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Lithospermum incisum ‘Pawnee’ Germplasm

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Lithospermums are a group of spring-flowering herbs that belong to the Boraginaceae Juss. Correll and Johnston (1977) reported there are ≈40 species of *Lithospermum* L. in North America and an additional 20 species outside of North America. Flower color can vary from yellow to greenish-yellow, to orange or white, depending on species. There are four species native to the Great Plains: *L. carolinense* (Walt.) MacMill., *L. canescens* (Michx.) Lehm, *L. latifolium* Michx., and *L. incisum* Lehm. (The Great Plains Flora Association, 1986). *Lithospermum arvense* L., non Bove ex DC., Ledeb. nor Thunb. is an introduced, naturalized species of the Great Plains, native to Eurasia. *Lithospermum* is from the Greek word lithos meaning stone and sperma, meaning a seed (Farrar, 1990). Puccoon is a Native American common name for these plants from which a purple dye was extracted from their roots (Correll and Johnston, 1977; Kindscher, 1992). Plants usually have two types of flowers. Chasmogamous flowers develop early in the spring, and have conspicuous petals (corollas) with little seed production. Cleistogamous flowers are produced in late spring and summer and have inconspicuous petals (corollas) but have higher fertility levels. Cleistogamous flowers have little ornamental value.

Lithospermum incisum [synonyms: *L. brevifolium* Engelm. & Gray, *L. linearifolium* Goldie, and *L. mandanense* Spreng. & Rydberg] (The Great Plains Flora Association, 1986) is found from Ontario to British Columbia, Canada, south to Utah, Texas, and northern Mexico (Barr, 1983; Gleason and Cronquist, 1963; The Great Plains Flora Association, 1986). *Incisum* refers to the fringed margins of the petals. Common names include narrow-leafed puccoon, plains stoneseed, fringed puccoon, and narrow-leafed gromwell, (Cronquist et al. 1984; Kindscher, 1992). The plant has been reported to be used by Native Americans as a treatment for hemorrhaging of the lungs, for paralysis, for coughs and colds, and as a stimulant (Kindscher, 1992).

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Its bright lemon yellow flowers make it an attractive plant. *Lithospermum incisum* can be used as an ornamental or wildflower for use alone or in combination with grasses and other plants. Genetic variation within *L. incisum* can be used to make improved selections of this species for landscape use.

Origin

Seeds from populations of both *L. incisum* and *L. carolinense* were collected in Lincoln County, Neb., in 1986. Seeds were germinated, and the resulting seedlings were transplanted to field plots at North Platte, Neb., in 1987. The soil at the site was a Cozad silt loam (Fluventic Haplustoll) with a pH of 7.6. Plants of *L. carolinense* had stunted chlorotic growth, and most plants did not survive the first growing season. The soil pH and soil type may have been the cause of their poor performance. However, plants of *L. incisum* grew vigorously during the 1987 season and began flowering in 1988. There was a difference between these plants with regard to the number of chasmogamous and cleistogamous flowers. Those plants producing the most chasmogamous flowers were marked (≈10% of the population), and their seed was collected. This process was continued for three more generations, visually selecting plants for the most abundant clusters of chasmogamous-type flowers.

In 1991, seedlings from the first generation of selected plants were included in a field study to evaluate their performance when planted in conjunction with warm season grasses. Plots consisted of 5 plants of *L. incisum* transplanted into buffalograss (*Buchloe dactyloides* (Nutt.) Engelm) ‘Texoka’, buffalograss ‘315’, buffalograss ‘378’, blue grama grass (*Bouteloua gracilis* (Kunth) Leg. ex Griffiths) and a blank treatment (kept hand-weeded). Each plot was

0.75 × 1.5 m. Plants of *L. incisum* and plugs and/or seeds of the warm season grasses were planted at the same time. Survival of the *L. incisum* plants in these plots was recorded from 1991 to 1998. Treatments were replicated four times.

In 1996, seeds of the selected population were germinated in the greenhouse and seedlings transplanted to the field in mid-May. Ten plants were selected randomly from this planting in 1998, and each plant was measured for height, average plant diameter, number of seeds produced per plant and number of flower stalks per plant. Seeds were counted and weighed for each of the ten plants. Seeds were collected eight times beginning 1 July and ending on 1 Sept. Seeds were collected with a rechargeable, battery-powered, hand-held vacuum cleaner to pick seeds up from the soil surface beneath each plant. Seeds were separated by hand from soil and debris. Seed samples were kept separate for each plant, cleaned, weighed and counted for each harvest date. In addition, seed germination studies were conducted in 1998 and 1999. The effects of a 6-week moist stratification (1 to 2 °C) treatment and a nonstratification treatment were compared.

In 2001, a bulk sample of the final selected population was collected by mounting a gas-powered generator on a wagon to power a 5-HP shop vacuum to pick seeds off the ground. This final population germplasm was designated as *L. incisum* ‘Pawnee’. The name ‘Pawnee’ was selected because these Native Americans were not only common to west central Nebraska, but they also used the *Lithospermum* plants.

