Growth of Legume Tree Species Growing in the Southwestern United States

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Abstract

Vegetative shoot growth of eleven legume tree species growing under field conditions in the Southwestern United States in Arizona were monitored over two periods of twelve months. Species included plants native to the Southwestern United States, Mexico, South America, and Australia. Based on shoot extension and branch differentiation species could be grouped into three categories. Fast growing legumes included *Acacia farnesiana*, *A. pendula*, *Olneya tesota*, *Parkinsonia floridum*, and *Prosopis chilensis*. Intermediate growth rates were monitored for *A. jennerae*, *A. salicina*, and *A. visco*. Slow growing species in this study included *A. stenophylla*, *P. microphylla*, and *P. praecox*. No buds, flowers, or pods were observed for *P. microphylla*, *O. tesota*, and *P. chilensis* during the study. Of the remaining species those native to the Americas flowered in spring and those native to Australia flowered in fall or winter.

Introduction

Southwestern landscapes, characterized by a semiarid climate and poor soils, rely on many native and non-native legume species for shade and aesthetic value. Desirable traits of trees for desert landscapes include fast growth, drought tolerance, and resistance to biotic stresses. In addition, cultivated trees are prized for showy flowers, little or no litter, lack of spines, and an upright growth habit (Dimmitt, 1987). Of the 11 species used in this study, six are commonly planted in the northern Sonoran Desert at low and mid elevations. The other species are used in the same area to a lesser extent, although they grow well in a semi-arid climate.

Acacia species are well adapted to severe climatic conditions of the dry tropical and subtropical regions and are important sources of fodder, fuel, and timber (Aref et al., 2003). In the Southwestern United States, acacias from North and South America and from Australia are dependable landscape plants, widely used in streetscapes, medians, and as shade trees in residential and commercial landscapes. *Parkinsonia* species occur naturally in a more confined range of semiarid climates. The species documented in this study are widely planted in the low to mid elevation Sonoran Desert and are prized for their green bark and profuse yellow spring flowers. *Prosopis chilensis* is a widely planted species in semiarid climates, because of its rapid growth, lack of spines in some varieties, tolerance of poor soil conditions and no major disease and pest problems. These desirable traits have resulted in its overuse in urban landscapes. *Olneya tesota* is native to the Sonoran Desert and has the most confined area of origin of the species studied. Limitations are frost hardiness of foliage to only -7°C. This plant is considered slow growing, but plays an important role as nurse species to wildlife and other plants associated with its native habitat.

The objective of this study was to document growth periodicity of legume trees widely used and underused in landscapes of the northern Sonoran Desert.

Materials and Methods

Shoot extension and branch development of eleven tree species from four genera were studied. *Acacia farnesiana, Acacia jennerae, Acacia pendula, Acacia salicina, Acacia stenophylla, Acacia visco, Parkinsonia floridum, Parkinsonia microphylla, Parkinsonia praecox, Olneya tesota,* and *Prosopis chilensis*. Two trees of each species were growing at the University of Agriculture West Campus Farm in Tucson, Arizona (32°16'N, 110°56'W, 713 m elevation) as part of the Desert Legume germplasm collection. One of the two trees from three species died and was replaced a year or two later (Table 1).

Plants were propagated from seed that had been collected in either their native habitat or from cultivated landscape plants (Table 1). Trees were planted at an average spacing of 5.8 m centers and experienced no competition above ground. The soil type is a conglomeration. Irrigation was supplied by two drip emitters per tree and plants were irrigated regularly to avoid stress from insufficient soil moisture.

In August 2000, three secondary branches per tree were randomly selected to cover different directions, roughly 120° apart where possible. Shoot length and number of branches was measured monthly until August 2001, with the exception of December. In February 2002, four new branches were selected from each tree, approximately 90° apart and shoot length and number of branches were measured monthly until February 2003. The presence of flower buds, flowers at anthesis, and pods was noted. Deciduousness was observed and noted.

