**Chenopodiaceae–Goosefoot family**

# *Grayia spinosa* (Hook.) Moq.

## spiny hopsage

Nancy L. Shaw, Marshall R. Haferkamp, and Emerenciana G. Hurd

Drs. Shaw and Hurd are botanists at the USDA Forest Service's Rocky Mountain Research Station, Forestry Sciences Laboratory, Boise, Idaho; Dr. Haferkamp is a rangeland scientist at the USDA Agricultural Research Service's Fort Keogh Livestock and Range Research Laboratory, Miles City, Montana.

**Growth habit, occurrence, and use.** The genus *Grayia* Hook. & Arn., named for the American botanist Asa Gray, contains a single species–spiny hopsage (table 1). Plants are erect to rounded, summer-deciduous shrubs 0.3 to 1.2 (1.5) m tall. Branches are divergent and thorn-tipped, with whitish gray to brownish bark that exfoliates in long strips. Leaves are gray-green, alternate, entire, and fleshy, sometimes turning bright red before abscising. Pubescence of young twigs and leaves consists of simple or stellate hairs. Prominent globose, gray-green overwintering leaf buds develop prior to summer leaf fall.

Widely distributed in the western United States (table 1), spiny hopsage is a common associated species in Wyoming big sagebrush, salt desert shrub, pinyon–juniper, Mojave Desert, and Great Basin–Mojave Desert transition communities, but it rarely grows in monocultures (Welsh and others 1987). The species occurs at elevations ranging from 160 to 2,130 m on soils that are silty to sandy, neutral to strongly basic, and often high in calcium. It also grows on sand dunes. Growth and nutrient content of vegetation growing near spiny hopsage are enhanced by the accumulation of litter rich in potassium and other cations (Rickard and Keough 1968).

Spiny hopsage provides cover for birds and other small animals; spring and early summer forage for big game and livestock, and soil stabilization on gentle to moderate slopes (McCullough 1969; USDA SCS 1968). The species was first cultivated in 1897 (Rehder 1940).

**Geographic races and hybrids.** Spiny hopsage is tetraploid (4x equals 36) (McArthur and Sanderson 1984). Natural hybridization between spiny hopsage and related chenopods has not been observed. However, Drobnick and Plummer (1966) were successful in fertilizing female flowers of fourwing saltbush–*Atriplex canescens* (Pursh) Nutt.–with spiny hopsage pollen and obtaining viable progeny.

**Flowering and fruiting.** Plants are monoecious or dioecious, with the percentage of each varying among populations (Goodrich and Neese 1986; McArthur and Sanderson 1984). Inflorescences develop on floral shoots that die back following fruit dispersal. Flowers are inconspicuous. Staminate flowers, each consisting of a 4- or 5-lobed perianth and 4 or 5 stamens, develop in glomerate spikes. Pistillate flowers develop in dense bracteate spikes, racemes, or panicles

with 1 to several flowers in the axil of each bract. Some flowers are commonly vestigial. Each flower consists of a single pistil enclosed in 2 cordate to orbicular bracteoles united along their length except for a minute apical opening. Bracteoles enlarge in fruit, forming a papery, dorsally wing-margined sac 9 to 15 mm in diameter (Shaw and others 1996) (figures 1 and 2). Mature bracteoles are white, green, or parchment-colored and are sometimes suffused with pink or red.

Fruits are utricles with the thin, papery pericarp free from the seed (Shaw and others 1996) (figures 3 and 4). Seeds are vertical, disk-shaped, and 1 to 2 mm in diameter (figures 3 and 4). The seedcoat consists of a thin, dark brown outer layer and a tough, elastic inner layer. A well-developed embryo with pale yellow cotyledons and an elongate, inferior radicle encircles the perisperm (figure 4).

