana*	Moonlight	Seed capsules rounded, slightly oblong; grouped in clusters; grayish green in color; 3.3 mm long × 2.1 mm wide. Seeds un-winged, shapes varied and irregular.	18.1	28– 415
Sungold butterfly bush	*B. ×weyeriana*	Sungold	Seed capsules oblong with rounded ends; grouped in clusters; grayish to medium brown in color; 2.8 mm long × 1.9 mm wide. Seeds un-winged, brown to dark brown, shapes varied, fine.	0.9	0.28–13
Violet eyes butterfly bush	*B. ×weyeriana* x *B. lindleyana*	Violet Eyes	Seed capsules rounded, slightly oblong; grouped in clusters; greenish brown in color; 3.8 mm long × 2.4 mm wide. Seeds un-winged, shapes varied and irregular.	18.9	95–197
Dartmoor butterfly bush	*B. davidii* x *B. davidii* var. *nanhoensis*	Dartmoor	Seed capsules elliptical, elongated with pointed ends; medium brown in color; 5.9 mm long × 1.7 mm wide. Seeds rounded inside winged sheath, fine.	43.0	73–711

[z]25.4 mm = 1 inch.
[y]Capsules were collected from open-pollinated plants grown in Fort Pierce conditions.
[x]Lower and higher ranges of seed count are representative of plants grown in southern and western Florida, respectively.

Buddleja taxa grown for 25 weeks in Fort Pierce, Fla. Seed were collected from plants at maturity and allowed to dehisce at room temperature [22 to 25 °C (71.6 to 77.0 °F)] in paper bags for 1–2 weeks. Seeds with visible indication of pathogen or insect damage were discarded. In accordance with the Association of Official Seed Analysts (AOSA, 2003), individual treatments for all germination experiments consisted of four replications of 50 seeds in 10.9 × 10.9-cm (4.29 inches) transparent polystyrene germination boxes (Hoffman Manufacturing, Albany, Ore.) containing two sheets of germination paper (Hoffman Manufacturing) moistened with 15 mL (0.5 fl oz) nanopure water. Germination boxes were placed in temperature and light controlled growth chambers equipped with cool-white fluorescent lamps (Conviron, CMP 4030, Controlled Environments, Winnipeg, Canada). Germination boxes were placed in light (12-h photoperiod) or darkness (no photoperiod) at 20/10, 25/15, 30/20 and 35/25 °C. The 12-h photoperiod was maintained in each chamber with an average photosynthetic photon flux of 84 $\mu mol\ m^{-2}\ s^{-1}$ at shelf level. The diurnal treatment with light was administered by providing 12 h light at 20, 25, 30 or 35 °C followed by 12 h of dark at 10, 15, 20, or 25 °C, respectively. Dark treatments were administered by wrapping germination boxes in two layers of heavy duty aluminum foil. These dishes remained unopened until the final day of the experiment. Germination of seed exposed to light was monitored daily for a period of 28 d. A seed was considered germinated when radicle emergence was ≥2.0 mm (0.08 inch). At the end of the germination period, final germination percentage (FGP) and T50 (days to 50% of FGP) were determined per germination box.

In accordance with the AOSA (2000), seed viability tests were replicated twice on 100 seeds per cultivar. Seeds were stained for 48 h at 40 °C (104.0 °F) in 1% tetrazolium (2, 3, 5-triphenyl chloride) solution with positive staining patterns confirming seed viability (Mid-West Seed Service, Brookings, S.D.).

Experimental design and statistical analysis. The field experiments were conducted at Milton and Fort Pierce, Fla. The experimental design from which seeds were collected was a randomized complete block with 14 cultivars and nine single-plant replications. Data were collected on each plant sample, subjected to analyses of variance (ANOVAs), and significant means separated by least significant difference (LSD) at 0.05.

A split block experimental design was used with temperature as the main block and taxa as the split-plot. Each treatment consisted of 50 seeds per germination box and was replicated four times. Data were subjected to ANOVA within temperatures. Taxa means were separated by LSD at 0.05 level.

