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Fabaceae—Pea family

Parkinsonia L.

palo verde

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Growth habit, occurrence, and uses. There are 3 noteworthy species of *Parkinsonia* grown in the United States. Two of these—blue palo verde and yellow palo *verde*—were formerly in the genus *Cercidium* but they are now considered to be in *Parkinsonia* (table 1). Palo verde is a thorny, green-barked shrub/small tree that can reach a height of 11 m (Vines 1960). The name is of Spanish-Mexican origin and refers to the very noticeable green (*verde*) color of the smooth trunk of this drought-resistant tree of the hot southern deserts (Jaegar 1940). The open-crowned trees have alternate, bipinnate leaves on slightly zig-zag green twigs (Little and Wadsworth 1964). The species are widely distributed in tropical America and widely planted in the southwestern United States and the Old World tropics (Little 1979; Little and Wadsworth 1964). Palo verde was introduced into Puerto Rico from the southwestern United States and is now naturalized (Francis and Liogier 1991). Blue palo verde and yellow palo verde are 2 closely related species, commonly found on the edges of washes, more occasionally in the washes, and scattered in the *bajadas* (Bainbridge and Virginia 1989). Both species drop their leaves when drought-stressed and only the green, thorny branches remain.

The 3 species serve as shelter for animals and rodents (Dean and Milton 1991), and the leaves and legumes (pods) as browse for livestock, rodents, rabbits, other mammals, and many species of birds (Bainbridge and Virginia 1989; Jaeger 1940; Little and Wadsworth 1964; Vines 1960). In the past, the legumes were a fairly important food for Native American inhabitants of the Sonoran Desert (Ebeling 1986; Felger and Moser 1985; Vines 1960). They were picked from July to August and dried; the beans were removed, ground in mortars into flour, and used in mush or cakes (Bean and Saubel 1972). The flowers of palo verde serve as a primary source of forage for megachilid bees in India (Jain and Kapil 1980; Sihag 1982), but the species is considered a weed in Australia (Pearce 1984).

Flowering and fruiting. Palo verdes have fragrant 5-petaled, showy, yellow flowers that form in loose racemes 5 to 20 cm long (Little and Wadsworth 1964). Blossoms appear in late March to June and occasionally in August to November after rains. In the past, these trees have been referred to as *fluvia de oro* or "fountain of gold" by Spanish Americans because of their incredible flower show after a generous rainy season. The fruits are 5 to 10 cm long, pointed legumes that contain 1 to 8 oblong, glossy, yellow-brown

Table 1—Parkinsonia, palo verde: nomenclature and occurrence

Scientific name & synonym(s)	Common name(s)	Occurrence
***P. aculeata* L.**	**palo verde,** Jerusalem-thorn, horsebean, *retama, palo de ray, palo rayo*	South to trans-Pecos Texas & S Arizona; widely distributed in tropical America; Puerto Rico
***P. florida* (Benth. ex Gray) S. Wats** *Cercidium floridum* Benth. ex Gray	**blue palo verde**	SW US
***P. microphylla* Torr.** *Cercidium mycrophyllum* (Torr.) Rose & I.M. Johnston	**yellow palo verde**	SW US

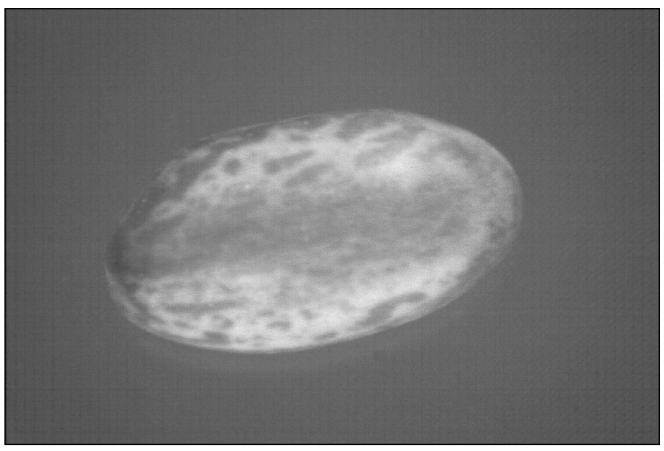
Sources: Bainbridge and Virginia (1989), Little (1979), Little and Wadsworth (1964).

seeds (figures 1 and 2) (Delorit and Gunn 1986; Vines 1960). Both flowers and legumes can occur throughout the year. The fruits are ripe when the legume turns yellow-brown and the seeds rattle (Bainbridge and Virginia 1989). Most legumes of blue palo verde contain only 1 seed (Siemens and Johnson 1995).