During a prolonged drought, spiny hopsage shrubs developing from a southern Idaho seeding did not begin flowering until they were 4 years of age (Shaw 1992b). Flowering occurs in late winter or early spring (table 2) and may be triggered by photoperiod (Ackerman and Bamberg 1974). Flowers are wind-pollinated. Fruits mature in late spring or early summer and are usually dispersed within 1 or 2 weeks, but high winds accompanying summer storms can rapidy remove all mature fruits. Herbage, flower, and fruit production are dependent upon the availability of soil water and other environmental factors and vary widely among years (Rickard and Warren 1981; Wallace and Romney 1972). In dry years, plants may remain dormant, producing neither leaves nor flowers.

**Collection of fruits.** Size and quality of the developing seed crop at prospective collecting sites should be estimated prior to the harvest season. Mature utricles can be harvested by hand stripping or by beating the shrubs with paddles or tennis rackets. Freshly harvested utricles should be spread in a thin layer over drying racks or screens in an enclosed area with good ventilation. Utricles dried outdoors or in open buildings must be covered with netting or wire screens as they are easily scattered by light breezes. The hygroscopic bracts absorb water rapidly if exposed to environments with increased humidity.

**Seed extraction and cleaning.** Preliminary separation of harvested seedlots with an air-screen machine removes twigs, large leaves, and other coarse material. Some empty bracts can also be separated by this process. Bracteoles may be removed, if necessary, by threshing them with a hammermill (King 1947) or a barley debearder (Jorgensen 1992). A seed scarifier, seed de-winger, or rubbing board may be used to thresh small collections (Shaw and Haferkamp 1990). Threshing generally results in complete removal of bracteoles and partial to complete removal of the pericarp, leaving seeds as the product. Some embryos may be damaged during threshing as the radicle tip is vulnerable to abrasion (figure 4).

Threshed seeds may be separated from chaff using an air-screen machine or a seed blower. Removing the chaff is necessary only when it is desirable to reduce bulk for storage or shipping. Otherwise, the chaff can serve as a diluent for the small seeds as it will feed through most seeding mechanisms when dry. Smith (1974) obtained 1.2 kg (2.6 lb) of cleaned seeds from 45.4 kg (100 lb) of fruits. Number of bracted utricles and seeds per weight and seed fill data are provided in table 3.

**Storage**. Kay (1976) and Kay and others (1977, 1984, 1988) found that total germination percentage of seeds dried to a water content of 5.1% and stored at –15 or 4 °C or room temperature in sealed glass containers containing a silica gel desiccant did not decline from the initial value of 42% after 14 years (Kay 1976; Kay and others 1977, 1984, 1988). Germination of air-dried seeds

stored in cloth bags in a warehouse decreased to about 20% after 1.5 years and to 0% after 7 years. All germination tests were conducted at 15 °C. Thus, for long-term storage, it is recommended that seeds be dried to a water content below 10% and kept in sealed containers.

**Pregermination treatments and germination tests**. Dormancy of freshly harvested utricles of many woody chenopods can be reduced by dry afterripening, whereas the response to wet prechilling and temperature is regulated by the environmental conditions in which they were produced (Ansley and Abernethy 1985; Kay and others 1988; Springfield 1972). However, the response of spiny hopsage seeds to dry afterripening is poorly known and may vary with seedlot and with seed age. Shaw and others (1994) found that field germination and seedling establishment of 2 spiny hopsage seed collections from the northern shrub steppe were similar after 2 and 4 years of dry storage at room temperature. By contrast, King (1947) found an additional 2 years of dry afterripening decreased the wet prechilling requirement for eastern Washington seeds from 12 weeks at 5 °C for 4-year-old seeds to 2 weeks for 6-year old seeds.

Spiny hopsage seeds produced in the northern shrub steppe are generally more responsive to wet prechilling than seeds produced in the Mojave Desert (Shaw 1992a; Wallace and Romney 1972; Wood and others 1976). Shaw (1992a) examined the effect of a 45-day wet prechill at 3 to 5 °C on 2 northern shrub steppe collections. Prechilled bracted utricles and cleaned seeds of each collection were incubated over a wide range of constant (10, 15, 20, 25 or 30 °C) and alternating (15/5 and 10/2 °C [8/16 hours]) temperatures. Prechilling increased germination from 9 to 64% and reduced days required to reach 50% germination from 40 to 29. Based on these results, she recommended 1 to 2 months of wet prechilling for northern shrub steppe seedlots.

