Zuckia brandegei (Gray) Welsh & Stutz ex Welsh

siltbush

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Other scientific names. *Zuckia arizonica* Standley, *Atriplex brandegei* (Gray) Collotzi, *Grayia brandegei* (Gray).

Other common names. spineless hopsage, applebush, saltbush.

Growth habit, occurrence, and use. Siltbush is an autumn-deciduous shrub or subshrub ranging from 0.1 to 0.8 m in height (Goodrich and Neese 1986). Stems of the current year are thornless and erect or ascending, branching from a persistent, woody base. Leaves are gray-scurfy and entire to lobed. Overwintering leaf buds are prominent, axillary, and globose (Welsh and others 1987).

A narrowly distributed edaphic endemic, siltbush is largely restricted to the Colorado River drainage of central and eastern Utah and northeast Arizona, southwest Wyoming, western Colorado, and northwest New Mexico (Smith 1974; Stutz and others 1987; Welsh and others 1987). It grows in isolated monotypic populations on weathered, often saline or seleniferous, fine-textured to sandy substrates in desert shrub to lower juniper communities at elevations from 1,280 to 2,240 m (Goodrich and Neese 1986). Although a poor competitor, siltbush is a stress-tolerant species capable of surviving on sites unfavorable for establishment of other species and enduring long periods of adverse environmental conditions. It is a potential revegetation species for mined lands and other disturbed sites within its native range (Pendleton and others 1996).

Geographic races and hybrids. Type specimens of *Zuckia brandegei* were originally described as *Grayia brandegei* Gray (Gray 1876). Stutz and others (1987) later identified 2 chromosome races. Diploid populations (2X=18) are small plants with narrow, linear leaves that are mostly restricted to south-central Utah and northeastern Arizona. Tetraploids (4X=36) are larger plants with large ovate to lanceolate leaves that occur primarily as isolated populations in northeastern Utah, south-central Wyoming, eastern Colorado, and northwestern New Mexico. Based on distribution patterns and interpopulation differences, Stutz and others (1987) suggested that the larger plants may be autotetraplooids of polyphyletic origin and designated them *G. brandegei* A. Gray var. *plummeri* Stutz and Sanderson var. nov. in honor of A. P. Plummer, pioneer shrub scientist.

Welsh (1984) and Welsh and others (1987) transferred *G. brandegei* to the genus *Zuckia*, renaming it *Z. b.* (Gray) Welsh & Stutz ex Welsh var. *brandegei* and reduced *Z. arizonica* Standley, the only species previously in the genus to *Z. b*. Welsh & Stutz ex Welsh var. *arizonica* (Standley) Welsh. *Z. b*. var. *arizonica* is diploid (Sanderson 2000) and is found in scattered populations from northern Arizona to northeastern Utah (Goodrich and Neese 1986). Dorn (1988) later transferred *G. b.* var. *plummeri* to *Z. b.* var. *plummeri* (Stutz & Sanderson) Dorn. Transfers from *Grayia* to *Zuckia* were made on the basis of fruit morphology, branching pattern, and pubescence type. Goodrich and Neese (1986) concurred with these distinctions but with the reservation that *Grayia* Acould logically be expanded to include *Zuckia.*@

Naturally occurring hybrids of siltbush with shadscale (*Atriplex confertifolia* [Torr. And Frem.] Wats.) and Castle Valley clover (*A. gardneri* [Moq.] D. Dietr. var. *cuneata* [A. Nels.] Welsh) were reported by Drobnick and Plummer (1966). Blauer and others (1976) obtained viable seeds, but no seedlings, by artificially pollinating pistillate flowers of fourwing saltbush with tetraploid siltbush pollen.

Flowering and fruiting. All siltbush varieties are monoecious and heterodichogamous (Pendleton and others 1988). Plants are protogynous (producing pistillate, then staminate flowers) or protandrous (producing staminate, then pistillate flowers) in about equal numbers. Within each plant, temporal separation of pistillate and staminate phases is nearly complete, generally precluding self-fertilization.

Staminate flowers each consist of 4 or 5 stamens and a 4- or 5-lobed perianth. They develop in clusters of 2 to 5 in bract axils (Goodrich and Neese 1986; Welsh and others 1987). Pistillate flowers are 1 to several in bract axils with each enveloped by 2 united bracts. The bracts are either dorsiventrally flattened and unequally 6-keeled with the seed horizontal (*Z. b*. var. *arizonica*) (figures 1and 2) or obcompressed and thin-margined with the seed vertical (*Z. b*. var. *bradegei* and *Z. b*. var. *plummeri*) (Goodrich and Neese 1986; Welsh and others 1987) (figures 1 and 2). Plants of all varieties flower in late spring or summer and fruits ripen in mid to late summer or fall (Blauer and others 1976; Pendleton and others 1988) (table 1).

Protogynous plants generally produce more seed, but protandrous plants may be equally productive in wet years or in years with low seed predation (Pendleton and others 2000). Fruits are dispersed slowly, with some usually remaining dormant on the plant through winter (Blauer and others 1976). Seeds are light yellowish brown at maturity (Hurd and Pendleton 1999) (figure 3). The outer layer of the seedcoat is elastic when imbibed. The embryo is well developed, with pale yellow cotyledons and an elongate, inferior radicle encircling the perisperm (figure 4). Seedling development is epigeal (figure 5).