Results and discussion

Seed production. Each of the 14 taxa evaluated produced seed in Fort Pierce and Milton (Tables 1 and 2). In both locations, earliest fruiting was observed for 'Nanho Blue' [36 d (Fort Pierce) or 12 d (Milton)] after planting of 8-week-old rooted liners (data not shown). Other cultivars such as 'Sungold' (*Buddleja* x *weyeriana*) did not fruit until day 79 (Fort Pierce) or day 58 (Milton) (data not shown).

Average number of seeds per capsule varied widely among taxa with japanese butterfly bush having the largest number of seeds per capsule and 'Sungold' having the least number of seeds per capsule (Table 1). Fruit capsules of lindley's butterfly bush or japanese butterfly bush contained many small seed stacked in layers (94 to 140 average seeds per capsule). Japanese butterfly bush, although listed as a separate species, is minimally different from lindley's butterfly bush (Dirr, 1998) and sometimes listed as *Buddleja lindleyana* var. *hemsleyana*. It appears that seed production varies greatly with cultivars of *Buddleja lindleyana*, since Anisko and Im (2001) reported 'Miss Vice' butterfly bush (*Buddleja lindleyana*) to not produce any seed. Reduced or lack of seed production is sometimes characteristic of plants having aggressive vegetative growth or suckering habit (S.B. Wilson, personal observation). Regardless, the suckering habit of lindley's butterfly bush and japanese butterfly bush coupled with the un-winged seed structure may suggest short-distance dispersal, particularly if seed viability is low.

While capsule weight is affected by the capsule wall thickness in addition to seed number, capsule production for each cultivar at each location is interesting to note. In Fort Pierce, japanese butterfly bush had the greatest capsule weight and 'Gloster' had the second greatest capsule weight as compared to other taxa (Table 2). In Milton, 'Gloster' had the greatest capsule weight, and japanese butterfly bush and 'Nanho Alba' (*Buddleja davidii* var. *nanhoensis*) had the second greatest capsule weights as compared to other taxa. In both locations, 'Dartmoor' (*Buddleja davidii* x *Buddleja davidii* var. *nanhoensis*), 'Honeycomb' (*Buddleja* ×*weyeriana*) and 'Sungold'

Table 2. Average capsule weight and capsule : flower ratios per plant of fourteen butterfly bush taxa planted in Fort Pierce (southern Florida) and Milton (western Florida) for 25 weeks.

	Capsule wt (g)[z]		Capsule : flower ratio	
Taxa	Fort Pierce	Milton	Fort Pierce	Milton
Black Knight	16.9	58.5	0.40	0.64
Pink Delight	15.7	60.3	0.19	0.55
White Profusion	16.4	63.7	0.12	0.25
Nanho Alba	16.7	150.0	0.10	0.74
Nanho Blue	7.8	44.2	0.16	0.44
Nanho Purple	30.3	78.0	0.30	0.49
Dartmoor	4.4	43.0	0.03	0.14
Lindley's butterfly bush	30.5	55.6	0.96	0.53
Gloster	55.0	202.9	0.68	0.82
Japanese butterfly bush	95.6	147.3	4.85	0.60
Violet Eyes	24.0	50.1	0.32	0.29
Honeycomb	1.5	1.1	0.02	0.01
Moonlight	5.5	80.3	0.11	0.44
Sungold	0.4	18.8	0.01	0.13
LSD (0.05)[y]	14.8	42.0	0.57	0.26

[z]1.0 g = 0.035 oz.

[y]Means separated by least significant difference test at 0.05.

on average had a capsule:flower dry weight ratio that was 56% to 98% lower than that of other cultivars. The shape and number of seed capsules per infructescence also varied with cultivar (Table 1). Seeds of all *Buddleja davidii*, *Buddleja davidii* var. *nanhoensis*, and *Buddleja davidii* x *Buddleja davidii* var. *nanhoensis* cultivars were contained within a winged sheath, whereas seeds of *Buddleja lindleyana*, *Buddleja* x*weyeriana*, and *Buddleja* x *weyeriana* x *Buddleja lindleyana* were not winged. The winged adaptation may facilitate seed dispersal by wind (Staples et al., 2000).