Wood and others (1976) examined the germination response of 4 Nevada (Great Basin) and 1 California (Mojave Desert) spiny hopsage seedlots at 55 constant and alternating temperatures. Prechilling was not required as the seeds were nondormant. After 1 week germination of seed lots incubated at constant temperatures was greatest at 10 and 15 °C (66 to 74%). For a seedlot collected at Dayton, Nevada, a 5 °C low temperature alternating with high temperatures between 10 and 30 °C, inclusive (8/16 hours alternations), provided the greatest germination percentages (85 to 90%). Maximum seedling elongation for this seedlot occurred after 1 week at 5, 20/15, 20, or 25/5 °C.

Wood and others (1976) also found that the presence of bracts did not affect germination of Nevada and California seed collections exposed to favorable incubation conditions. At low water potentials, greater germination of bracted utricles compared to seeds was attributed to the presence of the hygroscopic bracteoles. Shaw (1992a) found that prechilling enhanced subsequent germination of seeds more than bracted utricles from northern shrub steppe populations when placed under favorable incubation conditions and speculated that enhancement might be due to improved oxygen uptake by the seeds.

The following techniques and criteria recommended for laboratory analyses by Belcher (1985), Dueleheimer (1992), and Shaw (1992a):

*Germination*–Incubate seeds at 15/5 °C (8 hours/16 hours) or 15 °C. First count is taken at 7 days, last count at 14 days. Wet prechilling for 30 to 60 days at 3 to 5 °C is recommended for northern populations. Normal seedlings are epigeal, with a thin, 10- to 15-mm-long hypocotyl; small, narrow cotyledons; short epicotyl; and well-developed roots hairs (figure 5).

*Embryo excision*–Soak seeds in water at 28 °C for 12 hours, then drain; excise embryos with sharp needles. Spiny hopsage embryos germinate rapidly at 15/5 or 15 °C. Evaluate as described for germination of seeds.

*Viability testing*–Soak seeds in water at 28 °C for 12 hours, then drain; pierce seeds through perisperm with a sharp probe or needle; soak in a 1% 2,3,5-triphenyl tetrazolium chloride solution for 4 to 8 hours at 28 °C. Excise embryos with sharp needles and evaluate as described by Grabe (1970) for dicotyledonous species other than legumes.

X-radiography–Shoot at 12 kV for 30 seconds for Kodak AA film and Industrex paper or at 12 kV for 60 seconds for Polaroid film. Filled, empty, and abnormal development will be visible.

**Nursery practice.** Container stock can be grown using planting media described by Augustine and others (1979), Ferguson (1980), and Ferguson and Monsen (1974). Seeds should be given wet prechilling, if necessary.

Bareroot stock of northern spiny hopsage populations may be produced by fall-seeding to permit early spring germination (Shaw 1992a, Shaw and Haferkamp 1990). This treatment maximizes the period of active seedling growth prior to leaf abscission and the onset of summer dormancy. Spring seedings of prechilled seeds generally have not been successful as it is difficult to prepare and plant the nursery beds early enough in the season. Seedlings developing from fall plantings generally produce a branched shoot and a taproot system with few lateral roots during the first growing season. Plants may attain adequate size for lifting as 1+0 stock, or they may be allowed to grow for an additional season, during which time they develop a more extensively branched root system. Bareroot seedlings must be lifted, packed, and handled with care as stems and branches are brittle and break easily. For prolonged storage, seedlings should be stored at –2 –C in paper nursery bags packed in waxed cardboard boxes to reduce desiccation and mold problems (Beall 2000).