Collection of fruits and seed extraction and cleaning. Fruits are collected by hand-stripping or beating and air-dried. Coarse debris may be removed with an air-screen machine or a seed blower or by screening. Careful rubbing to remove bracts prevents radicle damage. The final product may consist of debracted utricles (Meyer and Pendleton 1990; Pendleton and Meyer 1990) or seeds (figure 3). Weight of bracted utricles and seeds and seed fill data are provided in table 2.

Storage. Germination of seeds incubated at 1 to 3 °C in constant darkness was 87% after 2 years of storage in cloth bags in a warehouse (Stevens and Jorgensen 1994; Stevens and others 1981). Germination from year 2 to year 4 was 88%, dropping to 57% by year 5, 13% by year 7, and 0% after 15 years. Viability of bracted utricles stored in paper bags at room temperature and debracted utricles from the same collection stored in a freezer at B 80 °C was 97% after 7 years as determined by tetrazolium chloride testing (Hurd and Pendleton 1994).

Pregermination treatments. Germination experiments have been conducted with seeds of *Z. b.* var. *brandegei* and *Z. b*. var. *plummeri*. Seeds of warm-winter populations may germinate opportunistically over a wide range of constant temperatures (15 to 30 °C) when water is available (Meyer and Pendleton 1990). Seeds of cold-winter populations are dormant at fall and winter temperatures, becoming germinable in early spring following exposure to overwinter chilling. Germination generally increased with duration of wet prechilling at 1 °C for up to 8 weeks, dry afterripening for up to 14 months, or removal of bracts (Meyer and Pendleton 1990; Pendleton and Meyer 1990).

Techniques and criteria recommended for characterizing normal seedlings, excising embryos, and testing viability are as described for spiny hopsage (Shaw 1992):

! Normal seedlingCEpigeal, with thin, 10- to 15mm-long hypocotyls; small, narrow cotyledons; short epicotyl; and well-developed root hairs (figure 5).

! Excised embryoCSeeds soaked in water at 28 °C for 12 hours and then drained can have their embryos excised with sharp needles; these embryos germinate rapidly at 15/5 or 15 °C and should be evaluated for presence of normal seedlings.

! ViabilityCSeeds soaked in water at 28 °C for 12 hours, and then drained can be pierced through the perisperm with a sharp probe or needle, then they are soaked in a 1% 2,3,5-triphenyl tetrazolium chloride solution for 4 to 8 hours at 28 °C; the seed coat is translucent after soaking, making excision unnecessary for evaluation of staining.

Nursery culture and direct seeding. Because few data are available, recommendations for spiny hopsage (see *Grayia*, page 00) may be used as guidelines for establishing siltbush from seed. Based on studies conducted in south-central Utah, Monsen (1996) found that siltbush seedlings develop more rapidly than those of spiny hopsage. Root systems of bareroot stock are much more extensive after 1 growing season. Palatability is low to moderate (Monsen 1996; Stutz 1995). Plants may attract rodents, other small animals, and occasionally deer.

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Table 1C*Zuckia brandegei*, siltbush: phenology of flowering and fruiting

Species	Location	Flowering dates	Fruit ripening dates	Seed dispersal dates
Z. brandegei	Central Utah	Mid-JuneBmid-Aug	Late SeptBearly Oct	Jan or later
	Uinta Basin, Utah	MayBJune	Sept	C
	Sanpete Co., Utah	Mid-MayBJuly	JulyBlate Sept	C
	C	C	Sept 10BDec 15	C

Sources: Blauer and others (1976), Goodrich and Neese (1986), Pendleton and others (1988), Plummer and others (1968).

Table 2C*Zuckia brandegei*, siltbush: fruit and seed characteristics

Species	Thousands of bracted utricles				Thousands of seeds				Filled seed (%)	
	Range		Average		Range		Average			
	/kg	/lb	/kg	/lb	/kg	/lb	/kg	/lb	Range	Average
Z. brandegei	263.2B312.5	119.4B141.7	284.0	129.0	555.5B769.2	252.0B348.9	C	C	5B27	16
Z. brandegei var. *arizonica*	372.5B1,061.2	168.9B481.4	732.4	332.2	420.3B793.6	190.7B360.0	418.4B561.1	190.0 B 254.5	7B21	15

Sources: Pendleton and others (1988), Plummer and others (1968), Smith (1974).

Figure 1C*Zuckia brandegei*, siltbush: bracted utricles of *Z. b.* var. *arizonica* (**a**), *Z. b.* var. *brandegei* (**b**), *Z. b*. var. *plummeri* (**c**). [**photos**]

Figure 2C*Zuckia brandegei*, siltbush: bracted utricles of *Z. b.* var. *arizonica* (top & side, × 12.5) and *Z. b.* var. *brandegei.* [**drawings**]

Figure 3C*Zuckia brandegei*, siltbush: utricles and seeds of *Z. b.* var. *arizonica* (**a**), × 19.5, and *Z. b.* var. *brandegei,* × 18. [**drawing**]

Figure 4C*Zuckia brandegei*, siltbush: embryo. [**DRAWING**]

Figure 5C*Zuckia brandegei*, siltbush: seedling development, × 3.3. [**DRAWING**]