Butterfly bush species tend to retain their seed capsules after dehiscence making it possible to estimate seed production at the end of a growing season. When computing the average number of seeds per capsule with the average number of capsules per plant, 'Nanho Purple' (*Buddleja davidii* var. *nanhoensis*) had the potential to produce over 1 million seeds in Fort Pierce (Table 1). In Milton, 'White Profusion' (*Buddleja davidii*), 'Nanho Blue', and lindley's butterfly bush had the potential to produce over 1 million seeds and 'Nanho Alba', 'Nanho Purple' and 'Gloster' had the potential to produce over 2 million seeds in a single growing season (Table 1). This information is useful, since length of flowering period does not necessarily indicate high seed production. Perrins et al. (1992) reported that the length of the flowering period was greater in weedy species as compared to non-weedy species. Long flowering periods may allow greater accessibility to pollinators and a greater chance of seed set (Reichard, 1997). This was not consistent with all butterfly bush taxa evaluated since 'Dartmoor' continually flowered (50% to 75% canopy coverage) throughout the study at both locations (Wilson et al., 2004), yet produced relatively few seeds (Tables 1, 2). In Milton, the consistently high flowering (75% or higher canopy coverage) of 'Nanho Alba' throughout most of the study (Wilson et al., 2004) was reflected in subsequently high seed production and high capsule : flower ratios (Table 2). It was not always possible to correlate the amount of seed produced by different butterfly bush taxa to the size of the infructescence. For example, of the *Buddleja davidii* var. *nanhoensis* cultivars, 'Nanho Blue' generally had shorter inflorescences (Wilson et al., 2004) with capsules containing 1.7 to 2.1 times greater the amount of seeds as 'Nanho Alba' or 'Nanho Purple' (Table 1).

GERMINATION AND VIABILITY. All taxa produced sufficient seed for a complete germination study with the exception of 'Sungold'. Of the remaining 13 taxa that could be evaluated, all produced a percentage of viable seed with germination varying among temperature treatments (Table 3). Regardless of cultivar or temperature, seeds had little or no germination (0 to 5%) in the dark (data not shown). At 20/10 °C 'Nanho Blue' had the greatest germination, and at 25/15 °C 'Moonlight' had the greatest germination, as compared to other cultivars. At 30/20 °C, 'Nanho Blue', japanese butterfly bush and 'Moonlight' had similarly high germination (53% to 66%). 'Nanho Blue' and 'Moonlight' also had highest germination (53% to 63%) at 35/25 °C. It is interesting to note that although 'Nanho Alba' had less than 3% germination of seeds collected in Fort Pierce, up to 35% germination has been observed for seeds collected from plants in Milton and germinated under similar conditions, suggesting that this cultivar can produce seeds with greater viability under different conditions.

The least number of mean days to achieve 50% germination varied with temperature and taxa (Table 3). At 20/10 °C, T50 values ranged from 13.5 d ('Violet Eyes' and 'Moonlight') to 22.5 d ('Nanho Purple'), whereas at 35/25 °C, T50 values were lower ranging from 6 d (japanese butterfly bush) to 16 d ('Honeycomb'). Germination rate can be a useful measure of the speed or velocity of germination since germination patterns can be different even if final germination percentages are almost identical (Hartmann et al., 2002).

Results indicate that 50% or more of seeds from cultivars of butterfly bush such as 'Nanho Blue' and 'Moonlight' have the capacity to germinate readily over a broad range of temperatures. Several weed species have been shown to germinate over a wide range of temperatures (Balyan and Bhan, 1986; Susko et al., 1999). Still, germination and viability was comparatively low as to that found in weed species. Some seed decay and subsequent fungal growth was observed for each cultivar but was pronounced for 'White Profusion'. Ungerminated, turgid seeds without fungal growth would indicate dormancy. Dormancy is a property of many weed seeds that enable them to survive harsh conditions and to germinate at a later time or in another location when conditions become more favorable (Baskin and Baskin, 2001). Butterfly bush is reported to

Table 3. Final germination percent (FGP) and number of days to 50% of final germination (T50) of seed collected from 14 butterfly bush taxa grown in Fort Pierce, Fla. Seeds were germinated with light (12-h photoperiod) in germination boxes placed in growth chambers set at 20/10, 25/15, 30/20 and 35/25 °C (68.0/50.0, 77.0/59.0, 86.0/68.0 and 95.0/77.0 °F) for 28 d.