Tree height and two canopy widths were measured on three occasions, March 2002, August 2002 and February 2003. Growth index was calculated by multiplying the tree height and the two widths. The rate of increase in branches and increase in shoot extension was determined by calculating the difference between number of branches or shoot length at the end of each season and at the beginning of each season, dividing this value by the number from the beginning of the season and multiplying it by 100. Data were analyzed separately for each species. Total shoot length, number of branches, and relative growth rate over each twelve month period were calculated.

Results and Discussion

Shoot growth and differentiation

The increase in number of branches and shoot elongation varied widely by species and year. *P. chilensis*, *A. floridum*, *A. pendula*, and *A. farnesiana* had among the greatest shoot elongation and branch increases (Table 2). *O. tesota* had among the greatest increases in branch numbers for both years and a medium to high increase in shoot extension. This is surprising since this species is considered a slow grower (Jones and Scamano, 2000). Our study suggests that with sufficient irrigation *O. tesota* may grow more rapid than currently estimated.

Branch division and shoot extension of *A. salicina*, *A. jennerae*, and *A. visco* was intermediate among the species of this study and were relatively consistent during both years (Table 1). Growth rates of *P. praecox* were low the first year and three or four times greater the second year (Table 1). *P. microphylla* and *A. stenophylla* were among the slowest growing species for both years with increases in number of branches and shoot extension ranging from 40% to 150% for both years (Table 1).

The differences in shoot extension and branch number increase between the first and second year of study for each species is likely related to several factors. Genetic growth patterns of individual trees are affected by environmental effects such as air and soil temperature, soil conditions, and water availability. Branch

selection at the beginning of each study season most likely affected some of the results. The decrease in new branches and branch elongation of *A. farnesiana* during the second year is partially caused by the fact that the large canopies of these trees started to grow into each other and caused significant shading.

Branch numbers of most species started to increase in March with significant increases throughout June, and small to no increases for the remainder of the year (Fig. 1). Significant increases in shoot extension were measured from April to June, while some species (*A. farnesiana* and *A. jennerae*) had a distinct second flush of growth during the summer months (Fig. 1). Most acacias ceased new branch differentiation and shoot elongation from August until March or April. Branch differentiation of *P. chilensis* was confined to the short period of April to May in 2001, but lasted from April to July in 2002.

Shoot elongation peaked from April to July for all acacias (Fig. 1). *A. visco* showed greatest increases in shoot elongation from April to May and from June to July. The most rapid increase in cumulative branch length was found for *A. jennerae* in May 2002 (Fig. 1) and *P. chilensis* in June 2002. The rapid increase in shoot elongation of *A. salicina* during the primary growing season and the small increases in branch numbers from October to November 2002 and moderate shoot elongation from December to January when most other species did not grow, indicate that this species is adapted to grow at a wider range of temperatures, both high and low, compared to the other acacias in this study.

The life spans of many of these species are not well documented. Estimates of life spans can be inferred from anecdotal information. *A. farnesiana*, *A. jennerae*, *A. pendula* and *A. stenophylla* can live 25-50 years. *A. salicina* is estimated to live 10-15 years and the life span of *A. visco* is not known. *Parkinsonia florida* can live 60 years. The life span of *P. microphylla* and *P. praecox* is not known. *Prosopis chilensis* lives 15-20 years and the longest lived species in our study *Olneya tesota* lives 500 years. (M. B. Johnson, personal communication)

Phenolgy

No buds, flowers, or pods were observed for *P. microphylla*, *O. tesota*, and *P. chilensis* during the study. Flowers were noted in *A. farnesiana* in April of 2001 and 2002, but pods were only observed from May to July 2002. Flower buds and flowers were recorded for *A. visco* in April and May, respectively for both years. Pods remained on the tree from July throughout the winter and contributed to the ornamental value of this species, especially when the foliage had abscised. Flower buds on *A. jennerae* were noted in late summer and fall, September to November 2001 and June to October in 2002. Flowers, however, were only seen in November and December 2002, with pods apparent from April to July 2001 and May 2002. *A. jennerae* appears to have a prolonged period of flower bud formation and flowering. *A. stenophylla* and *A. salicina* have comparably extended flowering times, with *A. salicina* flowers noted during the months of October to January, and *A. stenophylla* flowers observed in October and January during the first season, and June, August, and December during the second study season. Pods for both species appeared from late spring to early summer (April to July). Reproductive activity in *A. pendula* was only observed once in August 2002 when flower buds were observed, however, neither flowers nor pods were noted on the plants. *P. praecox* and *P. floridum* have a short, well defined flowering season in mid spring. The trees flowered in April of both years and pods were observed on *P. floridum* in May of the first season, and for both species from May to July the second season.