Collection, storage and germination. Seed collection should be timely because harvesting by animals and birds quickly reduces seed availability. Legumes dehisce upon drying, and small quantities of seeds can be hand-cleaned. A disc mill, meat grinder, or hammermill can be used to clean larger quantities. Reports on seeds per weight for palo verde range from 12,345 to 13,300/kg (5,600 to 6,000/lb) (Francis and Rodrıguez 1993; Little and Wadsworth 1964). The seeds are obviously orthodox, since Everitt (1983) found no reduction in seed viability after 2 years storage at room temperature.

Some form of seed scarification is necessary in order to achieve rapid and uniform germination. Francis and Rodrıguez (1993) germinated mechanically scarified seeds of palo verde on blotter paper and reported that 59% had germinated after 2 days. Everitt (1983) found that soaking seeds in concentrated sulfuric acid for 45 minutes increased germination from 1% to over 50%. Germination rose to over 87% at continuous temperatures of 15 to 35 °C, or at alternating temperatures of 10/20, 15/25, or 20/30 °C. Although percentage germination and radicle length were little affected by pH, results were enhanced if seeds were buried 1 to 7 cm (0.4 to 2 $^{3}/_{4}$ in) rather than left on the surface. Zodape (1991) reported germination of over 80% of seeds soaked in concentrated sulfuric acid. However, Bainbridge and Virginia (1989) found a negative effect of certain abrasion methods—they can create a dust on the seeds that encourages mold growth during germination.

Figure 1—*Parkinsonia aculeata*, palo verde: seed.



Although the seedcoat serves as a barrier to overcome when germinating, it also serves as a protective shield against insect infestation. Janzen (1977) found that the cause of mortality of larvae of the southern cowpea weevil—*Callosobruchus maculatus* F.—in palo verde seeds was not seed toxicity but rather the inability of the larvae to emerge through the seedcoat. Johnson and Siemens (1991) reported a field survival rate of less than 0.1% for *Stator* spp. larvae on palo verde seeds, also attributed to seedcoat density. Bainbridge and Virginia (1989) found that freezing the seeds will kill bruchid beetles, which are a major seed pest.

Nursery practice and seedling care. Palo verde seedlings are capable of fast root growth, for example, 35 cm (13.8 in) in 60 days, and may require air- or root-pruning. Young seedlings are susceptible to various damping-off diseases. Washing seeds with dilute hydrogen peroxide or dilute sodium hypochlorite (1:3 laundry bleach with water) before scarification may reduce problems with fungal disease (Bainbridge and Virginia 1989). Seedlings can be grown in a variety of deep, narrow containers. Pots that allow for uninterrupted taproot growth, such as the "tall pot," a 76-cm (30-in) PVC pipe used at the U.S. Department of the Interior National Park Service's Joshua Tree National Park (JTNP) seem to work well for revegetation projects. Soil mix should be sandy and drain well. Mychorrhizal inoculation is not required; however, use of VA-mycorrhizae may be desirable for planting in washes that are usually deficient in soil phosphorous (Virginia 1986).

Palo verde grown in the tall pots have been successfully outplanted without follow-up irrigation at JTNP (Rodgers and Miller 1995). Transplant studies determined that seedlings could be initially established with minimal irrigation. However, seedlings are tempting browse for small mammals, and plants are unlikely to survive without protective screening.

Direct seeding may be successful in the field, provided seeds are pretreated and sown after heavy rains or floods, when moisture and heat stress are low. In 1988, direct seeding trials were undertaken by Bainbridge and Virginia (1989) at the travertine site near the Salton Sea. Seeds were scarified, presoaked, and buried 6 to 12 mm deep in loose soil. Initial treatments of the first trial included control, supplemental water, supplemental water and screening, and supplemental water with screening and shade. After 7 months, only 1 tree was still alive, rated in good condition, in the plot with water and screen. A second trial in the same area in April used presoaked, scarified seeds planted at a density of 100 seeds/m^2 (9/ft^2). Plots were moistened before and after planting. No germination was observed, probably due

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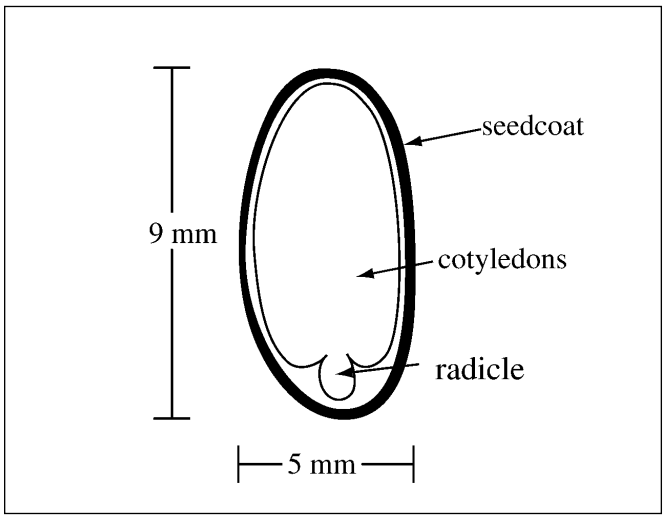
Figure 2—*Parkinsonia aculeata*, palo verde: longitudinal section of a seed.