	Germination (%)				T50 (d)			
Taxa	20/10	25/15	30/20	35/25	20/10	25/15	30/20	35/25
Black Knight	28.6	17.5	22.5	14.7	18.8	12.5	9.5	11.0
Pink Delight	24.8	24.8	32.3	23.9	20.5	12.0	10.0	9.5
White Profusion	12.1	13.0	17.1	12.1	15.5	8.5	7.8	9.0
Nanho Alba	0.8	2.9	1.0	1.9	19.0	12.5	20.0	14.0
Nanho Blue	71.2	63.0	65.5	62.7	14.8	8.8	8.0	8.8
Nanho Purple	18.3	21.5	29.4	16.7	22.5	17.5	13.3	15.8
Dartmoor	14.8	16.2	15.4	9.1	20.3	11.8	10.3	10.0
Lindley's butterfly bush	18.6	13.6	32.2	28.1	17.0	11.0	7.0	7.3
Gloster	34.7	29.2	27.6	35.0	16.0	11.0	7.8	7.8
Japanese butterfly bush	42.2	47.5	53.3	40.2	16.3	9.5	5.5	6.0
Violet Eyes	45.5	29.8	43.1	20.5	13.5	9.75	7.5	8.3
Honeycomb	11.8	25.6	15.2	12.3	18.3	17.0	13.5	16.0
Moonlight	51.8	74.1	63.4	52.6	13.5	8.0	7.3	8.0
LSD (0.05)[z]	12.4	8.9	12.9	10.6	2.6	2.0	1.8	3.0

[z]Means separated by least significant difference test at 0.05.

have deep dormancy and may remain in the soil for many years (Paterson, 2000) but to our knowledge, studies have not been designed specifically to document this. Separate tetrazolium tests generally concurred with percent germination of viable seed where positive staining values were similar or slightly higher (3% to 12%); with the exception of 'Black Knight' (*Buddleja davidii*) and 'Pink Delight' (*Buddleja davidii*), where 86% or 83%, respectively, of seeds were viable (data not shown). Tetrazolium tests also showed varying intensities of embryo staining among cultivars which may indicate varying levels of dormancy. Andersson and Milberg (1998) found large variation in seed dormancy among mother plants, populations, and years, which complicates drawing conclusions from germination characteristics alone. Baker (1974) suggested that germination requirements of an ideal weed could be fulfilled in a variety of environments. Almost no germination in the dark is significant, since seeds that require light for germination may not be capable of germinating when shaded by liter or a leaf canopy or following burial in soil.

Percentage of seed germination is only one important factor to consider when fully characterizing the invasive potential of a plant species. While the most "weedy" species of viper's bugloss (*Echium* spp.) in Australia germinated far more quickly than two less weedy species (Forcella et al., 1986), Rejmánek and Richardson (1996) found no differences between percent germination of invasive and noninvasive pine species. When considering total seed production, low germination of cultivars (less than 20%) such as 'White Profusion', 'Nanho Alba', 'Dartmoor', and 'Honeycomb' under optimal conditions (30/20 °C) can still be significant with regards to potential ecological impact. In Florida, *Buddleja davidii* is generally short lived and there is no documentation of its escape in naturalized areas (Wunderlin and Hansen, 2003). This is surprising since it will tolerate a variety of soil types and climatic conditions and in other parts of the U.S. has been found to colonize along roadsides, stream banks and other similarly disturbed sites (Randall and Marinelli, 1996). Lack of successful invasion in Florida may be attributed to the presence of root knot nematodes (Thetford and Kinlock, 2002).

The results from these studies suggest that quantity of seed production differs greatly among butterfly bush taxa and location. Taxa such as 'Dartmoor' and japanese butterfly bush had similarly high visual quality and landscape performance (Wilson et al., 2004), yet 'Dartmoor' may be preferred over japanese butterfly bush when selecting these plants for the landscape due to its significantly lower seed production and germination. While history of invasion in other parts of the world, long flowering periods, prolific seed production, easy germination, and aggressive growth do not constitute a plant as invasive, it does merit caution when utilizing this species in landscapes and it does warrant attention when selecting parent plants for breeding programs.

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