Dormant bareroot spiny hopsage seedlings or container stock should be planted as soon as the ground thaws and before native shrubs in the vicinity of the planting site break dormancy. Removal of competing vegetation is critical to shrub seedling survival. Container stock has been established using supplemental water the first year (Ferguson and Frischknecht 1981, 1985; Frischknecht and Ferguson 1984; Hunter and others 1980; Romney and others 1971; Tueller and others 1974; Wallace and Romney 1974; Wallace and others 1980). Hunter and others (1980) recommended protecting seedlings with chicken-wire sleeves to reduce seedling predation in areas with high rodent or rabbit densities.

**Direct seeding.** In the commercial trade, "cleaned seeds" may mean bracted utricles from which coarse debris has been removed or seeds that have been separated from the bracteoles, pericarp, and extraneous debris. Either bracted utricles or seeds may be planted, but it is important to know which structure one is using. Bulk is considerably greater for bracted utricles, whereas purity and viability are generally greater for seeds. In order to ensure uniformity of flow, use of a conventional drill seeder with an agitator or a drill with a separate seed box and agitator for fluffy seeds is required for planting bracted utricles. Seeds may be planted with most conventional seeders. Regulating the seeding rate for the small seeds may be difficult unless they are sown through a drill with precision seeding regulation or mixed with either a diluent or seeds of other shrubs.

Broadcasting without covering the seeds is not recommended. However, seeds or bracted utricles can be broadcast seeded if they are incorporated into the soil by harrowing. Wood and

others (1976) found emergence from broadcast seeding on a rough seedbed was greater for bracted utricles (18%) than from seeds (0%) in a greenhouse study. However, emergence of both bracted utricles and seeds was greater and similar (50%) from a 5-mm planting depth.

Spiny hopsage has been planted in southern Idaho in late fall or winter by direct seeding or by broadcasting and covering. Seeds are thereby exposed to cool, wet seedbed environments, permitting early spring emergence when soil water conditions are favorable for growth prior to the onset of summer drought (Shaw and others 1994). Some seeds not encountering favorable soil water conditions for germination may enter secondary dormancy. Shaw and Haferkamp (1990) found seedling density was greater on rough seedbeds than on smooth seedbeds in early spring, perhaps because of improved microsite conditions. First-year establishment ranged from 0 to 24% of viable seeds planted from early fall to late spring on rough and smooth seedbeds. Seedling predators included seed harvester ants (*Pogonomyrmex salinus* Olsen) and nymphs of an unidentified plant bug (*Melanotrichus* spp.).

Microenvironmental conditions in prepared seedbeds differ sharply from those in natural seedbeds as spiny hopsage seedlings usually establish beneath nurse plants (Manning and Groeneveld 1990; Shaw and Haferkamp 1990). Consequently, spiny hopsage establishment may be enhanced by mulching or water catchment techniques that moderate soil water and temperature conditions.

## References


Ackerman TL, Bamberg SA. 1974. Phenological studies in the Mojave Desert at Rock Valley (Nevada Test Site). In: Leith H, ed. Phenology and seasonality modeling, ecological studies. New York: Springer-Verlag 8: 215–226.

Ackerman TL, Romney EM, Wallace A, Kinnear JE. 1980. Phenology of desert shrubs in southern Nye County, Nevada. Great Basin Naturalist Memoirs 4: 4–23.

Ansley RJ, Abernethy RH. 1985. Environmental factors influencing Gardner saltbush seed dormancy alleviation. Journal of Range Management 38: 331–335.

Augustine G, Augustine J, Bach D, Backhaus R, Corgan J, and others 1979. Soil mixes for greenhouse and nursery growth of desert plants. Desert Plants 1: 82–88.

Beall K. 2000. Personal communication. Boise, Idaho: USDA Forest Service, Boise National Forest, Lucky Peak Nursery.

Belcher E. 1985. Handbook on seeds of browse-shrubs and forbs. Tech. Pub. R8-TP8. Atlanta: USDA Forest Service, Southern Region. 246 p.

Blauer AC, Plummer AP, McArthur ED, Stevens R, Giunta BC. 1976. Characteristics and hybridization of important Intermountain shrubs: 2. Chenopod family. Res. Pap. INT-335. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station. 78 p.

