

A survey of percent-filled and empty seeds in multiple years observations of *Juniperus arizonica* and *J. osteosperma*

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ABSTRACT

The percent-filled seeds are presented for *J. arizonica* and *J. osteosperma* (Salt Lake City, Utah and Sedona, AZ) covering 3 and 4 years respectively. The % filled seeds for *J. arizonica* varied as: 34.4% (2010); 33.4% (2011); and 12.4% (2013). For *J. osteosperma*, Salt Lake City, Utah, the % filled varied as: 0.0% (2010), 0.4% (2011), 0.0% (2013), 0.0% (2014). In contrast, *J. osteosperma*, Sedona, AZ, the % filled varied as: 79.0% (2010), 7.2% (2011), 0.0% (2013). A summary of % filled seed is presented for 13 *Juniperus* species of North America. Published on-line www.phytologia.org *Phytologia* 93(3): 164-169 (July 6, 2016). ISSN 030319430

KEY WORDS: *Juniperus arizonica*, *J. ashei*, *J. californica*, *J. coahuilensis*, *J. communis* var. *depressa*, *J. deppeana*, *J. grandis*, *J. monosperma*, *J. occidentalis*, *J. osteosperma*, *J. pinchotii*, *J. scopulorum*, *J. virginiana*, filled and empty seeds, X-ray analysis.

Recently, we (Adams and Thornburg, 2011; Adams, Thornburg and Corbet, 2014) have reported a general survey of the incidence of filled vs. empty seeds for most of the *Juniperus* species of the western United States. This note is to report on additional observations on the incidence of filled seed in *Juniperus arizonica* and *J. osteosperma*.

MATERIAL AND METHODS

Plant specimens collected:

- J. arizonica*, Adams 12505-12509, 5 normal female trees, Cottonwood, AZ, 3 Nov 2010, Adams 13178-13182, 5 normal female trees, Cottonwood, AZ, 28 Nov 2011, Adams 12510-12516, 7 'male' trees with seed cones, Cottonwood, AZ, 3 Nov 2010, Adams 14528-14532, Cottonwood, AZ, 30 Jan 2014, D. Thornburg, ns,
- J. osteosperma*, Adams 12408-12412, Big Cottonwood Canyon, Salt Lake City, UT, 4 Sep 2010, Adams 13188-13192, Big Cottonwood Canyon, Salt Lake City, UT, 4 Dec 2011, Adams 12323-12327, Adams 14190-14194, Big Cottonwood Canyon, Salt Lake City, UT, 16 Mar 2014, Adams 14539-14543, Big Cottonwood Canyon, Salt Lake City, UT, 15 Mar 2015,
- Big Bear Basin, CA, 20 Jul 2010 (too early to be filled?), Adams 12546-12550, n of Sedona, AZ, 34.491521° N, 111.690468° W, Nov 2010, Adams 13174-13177, n of Sedona, AZ, 34.491521° N, 111.690468° W, Nov 2011,

Voucher specimens are deposited in the herbarium (BAYLU), Baylor University, Waco, TX.

X-ray analysis of the seeds was performed by the US Forest Service, National Seed Laboratory, Dry Branch, GA.

RESULTS AND DISCUSSION

The % filled seeds in *J. arizonica* near Cottonwood, AZ varied (Table 1) as: 34.4%(2010); 33.4% (2011); and 12.4% (2013). The % filled ranged (within a population) from 24 - 56% (2010), 20 - 49% ((2011) and 0 - 40% (2013). Clearly, the 2013 seed crop was poorly filled. The odd, *J. arizonica* male trees, each with a few seed cones, averaged 52.5% filled (Table 1).

Table 1. The % filled seeds from normal, female *J. arizonica* trees and 7 'male' trees bearing a few seed cones near Cottonwood, AZ.

J. arizonica, 10 normal, female trees, Cottonwood, AZ, David Thornburg property.

	# cones	seeds/cone	#seeds X-rayed	% filled	coll. 3 Nov 2010
12505	50	1.22	50	28	
12506	50	1.00	50	30	
12507	50	1.11	50	34	
12508	50	1.14	50	56	
12509	50	1.00	50	24	avg = 34.4%
	# cones	seeds/cone	#seeds X-rayed	% filled	coll. 28 Nov 2011
13178	50	1.00	50	21	
13179	50	1.00	50	39	
13180	50	1.00	50	49	
13181	50	1.00	50	20	
13182	50	1.00	50	38	avg = 33.4%
	# cones	seeds/cone	#seeds X-rayed	% filled	coll. 17 Jan 2014 (2013 seed)
14528	50	1.00	50	0	
14529	50	1.00	50	40	
14530	50	1.00	50	0	
14531	50	1.00	50	0	
14532	50	1.00	50	22	avg = 12.4%