Because measurements were only taken once a month, data on flower buds is often missing, especially when flower bud development was synchronized over a short period of time, such as for the Parkinsonia species, which generally flower over a two-week period (Bowers and Dimmitt, 1994). Flower buds of the species studied are often very small and sometimes developed only in the upper part of the canopy above 2.5 m where they could not be observed due to their small size. Some of the plants studied have very dense canopies and therefore buds or flowers may have been hidden.

Literature Cited

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Table 1. General information of species monitored at two intervals from 2000 to 2003.

Species	Planting date	Seed Origin	Native	Trunk	Decidu-ousness	Growth index 2002	% GI increase by 2003
Acacia farnesiana	9/1998	San Luis Potosi, Mexico	North and South America	Multi	Deciduous	113	11
Acacia jennerae	10/1998	Australia	Australia	Multi, single	Evergreen	58	25
Acacia pendula	10/1998 and 4/1999	Australia	Australia	Single	Evergreen	14.5 3.1	98 166
Acacia salicina	9/1998	New South Wales, Australia	Australia	Single	Evergreen	39	37
Acacia stenophylla	10/1998	Tucson, Arizona, USA	Australia	Single	Evergreen	47	45
Acacia visco	10/1998 and 4/1999	La Rioja, Argentina	South America	Single	Deciduous	57	38
Olneya tesota	9/1998	Tucson, Arizona, USA	Sonoran desert	Multi	Deciduous	3.3	80
Parkinsonia floridum	10/1998	Tucson, Arizona, USA	SW United States, Mexico	Multi	Deciduous	20	61
Parkinsonia microphylla	10/1998	Superior, Arizona, USA	SW United States, Mexico	Single	Deciduous	2.9	188
Parkinsonia praecox	10/1998	Sonora, Mexico	Argentina	Single	Deciduous	35	98
Prosopis chilensis	9/1998 and 3/2000	Catamarca, Argentina	Chile, Peru, Argentina,	Single	Semi-deciduous	34	146

Growth index was calculated by multiplying plant height and two canopy diameter measurements.

Table 2. Increase in branch numbers and shoot extension of legume species over two growing seasons.