Branson FA, Miller RF, McQueen IS. 1967. Geographic distribution and factors affecting the distribution of salt desert shrubs in the United States. Journal of Range Management 20: 287–296.

Collotzi AW. 1966. Investigations in the genus *Grayia*, based on chromatographic, morphological, and embryological criteria. [MS thesis]. Logan: Utah State University. 42 p.

Dayton WA. 1931. Important western browse plants. USDA Misc. Pub. 101. Washington, DC: USDA. 214 p.
Drobnick R, Plummer AP. 1966. Progress in browse hybridization in Utah. Proceedings of the Conference of Western State Game and Fish Commissioners 46: 211–213.
Dueleheimer C. 1992. Unpublished data. Boise: Idaho State Seed Laboratory.
Everett RL, Tueller PT, Davis JB, Bruner AD. 1980. Plant phenology in galleta–shadscale and galleta–sagebrush associations. Journal of Range Management 33: 446–450.
Ferguson RB. 1980. Potting media for *Atriplex* production under greenhouse conditions. Res. Note INT-301. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station. 7 p.
Ferguson RB, Frischknecht NC. 1981. Shrub establishment on reconstructed soils in semiarid areas. In: Stelter LH, DePuit EJ, Mikol SJ, tech. coords. Shrub establishment on disturbed arid and semiarid lands; 1980 December 2–3; Laramie, WY. Cheyenne: Wyoming Game and Fish Department: 57–62.
Ferguson RB, Frischknecht NC. 1985. Reclamation on Utah's Emery and Alton coal fields: techniques and plant materials. Res. Pap. INT-335. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station. 78 p.
Ferguson RB, Monsen SB. 1974. Research with containerized shrubs and forbs in southern Idaho. In: Tinus RW, Stein WI, Balmer WE, eds. Proceedings, North American Containerized Forest Tree Seedling Symposium; 1974 August 26–29; Denver, CO. Pub. 68. Lincoln, NB: Great Plains Agricultural Council: 349–358.
Frischknecht NC, Ferguson RB. 1984. Performance of Chenopodiaceae species on processed oil shale. In: Tiedemann AR, McArthur ED, Stutz HC, Stevens R, Johnson KL, comps. Proceedings, Symposium on the Biology of *Atriplex* and Related Chenopods; 1983 May 2–6; Provo, UT. Gen. Tech. Rep. INT-172. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station: 293–297.
Goodrich S, Neese E. 1986. Uinta Basin flora. Ogden, UT: USDA Forest Service, Intermountain Region, Ashley National Forest and USDI Bureau of Land Management, Vernal District. 320 p.
Grabe DF, ed. 1970. Tetrazolium testing handbook for agricultural seeds. Contrib. 29. In: Handbook on seed testing. Association of Official Seed Analysts. 62 p.
Hitchcock CL, Cronquist A. 1973. Flora of the Pacific Northwest. Seattle: University of Washington Press. 730 p.
Hunter RB, Wallace A, Romney EM. 1980. Fencing enhances shrub survival and growth for Mojave Desert revegetation. Great Basin Naturalist Memoirs 4: 212–215.
Jorgensen K. 1992. Unpublished data. Ephraim: Utah Division of Wildlife Resources.
Kay BL. 1976. Test of seeds of Mojave Desert shrubs. Prog. Rep. BLM contract 535000-CT4-2(N). Davis: University of California. 48 p.
Kay BL, Graves WL, Young JA. 1988. Long-term storage of desert shrub seed. Mojave Revegetation Notes 23. Davis: University of California. 22 p.
Kay BL, Pergler CC, Graves WL. 1984. Storage of seed of Mojave Desert shrubs. Journal of Seed Technology 9: 20–28.