J. arizonica, 7 male trees, each with a few female cones, Cottonwood, AZ, David Thornburg property.

	# cones	seeds/cone	#seeds X-rayed	% filled	coll. 3 Nov 2010
12510 tree 1	13	1.08	14	42.8*	
12511 tree 2	50	1.04	50	88.0*	
12512 tree 3	1	1.00	1	100.0	
12513 tree 4	1	1.00	1	0.0	
12514 tree 8	1	1.00	1	100.0	
12515 tree 10	37	0.92	34	29.4*	
12516 tree 17	30	1.00	30	50.0*	avg. = 52.6% (for * trees)

The Utah juniper, *J. osteosperma*, is the dominant tree in many parts of Utah and Nevada and extends into northern Arizona, southern California, and western New Mexico (Adams, 2014). Seeds were collected from a small population (50 - 100 trees) growing at the mouth of the Big Cottonwood Canyon, SLC, Utah. No filled seeds were found in 2010 and only 1 seed (in 50, = 2%) was found in 2011 (Table 2). New collections found 0.0% (2013) and 0.0% (2014). So, of the 1,252 seeds x-rayed over four years (2010, 2011, 2013, 2014) only 2 seeds were filled! This is an extreme situation. The site is not too unusual and the cause for the very low seed set is not known, although Fuentes and Schupp (1998) suggested that empty seeds reduce seed predation by birds in *J. osteosperma*. They reasoned that birds finding mostly empty seeds on a tree would abandon that tree, thus, the few filled seeds might escape bird seed predation.

Table 2. The % filled seeds for *J. osteosperma* in Utah.

J. osteosperma, Big Cottonwood Canyon, SLC, UT coll. **4 Sep 2010**

	# cones	# w 2 seeds	seeds/cone	#seeds X-rayed	% filled
12408	90	0	1.00	90	0.0
12409	102	1	1.01	103	0.0
12410	101	0	1.00	101	0.0
12411	102	0	1.00	102	0.0
12412	100	6	1.06	106	0.0
					avg = 0.0%

J. osteosperma, Big Cottonwood Canyon, SLC, UT coll. **4 Dec 2011** ex Andy Hornbaker

	# cones	# w 2 seeds	seeds/cone	#seeds X-rayed	% filled
13188	50	0	1.00	50	2.0
13189	50	0	1.00	50	0.0
13190	50	0	1.00	50	0.0
13191	50	0	1.00	50	0.0
13192	50	0	1.00	50	0.0
					avg = 0.4%

J. osteosperma, Big Cottonwood Canyon, SLC, UT coll. **16 Mar 2014 (2013 seed crop)**

	# cones	# w 2 seeds	seeds/cone	#seeds X-rayed	% filled
14190	50	1	1.02	50	0.0
14191	50	2	1.04	50	0.0
14192	50	0	1.00	50	0.0
14193	50	0	1.00	50	0.0
14194	50	2	1.04	50	0.0
					avg = 0.0%

J. osteosperma, Big Cottonwood Canyon, SLC, UT coll. **15 Mar 2015 (2014 seed crop)**

	# cones	# w 2 seeds	seeds/cone	#seeds X-rayed	% filled
14539	50	0	1.00	50	0.0
14540	50	0	1.00	50	0.0
14541	50	0	1.00	50	0.0
14542	50	0	1.00	50	0.0
14543	50	0	1.00	50	0.0
					avg = 0.0%

Seeds from a population north of Sedona, AZ were collected in 2010, 2011 and 2013. The % filled seeds varied (Table 3) as 79.0% (2010), 7.2% (2011), and 0.0% (2013). It is interesting that trees from the same population varied so much by years. By comparison, a population at Big Bear Basin, San Bernardino Mtns., CA had 51.4% (2010). Note (Table 3) than in the Big Bear population, four trees were very uniform ranging from 61.5 to 66.7% filled seeds, whereas one individual had no filled seeds. This reinforces the idea of collecting from several tree sources to obtain viable seeds for germination.

Fuentes and Schupp (1998) examined the incidence of filled seeds in a semi-arid species, *J. osteosperma* from Utah. Their 34 trees varied from 0.0 to 16.5% filled seeds (avg. = 5.61%). So it is interesting that the Sedona, AZ, for 2011 samples display a range of variation similar to their Utah samples, but 2010 and 2013 are quite different from the 2011 data.

Table 3. The % filled seeds for *J. osteosperma* at Grasshopper Point, Sedona Arizona.