| Species	Branch number increase (%)		Shoot extension increase (%)	
	2001-2002	2002-2003	2001-2002	2002-2003
Acacia farnesiana	344	129	723	160
Acacia jennerae	304	270	255	252
Acacia pendula	505	161	659	279
Acacia salicina	296	334	283	527
Acacia stenophylla	95	152	87	110
Acacia visco	362	360	215	104
Olneya tesota	750	365	394	528
Parkinsonia floridum	547	375	667	439
Parkinsonia microphylla	43	102	42	89
Parkinsonia praecox	80	425	127	474
Prosopis chilensis	606	99	1119	444
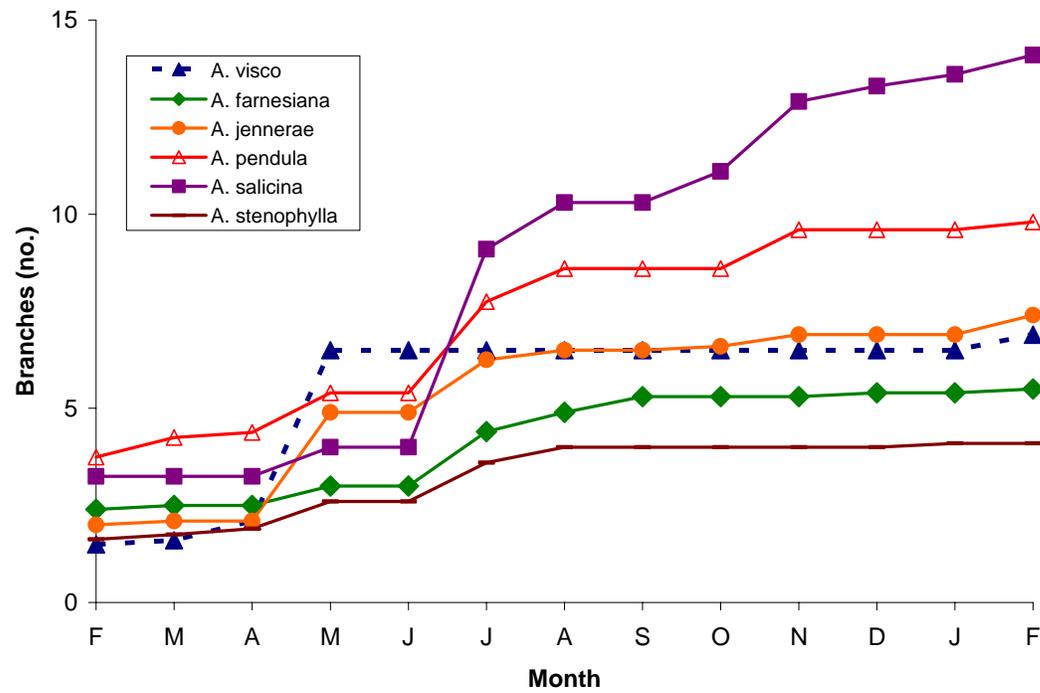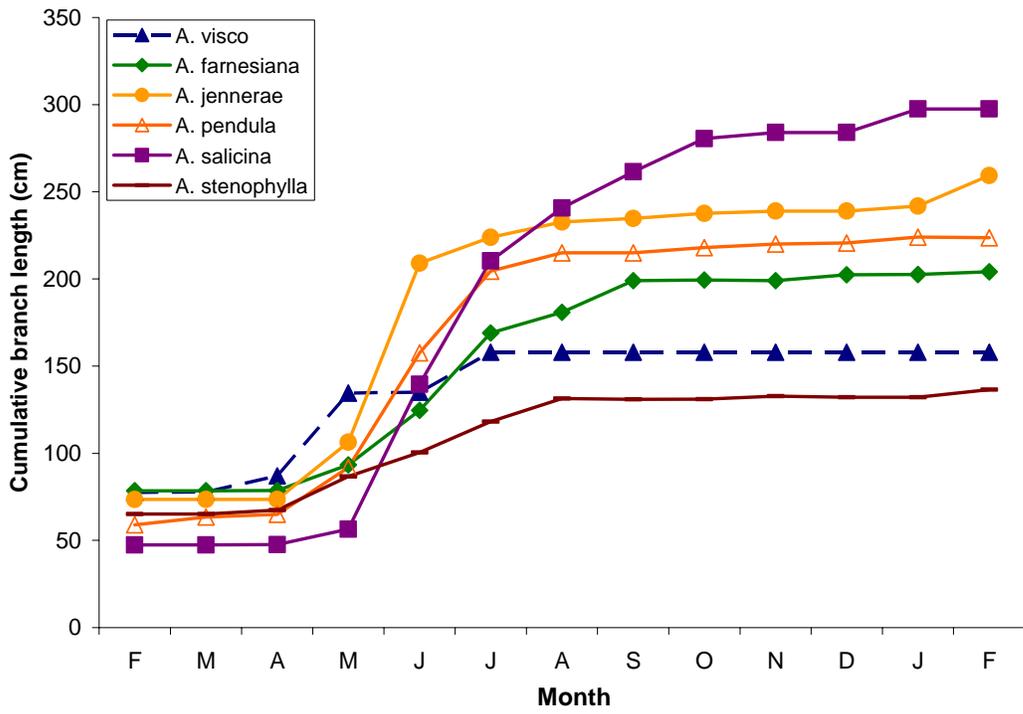
Fig. 1. Cumulative branch length and number of branches of acacias during the 2002/03 growing season.