to the late planting date. Results of both trials showed that seedlings in the 2-leaf stage are sensitive to both high winds and freezing; the best time for direct seeding appears to be in late January or early February. Subsequent trials suggest that the use of remote-site irrigation systems—pitchers, porous capsules, and wicks—can improve direct seeding success.

References

Bainbridge DA, Virginia RA. 1989. Restoration in the Colorado Desert: Species Notes. Unpublished manuscript prepared for the California Department of Transportation.

Bean LJ, Saubel KS. 1972. Temalpakh (from the earth): Cahuilla Indian knowledge and usage of plants. Morongo Indian Reservation, CA: Malki Museum Press. 225 p.

Dean WRJ, Milton SJ. 1991. Patch disturbances in arid grassy dunes: antelope, rodents and annual plants. Journal of Arid Environments 20(2): 231–237 [1992 Herbage Abstracts 62: 2115].

Delorit RJ, Gunn CR. 1986. Seeds of continental United States legumes (Fabaceae). Park Falls, WI: F.A. Weber & Sons. 134 p.

Ebeling W. 1986. Handbook of Indian foods and fibers of arid America. Berkeley: University of California Press. 971 p.

Everitt JH. 1983. Seed germination characteristics of two woody legumes (retama and twisted acacia) from south Texas. Journal of Range Management 36(4): 411–414 [1984 Forestry Abstracts 45: 4409].

Felger RS, Moser MB. 1985. People of the desert and the sea. Tucson: University of Arizona Press. 435 p.

Francis JK, Liogier HA. 1991. Naturalized exotic tree species in Puerto Rico. Gen. Tech. Rep. SO-82. New Orleans: USDA Forest Service, Southern Forest Experiment Station. 12 p.

Francis JK, Rodríguez A. 1993. Seeds of Puerto Rican trees and shrubs: second installment. Res. Note SO-374. New Orleans: USDA Forest Service, Southern Forest Experiment Station. 5 p.

Jaegar EC. 1940. Desert wildflowers. Stanford, CA: Stanford University Press. 322 p.

Jain KL, Kapil RP. 1980. Foraging rhythm of megachilid bees in relation to the flowering of *Medicago sativa* L. and *Parkinsonia aculeata* L. Indian Bee Journal 42(2): 35–38 [Apicultural Abstracts 1973+].

Janzen DH. 1977. How southern cowpea weevil larvae (Bruchidae: *Callosobruchus maculatus)* die on nonhost seeds. Ecology 58(4): 921–927.

Johnson CD, Siemens DH. 1991. Expanded oviposition range by a seed beetle (Coleoptera: Bruchidae) in proximity to a normal host. Environmental Entomology 20(6): 1577–1582 [1992 Review of Agricultural Entomology 80: 3799].

Little EL Jr. 1979. Checklist of United States trees (native and naturalized). Agric. Handbk. 541. Washington, DC: USDA Forest Service. 375 p.

Little EL Jr., Wadsworth FH. 1964. Common trees of Puerto Rico and the Virgin Islands. Agric. Handbk. 249. Washington DC: USDA Forest Service: 180–181.

Pearce GA. 1984. Research on declared plants and other weeds. Journal of Agriculture of Western Australia 25(1): 34–36 [1985 Weed Abstracts 34: 608].

Rodgers JE, Miller C. 1995. Unpublished data. Twentynine Palms, CA: USDI National Park Service, Joshua Tree National Park.

Siemens DH, Johnson CD. 1995. Number of seeds per pod in three species of perennial legumes: a compromise between ecological and physiological constraints? American Midland Naturalist 133: 197–205.

Sihag RC. 1982. Effect of competition with *Parkinsonia aculeata* L. on pollination and seed production in *Medicago sativa* L. Indian Bee Journal 44(4): 89–90 [1986 Apicultural Abstracts 37: 1044].

Vines RA. 1960. Trees, shrubs and woody vines of the Southwest. Austin: University of Texas Press. 1104 p.

Virginia RA. 1986. Soil development under legume tree canopies. Forest Ecology and Management 16: 69–79.

Zodape ST. 1991. The improvement of germination of some forest species by acid scarification. Indian Forester 117(1): 61–66 [1993 Seed Abstracts 16: 2616].