J. osteosperma, Sedona, AZ, coll. **Nov 2010** ex David Thornburg

	# cones	seeds/cone	#seeds X-rayed	% filled	
12546	50	1.00	49	89.8	
12547	49	1.02	48	85.4	
12548	49	1.02	44	95.5	
12549	47	1.06	48	54.2	
12550	47	1.06	50	70.0	avg = 79.0%

J. osteosperma, Sedona, AZ, coll. **Nov 2011** ex David Thornburg

			#seeds X-rayed	% filled	
13173			50	4.0	
13174			50	2.0	
13175			50	7.0	
13176			50	16.0	
13177			50	6.8	avg = 7.2%

J. osteosperma, Sedona, AZ, coll. **30 Jan 2014 (2013 seed crop)** ex David Thornburg

			#seeds X-rayed	% filled	
14534			50	0.0	
14535			50	0.0	
14536			50	0.0	
14537			50	0.0	
14538			50	0.0	avg = 0.0%

J. osteosperma, Big Bear Basin, CA, coll. **20 Jul 2010**

	# cones	# w 2 seeds	seeds/cone	#seeds X-rayed	% filled	
12323	50	2	1.04	52	61.5	
12324	50	12	1.24	62	64.6	
12325	50	0	1.00	50	64	
12326	52	2	1.04	54	66.7	
12327	45	0	1.00	45	0.00	avg = 51.4%

The amount of variation in % filled seeds is remarkable, varying both by year and by location. The % filled seeds for 13 *Juniperus* species from the US and Canada are shown in Table 4. These values range from 0.0 (*J. osteosperma*, Utah) to 79.0% (*J. osteosperma*, Sedona, AZ). Of interest is the variation from 2010 to 2011, with *J. osteosperma* (Utah) having 0.0 in 2010 and 0.4% in 2011. Yet, *J. osteosperma* (Sedona, AZ) had 79.0% filled in 2010, but only 7.2% (2011) and 0.0% (2014).

Interestingly, *J. deppeana* had a similar pattern: 38.2% filled in 2010 and 0.0 % filled in 2011. But, *J. arizonica*, collected nearby, had the same % filled in 2010 (34.4%) and 2011 (33.4%) (Table 4).

Juniperus virginiana, an easy juniper to germinate from seeds, had only 1.2% (2010), which is surely not typical for that species. Observations on % filled seed based only one year's seed crop should be taken with considerable caution, as other years are likely to be quite different.

Table 4. Comparison of % filled seeds for 13 *Juniperus* species in North America.

Species, location	% filled (year)
<i>J. arizonica</i> , Cottonwood, AZ	34.4 (2010), 33.4 (2011), 12.4% (2013)
<i>J. ashei</i> , Westlake Hills, Austin, TX	27.2 (2010)
<i>J. californica</i> , Bodfish, CA	58.4 (2012)
<i>J. californica</i> , Victorville, CA	63.2 (2012)
<i>J. californica</i> , Bagdad, AZ	77.6 (2012)
<i>J. coahuilensis</i> , Alpine, TX	22.8 (2010)
<i>J. communis</i> var. <i>depressa</i> , Winnipeg, Can.	11.6 (2010)
<i>J. deppeana</i> , 14 miles SE Camp Verde, AZ	38.2 (2010), 0.0 (2011)
<i>J. grandis</i> , Onyx Summit, CA	13.7 (7/2010), 15.6 (11/2010)
<i>J. monosperma</i> , Lake Tanglewood, TX	36.8 (2010)
<i>J. occidentalis</i> , Bend, OR	5.6 (2010)
<i>J. occidentalis</i> , sw of Susanville, CA	5.9 (2010)
<i>J. osteosperma</i> , Big Cottonwood Canyon, UT	0.0 (2010), 0.4 (2011), 0.0 (2013), 0.0 (2014)
<i>J. osteosperma</i> , Sedona, AZ	79.0 (2010), 7.2 (2011), 0.0 (2013)
<i>J. osteosperma</i> , Big Bear Basin, CA	51.4 (2010)
<i>J. pinchotii</i> , Palo Duro Canyon	2.8 (2010)
<i>J. pinchotii</i> , from Warren (2001)	
Palo Duro Canyon	17.0
Justiceburg, TX	9.5
San Angelo, TX	18.1
Guadalupe (Salt Flat, TX)	9.9
<i>J. scopulorum</i> , Cimarron Canyon, NM	43.4 (2010)
<i>J. virginiana</i> , Lockhart, TX	1.2 (2010)

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LITERATURE CITED

- Adams, R. P. and D. Thornburg. 2011. Sexual change in *Juniperus arizonica*: facultative monocious? Phytologia 93: 43-50.
- Adams, R. P. and D. Thornburg. 2014. A survey of percent-filled and empty seeds in *Juniperus* in the western United States. Phytologia 96: 47-57.
- Fuentes, M. and E. W. Schupp. 1998. Empty seed cones reduce seed predation by birds. Evol. Ecol. 12: 823-827.
- Warren, Y. 2001. Field germination and establishment characteristics of redberry juniper. Ph. D. Thesis, Texas Tech University, Lubbock, TX, 91 p.