Kay BL, Ross CM, Graves WL. 1977. Hop-sage. Mojave Revegetation Note 6. Davis: University of California. 5 p.
King JE. 1947. The effect of various treatments to induce germination of seed of some plants valuable for soil conservation and wildlife [MS thesis]. Moscow, ID: University of Idaho. 97 p.
Manning SJ, Groeneveld DP. 1990. Shrub rooting characteristics and water acquisition on xeric sites in the western Great Basin. In: McArthur ED, Romney EM, Smith SD, Tueller PT, comps. Proceedings, Symposium on Cheatgrass Invasion, Shrub Die-off, and Other Aspects of Shrub Biology and Management; 1989 April 5–7; Las Vegas, NV. Gen. Tech. Rep. INT-276. Ogden, UT: USDA Forest Service, Intermountain Research Station: 238–244.
McArthur ED, Sanderson SC. 1984. Distribution, systematics, and evolution of the Chenopodiaceae. In: Tiedemann AR, McArthur ED, Stutz HC, Stevens R, Johnson KL, comps. Proceedings, Symposium on the Biology of *Atriplex* and Related Chenopods; 1983 May 2–6; Provo, UT. Gen. Tech. Rep. INT-172. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station: 14–24.
McCullough DR. 1969. The Tule elk: its history, behavior, and ecology. Pub. in Zool. 88. Berkeley: University of California Press. 191 p. [REBECCA – THIS IS A MONOGRAPH]
Plummer AP, Christenson DR, Monsen SB. 1968. Restoring big-game range in Utah. Pub. 68-3. Salt lake City: Utah Division of Fish and Game. 183 p.
Rehder A. 1940. Manual of cultivated trees and shrubs. New York: Macmillan. 996 p.
Rickard WH, Keough RF. 1968. Soil-plant relationships of two steppe desert shrubs. Plant and Soil 19: 205–212.
Rickard WH, Warren JL. 1981. Response of steppe shrubs to the 1977 drought. Northwest Science 55: 108–112.
Romney EM, Wallace A, Childress JD. 1971. Revegetation problems following nuclear testing activities at the Nevada Test Site. In: Proceedings, 3rd National Symposium on Radioecology; 1971 May 10; Oak Ridge, TN. Los Angeles: University of California-Los Angeles, School of Medicine. Volume 2: 1015–1073.
Shaw NL. 1992a. Germination and seedling establishment of spiny hopsage (*Grayia spinosa* [Hook.] Moq.) [PhD dissertation]. Corvallis: Oregon State University [Dissertation Abstracts 9229768].
Shaw NL. 1992b. Unpublished data. Boise, ID: USDA Forest Service, Forestry Sciences Laboratory.
Shaw NL, Haferkamp MR. 1990. Field establishment of spiny hopsage. In: McArthur ED, Romney ER, Smith SD, Tueller PT, comps. Proceedings, Symposium on Cheatgrass Invasion, Shrub Die-off, and Other Aspects of Shrub Biology and Management; 1989 April 5–7; Las Vegas, NV. Gen. Tech. Rep. INT-276. Ogden, UT: USDA Forest Service, Intermountain Research Station: 193–199.
Shaw NL, Haferkamp MR, Hurd EG. 1994. Germination and seedling establishment of spiny hopsage in response to planting date and seedbed environment. Journal of Range Management 47: 165–174.
Shaw NL, Hurd EG, Haferkamp MR. 1996. Spiny hopsage fruit and seed morphology. Journal of Range Management 49: 551–553.

Smith JG. 1974. *Grayia* H. & A., hopsage. In: Shopmeyer CS, tech. coord. Seeds of woody plants in the United States. Agric. Handbk. 450. Washington, DC: USDA Forest Service: 434–436.

Springfield HW. 1972. Winterfat fruits undergo afterripening. Journal of Range Management 25: 69–70.

Swingle CF. 1939. Seed propagation of trees, shrubs, and forbs for conservation planting. SCS-TP-27. Washington, DC: USDA Soil Conservation Service. 198 p.

Tueller PT, Bruner AD, Everett R, Davis JB. 1974. The ecology of Hot Creek Valley, Nevada and nonradiation effects of an underground nuclear detonation. USAEC Rep. 96. Reno: University of Nevada, Max C. Fleischmann College of Agriculture. 51 p.