Description and Performance

Species description of *L. incisum*. In the Great Plains, growth of *L. incisum* begins in late March and early April and flowering usually begins in May. This perennial plant is strigose (stiff hairs lying close to the surface and pointing in one direction) and has a woody taproot (The Great Plains Flora Association, 1986). It grows 5 to 40 cm tall with one to several branched stems. It has narrow lanceolate or linear leaves, 3 to 6 cm long and ≈0.5 cm wide (Farrar, 1990). As with other *Lithospermum* species, it has two types of flowers, chasmogamous and cleistogamous. Chasmogamous flowers have trumpet-shaped corollas with fringed petals, 18 to 48 mm long. These chasmogamous flowers are characterized by bright yellow petals and usually are clustered

Table 1. Percent survival of *Lithospermum incisum* transplanted into four grass treatments and one blank (no vegetation) treatment.

Year ^a	Treatment ^b					
	Blank	315	BG	378	Tex	Avg
1991	100	100	100	100	95	99
1992	100	100	95	100	95	98
1993	80	80	65	75	85	77
1994	65	40	45	55	60	53
1995	20	15	30	20	30	23
1996	0	10	15	5	10	8
1997	0	5	5	0	5	3
1998	0	0	0	0	0	0

^aBlank = weed free, handweeded; 315 = buffalograss ‘315’; BG = blue grama, South Dakota source; 378 = buffalograss ‘378’ and Tex = buffalograss ‘Texoka’.

^bThe year effect was highly significant and the plot and plot × year effect nonsignificant.

Table 2. Average number of seeds per plant and average 100-seed weight (g) for ten plants harvested over eight collection dates in 2000 of *Lithospermum incisum* 'Pawnee' germplasm.

Harvest date	Avg (\pm SD) no. seed harvested/plant	100-Seed wt (g)
1 July	715 \pm 337	0.821 \pm 0.031
8 July	750 \pm 270	0.798 \pm 0.023
15 July	897 \pm 415	0.740 \pm 0.044
23 July	916 \pm 391	0.705 \pm 0.044
6 Aug.	2721 \pm 969	.635 \pm 0.058
14 Aug.	934 \pm 416	0.540 \pm 0.062
19 Aug.	410 \pm 261	0.520 \pm 0.072
1 Sept.	191 \pm 158	0.536 \pm 0.082

at the top of the leafy stem early in the season. Flowers are sessile with five stamens per flower, and the corolla and calyx are five-lobed. Cleistogamous flowers (closed and self-pollinating) have corollas up to 6 mm long with the calyx usually exceeding the corolla. Fruit of both types of flowers consists of gray/ivory/white, shiny hard nutlets \approx 3 mm long with four nutlets per flower. When mature, they detach easily from the plant and fall to the ground. It is reported that *L. incisum* plants in the northern Great Plains are often taller and have fewer basal leaves and flowers. Flowers of the northern populations are more obscured by foliage compared to plants in the southern Great Plains, which are shorter, bushier and have more basal leaves (The Great Plains Flora Association, 1986).

This species is adapted to a wide variety of soil types, but is typically found on well-drained soils. It provides little to no food value to livestock. It has potential use in ornamental, wildflower, or native plant plantings but has not been cultivated extensively because of the cleistogamous flowers and difficulty in collecting seed.

From 1991 to 1998, *L. incisum* initiated growth between 23 Mar. and 15 Apr. and began flowering between 30 Apr. and 20 May. Plants of the 'Pawnee' germplasm ranged in height from 14.5 to 22.5 cm (averaged 20.3), in width from 44.5 to 58.5 cm (averaged 51.0) and 11 to 29 (averaged 19) stems per plant in cultivated plots. Individual flowers ranged in length from 27 to 32 mm (averaged 30.0). When grown in conjunction with buffalograss, blue grama grass, or in vegetation-free (hand weeded) plots, *L. incisum* plants had about a 50% survival rate at the end of 4 years, and a few survived as long as 7 years (Table 1). During the course of the study, it did reseed with new seedlings growing throughout these plots. There were no significant statistical differences in the survival of *L. incisum* plants among treatments in the warm season grass study (Table 1).

There was a significant difference ($P < 0.01$) in seed germination between stratification treatments. Germination averaged 71% with no stratification and 33% for 6 weeks of stratification over studies replicated for two years. In addition to these study results, field observations noted that puccoon seed germinated readily after falling on the soil underneath the plant, suggesting that a seed pregermination treatment is unnecessary.

There was a significant difference between plants for seed production. Seeds produced per plant ranged from 3536 to 11,748 (averaged 7533). Seed began to mature and drop from the plant by 1 July and continued until after 1 Sept., more than a 2-month period (Table 2). But, seed production decreased significantly after mid-August. Seed weight decreased throughout the season, averaging 0.822 g/100 seeds on 1 July to 0.520 g/100 seeds on 19 Aug. for all plants.

Lithospermum incisum has potential as an ornamental landscape plant. Its bright yellow, fringed flowers, early flowering and compact growth make it an attractive plant. Harvesting seed in significant amounts is a limiting factor for the successful propagation of this plant. Our experiences demonstrated that seeds can be harvested by using a vacuum technique. The seed readily germinates without special treatment.

Availability

Seeds of the germplasm under the designation 'Pawnee', is available in limited amounts by contacting Dale T. Lindgren, University of Nebraska, West Central Research and Extension Center, 461 West University Drive, North Platte, NE 69101-7756.

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