USDA SCS. 1968. Management and uses of spiny hopsage in the sate of Washington. Washington Plant Sci. Handbk. Spokane, WA: USDA Soil Conservation Service, Plant Materials Section. 2 p.

Wallace A, Romney EM. 1972. Radioecology and ecophysiology of desert plants at the Nevada Test Site. USAEC Rep. TID-25954. Riverside, CA: University of California, Los Angeles Soil Science and Agricultural Engineering, Laboratory or Nuclear Medicine and Radiation Biology and Agricultural Sciences, Environmental Radiation Division. 439 p.

[REBECCA – FRONT PAGE FOR THIS REFERENCE IS ATTACHED]

Wallace A, Romney EM. 1974. Feasibility and alternate procedures for decontamination and post-treatment management of PU-contaminated areas in Nevada. Los Angeles: University of California-Los Angeles, School of Medicine: 251–337.

Wallace A, Romney EM, Hunter RB. 1980. The challenge of a desert: revegetation of disturbed desert lands. Great Basin Naturalist Memoirs 4: 216–225.

Welsh SL, Atwood ND, Goodrich S, Higgins LC, eds. 1987. A Utah flora. Great Basin Naturalist Memoirs 9: 1–894.

Wood MK, Knight RW, Young JA. 1976. Spiny hopsage germination. Journal of Range Management 29: 53–56.

List of Figures

**Table 1**–*Grayia spinosa*, spiny hopsage: nomenclature and occurrence

| Scientific name & synonyms | Common name | Occurrence |
|---|---|---|
| ***G. spinosa* (Hook.) Moq**.<br>*Chenopodium* ? *spinosum* Hook.<br>*G. polygaloides* Hook. & Arn.<br>*Eremosemium spinosum* Greene<br>*Atriplex grayii* Collotzi<br>*A. spinosa* (Hook.) Collotzi | **spiny hopsage**, applebush, grayia, Gray's saltbush, hopsage, horsebush, saltbrush, spiny-sage, wintersage | E-central & SE Washington, E Oregon, S & central Idaho, S Montana, Nevada, Utah, W Wyoming, W Colorado, E & S California, & N Arizona |

**Sources:** Collotzi (1966), Dayton (1931), Hitchcock and Cronquist (1973), Kay (1977), Shaw (1992a, b), Smith (1974), Welsh and others (1987).

**Table 2–***Grayia spinosa*, spiny hopsage: phenology of flowering and fruiting

| Location | Flowering dates | Fruit ripening dates | Seed dispersal dates |
|---|---|---|---|
| Northern Mojave Desert, NV | Mar | Mar | Mar |
| Great Basin, Mojave Transition Desert, NV | Feb-April | Mar-Apr | Apr |
| Book Cliffs, CO | Mar-May | May | May-JuneGreat |
| Basin, NV | April & June | May & July | May & Aug |
| Sagebrush steppe, OR & ID | April-May | May-June | May-June |

**Sources:** Ackerman and Bamberg (1974), Ackerman and others (1980), Blauer and others (1976), Branson and others (1967), Everett and others (1980), Goodrich and Neese (1986), Plummer and others (1968), Shaw (1992b), Wallace and Romney (1972).

**Table 3–** *Grayia spinosa*, spiny hopsage: fruit and seed characteristics

| Bracted utricles/weight | | Seeds/weight | | | |
|---|---|---|---|---|---|
| | | Range | | Average | |
| /kg | /lb | /kg | /lb | /kg | /lb |
| 337,000-447,000 | 152,900-202,800 | 339,000-930,000 | 153,800-421,800 | 500,000 | 227,000 |
| | | 692,600-1,031,600 | 314,200-468,000 | 1,219,500 | 553,200 |

**Sources:** Belcher (1985), Kay and others (1977), King (1947), Plummer and others (1968), Shaw (1992b), Smith (1974), Swingle (1939).
**Note:** Filled seeds (%) = 18 to 95.